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April 30, 2016

Mr. Todd Gmitro (DE-9J)
U.S. EPA Region 5 Remediation and Reuse Branch
Corrective Action Section 1
77 West Jackson Boulevard
Chicago, IL 60664-3590

Re: Response to Comments: Baseline Ecological Risk Assessment and Data Summary Report
RCRA 3008(h) Order
BASF Corporation, 471 Howard Avenue, Holland, MI

Dear Mr. Gmitro:

AECOM Technology Services (AECOM) hereby submits the following documents to the U.S. Environmental Protection Agency (U.S. EPA) on behalf of BASF Corporation (BASF):

1) *Response to EPA's March 11, 2016 comments on the November 2015 Baseline Ecological Risk Assessment and Data Summary Report for the former BASF facility at 471 Howard Avenue in Holland, MI.*
2) *Revised Baseline Ecological Risk Assessment and Data Summary Report, and*
3) *Lake Macatawa Corrective Measures Implementation Work Plan Addendum.*

BASF has reviewed U.S. EPA's March 11, 2016 comments on the Ecological Risk Assessment and Data Summary Report and has revised this report to reflect U.S. EPA's comments, which focus primarily on the interpretation of site-specific sediment toxicity testing data and their relationship to barium concentrations in sediment. In particular, BASF understands and appreciates the U.S. EPA's position that sub-lethal (growth), as well as lethal (mortality) impacts warrant additional consideration in the risk assessment, and the document has been revised to include additional discussion of these data.

As detailed in the risk assessment, multiple lines of evidence were reviewed in order to develop barium effects concentrations that are protective of benthic ecological receptors. For three of the four toxicological endpoints evaluated in the risk assessment (midge survival, amphipod survival, amphipod growth), the revised risk assessment determined that a barium concentration of approximately 6,400 milligrams per kilogram (mg/Kg) is protective of benthic receptors. However, for one toxicological endpoint (midge growth), the risk assessment suggests that a lower barium concentration (approximately 1,300 mg/Kg) would be protective. The revised risk assessment explores uncertainties associated with each of these values and characterizes potential risks to benthic receptors using a preponderance of evidence approach. As discussed in the accompanying Response to Comments package, BASF does not believe that the endpoint of midge growth should be the basis upon which PRGs are established. There is considerable uncertainty that the observed growth impacts are entirely due to barium, and the observed growth, with the exception of one sampling location (SD-30), is, at worst, approximately 70% of the laboratory control and 60% of reference location SD-45.

We have developed the Lake Macatawa Corrective Measures Implementation Work Plan Addendum based on the preponderance of evidence from the ecological risk assessment and our understanding of precedent at other potentially impacted sites on Lake Macatawa, including the Former Warner-Lambert Facility RCRA site located on Lake Macatawa approximately 3,500 feet upstream of the BASF site (also known as the Pfizer site). In the Pfizer sediment toxicity testing effort, a moderate toxic response (i.e., statistically significant difference and 20% reduction relative to the reference site) was observed for the midge growth endpoint in two samples. Pfizer concluded, and MDEQ agreed, that these growth reductions were ecologically insignificant relative to other stressors in the system (e.g., eutrophication and physical habitat alterations). This finding is consistent with the Lake Macatawa TMDL work of MDEQ, which indicates that Lake Macatawa exhibits symptoms of a hypereutrophic lake including high nutrient levels, periodic algal blooms, excessive turbidity, and a high rate of sediment deposition (all factors which could potentially impact the benthic community in the lake).

Given the similar characteristics of sediment at the BASF and Pfizer sites, BASF has prepared the work plan addendum to address Lake Macatawa sediments near the former Howard Avenue facility in a consistent manner with this earlier decision. The work plan describes the response actions that BASF is prepared to undertake to address sediment with barium concentrations in excess of 6,400 mg/Kg to achieve risk-based site closure.

Thank you for your attention to this matter. If any further questions arise, please do not hesitate to contact Mr. Doug Reid-Green at BASF (908-507-8820) or Mr. Randy Ellis at AECOM (269-267-2868)

Sincerely,

Randy Ellis
Sr. Project Manager

John A. Bleiler
Program Manager

Cc: Mr. Doug Reid-Green, BASF
Ms. Nancy Martin, BASF

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Responses to March 11, 2016 U.S. EPA Comments
Baseline Ecological Risk Assessment and Data Summary Report (dated November 18, 2015)
Former BASF facility
471 Howard Avenue
Holland, MI

GENERAL COMMENTS

General Comment 1.

1. EPA does not concur that the data supports the BERA conclusion that risk is limited to the area surrounding sediment sample location SD-30. While we do agree that no meaningful effects on benthic invertebrate survival were observed at any other sample locations, it is also important to consider growth effects as well as data gaps. The following are key areas of concern in the BERA.

(a) The barium concentration threshold for *Chironomus* survival effects cannot be determined based on the available toxicity test data. The highest barium concentration at which no or negligible effects on *Chironomus dilutus* survival were observed is 2,705 milligrams per kilogram (mg/kg), and the lowest barium concentration at which survival effects were observed is 15,300 mg/kg. No concentrations intermediate between these two were included in the toxicity tests and, thus, the threshold for survival effects in the range of concentrations between these two values (2,705 mg/kg and 15,300 mg/kg) is uncertain. Considering the magnitude of effect (i.e., 22.5% survival) at the 15,300 mg/kg concentration, it is likely that the threshold for survival effects would occur at considerably lower concentrations.

(b) Observed impacts on sub-lethal endpoints need further consideration. First, based on organic carbon content and grain size analysis of the site and reference samples, reference location SD-45 is most representative of site conditions. The other two reference locations (SD-46 and LMW08-13) are substantially different from all site locations except SD-25 (Tables 2-3 and 2-7). Consequently, EPA recommends that SD-45 be used alone to evaluate relative magnitude of effects (rather than the 'pooled reference' that is currently used). Because *Chironomus* survival and growth were generally higher in SD-45 than in one or both of the other two reference locations, this revision will tend to increase the effects percentages reported in Table 5-3.

Nonetheless, even when using the pooled reference data (Table 5-3), available data indicate that growth effects on *Chironomus dilutus* begin to occur at barium concentrations much lower than 15,300 mg/kg. In comparison to the pooled reference, mean ash—free dry weight and biomass were both reduced by more than 20 percent at locations SD~32, SD-39, SD-40, and SD~50, where barium concentrations ranged from 961 mg/kg to 2,705 mg/kg. The reduced growth at each of these locations was found to be statistically significant. In contrast, barium concentrations at locations where no growth effects were observed ranged from 140 mg/kg to 1,180 mg/kg. These data suggest that a threshold for growth effects occurs in the barium concentration range of roughly 900 mg/kg to 1,200 mg/kg. Variability in the level of effect within this concentration range is expected, considering the nature of sediment toxicity testing and the presence of multiple stressors.

For these reasons, EPA does not agree with the BERA's conclusions that growth effects related to barium are limited to location SD-30. See Comment 5 regarding the correlation between barium concentrations and observed toxicity, and Comment 9 regarding remediation goals.

(c) The extent of sediment toxicity has not yet been fully delineated in Lake Macatawa, because locations with intermediate barium concentrations (e.g., SD-31 and SD-53) were not included in the toxicity testing. The August 2015 data set includes two locations where relatively high barium

concentrations were detected (i.e., 9,490 mg/kg at SD-53 and 10,700 mg/kg at SD-31), but where toxicity tests were not conducted. Although there in uncertainty regarding risks to benthic invertebrates at these locations, the analysis above indicates the available Chironomus data demonstrate an upper range for a likely growth effects threshold at a barium concentration of 1,200 mg/kg. This suggests that growth effects are likely given the findings of no effect on survival at a concentration of 2,705 mg/kg and 22.5 percent survival at 15,300 mg/kg (Table 5-3).

Recommendations: (Section 8.0) proposes remedial action only in the vicinity of SD-30; however, available data are insufficient to demonstrate that this proposed approach will be adequately protective of benthic invertebrates.

Response

BASF understands and appreciates the U.S. EPA's position that sub-lethal (growth), as well as lethal (mortality), impacts warrant additional consideration in the risk assessment, and the document has been revised to include additional discussion of these sub-lethal data.

(a) The draft BERA recognized that the toxicity test samples (midge and amphipod) did not include concentrations of barium between 2,705 and 15,300 milligrams per kilogram (mg/Kg). The discussion relative to this concentration gap has been expanded in the Final BERA to include: (1) additional discussion of the uncertainties associated with the barium concentration data gap, and (2) estimates of threshold effects determined using the lethal and sub-lethal data and conventional toxicological analyses (e.g., MATC [maximum acceptable toxicant concentration] values, which were calculated as the geometric mean of NOECs and LOECs for both lethal and sub-lethal effects for both species of invertebrate tested in the sediment toxicity testing program).

(b) As detailed in the risk assessment, multiple lines of evidence were reviewed to develop barium effects concentrations that are protective of benthic ecological receptors. For three of the four toxicological endpoints evaluated in the risk assessment (midge survival, amphipod survival, amphipod growth), the revised risk assessment determined that a barium concentration of approximately 6,400 milligrams per kilogram (mg/Kg) is protective of benthic receptors. However, for one toxicological endpoint evaluated in the risk assessment (midge growth), a lower barium effects concentration (1,300 mg/Kg) was identified. Based on this finding, U.S. EPA is in Comment 9 (referenced in this General Comment) recommending a remedial goal of 1,000 mg/kg.

BASF understands the U.S. EPA analysis, but does not believe the midge growth endpoint deserves the same weight of consideration as the other three endpoints. There is substantial uncertainty associated with the cause of the reduction in midge growth, and, although there was a reduction in growth that was greater than 20% when compared to the laboratory controls and reference locations, with the exception of SD-30, the growth in the most impaired sample was approximately 70% when compared to the laboratory reference and 60% when compared to SD-45.

The regression analyses presented in the risk assessment indicate that only 45 to 55 percent of the variability in midge growth could be explained by barium in sediment. This suggests that other stressors may be playing a role in the midge growth impacts. It also suggests that the reduction in growth associated with barium alone would be substantively less than the reductions observed in the toxicity tests, which presumably included other non-site stressors.

The finding that stressors other than barium are responsible to the reduction in growth is consistent with the description of Lake Macatawa presented in the MDEQ Total Maximum Daily Load (TMDL) for phosphorous in the lake, which indicated that Lake Macatawa exhibits symptoms of a hypereutrophic lake including high nutrient levels, periodic algal blooms, excessive turbidity, and a high rate of sediment deposition (all factors which could potentially impact the benthic community in the lake). A recent evaluation of *Hyalella* and *Chironomus* toxicity results from seven metropolitan areas in the U.S. reported similar results, although in their case the amphipod was more sensitive than the midge. In this study (Kemble et al. 2013), the correlations between priority pollutants and toxicity were weak, and the authors suggested that in urbanized settings residential pesticides (e.g., pyrethroid pesticide bifenthrin) may be a stressor of concern. Given the setting of the Lake Macatawa watershed, and observations by MDEQ relative to the overall health and eutrophication of the lake, it is probable that, unlike the other three endpoints, chemicals or stressors other than barium substantively contributed to the midge sub-lethal toxicity results.

Based on the weight of evidence from the ecological risk assessment (i.e., 3 of 4 endpoints evaluated align consistently with a 6,400 mg/Kg barium effects level) and in consideration of the uncertainty with the sub-lethal midge data (which are only partially explained by barium), a preliminary remedial goal of 6,400 mg/Kg barium is recommended for the Holland site.

In response to U.S. EPA's comment that SD-45 is "most representative of site conditions" and therefore should "be used alone to evaluate relative magnitude of risks", the BERA has been revised to include an evaluation of the Site results relative to the laboratory control, sampling location SD-45, and the current pooled reference condition evaluation . MATCs were developed solely using SD-45 to represent the reference condition.

Lastly, the revised BERA has been updated to further clarify the significance of the sub-lethal endpoints generated in the laboratory toxicity testing program. Although two sub-lethal endpoints were reported for both species (biomass and growth, as ash free dry weight [AFDW]), U.S. EPA guidance (*Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates*; Section 2.3) states that biomass is not a primary endpoint in the test methods, whereas growth (as AFDW) is listed as a primary endpoint. Therefore, while the BERA has been revised to include an evaluation of both sub-lethal endpoints, AFDW is the focus of the concentration/response analysis used to establish the potential for sub-lethal barium risk to benthic receptors.

(c) BASF acknowledges the uncertainty associated with the lack of toxicity testing data from locations with intermediate barium concentrations (e.g., SD-31 and SD-53). The data evaluation presented in the revised BERA was conducted using NOECs, LOECs, and MATCs and is designed to help bridge these data gaps. The revised risk assessment acknowledges that areas outside SD-30 may exhibit sub-lethal toxicity (AFDW) reductions). In order to address the potential for benthic risks associated with exposure to barium in sediment, the draft risk assessment proposed remedial action in the vicinity of one sampling station (SD-30). To address U.S. EPA's comment, the revised risk assessment does not include remedial recommendations, but rather presents a characterization of potential risks to benthic receptors. A Corrective Measures Implementation Work Plan Addendum has been prepared to accompany the revised risk assessment and outline the proposed response action, which includes substantial sediment removal (e.g., well beyond sampling station SD-30).

SPECIFIC COMMENTS

Section 2.2.2.1 Inorganic compounds in surface sediment

2. There are a number of inconsistencies between the text of this section and the data presented in Table 2-4. For example, the majority of arsenic concentrations were reported between 7 and 9 mg/kg, slightly higher than suggested in the text. Nine locations reported barium concentrations greater than 1,000 mg/kg. Contrary to the text, only four of the chromium concentrations were reported within the 50-100 mg/kg range. In fact, the chromium concentrations were evenly split between those greater than and less than 100 mg/kg. Review data and conclusions presented in the text and table for accuracy and consistency with the chemical analysis deliverable from the laboratory, and make all necessary corrections to the report.

Response

Section 2.2.2.1 of the revised report has been updated to include:

- The range of arsenic concentrations between 7 and 9 mg/Kg;
- An acknowledgement of the nine locations with barium concentrations greater than 1,000 mg/Kg; and,
- An acknowledgement that chromium concentrations were evenly split between those greater than and less than 100 mg/Kg.

Section 2.2.2.2, Inorganic Compounds in Sub-Surface Sediment, pages 2-4 and 2-5

3. The second paragraph in this section indicated that subsurface concentrations of barium were slightly higher in the 0.5-1 foot (shallowest) interval than in the 8-10 foot (deepest) interval at sampling locations SD-30. To accurately reflect conditions in this location, the text should be revised to note that the barium concentration in the shallowest interval (19,800 mg/kg) is three orders of magnitude higher than that reported in the deepest interval. It is also unclear why this section discusses vertical metals distribution in only half of the subsurface sampling locations. Clarify why the referenced locations and concentration patterns are of particular interest to this investigation, or expand the text to provide specific detail on the vertical contaminant distribution at locations SD-28, SD-36, and SD-50.

Response

Section 2.2.2.2 has been updated to include the following revisions:

- The statement regarding barium in SD-30 has been revised to state that the concentration in the 0.5-1 ft sampling interval is three orders of magnitude higher than that reported in the deepest interval;
- A discussion of the ranges of concentrations measured in samples SD-28, SD-36, and SD-50 has been added. The barium concentration trends in these samples are consistent with the other samples reported in the BERA: concentrations decrease markedly with depth, indicating that vertical nature and extent delineation has been achieved.

Section 5.2, Sediment Bioassays, page 5-2

4. In the first paragraph on page 5-2, BASF indicates that the only growth reductions for *Chironomus dilutus* were at location SD-30. However, growth effects (statistically significant and greater than 20% reduction) were also observed at locations SD-32, SD-39, SD-40, and SD-50 (Tables 2-10 and 5-3). Similarly, the text in the fourth bullet toward the end of this section states, “Compared to the pooled reference, growth ranged from 83 to 132%...” but the range reported in Table 5-3 is 63 to 87 percent. Please revise this text to correct these discrepancies between the text and tables. This comment is also applicable to text in Sections 6.1, 6.3 and 7.0. "

Response

As presented in Tables 2-10 and 5-3, sampling location SD-30 is the only location with statistically significant and 20% reduced survival compared to the pooled reference samples. This section has been edited to reflect this finding and also includes an evaluation of site data relative to the individual reference sample (SD-45). Further, the text has been revised to acknowledge that reductions in growth relative to the pooled reference were observed with the midge sub-lethal data (but not the amphipod), when compared to the pooled reference; growth (AFDW) at sampling locations SD-30, SD-32, SD-39, SD-40, and SD-50 are statistically different and exhibited greater than 20% reduction relative to the pooled reference.

Section 5.2 has been revised to include:

- A more robust discussion of sub-lethal growth effects is included in the text. This discussion provides additional clarification that statistical evaluations of site date were conducted relative to both the laboratory controls and the field reference data. In addition, per comments from U.S. EPA (part b of General Comment 1), an evaluation of site data relative to the individual reference sample (SD-45) as well as the pooled reference has been included in the tables and the text.
- The fourth bullet has been revised to “Compared to the pooled reference, growth ranged from 36 to 87%...” Further, text will has been added discussing the comparison to the individual reference sample SD-45.
- These changes have been made throughout the document, as appropriate (e.g., text in Sections 6.1, 6.3, and 7.0 have been updated accordingly).

Section 5.3, Benthic Toxicity Interpretation, pages 5-3 to 5-4

5. The available data do not support the conclusion in the last paragraph of this section that “the slightly reduced ...biomass in the other samples [besides SD-30] is not linked to barium.” This BERA statement is based on regression analysis that removed sample SD-30 from the dataset. Removal of the sample with the strongest effects should be expected to reduce the strength of the relationship; this does not mean there is no relationship. Rather, it is important to consider the following: at the lowest barium concentrations tested (i.e., the 140 to 750 mg/kg range), no significant effects on biomass were observed; at an intermediate range of barium concentrations (961 to 1180 mg/kg) effects were variable; and at higher barium concentrations (1,500 to 15,300 mg/kg) significant effects were consistently observed.

It is not appropriate to remove sample SD-30 from the regression analysis, because higher levels of response must be included in the analysis to effectively characterize a dose-response relationship. However, it is notable that, even when sample SD-30 is removed from the dataset, the p-value for the

regression between barium and biomass (p = 0.013 as reported by BASF) still confirms that this correlation is statistically significant. The BERA text in this section and in Section 7.0 Summary and Conclusions should be revised in accordance with this comment.

Response

BASF respectfully disagrees with U.S. EPA that removal of SD-30 from the regression analysis is inappropriate. Rather, running the analysis twice, once with this data point included and once with removal of this outlying concentration of barium (15,300 mg/Kg) provides insight into the potential effects of barium at lower barium concentrations, and helps in the evaluation of concentration/response. U.S EPA suggests that effects on biomass were present at concentrations as low as 1,500 mg/Kg and were variable between 961 and 1,180 mg/Kg. If barium were responsible for the toxicological responses, one would expect to see a relationship in either analysis (with and without sampling station SD-30). However, while the regression conducted with removal of sampling location SD-30 was significant (p = 0.013), it is important to note that the coefficient (R^2) was only 0.47. This indicates that less than half the variability in the biomass data can be attributed to barium. For this reason, BASF believes that barium is not strongly linked to reduction in biomass at lower concentrations. This has been clarified in the text and in the uncertainty analysis. The regression analyses for midge growth and biomass relative to barium concentrations have been added to the BERA.

Section 6.1, Uncertainties Associated with Sediment Toxicity Tests, pages 6-l to 6-2

6. This section should include discussion of the barium concentration gap in the dataset (i.e., no toxicity tests were conducted at barium concentrations between 2,705 and 15,300 mg/kg). This is a key uncertainty in this BERA, since the toxicity test results indicate that barium thresholds for the survival endpoints in the site sediments appear to lie within this range.

Response

A discussion of the range of barium concentrations has been added to Section 6.1 as a source of uncertainty for the sediment toxicity tests.

Section 7.0, BERA Summary and Conclusions, pages 7-1 to 7-2

7. This section should be revised in consideration of the issues raised in the comments above.

Response

Section 7.0 has been revised and clarified to be consistent with the comments raised by the U.S. EPA and the responses detailed in this letter.

Section 8.0, Recommendations, page 8-1

8. This section recommends a response action to address sediment in the vicinity of sampling location SD-30. As noted in General Comment 1, available data are insufficient to demonstrate that this proposed approach will be adequately protective, particularly considering the high detected concentrations of barium at SD-31 and SD-53. Recommendations for remediation areas should be

reconsidered once agreement is reached on BERA conclusions regarding which locations are found to present unacceptable risks.

Response

Please see response to General Comment 1.

9. The BERA dismisses the growth effects (22 to 37 percent reductions in comparison to the pooled reference) observed at several sample locations, despite the BERA's use of 20 percent as the threshold for a biologically significant reduction. We concur that a 20 percent threshold is protective and are familiar with precedents for its use. For example, the state of Washington has recently promulgated cleanup standards that require remediation if *Chironomus* growth is more than 20 to 30 percent reduced in comparison to control sediments. The 2015 dataset likely includes sufficient data to define a dose-response relationship between barium and *Chironomus* growth effects, and would allow for computation of a barium remediation goal at a given effect level.

EPA advises using chronic sediment toxicity tests (EPA 600/R-99/064 March 2000). However, acute test are acceptable provided toxicity is clearly demonstrated. The acute test does not measure adverse reproductive effects (more sensitive than survival or growth indicators).

When adverse effects are widely bracketed, a geometric mean has been used to support ecological risk management. For the survival and growth indicators, EPA would recommend the following remediation goals for Barium: 6,433 mg/kg (geometric mean of 2,705 and 15,300 mg/kg) for survival and 1,039 mg/kg (geometric mean of 900 and 1200 mg/kg) for growth. If a chronic test were to be conducted, the remediation goal for survival would be expected to be lower than that for growth. Therefore, EPA believes that a Barium remediation goal of 1000 mg/kg would be sufficiently conservative for this site.

Response

See response to General Comment 1. As discussed, BASF does not believe that the endpoint of midge growth should be the basis upon which PRGs are established. There is considerable uncertainty that the observed growth impacts are entirely due to barium, and the observed growth, with the exception of SD-30, is, at worst, approximately 70% of the laboratory control and 60% of location SD-45.

The BERA has been revised to consider sub-lethal endpoint reductions compared to the pooled reference samples, individual reference sample SD-45, and the laboratory control.

BASF agrees that the 2015 dataset includes sufficient data to define a dose-response relationship between barium and growth in the midge. However, as discussed in the response to General Comment 1, there is uncertainty as to whether the growth effects that are observed are entirely the result of exposure to barium. BASF also agrees with U.S. EPA that a geometric mean of NOEC and LOEC for the appropriate endpoints (i.e., a MATC) can be used to support the ecological risk management process.

In the revised risk assessment, MATCs were calculated for reductions compared to SD-45 and the laboratory control. These MATCs take into account survival and growth endpoints for the most sensitive organism (the midge) and are based on an ecological relevance rule of greater than 20% reduction. Similar calculations were conducted for the amphipod.

In addition to MATCs, NOECs and LOECs derived for each midge and amphipod endpoint are also presented in the revised assessment. The NOECs are based on the highest concentration at which no effects were observed based on the 20% reduction relative to reference/control. The LOEC is the lowest concentration greater than the NOEC at which effects were observed.

Based on the primary endpoints for these tests and evaluating site data relative reference sample SD-45 (as requested by U.S. EPA), the following MATCs were generated:

- **Midge**: the MATC for growth is 1,330 mg/Kg barium and the MATC for survival is 6,433 mg/Kg.
- **Amphipod**: the MATC for growth is 6,433 mg/Kg barium and the MATC for survival is 15,300 mg/Kg.

In order to define barium effects concentrations for risk management consideration, the BERA uses a weight of evidence approach, consideration of the uncertainties associated with the midge sub-lethal data (which are only partially explained by barium in sediment), as well as consideration of precedent from another Lake Macatawa site in the immediate vicinity of the former BASF site (the Former Warner-Lambert Facility RCRA site located on Lake Macatawa approximately 3,500 feet upstream of the BASF site [also known as the “Pfizer” site]).

Using a weight of evidence approach that considers each endpoint for midge and amphipod is generally consistent with the findings of the Pfizer 2009 Sediment Assessment Report (Pfizer, Inc., 2009) in which a moderate toxic response was observed for the *Hyalella* growth endpoint in two samples (i.e., statistically significant difference and 20% reduction relative to the reference site). In the Pfizer (2009) report, it was stated that these growth reductions were not ecologically significant relative to other stressors in the system (e.g., eutrophication and physical habitat alterations). The MDEQ (2010) concluded that the results of the toxicity testing indicated that none of the samples exhibited a biologically significant response to three endpoints.

At the BASF site, the findings based on the midge survival endpoints correlate strongly and significantly with the elevated barium concentrations in sediment ($R^2 = 0.83$, $p = 0.000$), and a benthic invertebrate preliminary remedial goal has been developed based on the geometric mean of the NOEC and LOEC of the available data (e.g., approximately 6,400 mg/Kg represents the survival MATC for the midge).

In contrast to the survival data, there is considerable uncertainty with the sub-lethal data and the barium concentration response. One of two species tested (amphipod) exhibited little to no growth impacts except at the highest concentration measured (15,300 mg/Kg), and the second species tested (midge) exhibited sub-lethal impacts that are slightly higher but generally comparable to the Pfizer study growth results. In addition, AFDW results did not correlate strongly with barium concentrations ($R^2 = 0.55$), although this relationship was statistically significant ($p = 0.003$). This suggests that the growth endpoint results are not solely explained by barium concentration and indicate that other stressors in the system (such as eutrophication or physical habitat alterations) may contribute to the observed sub-lethal endpoint reductions.

Therefore, it is recommended that remedial goals for the former BASF site be based on the geometric mean of midge survival NOEC and LOEC, which is also protective of amphipod growth and survival (i.e., approximately 6,400 mg/Kg barium is recommended as the Preliminary Remedial Goal for surficial sediments at this Site).

References:

MDEQ, 2010. Letter from Cheryl Howe (Environmental Engineering Scientist, MDEQ) to Mr. Brett Gampper (Site Remediation and Due Diligence, Pfizer, Inc.): RE: Final Sediment Assessment Report (Report); Warner-Lambert Company, LLC, Plant Site Property, Holland, Michigan; MID 006 013 643. March 17, 2010.

Pfizer Inc. 2009. Final Sediment Assessment Report, Warner-Lambert Company LLC, Plant Site Property, 188 Howard Avenue, Holland, Michigan (MID 006 013 643). December 2009.

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April 2016

Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report

Former BASF Corporation
Howard Avenue Facility
Holland, Michigan

AECOM

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April 2016

Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report

Former BASF Corporation
Howard Avenue Facility
Holland, Michigan

Prepared By Kristen Durocher

Reviewed By John Bleiler

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List of Acronyms and Abbreviations

µg/Kg	Micrograms per Kilogram
µmol/g_{oc}	Micromoles per Gram Organic Carbon
ACO	Administrative Consent Order
AFDW	Ash Free Dry Weight
ANOVA	Analysis of Variance
ASTM	American Society for Testing and Materials
AVS	Acid Volatile Sulfide
BERA	Baseline Ecological Risk Assessment
BSAF	Biota-Sediment Accumulation Factor
bts	Below Top of Sediment
COPC	Constituents of Potential Concern
CSM	Conceptual Site Model
ESLs	Ecological Screening Levels
FD/RC	Final Decision and Response to Comments
f_{oc}	Fraction Organic Carbon
ft	feet
LC50	Lethal Concentration to 50% of Organisms
MATC	Maximum Acceptable Toxicant Concentration
mg/Kg	Milligrams per Kilogram
mg/L	Milligrams per Liter
MDEQ	Michigan Department of Environmental Quality
NPDES	National Pollutant Discharge Elimination System
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
PRG	Preliminary Remedial Goal
RCRA	Resource Conservation and Recovery Act
RG	Remedial Goal
SEM/AVS	Simultaneously Extracted Metals/Acid-Volatile Sulfides
SLERA	Screening Level Ecological Risk Assessment
SOP	Standard Operating Procedure
SOW	Scope of Work
TOC	Total Organic Carbon
TRV	Toxicity Reference Value
USEPA	United States Environmental Protection Agency
UCL	Upper Confidence Limit
VOCs	Volatile Organic Compounds
WHO	World Health Organization

1.0 Introduction

AECOM Technology Services (AECOM) has prepared this Data Summary Report and Baseline Ecological Risk Assessment (BERA) on behalf of the BASF Corporation (BASF) to evaluate the potential for risks to ecological receptors exposed to sediments in Lake Macatawa near the Former BASF Howard Avenue Facility (the "Site") in Holland, Michigan. BASF is currently conducting an environmental evaluation of the Site in accordance with an Administrative Consent Order (ACO) between BASF and the USEPA effective January 8, 1999.

This BERA has been prepared in accordance with federal and state ERA guidance (Michigan Department of Environmental Quality (MDEQ), 2006; United States Environmental Protection Agency (USEPA), 1997; USEPA, 1998; USEPA, 2001), including (USEPA Region 5 guidance for ecological risk assessments (http://www.epa.gov/region5/superfund/ecology/). The primary objective of the BERA is to evaluate if constituents of potential concern (COPCs) that are attributable to past Site operations have the potential to cause unacceptable adverse risk to ecological receptors exposed to Lake Macatawa sediments adjacent to the Site.

In addition to the BERA, this report provides a summary of Lake Macatawa data collected by BASF in the summer of 2015. **Figure 1-1** depicts the Site and Lake Macatawa, a five mile long freshwater body that forms at the junction of the Macatawa River with Lake Michigan.

This BERA report was originally submitted to the USEPA as a draft report on November 18, 2015. USEPA comments on the draft report were received on March 11, 2016, and this report has been revised and finalized in response to these comments.

1.1 Site Background

The BASF Holland Site, including Lake Macatawa, has been under investigation as part of a Resource Conservation and Recovery Act (RCRA) Corrective Action program for much of the past decade. In August 2009, USEPA issued a Final Decision and Response to Comments (FD/RC) for the selection of Remedial Alternative for BASF Facility, Holland, Michigan (USEPA, 2009) requiring BASF to draft a Work Plan identifying an approach to assess sediment quality in Lake Macatawa. The USEPA Final Decision indicated that BASF should develop a scope of work "to delineate the nature and extent of sediment contamination and to conduct site specific toxicity testing to determine whether potential risks exist to aquatic habitat and biota." BASF submitted a Sediment Sampling Work Plan to USEPA in April 2010, followed by a revised work plan in September 2010 (AECOM, 2010). The revised work plan was approved by USEPA on October 19, 2010. Subsequent to Work Plan approval, surficial and sub-surficial sediment samples were collected from Lake Macatawa adjacent to the Site (**Figure 1-2**) and at nearby reference areas in July 2011. The results of this program were reported in the *Sediment Sampling* Report (AECOM, 2012) and further analyzed in the January 2013 *Proposed No Action Remedy Addendum* (AECOM, 2013) to the Sediment Sampling Report.

The Sediment Sampling Report (AECOM, 2012) included an evaluation of the nature and extent of compounds in the surficial and sub-surficial sediments adjacent to the former BASF Site at Lake Macatawa, as well as a screening level ecological risk assessment (SLERA). Key findings from this report are presented below:

- Site-related volatile organic compounds (VOCs), including primarily chlorobenzene and 1,4-dichlorobenzene, are present in surficial and sub-surficial sediments at levels slightly in excess of USEPA Region 5 Ecological Screening Levels (Region 5 ESLs).
- Polychlorinated biphenyls (PCBs) are also present in the sediment at the Site at concentrations in excess of Region 5 ESLs. The concentrations of PCBs are generally consistent with those found elsewhere in Lake Macatawa.
- Several inorganic constituents (metals) are co-located with the Site-related VOCs and are also present at concentrations in excess of Region 5 ESLs. Review of the inorganic constituent data suggests that concentrations of several of the metals are consistent with Regional or background conditions elsewhere in the lake.
- Review of historical data from the Site suggests that bioavailability of divalent metals (i.e., cadmium, copper, lead, and zinc) is limited by the presence of total organic carbon (TOC) and acid-volatile sulfides (AVS) binding phases.
- The majority of impacted sediment is located approximately 50 to 500 feet from the shoreline at depths of 0 to 2 feet below top of sediment (bts), with isolated areas of impacts to a depth of 4 or 6 feet bts. Sediment in this area consists of fine-grained material with high levels of TOC. It is possible that the high level of TOC in this region (average ~5%) limits the bioavailability of both organic and inorganic COPCs.
- The VOCs exceeding Region 5 ESLs are centered around a former National Pollutant Discharge Elimination System (NPDES) outfall located approximately 350 feet from the shoreline. The source of VOCs into this outfall has been eliminated since 2008 when the current Site owner, Flint Group, ceased operations at the facility (BASF sold the facility to Flint in May 1996).
- Results from a macroinvertebrate survey indicate that there is a similar benthic macroinvertebrate community throughout the entire study area (including the background reference areas sampled).
- An existing groundwater treatment system has been running on the upland portion of the Site since 2006. As a result of system operation, concentrations of chlorobenzene and other VOCs have decreased in the nearshore sediments.

Review of these data in the *Proposed No Action Addendum Report* (AECOM, 2013) indicated that it is unlikely that the VOCs and PCBs at the Site are contributing to potential Site risks, and only a limited and finite potential for environmental risks was identified in the September 2012 Sediment Sampling Report. The sources that had historically contributed to the presence of organic COPCs in sediment have been eliminated, and the high TOC sediment adjacent to the Site likely limits the bioavailability of these organic COPCs at this Site. A number of the constituents present at the Site are found at similar concentrations elsewhere in Lake Macatawa, and toxicity testing data conducted by others indicate that the VOC- and PCB-containing sediments from the Site are not toxic to benthic receptors.

On March 26, 2013 the USEPA Region 5 provided BASF with comments on both the September 2012 Sediment Sampling Report and the January 2013 *Proposed No Action Remedy* Addendum to the Sediment Sampling Report. In their March 2013 comment letter, the USEPA suggested that the *No Action Report Addendum* did not adequately address elevated concentrations of inorganic constituents (specifically barium and copper) in sediment adjacent to the BASF Site, and that additional sampling and analysis activities focused on these two inorganic COPCs is warranted. Specifically, the USEPA letter requested the following additional field studies:

1. Additional nature and extent sampling to better characterize the concentrations of barium and copper in sub-surficial sediments;
2. Sediment toxicity testing to determine if there is ecological impairment associated with benthic invertebrate exposure to Site-related constituents in sediments adjacent to the Site.
3. Additional sediment chemistry analysis in surficial sediment including select metals (arsenic, barium, cadmium, chromium, copper, lead and zinc) and select VOCs (benzene, chlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, o-xylene and total xylene) that were detected above USEPA Region 5 ESLs to evaluate potential risk to benthic invertebrates.

In addition, USEPA requested that BASF prepare a food web model to evaluate potential ecological exposure pathways.

On September 9, 2013, BASF provided USEPA Region 5 with a Work Plan Addendum, and on October 29, 2013 BASF provided a Food Web Model to USEPA (AECOM, 2013a, b). The Work Plan Addendum provided the scope of work (SOW) to address the above topics at the BASF Holland Site. USEPA provided comments on these documents on January 23, 2014, and BASF responded to these comments on July 21, 2014. USEPA submitted additional comments on October 8, 2014 and on April 10, 2015, BASF provided USEPA Region 5 with responses to comments on the Sediment Sampling Report, Work Plan Addendum, and Food Web Model.

The April 2015 BASF response to comments package included an ecological evaluation of Lake Macatawa sediments using existing data. This evaluation (hereinafter referred to as the “Ecological Evaluation”) is re-presented (updated to include evaluation of the newly collected 2015 data) in **Appendix A** of this BERA. The Ecological Evaluation addressed specific comments from EPA and presented the following analyses:

- **Sediment Benchmark Screening**. EPA requested that BASF provide a fully documented screening of surficial sediment data against ecological benchmarks, including comparisons with corresponding reference or background conditions.
- **Evaluation of Dietary Risks to Fish**. USEPA requested that an evaluation of potential risks to fish due to dietary sediment exposures be provided. To address this comment, a fish dietary pathway evaluation was conducted consistent with the methods of Windward Environmental (2012), as suggested by USEPA.
- **Food Web Modeling**. USEPA requested several updates to the wildlife food web model evaluation including changes to the wildlife exposure parameters, to avian toxicity reference value (TRV) for arsenic, and presentation of Upper Confidence Limit (UCL) calculations and quality control review.
- **Biota-to-Sediment Accumulation Factors (BSAFs) Uncertainty Evaluation.** A quantitative evaluation of the uncertainty associated with the BSAFs used in the food web modeling was provided to address the uncertainties associated with BSAFs.
- **Uncertainty Evaluation**. The uncertainty evaluation was updated to provide a more balanced discussion including discussion of BSAFs and potential bioavailability of Site-related COPCs.

Based on the Ecological Evaluation (**Appendix A**), it was determined that the mammalian and avian food web and fish ingestion pathways did not indicate unacceptable risk, but the potential for risks to benthic organisms from exposures to surficial sediments could not be eliminated. On June 12, 2015,

USEPA provided BASF with a letter approving the response to comments and the Ecological Evaluation. In the June 2015 approval letter, USEPA requested that BASF integrate all components of the Ecological Evaluation into this comprehensive BERA report.

1.2 BERA Objectives

The specific objectives of this BERA are as follows:

- Evaluate potential risks to the benthic community based on August 2015 laboratory toxicity test results.
- Confirm Ecological Evaluation findings of no potential for risk to fish based on a modeled dietary pathway, through evaluation of additional sediment data collected in August 2015.
- Confirm Ecological Evaluation findings of no potential for risk to higher trophic level ecological receptors using food web modeling, through evaluation of additional sediment data collected in August 2015.

The remainder of this document is organized into the following sections:

- Section 2 – Summary of 2015 Field Program
- Section 3 – Problem Formulation
- Section 4 – Risk Analysis
- Section 5 – Risk Characterization
- Section 6 – Uncertainty Analysis
- Section 7 – Summary and Conclusions
- Section 8 – References

2.0 Summary of 2015 Field Program and Data Summary Report

In accordance with the final approved Work Plan (AECOM, 2015), a Lake Macatawa sampling and analysis program was conducted in August 2015. Sediment sampling locations from the 2015 field program are presented on **Figure 2-1, Figure 2-2, and Figure 2-3**. The sampling and analysis program included limited additional nature and extent sediment sampling and analysis, as well as collection of surficial sediment samples for analytical chemistry and laboratory toxicity testing purposes. The results of the sediment chemistry analysis and laboratory toxicity testing conducted were incorporated into the ecological risk analyses previously presented in the April 2015 Ecological Evaluation and the updated analyses are presented in **Appendix A** this BERA.

2.1 Sediment Sampling and Analysis Methods

The Sediment Sampling Work Plan (AECOM, 2015) and Standard Operating Procedure (SOP) documents provided in the project QAPP (AECOM, 2010) detail the specifics of sediment sampling procedures implemented in the field. Sediments were collected in a manner consistent with USEPA's Technical Manual for the Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses (USEPA 2001).

The field program included surficial and sub-surficial sediment sampling and chemical analysis, as well as collection of sediment for laboratory toxicity testing. Sediment collected for toxicity testing was co-located in time and space with the sediment collected for analytical chemistry sampling. Data generated through this field program supplement previously collected data and have been used to further the evaluation of the nature and extent of potentially impacted sediments and to evaluate the potential for benthic toxicity from Site-related constituents in the portion of Lake Macatawa adjacent to the Site.

The field sampling program was conducted in August 2015. The program included the following components:

- Sub-Surficial Sediment Sampling. Sediment core samples were collected from seven locations in Lake Macatawa to further delineate the nature and extent of potentially impacted sediments in this area.
- Surficial Sediment Sampling. Surficial sediment samples were collected from seventeen locations in Lake Macatawa; fourteen locations at the Site and three locations from background/reference. Sediment toxicity testing was conducted to evaluate the potential toxicity of surficial sediments to benthic invertebrates from Site-related constituents. Samples collected for toxicity testing included ten of the fourteen Site samples and the three reference locations.

The sediment coring and all surficial sediment sampling locations are shown on **Figure 2-1**, the sub-set of toxicity sampling locations are shown on **Figure 2-2**, and the reference sampling locations are shown on **Figure 2-3**.

Sediment core samples were collected from seven (7) locations within Lake Macatawa to further evaluate the vertical extent of potentially impacted sediments in this area (**Figure 2-1**). This portion of the Site was sampled in July 2011 and a review of these data noted elevated levels of metals in some sub-surficial sediment samples (AECOM, 2012; USEPA, 2013).

In their March 26, 2013 sediment report comments, USEPA recommended that "Vertical delineation should be completed to the depth that could be resuspended". Consistent with the previous sampling plan (AECOM, 2010), the following distinct sediment horizons were evaluated in this program:

- to 0.5 feet (ft)
- 0.5 to 2 ft
- 2 to 4 ft
- 4 to 6 ft
- 6 to 8 ft

In addition, one sample from SD-30 was sampled from the 8 to 10 ft horizon. Due to lack of adequate penetration (i.e., refusal), location SD-50 was sampled to 7.5 ft instead of the target 8 ft.

Sub-surface sediment samples (**Table 2-1**) were analyzed for barium and copper.

Surface sediment samples (0-0.5 ft) were collected from the seven coring locations, seven additional Site samples, and three background/reference locations. All surface sediment samples were evaluated for the following parameters, as summarized in **Table 2-2**:

- Arsenic
- Barium
- Cadmium
- Chromium
- Copper
- Lead
- Zinc
- Benzene
- Chlorobenzene
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene
- O-Xylene
- Total Xylene
- Grain Size
- Total Organic Carbon (TOC)

In addition, to evaluate toxicity and the potential for divalent metals to be bioavailable, Simultaneously Extracted Metals and Acid-Volatile Sulfide (SEM and AVS) samples were collected from 10 sediment sampling locations (seven site and three reference locations). To provide a conservative estimate of metal's bioavailability, SEM and AVS data were collected from the thin bioactive zone (BAZ), operationally defined as the 0 to 1 inch (i.e., 0 to 2 centimeter) horizon.

Surface sediment samples were collected using a petite ponar grab sampler. Subsurface sediment samples were collected using a vibracore system with polycarbonate core liners. The latitude and longitude of each sample location was recorded with a portable GPS unit. At the sample site, sediment penetration depth, and core recovery thickness (or sediment thickness within the grab sampler) were recorded in the field on standardized forms (**Appendix B**).

Grab samples were removed from the sampler and deposited directly into decontaminated stainless steel trays and transported to the onshore sediment logging station. Cores were brought ashore and cut into 4 foot sections prior to splitting and sampling.

Upon opening of the grab sample container, a sediment sample was collected for VOCs using a cutoff sampling syringe and a subsample of the top inch was sampled for SEM/AVS.

All samples were screened in the field using a calibrated photoionization detector (PID). A portion of the sample interval was placed into a plastic bag, sealed, agitated, covered, and allowed to sit. PID readings were then taken from the headspace in the plastic bag and recorded on the sediment log. Sediment logging was conducted by a geologist using Universal Soils Classification System and Munsell Color Classification. All cores and grab samples were documented, and information was recorded relative to sediment coloration, sheens, and odors. Upon logging, sediment from each interval was transferred to stainless steel bowls and homogenized. Homogenized sediments were sampled for the analyte lists.

2.1.1 Analytical Methods

Sediment samples were analyzed for VOCs using EPA Method SW-846 8260. Metals were analyzed using EPA Method SW-846 6010B/6020/7000. TOC analysis was performed using EPA Method SW - 846 9060. Grain size analysis was performed using ASTM D-422.

2.1.2 Laboratory Toxicity Testing

Laboratory toxicity testing was conducted to evaluate potential risks to benthic invertebrates from direct exposure to surficial sediments within the portion of Lake Macatawa adjacent to the Site. Toxicity test sampling locations were co-located in time and space with 13 sediment chemistry sampling locations (10 Site locations, and 3 Reference Area locations, **Figures 2-2** and **2-3**), allowing for a detailed evaluation of co-occurring analytical data. The sediment toxicity testing was conducted in accordance with MDEQ's Operational Memorandum on Sediments (Op Memo 4) (MDEQ, 2006). All toxicity tests were conducted using whole environmental media only (e.g., no dilution series toxicity testing were conducted).

The objective of the sediment toxicity testing program was to obtain laboratory data to further evaluate potential ecological risks to invertebrate receptors from exposure to Site-related inorganic constituents. The following two sediment toxicity tests were conducted in accordance with USEPA (2000) guidance and consistent with MDEQ RRD Operation Memorandum No. 4 (2006), Attachment 3: Sediments:

- Test Method 100.1: *Hyalella azteca* 10-day Survival and Growth Test for Sediments
- Test Method 100.2: *Chironomus tentans* 10-day Survival and Growth Tests for Sediments

These tests provide a direct measure of the potential for benthic invertebrate toxicity due to exposure to sediment. For each test, eight replicates containing 10 organisms each were exposed to sediment for 10 days under laboratory conditions. A laboratory control (i.e., negative control) was included with each test to assess the health of the test organisms and to determine test acceptability. At test termination, both survival and growth were measured. As indicated in the testing guidance (USEPA, 2000) test acceptability for the *H. azteca* test include an average of at least 80% survival in the laboratory control and measureable growth of test organisms in the control sediment. For the *C. tentans*, control survival must be at least 70% and mean weight at test termination in the laboratory control must be at least 0.48 mg ash-free dry weight/surviving organism USEPA 2000).

The results of the Lake Macatawa sediment toxicity tests were compared to the results of both laboratory control tests and tests conducted with samples collected from nearby reference stations (**Figure 2-3** depicts the sampling locations). Standardized statistical tests, such as analysis of variance (ANOVA) were conducted to determine if significant differences in survival, growth, or other measured response are observed.

2.2 Field Program Results

A summary of the analytical and toxicological data collected during the 2015 field program is presented in this Section.

2.2.1 Sediment Grain Size

Sediment grainsize was analyzed in the ten surface sediment Site samples and three background/reference samples used for toxicity testing. Sediment grain size results are presented in **Table 2-3**. The grain size of surface sediment samples collected in 2015 is generally dominated by fines (silt and clay fractions). The exception is the sample from SD-25 which is dominated by fine sand. In the offsite reference samples, sand dominates both LM-08-13 and SD-46. Sample SD-45 is approximately half sand and half fines.

2.2.2 Inorganic Compounds in Sediment

Sample-by-sample summaries of inorganic COPC in surface and subsurface sediment are presented in **Tables 2-4** and **2-5**, respectively.

2.2.2.1 Surface Sediment

Metals were analyzed in all fourteen surface sediment Site samples and three background/reference samples. The concentrations of several of the inorganic COPC were found to be higher in the sample locations consisting of fine grained sediment (e.g., SD-30) compared to concentrations found in sample SD-25, which consisted of coarser grained sediment (i.e., sand). Five of the seven metals were highest in SD-53, for which grain size data were not available. A similar pattern was observed in background/reference sample locations with lower inorganic COPC concentrations detected in locations LM-08-13 and SD-46 consisting of coarser grained sediment and higher inorganic COPC concentrations in location SD-45, which was comprised of finer grained sediment.

The seven metals analyzed in surface sediment were detected in every sample, including the three background/reference locations. Concentrations of all metals were lower in background than Site samples.

Arsenic concentrations ranged from 4.5 milligrams per kilogram (mg/Kg) (SD-25) to 10.3 mg/Kg (SD-53). The majority of arsenic concentrations were in the 7 to 9 mg/Kg range.

Barium concentrations ranged from 140 mg/Kg (SD-25) to 15,300 mg/Kg (SD-30). Concentrations were wide-ranging. Nine locations contained concentrations greater than 1,000 mg/Kg; three of these samples had concentrations in excess of 5,000 mg/Kg. Concentrations of barium in the remaining five stations were 140 mg/kg (SD-25), 217 mg/Kg (SD-59), 286 mg/Kg (SD-58), 780 mg/Kg (SD-54), and 961 mg/Kg (SD-50).

The majority of cadmium concentrations ranged from 1 to 2 mg/Kg. The lowest concentration (0.38 mg/Kg) was detected in SD-25 and the highest concentration (2.1 mg/Kg) was detected in SD-53.

Concentrations of chromium and copper were lowest in SD-59 (35.4 mg/Kg and 51.4 mg/Kg, respectively). The highest concentration of chromium (398 mg/Kg) was detected in SD-53. Concentrations of chromium were evenly split between those greater than and less than 100 mg/Kg. The highest concentration of copper (337 mg/Kg) was detected in SD-30.

Lead and zinc concentrations were lowest in SD-25 (15.7 mg/Kg and 86.1 mg/Kg, respectively) and highest in SD-53 (117 mg/Kg lead and 291 mg/Kg zinc).

Section 4.1.1 presents a comparison of surface sediment analytical data to benchmark screening values.

2.2.2.2 Sub-Surface Sediment

Sub-surface sediment samples were collected and analyzed for barium and copper, to further delineate the vertical extent of these COPC.

In SD-28, sub-surface concentrations of barium were highest in the 0.5-2 ft interval (3,440 mg/Kg) and decreased with depth to 12.1 mg/Kg in the 6-8 ft interval. Copper concentrations were highest in the 2-4 ft interval (1,030 mg/Kg) decreasing to 1.1 mg/Kg in the 6-8 ft interval.

In SD-30, the sub-surface concentration of barium in the 0.5-2 ft interval (19,800 mg/Kg)was up to three orders of magnitude higher than the concentration reported for the deepest interval (17.1 mg/Kg in the 8-10 ft horizon). Copper concentrations were highest at the 4-6 ft interval (8,660 mg/Kg), but decreased to 2.6 mg/Kg at 8-10 ft horizon.

In SD-31, sub-surface concentrations of barium were highest in the 0.5-2 ft interval (9,560 mg/Kg), but decreased with depth to 68.2 mg/Kg in the 6-8 ft horizon. Copper concentrations were highest at the 4-6 ft interval (811 mg/Kg), but decreased to 8.1 mg/Kg at 6-8 ft horizon.

In SD-32, sub-surface concentrations of barium decreased with depth to 49.5 mg/Kg in the 6-8 ft horizon. Copper concentrations were highest at the 2-4 ft interval (408 mg/Kg), but decrease to 5.6 mg/Kg at 6-8 ft horizon.

In SD-36, the trend in barium concentrations was consistent with the samples described above where the highest levels were detected in the 0.5-1 ft interval (4,170 mg/Kg) and decreased with depth. Copper concentrations were highest in the 2-4 ft interval (150 mg/Kg) decreasing with depth to 13.7 mg/Kg in the 6-8 ft horizon.

In SD-50, barium concentrations were highest in the 0.5-2 ft interval (992 mg/Kg) and decreased with depth to 4.9 and 6.3 mg/Kg in the 4-6 ft and 6-7.5 ft intervals. Copper concentrations were highest in the 2-4 ft interval (103 mg/Kg) and the 0.5-2 ft interval (72 mg/Kg). Markedly lower concentrations were observed in the 4-6 ft interval (1.9 mg/Kg) and the 6-7.5 ft interval (2.3 mg/Kg) .

In SD-53, sub-surface concentrations of barium are lower than surface in the 0.5-2 ft interval (1,810 mg/Kg), and decrease with depth to 111 mg/Kg in the 6-8 ft horizon. Copper concentrations in the sub-surface are lower than the surface, but highest at the 2-4 ft interval (97 mg/Kg), and decrease to 13.7 mg/Kg at 6-8 ft horizon.

All concentrations of barium and copper in the sub-surface cores demonstrate decreasing concentration in the lowest intervals, indicating that vertical nature and extent delineation has been achieved.

2.2.3 Volatile Organic Compounds (VOCs) in Surficial Sediment

VOCs were analyzed in all fourteen surface sediment Site samples and three background/reference samples. A sample-by-sample summary of the VOCs analyzed in surface sediment samples during this study is presented in **Table 2-6**.

Benzene, and the xylenes (m,p-xylene, o-xylene, and total xylenes) were detected infrequently. Benzene was detected in two samples (SD-30 [34 µg/Kg] and SD-40 [210 µg/Kg]). m,p-Xylene was detected in SD-25 (28 µg/Kg) and SD-30 (350 µg/Kg). O-xylene was detected in SD-30 (660 µg/Kg) and SD-39 (35 µg/Kg). Total xylenes were detected in SD-25 (28 µg/Kg), SD-30 (1,000 µg/Kg) and SD-39 (35 µg/Kg).

The highest concentrations of most VOCs were found in SD-30. However, the highest concentration of chlorobenzene (9,400 µg/Kg), which was detected in 13 of the 17 samples evaluated, was detected in SD-40.

2.2.4 Total Organic Carbon (TOC) in Sediment

TOC was analyzed in the ten surface sediment Site samples and three background/reference samples used for toxicity testing. **Table 2-7** presents the analytical results for TOC in sediment. TOC levels in sediment were typically higher in the Site samples relative to those of the offsite reference locations. The TOC level in the Site sampling locations with coarse grain size (SD-25, TOC = 6,300 mg/Kg) was lower than those detected in other Site samples, which ranged from 51,700 mg/Kg (SD39) to 78,600 mg/Kg (SD-30). In the reference locations, TOC was higher in SD-45 (34,200 mg/Kg) than in LM-08-13 (6,510 mg/Kg) or SD-46 (1,310 mg/Kg).

2.2.5 SEM/AVS in Sediment

Among COPCs identified in the Ecological Evaluation were divalent metals. To account for the potential for divalent metals bioavailability to be limited at the Site, SEM, AVS, and TOC were measured in sediments collected at the ten Site and three reference toxicity testing locations. These

data rely on the EqP approach for establishing sediment quality criteria and account for the bioavailability of metals in sediments (USEPA, 2005a).

The USEPA (2005a) evaluation of metals bioavailability also evaluates possible binding of metals not just by AVS, but also by organic matter. The enhancements to the SEM-AVS approach presented in USEPA (2005a) include calculating the difference between the total SEM and the total AVS, then normalizing this fraction (the sum SEM-AVS fraction) to the amount of organic carbon present in the sediment. This approach is presented as $(\sum SEM\text{-}AVS)/f_{oc}$, where f_{oc} is the fraction of organic carbon in the sediment sample.

Data collected from the ecological exposure areas were evaluated on a sample-by-sample basis using the following scale to evaluate whether or not the organic carbon binding phase (represented as fraction organic carbon or f_{oc}), in conjunction with the AVS, is affecting the bioavailability of divalent metals in sediments:

- If the $(\sum SEM\text{-}AVS)/f_{oc}$ excess exceeds 3,000 micromoles per gram organic carbon ($\mu mol/g_{oc}$), the sediments are presumed to be “likely to be toxic”;
- If the $(\sum SEM\text{-}AVS)/f_{oc}$ excess is between 130 and 3,000 $\mu mol/g_{oc}$, predictions of effects are uncertain; and
- If the $(\sum SEM\text{-}AVS)/f_{oc}$ excess is less than 130 $\mu mol/g_{oc}$, the sediments are presumed to "not likely" be toxic.

One half of the detection limit used as a surrogate concentration for metals non-detects in the calculations. Sulfides were detected in all samples. The results of the SEM/AVS data are presented in **Table 2-8**. With the exception of SD-25 (SEM/AVS/foc = 136.8 $\mu mol/g_{oc}$), the results of all samples are less than the 130 $\mu mol/g_{oc}$ threshold for potentially toxic sediment (due to divalent metals), indicating that divalent metals are likely not available in surficial sediment samples at this Site.

2.2.6 Laboratory Toxicity Testing

This Section presents a summary of the laboratory toxicity tests. **Appendix C** contains the laboratory report on the toxicity testing.

Laboratory toxicity tests were conducted with two test species, *Hyalella azteca* (amphipod) and *Chironomus dilutus* (midge), using sediment samples collected from ten Lake Macatawa Site sediment samples and three off-Site reference samples. Endpoints measured in each test included survival, growth (as dry weight[1]), and biomass[2]. Biomass is typically a more sensitive growth endpoint than dry weight because it incorporates both weight and starting organism counts.

The results of the laboratory toxicity tests were compared to the results of both laboratory control tests and tests conducted with samples collected from the reference locations. Standardized statistical tests (e.g., ANOVA) were conducted to determine if significant differences in survival, growth, or biomass responses were observed.

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[1] Determined taking the dry weight obtained for a replicate and dividing it by the number of organisms recovered at the end of the assay.

[2] Determined taking the dry weight obtained for a replicate and dividing it by the number of organisms exposed at the start of the assay.

Tables 2-9 and 2-10 summarize the survival and growth results for the amphipod and midge tests, respectively, and identify the samples that are statistically different from the laboratory control and from the relevant reference samples. Toxicity results from the Site sediment samples were compared against each of the three Reference samples separately and pooled, as well as to laboratory control samples.

3.0 Problem Formulation

Problem formulation is the initial step of the BERA process and provides the basis for decisions regarding the scope and objectives of the BERA. The problem formulation phase includes:

- Identification of receptors and potentially complete exposure pathways
- Development of the ecological conceptual site model (CSM) (Figure 3-1)
- Identification of assessment and measurement endpoints

3.1 Definition of Risk Assessment Objectives

The primary objective of the BERA is to evaluate whether or not populations of ecological receptors are potentially at risk due to exposure to Site-related chemical stressors. A secondary objective is to develop defensible remedial goals (RGs), if needed, based on the evaluation of additional Site-specific data. RGs will not be developed as part of the BERA process but will be developed, as necessary, to support the risk management decisions at the Site.

3.2 Summary of SLERA and Ecological Evaluation

A SLERA was conducted in 2012 (AECOM, 2012). Maximum detected concentrations of constituents in surface sediments were compared to Region 5 ESLs. The SLERA indicated that potential risks to ecological receptors due to potential exposure to VOCs and metals in surficial sediments could not be eliminated. Although concentrations of PCBs exceeded ESLs, the SLERA determined that Site concentrations of these compounds were consistent with regional background concentrations.

Additional risk evaluation, in the form of the Ecological Evaluation (**Appendix A**) was conducted based on USEPA comments. This analysis included a food web and fish ingestion pathway analysis. This Ecological Evaluation was submitted to USEPA in April 2015 and approved by USEPA June 12, 2015. The April 2015 ecological evaluation concluded that there were no potential unacceptable risks to fish and wildlife from food chain exposure pathways, but that potential risks to benthic receptors from exposure to sediment could not be ruled out and required further evaluation. This evaluation was updated (**Appendix A**) to include the newly collected 2015 data and the results remain consistent: potential risks from benthic receptor exposure to sediments warrant further evaluation. Therefore, the remainder of the BERA Problem Formulation focuses primarily on this potentially complete exposure pathway.

3.3 Selection of Specific Receptors and Exposure Pathways

This BERA focuses on the direct contact with surface sediment by benthic macroinvertebrates exposure pathway, and includes analysis of food chain pathways (**Appendix A**). **Table 3-1** presents a list of Site samples used in the BERA. Background and Regional Reference sediment samples used the BERA are listed in **Table 3-2**.

3.4 Selection of Biological Endpoints

Ecologically-based assessment endpoints and measures of effect were designed to evaluate potential ecotoxicological effects associated with exposure to identified COPC. According to the USEPA (1998), assessment endpoints are formal expressions of the actual environmental value to be protected. They usually describe potential adverse effects to long-term persistence, abundance, or production of populations of key species or key habitats. Typically, assessment endpoints and receptors are selected for their potential exposure, ecological significance, economic importance, and/or societal relevance.

Because assessment endpoints often cannot be measured directly, a set of surrogate endpoints (measurement endpoints) are generally selected for ecological risk assessment that relate to the assessment endpoints and have measurable attributes (e.g., comparison of media concentrations to screening levels, results of food web models) (USEPA, 1997 and 1998). These measurement endpoints provide a quantitative metric for evaluating potential effects of constituents on the ecosystem components potentially at risk. Since each measurement endpoint has intrinsic and extrinsic strengths and limitations, several endpoints were used to evaluate each assessment endpoint. The assessment and measurement endpoints selected to quantify the potential adverse impacts to benthic ecological receptors are discussed below.

Assessment Endpoint	Risk Question	Measurement Endpoint(s)
Protection of the benthic macroinvertebrate community potentially exposed to COPCs in sediment.	Are concentrations of COPCs in sediment sufficiently elevated such that they would potentially cause adverse effects to the benthic macroinvertebrate community?	<u>Sediment Chemistry</u> Compare COPC concentrations measured in Site sediment to sediment screening values and to concentrations measured at background or regional background locations. Evaluation of SEM and AVS data relative to divalent metal bioavailability. <u>Sediment Bioassay</u> Use sediment toxicity bioassays to compare survival and growth at Site locations to survival and growth at reference locations.

3.5 Conceptual Site Model

The end product of the problem formulation step is the development of an ecological CSM. The CSM helps to describe the COPC origin, fate, transport, exposure pathways, and receptors of concern. A CSM is a process by which Site issues are identified, existing data are evaluated, a hypothesis regarding the problem is developed, DQOs are established, data gaps are identified, and then data gaps are filled to test the hypothesis. After information is collected to fill the data gaps, the CSM is refined, conclusions are drawn, and additional data gaps are identified, if present. The CSM is an iterative process that directs the Site toward closure and provides a framework for stakeholders (e.g., BASF, USEPA, MDEQ, etc.) to follow the logic used along the way. **Figure 3-1** presents the BERA CSM figure for the Site identifying potential source areas, migration pathways, and potentially exposed ecological receptors. The BERA CSM reflects the findings from the SLERA and Ecological

Evaluation. Exposure pathways evaluated in these phases of work but deemed incomplete are indicated on the figure.

4.0 Risk Analysis

During the risk analysis phase, an evaluation of ecological and chemical data is conducted to determine the potential for ecological exposure and adverse effects. The assessment and measurement endpoints, as well as the ecological CSM developed during problem formulation, help focus this analysis. The analysis consists of two components: (1) effects analysis and (2) exposure analysis. The results of these evaluations provide the information necessary to estimate potential risks to the representative species and communities.

4.1 Benthic Community Evaluation

4.1.1 Sediment Benchmark Screen

As detailed in the Ecological Evaluation (Appendix A), surficial sediment chemistry data from all sampling rounds were screened against the USEPA Region 5 ESLs[3] to identify COPCs for evaluation in the BERA. The background and regional background datasets previously identified for the Site in the Sediment Sampling Report (AECOM, 2012) were also considered in this analysis. In accordance with EPA guidance, COPCs were not screened out based on comparison to background concentrations. This evaluation was conducted to help place the Site data in a regional context.

The results of Ecological Evaluation analysis indicated that the following COPC warrant further evaluation relative to the benthic macroinvertebrate exposure pathway analysis: arsenic, barium, cadmium, chromium, copper, lead, zinc, and select VOCs.

In 2015, fourteen surficial sediment samples were collected (ten synoptically with toxicity testing samples) from the Site. **Tables 4-1** and **4-2** present the sediment chemistry results for metals and VOCs, respectively, screened against the USEPA Region 5 ESLs or equivalent. ESLs were not adjusted to site-specific TOC.

The arsenic concentration in one of the samples (SD-53; 10.3 mg/Kg) exceeded the ESL. Barium concentrations from all Site and background/reference samples exceeded the screening benchmark (1.04 mg/Kg). The barium benchmark is a soil ESL and may not be applicable to sediment. Chromium concentrations in all samples except SD-25 and SD-59 exceeded the ESL. Of the divalent metals (cadmium, copper, lead and zinc), the majority of Site sample concentrations were greater than the ESLs.

No detected concentrations of 1,3-dichlorobenzene or m,p-xylene exceeded their respective ESLs. Benzene exceeded its ESL only at SD-40 (210 µg/Kg compared to an ESL of 142 µg/Kg). Total xylene (1,000 µg/Kg) and o-xylene (660 µg/Kg) exceed the ESL (433 µg/Kg) in sample SD-30, but not in any other samples. Concentrations of 1,4-dichlorobenzene and chlorobenzene exceeded their respective ESLs in several samples including SD-25, SD-30, SD-36, SD-40, and SD-53.

[3] Available at: http://epa.gov/region5/waste/cars/pdfs/ecological-screening-levels-200308.pdf

4.1.2 Sediment Bioassays

Sub-chronic duration (10-day) laboratory toxicity tests with two invertebrate species (a midge [*Chironomus dilutus*] and amphipod [*Hyalella azteca*]) were conducted using sediment collected from sampling locations co-located with bulk sediment analytical sampling locations in the Adjacent Offshore area and three off-Site reference locations (SD-45, SD-46 and LM-08-13). The purpose of testing reference sediment is to provide a Site-specific negative control for the tests. The reference sediment provides similar sediment composition and characteristics without presence of Site-related COPC. The reference sediment is used to control for physical and physio-chemical factors (e.g., grain size, TOC, ammonia, etc.) as well as upstream anthropogenic impacts that may be present in sediments from the Site and surrounding areas, but not present in laboratory control sediment. Based on a review of the physical characteristics of the three reference samples, SD-45 was deemed the most similar to site samples.

These tests were used to evaluate the Site-specific bioavailability and toxicity of chemical stressors at these exposure areas. The bioavailability of chemicals is dependent on a number of factors, which are both Site-specific and medium-specific. Although many of these factors can be estimated using equilibrium partitioning techniques, it is difficult to account for all the physical and chemical properties which could potentially affect bioavailability. Laboratory toxicity tests can be used to demonstrate the reaction of selected organisms to the combination of physical and chemical characteristics in an environmental medium.

Two species were used to help bracket the potential response. USEPA (2000) indicates that, in general, *Hyalella azteca* is more sensitive than *Chironomus dilutus* (formerly *C. tentans*) for a majority of metals and pesticides. However, both species are deemed sensitive by USEPA (2000) and appropriate for use to help determine sediment quality.

4.1.3 SEM, AVS, and TOC Evaluation

To account for the potential for divalent metals bioavailability to be limited at the Site, SEM, AVS, and TOC were measured in sediments collected at the toxicity testing locations. These data rely on the EqP approach for establishing sediment quality criteria and account for the bioavailability of metals in sediments (USEPA, 2005a). The basis of the EqP approach for deriving screening criteria for metals in sediments is that metal partitioning occurs in sediments between solid and aqueous phases. Sulfides play a critical role in the partitioning of metals in sediments. The majority of sulfides in sediments are present as solid phase iron monosulfides and disulfides (e.g., pyrite). Monosulfides are considerably more reactive than disulfides. The most labile sulfidic fraction in sediments consists of the AVS. This fraction is associated with the iron and manganese monosulfides. Iron and manganese sulfides readily dissolve in interstitial pore water in the presence of divalent metals. Conversely, many other metal sulfides are quite insoluble. Insoluble metal sulfide complexes (solid phase) tend to have low bioavailability and therefore low toxicity for aquatic organisms.

Divalent metals in sediments will bind to available AVS in order of increasing solubility. Silver, copper, lead, cadmium, zinc, and nickel will bind to available AVS and be sequentially converted to silver sulfide, copper sulfide, lead sulfide, cadmium sulfide, zinc sulfide, and nickel sulfide (i.e., in the order of increasing solubility). This reaction takes place as long as sulfides, in particular AVS, are available. If the molar sum of divalent cations (i.e., silver, copper, lead, cadmium, zinc, and nickel) is less than the molar concentration of available AVS, these metals will exist as metal sulfides. Such metal sulfides are insoluble and are not present in sediment pore water. Therefore, sediments with higher concentrations of AVS than metals will tend to exhibit low metals toxicity. Conversely, when the molar sum of the metals is greater than the molar AVS concentration, the portion of the metals in excess of

the AVS concentration can potentially exist as free metals, and thus can potentially be bioavailable and toxic.

The appropriate analytical measurement of metals used to calculate the metals:AVS ratio is known as the SEM concentration. The SEM concentration represents the metals extracted in the AVS analytical procedure recommended by the USEPA. Sediments with SEM:AVS ratios less than 1 typically have sufficient metal binding capacity to maintain dissolved metals concentrations in the pore water below toxic levels. When the SEM:AVS molar ratio is less than 1, the USEPA briefing report to the USEPA science advisory board (USEPA, 1994) states that “in virtually no instance has metals toxicity been observed.” Conversely, when the SEM:AVS ratio is greater than 1, toxicity is often, but not always, predicted. This suggests that other binding phases beyond AVS (i.e., total organic carbon) may also limit the bioavailability and resulting toxicity of metals in sediments. The USEPA (2005a) suggests using the difference (SEM minus AVS) rather than the ratio (SEM:AVS) for evaluation of metals bioavailability in sediments; therefore, this evaluation considers both SEM:AVS and SEM-AVS.

When multiple metals are present, it is necessary to evaluate the metals in terms of their solubility products. For instance, if sediments at a site are contaminated with both lead and cadmium, it is possible that AVS (i.e., iron sulfide) could limit the bioavailability and toxicity of one or both of these metals. In the presence of sulfide ions, lead is less soluble than cadmium. Therefore, lead has a higher affinity for AVS than cadmium and will preferentially bind to available AVS to form solid phase, non-toxic lead sulfide. If sufficient AVS is available, all of the lead in the system will be tightly bound as lead sulfide. If excess AVS is still available when all of the lead is sulfide-bound, then cadmium ions will bind to the remaining sulfide ions. When the molar concentration of lead and cadmium ions exceeds the molar concentration of sulfide ions, the metals will no longer be present as sulfide-bound, insoluble complexes. If this situation occurs, sediment toxicity is possible, depending upon the presence and role of other binding phases in the sediment.

The USEPA (2005a) evaluation of metals bioavailability also evaluates possible binding of metals not just by AVS, but also by organic matter. The enhancements to the SEM-AVS approach presented in USEPA (2005a) include calculating the difference between the total SEM and the total AVS, then normalizing this fraction (the sum SEM-AVS fraction) to the amount of organic carbon present in the sediment. This approach is presented as $(\sum SEM\text{-}AVS)/f_{oc}$, where f_{oc} is the fraction of organic carbon in the sediment sample.

Data collected from the ecological exposure areas were evaluated on a sample-by-sample basis using the following scale to evaluate whether or not the organic carbon binding phase (represented as fraction organic carbon or f_{oc}), in conjunction with the AVS, is affecting the bioavailability of divalent metals in sediments:

- If the $(\sum SEM\text{-}AVS)/f_{oc}$ excess exceeds 3,000 micromoles per gram organic carbon ($\mu mol/g_{oc}$), the sediments are presumed to be “likely to be toxic”;
- If the $(\sum SEM\text{-}AVS)/f_{oc}$ excess is between 130 and 3,000 $\mu mol/g_{oc}$, predictions of effects are uncertain
- If the $(\sum SEM\text{-}AVS)/f_{oc}$ excess is less than 130 $\mu mol/g_{oc}$, the sediments are presumed to "not likely" be toxic.

USEPA (2005a) also discusses the interpretation of chromium bioavailability in the overall metals mixture. In sediment containing AVS, chromium is present as trivalent chromium and therefore toxicity

due to exposure is expected to be low. Therefore, in addition to the guidelines above, the document presents:

1. Any sediment with AVS > 0.0 will not cause adverse biological effects due to chromium or silver.

5.0 Risk Characterization

The risk characterization of Lake Macatawa sediments focuses on potential risks to the benthic community. The samples used in the evaluation are summarized in **Table 3-1**. Background and Regional Reference data were also included in the risk characterization. These samples are identified in **Table 3-2**.

5.1 Sediment Benchmark Screen

The results of the 2015 sediment screen are presented in **Table 5-1**. Detected concentrations of arsenic, barium, cadmium, chromium, copper, lead, zinc, benzene, chlorobenzene, total xylene, o-xylene, and 1,4-dichlorobenzene in sediment are greater than the Region 5 ESLs. Concentrations of m,p-xylene were below the ESL.

Newly collected Site and background data were evaluated relative to one-another. The site maximum concentrations of all detected metals are greater than the background maximum concentrations, although some concentrations of metals in the newly collected Site data are consistent with the broader historically evaluated data set presented in Appendix A. VOCs were not detected at background sampling stations.

5.2 Sediment Bioassays

Tables 5-2 and 5-3 present the results of the toxicity testing and indicate percent reduction in Site samples from the laboratory control and from the relevant reference samples. Based on the organic carbon content and grain size analysis, reference location SD-45 is most representative of site conditions and therefore the toxicity testing results from site samples were evaluated relative to the reference condition by conducting comparisons to results from sampling location SD-45, and by conducting comparison to a pooled reference (the geometric mean of the results from the three reference samples [SD-45, SD-46 and LM-08s-13]).

Although two sub-lethal endpoints were reported for both species (growth, as ash free dry weight [AFDW] and biomass), USEPA guidance (*Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates*; Section 2.3) states that biomass is not a primary endpoint in the test methods, whereas growth (as AFDW) is listed as a primary endpoint in the test methods. Therefore, while this BERA includes an evaluation of both sub-lethal endpoints, AFDW is the focus of the concentration/response analysis used to establish the potential for sub-lethal barium risk to benthic receptors.

5.2.1 Amphipod (*Hyalella azteca*)

The results indicate that, with the possible exception of surficial sediment from sampling location SD-30, amphipods generally experience no unacceptable lethal or sub-lethal toxicity when exposed to sediment from the BASF site.

5.2.1.1 Primary Endpoints (Survival and Growth)

Based on available information from USEPA (2000), toxicity to amphipods would be expected more than that to midge, given the suite of COPCs at the Site (i.e., primarily metals). However, amphipod

survival surpassed 90% in all samples, indicating no substantial risk to this species. For this test to be considered valid, USEPA Method 100.1 has a test acceptability criterion of 80% survival in the laboratory control. Rates of survival >90% are not indicative of an impacted area.

Relative to amphipod growth (AFDW), only sample SD-30 indicated reductions compared to the laboratory control, reference sample SD-45 , and the pooled reference. Growth in SD-30 was 67% of laboratory control, 65% of SD-45, and 65% of the pooled reference samples (**Table 5-3**).

5.2.1.2 Secondary Endpoint (Biomass)

Relative to amphipod biomass, only sample SD-30 indicated reductions compared to the laboratory control, individual reference sample SD-45, and the pooled reference. Biomass was slightly more reduced than growth; 66% of the laboratory control, 62% of SD-45, and 61% of the pooled reference condition (**Table 5-3**).

5.2.2 Midge (*Chironomus dilutus*)

The results indicate that, with the possible exception of surficial sediment from sampling location SD-30, midge generally experience no unacceptable lethal toxicity when exposed to sediment from the BASF site. For midge sub-lethal effects, some toxicity is noted in other samples.

5.2.2.1 Primary Endpoints (Survival and Growth)

Midge survival surpassed 80% in all samples except SD-30 (22.5%). For this test to be considered valid, USEPA Method 100.2 has a test acceptability criterion of 70% survival in the laboratory control. Rates of survival >80% are not indicative of an impacted area. Midge survival was reduced >20% only in sample SD-30 when compared to the laboratory control, the reference sample, SD-45 and the pooled reference.

Overall growth (AFDW) surpassed 0.9 mg per organism in all samples except SD-30 (0.54 mg). For a test to be considered valid, USEPA Method 100.2 has a test acceptability criterion of 0.6 mg per organism in the laboratory control. Rates of growth seen in all samples (except SD-30; AFDW = 0.54 mg/organism) are likely not indicative of an impacted area. However, for growth, samples were >20% reduced when compared to: the laboratory control (SD-30, SD-32, SD-50); SD-45 (SD-30, SD-32, SD-39, SD-40, SD-50 and SD-58); and the pooled reference (SD-30, SD-32, SD-39, SD-40, and SD-50) (**Table 5-3**).

5.2.2.2 Secondary Endpoint (Biomass)

Biomass was reduced compared to the laboratory control, SD-45, and the pooled reference in several samples. Biomass was >20% reduced in SD-30, SD-32, SD-39, SD40 and SD-50. In addition, biomass in SD-58 was 79% of SD-45 (**Table 5-3**).

5.2.3 Summary

The review of the sediment toxicity testing results indicated the following:

- No statistically significant toxicity was reported for amphipod survival compared to laboratory controls or SD-45. While some samples were statistically significantly different from the pooled reference samples, no sample yielded less than 91% survival, indicating that this receptor is not experiencing any adverse lethal impacts from exposure to Site-related COPC.

- Amphipod growth and biomass were reduced compared to laboratory controls and the reference data (individual and pooled reference samples) in one sample, SD-30. Other than this single sample, the growth ranged from 84-101% of laboratory control, 81-97% of SD-45, and 82-98% of the pooled reference. Biomass, without SD-30, ranged from 87 to 101% of laboratory control. 82-96% of SD-45, and 80-94% of the pooled reference. These data indicate that this receptor, with the possible exception of sampling location SD-30, is not experiencing any unacceptable adverse sub-lethal impacts from exposure to Site-related COPC.
- Statistically significant toxicity was reported for midge survival compared to laboratory controls and reference samples. Other than SD-30, which exhibited toxicity (survival 22.5%), survival ranged from 87.5- 98.8% which is 90 - 102% of laboratory control survival, 95 – 107% of SD-45 survival, and 102 -116% of the pooled reference survival. Review of these data indicates that, with the exception of sampling location SD-30, this receptor is not experiencing any unacceptable adverse lethal impacts from exposure to Site-related COPC.
- Similar trends were noted relative to midge growth and biomass endpoints. Some samples exhibited reduced growth or biomass relative to the laboratory control. Other than SD-30, growth ranged from 69 - 95% of laboratory control AFDW, 61 – 85% of SD-45 AFDW, and 63 -87% of the pooled reference AFDW.
- Biomass ranged from 69 - 93% of laboratory control, 66 – 90% of SD-45, and 73 -98% of the pooled reference. In SD-30, growth and biomass were 36% and 10%, respectively, of the pooled reference results.
- At the intermediate range of barium concentrations (1,180 to 2,705 mg/Kg), no significant effects were observed on amphipod survival and growth and midge survival with the exception of comparison to reference.
- Effects on midge growth were variable. However, for 3 of the 4 toxicity testing endpoints, no effects were observed. For the 4th endpoint (midge growth), some but not all of the data points suggested adverse effects).
- At the highest concentration (15,300 mg/Kg), no significant effects were observed on amphipod survival. Significant effects were observed on midge survival, amphipod growth, and midge growth. (i.e., the toxicity tests demonstrated impacts for 3 of the 4 endpoints at sampling location SD-30 (15,300 mg/kg).

Based on the above findings, only one of the Site sediment samples (SD-30) consistently exhibited biologically significant responses for midge survival, growth and biomass, and amphipod survival, growth and biomass. For three of the four toxicological endpoints evaluated in the risk assessment (midge survival, amphipod survival, amphipod growth), no adverse impacts to benthic invertebrates were observed in the toxicity testing program. However, for one toxicological endpoint (midge growth), the toxicity testing program suggests potential risk to this receptor.

5.2.4 SEM, AVS, and TOC Evaluation

The results of the SEM, AVS, and TOC analysis (**Table 5-4**) indicate that sulfides and organic carbon are expected to limit the bioavailability and toxicity of the divalent metals.

When only the binding potential with sulfides is considered (SEM:AVS and SEM-AVS), the results indicate that the divalent metals present in all samples (except SD-25) were unlikely to be bioavailable and potentially toxic. When the binding capacity of TOC is also considered ($(\sum SEM\text{-}AVS)/f_{oc}$), toxicity

appears to be unlikely at all locations except SD-25 ((∑SEM-AVS)/f_{oc} = 136.8 µmol/g_{oc}), which was just above the guideline for 130 µmol/g_{oc} indicating potential availability. For most samples, including all samples where toxicity was observed in the laboratory toxicity tests, the available sulfides and TOC were adequate to bind the divalent metals and the resulting values for (∑SEM-AVS)/f_{oc} were < 130 µmol/g_{oc}.

No toxicity was noted in SD-25, the station with the highest ∑SEM-AVS)/f_{oc} value. Furthermore, SD-30, the station with the most apparent benthic toxicity, was characterized as "not likely to be toxic", with an SEM/AVS well below 1 (0.4). These results suggest that divalent metals are likely not responsible for the observed toxicity in sediment from location SD-30.

As indicated previously (Section 4.1.3), USEPA (2005a) states that chromium toxicity would be unlikely in sediment samples where AVS is detected. AVS was detected in all Lake Macatawa sediment samples. Therefore, given the amount of AVS present in the sediments from Lake Macatawa, chromium is not expected to contribute to toxicity.

5.3 Benthic Toxicity Interpretation

The results of the SEM/AVS testing indicate that the divalent metals silver, cadmium, copper, nickel, lead and zinc are not likely to be causing the observed toxicity to the midge at Station SD-30 (**Table 5-4**). Similarly, it is unlikely that chromium, due to the abundance of AVS present in all samples except SD-25 (where AVS was still detected, but at a low level), is causing toxicity at SD-30.

Concentrations of the VOCs measured in the Lake Macatawa sediment samples (1,3-dichlorobenzene, 1,4-dichlorobenzene, benzene, chlorobenzene, and the xylene compounds) are mostly non-detect and below the ESLs. Therefore, it is unlikely that the VOCs are contributing to the observed toxicity. Concentrations of VOCs relative to midge survival are provided in **Figure 5-1** (Chlorobenzene) and **Figure 5-2** (total VOCs). Other VOCs were more than 50% non-detect and were therefore not presented. These plots indicate no relationship between VOC concentrations and midge survival. Review of these figures indicates that the highest levels of VOCs were not found in sampling station SD-30, the sample with the highest level of benthic toxicity. Rather, the samples with the highest concentrations of chlorobenzene and the highest concentration of total VOCs has >80% midge survival.

A similar set of figures is provided for potential physical stressors (TOC [**Figure 5-3**] and grain size as percent fines [**Figure 5-4**]). None of these factors appear to have a relationship to the results of the toxicity texts. All of these charts show the same pattern. The majority of the potential stressor data are clustered, with the one survival (SD-30) data point shown as an outlier.

Given that neither VOCs, nor divalent metals, nor chromium, nor physical factors are likely contributing to the observed toxicity, the arsenic and barium data were reviewed respective to the adverse effects noted in the midge toxicity testing. The concentrations of arsenic and barium in the samples submitted for toxicity testing were evaluated, on a sample-by-sample basis, to see if any concentration-response trends could be elucidated. In addition, simple linear regression techniques were used to determine whether any relationship exists between the concentrations of these two COPCs and the observed toxicity. These regressions are provided in **Appendix C**.

Arsenic concentrations were generally low. Only one sample (SD-32, which did not demonstrate reduced survival) had arsenic present above the ESL (SD-32 = 10.4 mg/Kg compared to an ESL of

9.79 mg/Kg). A regression analysis of arsenic concentrations and midge survival data indicates no relationship (R^2 = 0.002) with no significance (p = 0.9) (**Figure 5-5**)

Barium concentrations demonstrated a stronger relationship to the midge toxicity and biomass. Regression analysis of midge survival and barium indicated a strong relationship (R^2 = 0.83) with significance (p = 0.000). The relationship appears to be largely driven by the high concentration in SD-30 (15,300 mg/Kg) and the low survival in that sample (**Figure 5-6**).

The results of the regression analysis indicate that the strongest relationships between midge toxicity and COPCs are associated with barium. Therefore, further evaluations of barium concentrations and midge toxicity testing data were conducted to evaluate potential relationships between surficial barium concentrations and the three toxicological endpoints available from the Site-specific toxicity testing program (1) midge survival (primary endpoint), (2) midge growth (AFDW) (primary endpoint), and (3) midge biomass. As discussed in the uncertainty evaluation (Section 6.1), there are some uncertainties with this analysis due to a barium concentration gap in the data set (no toxicity tests were conducted on samples with barium concentrations between 15,300 and 2,705 mg/Kg)

In order to help understand the uncertainties associated with the barium concentration gap, the data from SD-30 were removed from the regression analysis for survival to determine if the remaining samples (i.e., samples with barium concentrations ranging from 140 to 2,705 mg/Kg) demonstrated a relationship between barium and survival. Survival demonstrated no relationship (R^2 = 0.14) with no significance (p = 0.23) (**Figure 5-7**).

Regression analyses were conducted for barium and midge growth (AFDW) and midge biomass to determine if any relationship was evident.. Growth demonstrated a moderate and significant relationship (R^2 = 0.55, p = 0.003) (**Figure 5-8**). Biomass exhibited a strong relationship (R^2 = 0.87; p = 0.00) (**Figure 5-9**). When SD-30 was removed, the relationships were less strong (although both were significant with $p < 0.05$). The R^2 for barium and growth was 0.45 (**Figure 5-10**) and the R^2 for biomass and barium was 0.47 (**Figure 5-11**).

This analysis suggests that the slightly reduced survival, growth, and biomass in samples other than SD-30 may not be linked solely to barium (**Figure 5-7**), and that the high concentration of 15,300 mg/Kg barium in SD-30 truly “drives” the observed relationship between barium and toxicity.

6.0 Uncertainty Analysis

An Uncertainty Evaluation was presented in the Ecological Evaluation (**Appendix A**) to address uncertainties associated with the fish dietary pathway evaluation, the wildlife dietary pathway evaluation, and the BSAFs used in each evaluation to model prey tissue concentrations. This evaluation remains valid based on the updated analyses presented in this BERA. Uncertainties associated with the sediment toxicity tests and the SEM, AVS, and TOC evaluation are presented in the sections below.

6.1 Uncertainties Associated with Sediment Toxicity Tests

Although the results of toxicity tests can be used to evaluate potential effects that might occur to aquatic receptors *in situ*, it is important to recognize that:

- Mobile organisms may be able to avoid prolonged exposure to contaminated media.
- Although the tests are designed to predict adverse effects on biological communities, they are not multi-generation chronic tests, in that they do not consider population effects by assessing potential effects over several generations during the test period.
- Toxicity to organisms in situ may be dependent upon physical characteristics and equilibrium partitioning that is not replicated under laboratory conditions.
- The species used in toxicity testing programs are typically chosen to be representative and protective of the organisms which may be found on site, but the use of surrogate species cannot precisely predict the health of ecological communities on site.

Laboratory toxicity tests are normally conducted with species that are highly sensitive to contaminants in the media of exposure. Guidance manuals from the American Society for Testing and Materials (ASTM) (ASTM, 2010) contain lists of these organisms that they consider to be sensitive enough to be protective of naturally occurring organisms at a site. However, reaction of all species to a COPC is not known, and species found in Lake Macatawa adjacent to the BASF Site might be more or less sensitive than those used in the laboratory toxicity testing.

In addition, species introduced to test media have not been acclimated to Site conditions. Species found within a particular site have usually been naturally acclimated to certain physical and chemical conditions and potential stressors. When organisms from a controlled laboratory environment are introduced to media collected from the site, they are often susceptible to these stressors, and may have adverse reactions that are not indicative of site conditions.

Field and laboratory manipulation of sediment prior to the introduction of laboratory test organisms may alter the bioavailability of COPCs. Sediment in its native state is often at some degree of chemical equilibrium. When samples are collected, they are homogenized, sieved, and otherwise handled prior to testing. This can alter the bioavailability of COPCs, making them more or less available to test organism exposure. VOCs, for instance, can be lost during this process.

If a toxic impact is observed in a toxicity test, there may not be a causal relationship between the toxic effect and measured chemical concentrations in the sediment. Physical properties of sediment (e.g.

carbon content or grain size) may also impact the ability of test organisms to survive and grow. Alternatively, unidentified and unmeasured chemicals may also be present. Lake Macatawa is not a pristine system and non-Site related stressors (e.g., discharges and releases from other industrial contributors on the lake) are expected to be present in sediments including the sediments near the Site. Only those constituents related to the Site should be considered as potential causative factors in the observed toxicity testing results.

The range of barium concentrations between the highest no observed effect concentration (2,705 mg/Kg) and the lowest observed effect concentrations (15,300 mg/Kg) is a source of uncertainty for the sediment toxicity tests. It is uncertain where the threshold for midge survival and growth for both test organisms occurs within this range of 2,705 to 15,300 mg/Kg. To account for some of this uncertainty, maximum acceptable toxicant concentrations (MATCs) were developed for midge and amphipod survival and growth (as AFDW). MATC development is presented in **Appendix D.** MATCs represent the geometric mean of NOEC and LOECs from the toxicity testing data. Based on the results of the chemical analysis of the reference samples, SD-45, the sample most similar to the site samples, was used to establish NOECs and LOECs. A > 20% reduction in response, compared to the reference condition at SD-45, was used as the benchmark. MATCs for amphipods and midge are presented in **Tables 6-1** and **6-2**, respectively.

- MATCs for midge survival and amphipod growth were 6,433 mg/Kg, calculated as the geometric mean of 2,705 and 15,300 mg/Kg.
- For amphipod survival, no LOEC was established, so the MATC is the NOEC of 15,300 mg/Kg.
- Midge growth was reduced at lower concentrations, and the resulting MATC was 1,330 mg/Kg (based on a NOEC of 1,500 mg/Kg and a LOEC of 1,180 mg/Kg).

Based on these calculations, three of the four primary endpoints are protected at 6,400 mg/Kg barium.

As described by Pfizer (2009; Final Sediment Assessment Report) for their Holland, Michigan site, MDEQ (2002) has indicated that widespread eutrophication, such as that found on Lake Macatawa due to shoreline development, can substantially impact the benthic invertebrate community. The eutrophication is due largely to phosphorous loading, and MDEQ has developed a TMDL (total maximum daily load) for phosphorous on Lake Macatawa (MDEQ, 1999). MDEQ's historic sampling exhibited communities strongly dominated by tolerant groups of macroinvertebrates, including chironomids and oligochaetes.

The interpretation of the laboratory toxicity testing for the Pfizer site indicated that the growth reduction observed in one of two species tested would be small compared to the effects of the background influences of eutrophication and habitat alterations. These physical and nutrient impacts may have impacted the toxicity testing results from this BASF program as well. Further, given that MDEQ has indicated that the macroinvertebrate community in the lake is dominated by a healthy chironomid community, it is unlikely that sub-lethal impacts associated with midge exposure to sediments near the BASF facility are contributing to an overall decline in the chironomid communities.

Lastly, the toxicity tests conducted for this study were sub-chronic tests. Although no significant toxicity was observed in all but one sample (SD-30), it is unknown how organisms would respond if longer duration chronic tests were conducted at this Site.

6.2 Uncertainties Associated with SEM, AVS, and TOC Evaluation

There are a number of uncertainties associated with the SEM, AVS, and TOC data evaluation which may over or under estimate risks. AVS formation is affected by a number of abiotic and biotic factors, including temperature, redox conditions, sediment resuspension, seasonal changes, and sulfate concentrations. AVS tends to be produced during the warmer summer months. Sampling in August, as was done for this program, may bias the interpretation of the data. However, sampling of the shallow horizon (0 to 2 cm) helps negate this bias and it is unlikely that this influenced the results of the BERA.

The SEM, AVS, and TOC data evaluation approach is based on equilibrium partitioning theory, which assumes a steady-state system (USEPA, 2005a). This assumption may or may not be as valid in field conditions as it is in laboratory tests of the method. In addition, the SEM, AVS, and TOC data evaluation approach does not take into account possible toxicity from any other inorganic constituents detected in the sediment, and does not explicitly consider bioaccumulation or ingestion of contaminated sediment.

There are also uncertainties associated with the evaluation of $(\sum SEM\text{-}AVS)/f_{oc}$. Normalization of SEM-AVS to fraction organic carbon reduces the variability in exposure assessments, especially in laboratory experiments. There is some uncertainty in extrapolating these relationships into field conditions. In particular, there is evidence that the effect of organic carbon on bioavailability depends on the nature of the organic carbon (USEPA, 2005a).

6.3 Uncertainties Associated with Barium Toxicity in Freshwater Sediment

The regression analyses for barium sediment concentrations and toxicity test results (**Appendix C**) suggest potential relationships between midge survival or midge growth, and barium concentrations. However, these relationships appear to be driven by the maximum concentration detected in sample SD-30 (15,300 mg/Kg) and the low survival and growth in that sample; when this sample is removed from the regression analysis, there is a weaker relationship between barium concentrations and survival/growth. Overall, approximately 50% of the variability in midge growth data (55% with SD-30 and 45% with SD-30 removed) could be accounted for by barium concentrations. For survival, most (82%) variability was explained with SD-30 included in the regression, but with the outlier (SD-30) removed, this accounting dropped to 14%. These results indicate that there may be other factors strongly contributing to the adverse effects on midge noted in the toxicity testing. No other Site-related constituent was significantly correlated with the toxicity testing results data, and factors such as TOC and grain size also did not exhibit any relationship with the toxicity testing results. A recent evaluation of *Hyalella* and *Chironomus* toxicity results from seven metropolitan areas in the United States reported similar results (mixed toxicity), although in their case the amphipod was more sensitive than the midge. In this study (Kemble et al. 2013), the correlations between priority pollutants and toxicity were weak, and the authors suggested that in urbanized settings residential pesticides (e.g., pyrethroid pesticides such as bifenthrin) may be stressors of concern. Given the setting of the Lake Macatawa watershed, and observations by MDEQ relative to the overall health and eutrophication of the lake, it is possible that chemicals or stressors other than priority pollutants may have contributed to the midge sub-lethal toxicity results.

Studies examining the toxicity of barium to freshwater organisms are limited. In a review of barium toxicity (World Health Organization [WHO], 2001), the range of concentrations at which barium in surface water is toxic to freshwater organisms (based on survival and growth) ranged from 5.8 milligrams per liter (mg/L) during a 21-day test for daphnids, 122-238 mg/L LC50 (lethal concentration for 50% of organisms) for a 96-hr test of amphipods, to 500 mg/L LC50 for sheepshead minnow.

These concentrations represent relatively high levels of barium in surface waters and therefore, it was concluded that only high levels of barium may pose risk to aquatic organisms (WHO, 2001). Based on a review of toxicity studies available in ECOTOX (http://cfpub.epa.gov/ecotox/) for freshwater invertebrate and fish exposed to barium in surface water, lethal concentrations (based on acute and chronic tests) ranged up to 76,000 mg/L with an average lethal concentration of approximately 2,400 mg/L. Data for the exposure of freshwater sediment invertebrates to barium could not be located. Like many metals, it is likely that the potential toxicity of barium to benthic organisms depends on the solubility of the metal.

Soluble forms of barium have much higher absorption efficiencies than insoluble forms and thus, are more toxic (McGinty et al., 2007). Insoluble forms of barium include barium sulfate and carbonate salts which are formed when soluble barium reacts in water with sulfates and carbonates (USEPA, 2005b). Barium sulfate is a major constituent of drilling muds and no mortality was observed for marine invertebrates and fish exposed to levels as high as 7,500 mg/Kg (WHO, 2001). Barium may also be limited by organic matter content; in soils, barium solubility and mobility increased with decreasing organic matter (USEPA, 2005b). Therefore, the high TOC levels measured in the Site sediment samples (generally 5-8% in samples in the toxicity tests) may limit the toxicity of barium.

The barium concentration detected in SD-30 (15,300 mg/Kg) was the only linkage between the midge toxicity and COPC concentrations. Given the paucity of literature on the potential toxicity of sediment-associated barium to freshwater invertebrates, it is unknown if this concentration would be expected to cause toxicity, or if the observed toxicity was due to other, non-Site related factors. The second highest concentration of barium was detected in SD-32 (2,705 mg/Kg). SD-32 did not demonstrate any reductions in midge mortality; survival was greater than the laboratory control and all reference samples.

7.0 BERA Summary and Conclusions

The findings of the BERA are summarized for each assessment endpoint below.

Benthic Invertebrate Community:

- Based on the August 2015 sediment chemistry dataset, Site-related COPCs are present at concentrations that exceed Region 5 ESLs.
  - Based on the screening of updated sediment data, detected concentrations of arsenic, barium, cadmium, chromium, copper, lead, zinc, benzene, chlorobenzene, total xylene, o-xylene, and 1,4-dichlorobenzene in sediment are greater than the Region 5 ESLs. Concentrations of m,p-xylene were below the ESL.
  - These COPCs are identical to the list of COPCs presented in the AECOM (2015) Ecological Evaluation.
- Evaluation of the SEM, AVS, and TOC results indicates that for all but one sample (SD-25), the available sulfides and TOC were adequate to bind the divalent metals and therefore these metals were unlikely to be bioavailable and potentially toxic. The $(\sum SEM\text{-}AVS)/f_{oc}$ value for SD25 was slightly higher than the 130 $\mu mol/g_{oc}$ threshold. However, SD-25 did not demonstrate any toxicity to either the amphipod or the midge. This suggests that divalent metals are largely not bioavailable.
- In the presence of AVS, chromium is not likely to be bioavailable.
- The results of the toxicity test indicate no lethal or sub-lethal toxicity for amphipod when compared to laboratory controls and reference samples. Survival in all amphipod tests exceeded 90%, well above USEPA test acceptability criteria. Likewise, growth endpoints from only one sampling location (SD-30) differed substantively from reference conditions.
- The midge toxicity testing data exhibited slightly more toxicity than the amphipod (for which toxicity was essentially not existent). With the exception of one sample (SD-30, which exhibited toxicity [survival 22.5%]), survival ranged from 90 to 102% of laboratory control survival and 95 to 107% of the reference sample SD-45 survival. Growth in several samples was statistically different from the laboratory controls or reference samples.
- Review of the Site barium and midge toxicity testing data demonstrated a relationship between barium and midge survival, indicating that barium may be causing impairment to the midge. No other COPCs demonstrated a strong relationship, and very weak relationships were noted when SD-30 was removed from the evaluation.
- A weak relationship was noted between barium concentrations and non-lethal midge endpoints. Some samples with lower barium concentrations (i.e., < 15,300 mg/Kg) had significant growth effects, but the results were variable and do not support a strong relationship between reduced growth and barium concentrations.
- Using SD-45 as the best fit reference condition, LOECs and NOECs were determined for the four primary endpoints: midge survival, amphipod survival, midge growth and amphipod growth. The geometric mean of the NOEC and LOEC for each endpoint was determined as

the MATC. The MATC is a value commonly calculated to estimate reasonable effects concentrations from toxicity testing data. The MATCs were:

- 6,443 mg/Kg for midge survival;
- 15,300 mg/Kg for amphipod survival (no effects noted; MATC equal to NOEC)
- 1,330 mg/Kg for midge growth, and
- 6,443 mg/Kg for amphipod growth.

- For three of these four endpoints, 6,400 mg/Kg barium is an acceptable MATC. If the secondary endpoint, biomass, is considered, the results are the same as for growth.
- The results of this toxicity testing program are similar to those conducted in 2008 at a nearby facility (Pfizer, Inc.), where two species were tested, and three of four endpoints indicated no risk to benthic receptors, but one sub-lethal endpoint indicated a possible risk to these receptors. Based on information from MDEQ as cited in the Pfizer (2009) report, it is possible that the one sub-lethal result that indicated a possible risk to benthic receptors is related to the overall health of Lake Macatawa, which has been compromised by shoreland development and resulting eutrophication. These factors may also have impacted the results of BASF toxicity testing effort.

Fish Dietary Pathway Evaluation:

- As presented in Appendix A, there is no unacceptable risk to fish from the dietary exposure pathway.

Wildlife Dietary Pathway Evaluation:

- As presented in Appendix A, no unacceptable ecological risks are expected for dietary exposure for fish, birds, or mammalian wildlife.

7.1 Conclusions

Based the weight-of-evidence approach presented herein, the following BERA conclusions were reached:

- There is no unacceptable risk to fish or wildlife receptors from potential exposure to sediments in Lake Macatawa.
- The results of the benthic toxicity testing program indicate that there is a limited potential for benthic toxicity associated with exposure to barium in surficial sediments.
- Multiple lines of evidence were reviewed in order to develop barium effects concentrations that are protective of benthic ecological receptors. For three of the four toxicological endpoints evaluated in the risk assessment (midge survival, amphipod survival, amphipod growth), the risk assessment determined that a barium concentration of approximately 6,400 mg/Kg is protective of benthic receptors. However, for one toxicological endpoint (midge growth), the risk assessment suggests that a lower barium concentration (1,300 mg/Kg) is protective, although there is considerably more uncertainty with this value than the 6,400 mg/Kg value.
- It is recommended that the barium preliminary remedial goal (PRG) for the former BASF site be based on the geometric mean of midge survival NOEC and LOEC, which is also protective

of amphipod growth and survival (i.e., approximately 6,400 mg/Kg barium is recommended as the PRG for surficial sediments at this Site).

8.0 References

*Additional references specific to the Ecological Evaluation are found in **Table 28** of **Appendix A**.*

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Tables

Table 2-1
Sub-Surface Sediment Samples Collected in 2015
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data
Former BASF Corporation Howard Avenue Facility, Holland, MI

Sample	Depth (ft)	Analyses	
Site Samples		Barium	Copper
SD28-0.5-2.0-15A-S	0.5 - 2 ft	X	X
SD28-2.0-4.0-15A-S	2 - 4 ft	X	X
SD28-4.0-6.0-15A-S	4 - 6 ft	X	X
SD28-6.0-8.0-15A-S	6 - 8 ft	X	X
SD30-0.5-2.0-15A-S	0.5 - 2 ft	X	X
SD30-2.0-4.0-15A-S	2 - 4 ft	X	X
SD30-4.0-6.0-15A-S	4 - 6 ft	X	X
SD30-6.0-8.0-15A-S	6 - 8 ft	X	X
SD30-8.0-10.0-15A-S	8 - 10 ft	X	X
SD31-0.5-2.0-15A-S	0.5 - 2 ft	X	X
SD31-2.0-4.0-15A-S	2 - 4 ft	X	X
SD31-4.0-6.0-15A-S	4 - 6 ft	X	X
SD31-6.0-8.0-15A-S	6 - 8 ft	X	X
SD32-0.5-2.0-15A-S	0.5 - 2 ft	X	X
SD32-2.0-4.0-15A-S	2 - 4 ft	X	X
SD32-4.0-6.0-15A-S	4 - 6 ft	X	X
SD32-6.0-8.0-15A-S	6 - 8 ft	X	X
SD36-0.5-2.0-15A-S	0.5 - 2 ft	X	X
SD36-2.0-4.0-15A-S	2 - 4 ft	X	X
SD36-4.0-6.0-15A-S	4 - 6 ft	X	X
SD36-6.0-8.0-15A-S	6 - 8 ft	X	X
SD50-0.5-2.0-15A-S	0.5 - 2 ft	X	X
SD50-2.0-4.0-15A-S	2 - 4 ft	X	X
SD50-4.0-6.0-15A-S	4 - 6 ft	X	X
SD50-6.0-7.5-15A-S	6 - 7.5 ft	X	X
SD53-0.5-2.0-15A-S	0.5 - 2 ft	X	X
SD53-2.0-4.0-15A-S	2 - 4 ft	X	X
SD53-4.0-6.0-15A-S	4 - 6 ft	X	X
SD53-6.0-8.0-15A-S	6 - 8 ft	X	X

Notes
ft = feet

Table 2-2
Surface Sediment Samples Collected in 2015
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Sample	Depth (ft)	Analyses					
Site Samples		**Grainsize**	**Metals**	**TOC**	**VOCs**	**Toxicity Testing**	**SEM/AVS**
SD25-0-0.5-15A-S	0 - 0.5	X	X	X	X	X	X
SD28-0-0.5-15A-S	0 - 0.5		X		X		
SD30-0-0.5-15A-S	0 - 0.5	X	X	X	X	X	X
SD31-0-0.5-15A-S	0 - 0.5		X		X		
SD32-0-0.5-15A-S	0 - 0.5	X	X	X	X	X	X
SD32-0-0.5-15A-D (field duplicate)	0 - 0.5		X				
SD36-0-0.5-15A-S	0 - 0.5		X		X		
SD36-0-0.5-15A-D (field duplicate)	0 - 0.5				X		
SD39-0-0.5-15A-S	0 - 0.5	X	X	X	X	X	X
SD39-0-0.5-15A-D (field duplicate)	0 - 0.5		X	X			
SD40-0-0.5-15A-S	0 - 0.5	X	X	X	X	X	X
SD40-0-0.5-15A-D (field duplicate)	0 - 0.5	X					X
SD50-0-0.5-15A-S	0 - 0.5	X	X	X	X	X	X
SD53-0-0.5-15A-S	0 - 0.5		X		X		
SD54-0-0.5-15A-S	0 - 0.5	X	X	X	X	X	X
SD55-0-0.5-15A-S	0 - 0.5	X	X	X	X	X	X
SD58-0-0.5-15A-S	0 - 0.5	X	X	X	X	X	X
SD59-0-0.5-15A-S	0 - 0.5	X	X	X	X	X	X
Background/Reference							
SD45-0-0.5-15A-S	0 - 0.5	X	X	X	X	X	X
SD46-0-0.5-15A-S	0 - 0.5	X	X	X	X	X	X
LM-08-13-0-0.5-15A-S	0 - 0.5	X	X	X	X	X	X
LM-08-13-0-0.5-15A-D (field duplicate)	0 - 0.5		X				

Notes
ft = feet
TOC = Total Organic Carbon
VOCs = Volatile Organic Compounds
SEM/AVS = Simultaneously Extracted Metals/Acid Volatile Sulfide

Table 2-3
Sediment Grain Size Results - Surface Sediment
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

		COARSE SAND %	FINE SAND %	GRAVEL %	MEDIUM SAND %	TOTAL CLAY %	TOTAL SAND %	TOTAL SILT %
Sample ID	Depth Interval							
Site Locations								
SD25-0-0.5-15A-S	0 - 0.5 ft	1	78.6	0	10.6	3.1	90.2	6.7
SD30-0-0.5-15A-S	0 - 0.5 ft	0	7.6	0	3	54.9	10.6	34.5
SD32-0-0.5-15A-S	0 - 0.5 ft	0	16.6	0	3.2	35.3	19.8	44.9
SD39-0-0.5-15A-S	0 - 0.5 ft	0	14.4	0	2.1	36.1	16.5	47.4
SD40-0-0.5-15A-D	0 - 0.5 ft	0.3	10.3	0	3	49	13.6	37.4
SD40-0-0.5-15A-S	0 - 0.5 ft	0	12	0	2.1	50.6	14.1	35.3
SD50-0-0.5-15A-S	0 - 0.5 ft	0	15.6	0	3.6	36.5	19.2	44.3
SD54-0-0.5-15A-S	0 - 0.5 ft	0	15.3	0	2.7	37.6	18	44.4
SD55-0-0.5-15A-S	0 - 0.5 ft	0.9	18.9	0	3.9	37	23.7	39.3
SD58-0-0.5-15A-S	0 - 0.5 ft	0	17.9	0	2.9	33.6	20.8	45.6
SD59-0-0.5-15A-S	0 - 0.5 ft	0	11.7	0	2	38.8	13.7	47.5
Background/Reference Locations								
SD45-0-0.5-15A-S	0 - 0.5 ft	0.9	45.2	0	4.9	17.2	51	31.8
SD46-0-0.5-15A-S	0 - 0.5 ft	5	25.5	1.8	62.5	2.5	93	2.7
LM-08-13-0-0.5-15A-S	0 - 0.5 ft	1.8	59.5	0.2	30.4	3.4	91.7	4.7

Notes:
% = percent
ft = foot

Table 2-4
Metals Results - Surface Sediment
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

		ARSENIC mg/Kg	BARIUM mg/Kg	CADMIUM mg/Kg	CHROMIUM mg/Kg	COPPER mg/Kg	LEAD mg/Kg	ZINC mg/Kg
Sample ID	Depth Interval							
Site Locations								
SD25-0-0.5-15A-S	0 - 0.5 ft	4.5	140	0.38	41.9	131	15.7 J	86.1
SD28-0-0.5-15A-S	0 - 0.5 ft	8	1090	0.97	49.1	90.1	41.9 J	165
SD30-0-0.5-15A-S	0 - 0.5 ft	8.1 J	15300 J	1.8 J	242 J	337 J	99.8 J	262 J
SD31-0-0.5-15A-S	0 - 0.5 ft	8.6 J	10700 J	1.7 J	143 J	233 J	91.3 J	251 J
SD32-0-0.5-15A-D	0 - 0.5 ft	9.1 J	2790 J	1.4 J	101 J	252 J	66.9 J	221 J
SD32-0-0.5-15A-S	0 - 0.5 ft	10.4 J	2620 J	1.5 J	105 J	314 J	72.6 J	231 J
SD36-0-0.5-15A-S	0 - 0.5 ft	7.6	1390	1.8	145	151	81.5 J	264
SD39-0-0.5-15A-D	0 - 0.5 ft	8.2 J	2440 J	1.5 J	126 J	207 J	110 J	237 J
SD39-0-0.5-15A-S	0 - 0.5 ft	4.8 J	1110 J	0.89 J	66 J	119 J	43 J	134 J
SD40-0-0.5-15A-S	0 - 0.5 ft	8.3 J	1500 J	1.4 J	91.8 J	183 J	63.1 J	197 J
SD50-0-0.5-15A-S	0 - 0.5 ft	8.7 J	961 J	1.3 J	68.8 J	89.1 J	55.9 J	208 J
SD53-0-0.5-15A-S	0 - 0.5 ft	10.3 J	9490 J	2 J	398 J	271 J	117 J	291 J
SD54-0-0.5-15A-S	0 - 0.5 ft	7.8	750	1.2	50	61.6	42.6 J	178
SD55-0-0.5-15A-S	0 - 0.5 ft	8.3	1180	1.3	101	122	57.5 J	207
SD58-0-0.5-15A-S	0 - 0.5 ft	7.8	286	1.1	46.6	58.3	40.4 J	181
SD59-0-0.5-15A-S	0 - 0.5 ft	7.4	217	0.86	35.4	51.4	35.2 J	166
Background/Reference Locations								
SD45-0-0.5-15A-S	0 - 0.5 ft	4.1	87.3	0.48	15.3	18.9	16.2 J	77.5
SD46-0-0.5-15A-S	0 - 0.5 ft	1.1	15	0.063	5.3	2.7	2.9 J	15.3
LM-08-13-0-0.5-15A-D	0 - 0.5 ft	0.75	23.6	0.12	5.6	5.4	4.6	22.7
LM-08-13-0-0.5-15A-S	0 - 0.5 ft	0.58	18	0.1	4.8	3.8	3.1 J	16.7

Notes:
mg/Kg = milligrams per kilogram
ft = foot
J = Estimated Value

Table 2-5
Metals Results - Sub-Surface Sediment
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report Former BASF Corporation Howard Avenue Facility, Holland, MI

		BARIUM mg/Kg	COPPER mg/Kg
Sample ID	Depth Interval		
Site Locations			
SD28-0.5-2.0-15A-S	0.5 - 2 ft	3440	342 J
SD28-2.0-4.0-15A-S	2 - 4 ft	403	1030 J
SD28-4.0-6.0-15A-S	4 - 6 ft	45.5	19.4 J
SD28-6.0-8.0-15A-S	6 - 8 ft	12.1	1.1 J
SD30-0.5-2.0-15A-S	0.5 - 2 ft	19800	501 J
SD30-2.0-4.0-15A-S	2 - 4 ft	5080	1160 J
SD30-4.0-6.0-15A-S	4 - 6 ft	293	8660 J
SD30-6.0-8.0-15A-S	6 - 8 ft	98.9	12.7 J
SD30-8.0-10.0-15A-S	8 - 10 ft	17.1	2.6 J
SD31-0.5-2.0-15A-S	0.5 - 2 ft	9560	114 J
SD31-2.0-4.0-15A-S	2 - 4 ft	3080	413 J
SD31-4.0-6.0-15A-S	4 - 6 ft	232	811 J
SD31-6.0-8.0-15A-S	6 - 8 ft	68.2	8.1 J
SD32-0.5-2.0-15A-S	0.5 - 2 ft	2760	105 J
SD32-2.0-4.0-15A-S	2 - 4 ft	1690	408 J
SD32-4.0-6.0-15A-S	4 - 6 ft	218	203 J
SD32-6.0-8.0-15A-S	6 - 8 ft	49.5	5.6 J
SD36-0.5-2.0-15A-S	0.5 - 2 ft	4170	80.4 J
SD36-2.0-4.0-15A-S	2 - 4 ft	1810	150 J
SD36-4.0-6.0-15A-S	4 - 6 ft	274	121 J
SD36-6.0-8.0-15A-S	6 - 8 ft	101	13.7
SD50-0.5-2.0-15A-S	0.5 - 2 ft	992	71.9
SD50-2.0-4.0-15A-S	2 - 4 ft	344	103
SD50-4.0-6.0-15A-S	4 - 6 ft	4.9	1.9
SD50-6.0-7.5-15A-S	6 - 7.5 ft	6.3	2.3
SD53-0.5-2.0-15A-S	0.5 - 2 ft	1810	58.4
SD53-2.0-4.0-15A-S	2 - 4 ft	400	97
SD53-4.0-6.0-15A-S	4 - 6 ft	186	18.4
SD53-6.0-8.0-15A-S	6 - 8 ft	111	13.7

Notes:
mg/Kg = milligrams per kilogram ft = foot
J = Estimated value

Table 2-6
Volatile Organic Compounds (VOCs) - Surface Sediment
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

		1,3-DICHLOROBENZENE ug/Kg	1,4-DICHLOROBENZENE ug/Kg	BENZENE ug/Kg	CHLOROBENZENE ug/Kg	M,P-XYLENES ug/Kg	O-XYLENE ug/Kg	Xylene (Total) ug/Kg
Sample ID	Depth Interval							
Site Locations								
SD25-0-0.5-15A-S	0 - 0.5 ft	150	990	68 U	820	28 J	68 U	28 J
SD28-0-0.5-15A-S	0 - 0.5 ft	11 UJ	11 UJ	11 UJ	4.5 J	11 UJ	11 UJ	22 UJ
SD30-0-0.5-15A-S	0 - 0.5 ft	620 J	890 J	34 J	5800 J	350 J	660 J	1000 J
SD31-0-0.5-15A-S	0 - 0.5 ft	290 UJ	260 J	290 UJ	380 J	290 UJ	290 UJ	580 UJ
SD32-0-0.5-15A-S	0 - 0.5 ft	280 UJ	500 J	280 UJ	180 J	280 UJ	280 UJ	560 UJ
SD36-0-0.5-15A-D	0 - 0.5 ft	180 J	450	270 U	2100	270 U	270 U	550 U
SD36-0-0.5-15A-S	0 - 0.5 ft	180 J	460	260 U	2100	260 U	260 U	520 U
SD39-0-0.5-15A-S	0 - 0.5 ft	76 J	240	220 U	7900	220 U	35 J	35 J
SD40-0-0.5-15A-S	0 - 0.5 ft	290 UJ	320 J	210 J	9400 J	290 UJ	290 UJ	580 UJ
SD50-0-0.5-15A-S	0 - 0.5 ft	15 UJ	15 UJ	15 UJ	24 J	15 UJ	15 UJ	30 UJ
SD53-0-0.5-15A-S	0 - 0.5 ft	320 UJ	370 J	320 UJ	2900 J	320 UJ	320 UJ	640 UJ
SD54-0-0.5-15A-S	0 - 0.5 ft	14 UJ	14 UJ	14 U	16	14 U	14 U	29 U
SD55-0-0.5-15A-S	0 - 0.5 ft	16 UJ	16 UJ	16 U	160	16 U	16 U	32 U
SD58-0-0.5-15A-S	0 - 0.5 ft	16 U	16 U	16 U	16 U	16 U	16 U	31 U
SD59-0-0.5-15A-S	0 - 0.5 ft	14 UJ	14 UJ	14 U	2.8 J	14 U	14 U	28 U
BacKground/Reference Locations								
SD45-0-0.5-15A-S	0 - 0.5 ft	9 UJ	9 UJ	9 U	9 U	9 U	9 U	18 U
SD46-0-0.5-15A-S	0 - 0.5 ft	4.2 U	4.2 U	4.2 U	4.2 U	4.2 U	4.2 U	8.5 U
LM-08-13-0-0.5-15A-S	0 - 0.5 ft	5 U	5 U	5 U	5 U	5 U	5 U	10 U

Notes:
ug/Kg = micrograms per kilogram
ft = foot
J = Estimated Value
U = Non detect

Table 2-7
Total Organic Carbon (TOC) - Surface Sediment
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report Former BASF Corporation Howard Avenue Facility, Holland, MI

		TOTAL ORGANIC CARBON mg/Kg
Sample ID	Depth Interval	
Site Locations		
SD25-0-0.5-15A-S	0 - 0.5 ft	6300
SD30-0-0.5-15A-S	0 - 0.5 ft	78600
SD32-0-0.5-15A-S	0 - 0.5 ft	59400
SD39-0-0.5-15A-D	0 - 0.5 ft	51700
SD39-0-0.5-15A-S	0 - 0.5 ft	52900
SD40-0-0.5-15A-S	0 - 0.5 ft	62000
SD50-0-0.5-15A-S	0 - 0.5 ft	53500
SD54-0-0.5-15A-S	0 - 0.5 ft	54500
SD55-0-0.5-15A-S	0 - 0.5 ft	55300
SD58-0-0.5-15A-S	0 - 0.5 ft	57900
SD59-0-0.5-15A-S	0 - 0.5 ft	69700
Background/Reference Locations		
SD45-0-0.5-15A-S	0 - 0.5 ft	34200
SD46-0-0.5-15A-S	0 - 0.5 ft	1310
LM-08-13-0-0.5-15A-S	0 - 0.5 ft	6510

Notes:
mg/Kg = milligrams per kilogram ft = foot

Table 2-8
Simultaneously Extracted Metals (SEM) Acid Volatile Sulfide (AVS) - Surface Sediment
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

		CADMIUM umols/g	COPPER umols/g	LEAD umols/g	NICKEL umols/g	SILVER umols/g	ZINC umols/g	SULFIDE umols/g
Sample ID	Depth Interval							
Site Locations								
SD25-0-0.5-15A-S	0 - 0.5 ft	0.002527	0.05715 J-	0.03288	0.01558	0.0003 U	0.9337	0.18 J-
SD30-0-0.5-15A-S	0 - 0.5 ft	0.01185 J	0.05094 J	0.5166 J	0.3315 J	0.00081 UJ	3.339 UJ	2.5 J
SD32-0-0.5-15A-S	0 - 0.5 ft	0.01231 J	0.4561 J	0.3425 J	0.2308 J	0.0073 J	2.648 J	6.6 J
SD39-0-0.5-15A-S	0 - 0.5 ft	0.01163 J	1.551 J	0.3743 J	0.5496 J	0.005 J	2.701 J	200 J
SD40-0-0.5-15A-D	0 - 0.5 ft	0.01232 J	1.813 J	0.5243 J	0.7027 J	0.0079 J	3.193 J	120 J
SD40-0-0.5-15A-S	0 - 0.5 ft	0.01024	1.228 J-	0.4298	0.573	0.0054	2.653	100 J-
SD50-0-0.5-15A-S	0 - 0.5 ft	0.007275	0.02541 J-	0.1733	0.1121	0.0013	1.561	4.2 J-
SD54-0-0.5-15A-S	0 - 0.5 ft	0.003426	0.1561 J-	0.07863	0.06268	0.001	0.9081	6.6 J-
SD55-0-0.5-15A-S	0 - 0.5 ft	0.002588	0.04068 J-	0.06526	0.07895	0.0007 U	0.7846	5.2 J-
SD58-0-0.5-15A-S	0 - 0.5 ft	0.007346	0.3917 J-	0.1456	0.1404	0.0017	1.852	29 J-
SD59-0-0.5-15A-S	0 - 0.5 ft	0.002113	0.06752 J-	0.04532	0.03507	0.00069 U	0.6046	5.3 J-
Background/Reference Locations								
SD45-0-0.5-15A-S	0 - 0.5 ft	0.002957	0.1124 J-	0.05123	0.05111	0.00051 U	0.5996	6.7 J-
SD46-0-0.5-15A-S	0 - 0.5 ft	0.0004734	0.01982 J-	0.009558	0.01548	0.00028 U	0.1268	0.53 J-
LM-08-13-0-0.5-15A-S	0 - 0.5 ft	0.0007774	0.03435 J-	0.0123	0.01447	0.0003 U	0.1627	0.57 J-

Notes:
umols/g = micromoles per gram
ft = foot
J = Estimated Value
U = Non detect

Table 2-9
Results of Sediment Toxicity Testing - Amphipod (*Hyalella azteca*)
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

	Mean 10 Day Survival						Mean Ash-Free Dry						Biomass (mg)					
Lab Control	93.8						0.11890						0.11100					
SD-45 - reference	92.5			b	c		0.12321						0.11750					
SD-46 - reference	100						0.10986				c		0.10986				c	
LM-08-13 - reference	98.8						0.13479						0.13300					
SD-25	95.0			b			0.10626				c	d	0.10125				c	d
SD-30	92.5			b	c	d	0.07949	*	a	b	c	d	0.07338	*	a	b	c	d
SD-32	91.3			b	c	d	0.11776						0.10775				c	
SD-39	93.8			b	c		0.10311	*			c	d	0.09625	*			c	d
SD-40	96.3			b			0.10340	*			c	d	0.09925				c	d
SD-50	97.5						0.10009	*			c	d	0.09737				c	d
SD-54	93.8			b			0.11953				c		0.11225				c	
SD-55	95.0						0.11416				c		0.10863				c	
SD-58	96.3						0.11266				c		0.10837				c	
SD-59	92.5			b	c	d	0.11897				c		0.11038	*			c	

* - Statistically significant reduction ($p<0.05$) relative to lab control.
a - Statistically significant reduction ($p<0.05$) relative to SD-45.
b - Statistically significant reduction ($p<0.05$) relative to SD-46.
c - Statistically significant reduction ($p<0.05$) relative to LM-08-13.
d - Statistically significant reduction ($p<0.05$) relative to pooled reference.
mg = milligram

Table 2-10
Results of Sediment Toxicity Testing - Midge (*Chironomus dilutus)*
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

	Mean 10 Day Survival						Mean Ash-Free Dry						Biomass (mg)					
Lab Control	97.1						1.3584						1.31711					
SD-45 - reference	92.5						1.52862						1.37185					
SD-46 - reference	91.3						1.21462				c		1.10463	*	a			
LM-08-13 - reference	73.8	*	a	b			1.78601						1.28325					
SD-25	96.3						1.23801	*			c	d	1.18753	*	a			
SD-30	22.5	*	a	b	c	d	0.53854	*	a	b	c	d	0.12600	*	a	b	c	d
SD-32	97.5						0.93929	*	a	b	c	d	0.91188	*	a	b	c	d
SD-39	87.5	*					1.12747	*	a		c	d	0.97663	*	a		c	d
SD-40	90.0						1.09135	*	a		c	d	0.97706	*	a		c	d
SD-50	97.5						0.96564	*	a	b	c	d	0.93850	*	a	b	c	d
SD-54	98.8						1.24604				c	d	1.22871					
SD-55	96.3						1.26844	*			c	d	1.21803	*				
SD-58	90.0	*					1.21191	*			c	d	1.08525	*	a		c	d
SD-59	92.5						1.29272				c	d	1.18825	*				

* - Statistically significant reduction ($p<0.05$) relative to lab control.
a - Statistically significant reduction ($p<0.05$) relative to SD-45.
b - Statistically significant reduction ($p<0.05$) relative to SD-46.
c - Statistically significant reduction ($p<0.05$) relative to LM-08-13.
d - Statistically significant reduction ($p<0.05$) relative to pooled reference.
mg = milligram

Table 3-1
Site Surface Sediment Samples Included in BERA
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Sample	Date	Depth (ft)	Type
SD25-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Test Sample
SD28-0-0.5-15A-S	8/4/2015	0 - 0.5	
SD30-0-0.5-15A-S	8/4/2015	0 - 0.5	Toxicity Test Sample
SD31-0-0.5-15A-S	8/4/2015	0 - 0.5	
SD32-0-0.5-15A-S	8/4/2015	0 - 0.5	Toxicity Test Sample
SD32-0-0.5-15A-D	8/4/2015	0 - 0.5	Duplicate
SD36-0-0.5-15A-S	8/4/2015	0 - 0.5	
SD36-0-0.5-15A-D	8/4/2015	0 - 0.5	Duplicate
SD39-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Test Sample
SD39-0-0.5-15A-D	8/5/2015	0 - 0.5	Duplicate
SD40-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Test Sample
SD50-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Test Sample
SD53-0-0.5-15A-S	8/5/2015	0 - 0.5	
SD54-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Test Sample
SD55-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Test Sample
SD58-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Test Sample
SD59-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Test Sample

Notes:
ft - feet

Table 3-2
Background and Regional Reference Surface Sediment Samples Included in BERA
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Sample	Date	Depth (ft)	Type
SD45-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Testing Reference Sample
SD46-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Testing Reference Sample
LM-08-13-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Testing Reference Sample
LM-08-13-0-0.5-15A-D	8/5/2015	0 - 0.5	Duplicate

Notes:
ft - feet

Table 4-1
Comparison of 2015 Surface Sediment Metals Data to Screening Benchmarks
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

		ARSENIC mg/Kg	BARIUM mg/Kg	CADMIUM mg/Kg	CHROMIUM mg/Kg	COPPER mg/Kg	LEAD mg/Kg	ZINC mg/Kg
	Screening benchmark	9.79	1.04	0.99	43.4	31.6	35.8	121
Sample ID	Depth Interval							
Site Locations								
SD25-0-0.5-15A-S	0 - 0.5 ft	4.5	140	0.38	41.9	131	15.7 J	86.1
SD28-0-0.5-15A-S	0 - 0.5 ft	8	1090	0.97	49.1	90.1	41.9 J	165
SD30-0-0.5-15A-S	0 - 0.5 ft	8.1 J	15300 J	1.8 J	242 J	337 J	99.8 J	262 J
SD31-0-0.5-15A-S	0 - 0.5 ft	8.6 J	10700 J	1.7 J	143 J	233 J	91.3 J	251 J
SD32-0-0.5-15A-S/D (a)	0 - 0.5 ft	9.75 J	2705 J	1.45 J	103 J	283 J	69.75 J	226 J
SD36-0-0.5-15A-S	0 - 0.5 ft	7.6	1390	1.8	145	151	81.5 J	264
SD39-0-0.5-15A-S/D (a)	0 - 0.5 ft	6.5 J	1775 J	1.195 J	96 J	163 J	76.5 J	185.5 J
SD40-0-0.5-15A-S	0 - 0.5 ft	8.3 J	1500 J	1.4 J	91.8 J	183 J	63.1 J	197 J
SD50-0-0.5-15A-S	0 - 0.5 ft	8.7 J	961 J	1.3 J	68.8 J	89.1 J	55.9 J	208 J
SD53-0-0.5-15A-S	0 - 0.5 ft	10.3 J	9490 J	2 J	398 J	271 J	117 J	291 J
SD54-0-0.5-15A-S	0 - 0.5 ft	7.8	750	1.2	50	61.6	42.6 J	178
SD55-0-0.5-15A-S	0 - 0.5 ft	8.3	1180	1.3	101	122	57.5 J	207
SD58-0-0.5-15A-S	0 - 0.5 ft	7.8	286	1.1	46.6	58.3	40.4 J	181
SD59-0-0.5-15A-S	0 - 0.5 ft	7.4	217	0.86	35.4	51.4	35.2 J	166
Background/Reference Locations								
SD45-0-0.5-15A-S	0 - 0.5 ft	4.1	87.3	0.48	15.3	18.9	16.2 J	77.5
SD46-0-0.5-15A-S	0 - 0.5 ft	1.1	15	0.063	5.3	2.7	2.9 J	15.3
LM-08-13-0-0.5-15A-S/D (a)	0 - 0.5 ft	0.665	20.8	0.11	5.2	4.6	4.6	19.7

Notes:
(a) Concentration is average of parent sample and duplicate.
mg/Kg = milligrams per kilogram
ft = foot
J = Estimated Value
Detected concentrations exceeding the screening benchmark are shaded.

Table 4-2
Comparison of 2015 Surface Sediment VOCs Data to Screening Benchmarks
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

		1,3-DICHLOROBENZENE ug/Kg	1,4-DICHLOROBENZENE ug/Kg	BENZENE ug/Kg	CHLOROBENZENE ug/Kg	M,P-XYLENES ug/Kg	O-XYLENE ug/Kg	Xylene (Total) ug/Kg
Screening benchmark		1315	318	142	291	433	433	433
Sample ID	Depth Interval							
Site Locations								
SD25-0-0.5-15A-S	0 - 0.5 ft	150	990	68 U	820	28 J	68 U	28 J
SD28-0-0.5-15A-S	0 - 0.5 ft	11 UJ	11 UJ	11 UJ	4.5 J	11 UJ	11 UJ	22 UJ
SD30-0-0.5-15A-S	0 - 0.5 ft	620 J	890 J	34 J	5800 J	350 J	660 J	1000 J
SD31-0-0.5-15A-S	0 - 0.5 ft	290 UJ	260 J	290 UJ	380 J	290 UJ	290 UJ	580 UJ
SD32-0-0.5-15A-S	0 - 0.5 ft	280 UJ	500 J	280 UJ	180 J	280 UJ	280 UJ	560 UJ
SD36-0-0.5-15A-S/D (a)	0 - 0.5 ft	180 J	455	265 U	2100	265 U	265 U	535 U
SD39-0-0.5-15A-S	0 - 0.5 ft	76 J	240	220 U	7900	220 U	35 J	35 J
SD40-0-0.5-15A-S	0 - 0.5 ft	290 UJ	320 J	210 J	9400 J	290 UJ	290 UJ	580 UJ
SD50-0-0.5-15A-S	0 - 0.5 ft	15 UJ	15 UJ	15 UJ	24 J	15 UJ	15 UJ	30 UJ
SD53-0-0.5-15A-S	0 - 0.5 ft	320 UJ	370 J	320 UJ	2900 J	320 UJ	320 UJ	640 UJ
SD54-0-0.5-15A-S	0 - 0.5 ft	14 UJ	14 UJ	14 U	16	14 U	14 U	29 U
SD55-0-0.5-15A-S	0 - 0.5 ft	16 UJ	16 UJ	16 U	160	16 U	16 U	32 U
SD58-0-0.5-15A-S	0 - 0.5 ft	16 U	16 U	16 U	16 U	16 U	16 U	31 U
SD59-0-0.5-15A-S	0 - 0.5 ft	14 UJ	14 UJ	14 U	2.8 J	14 U	14 U	28 U
BacKground/Reference Locations								
SD45-0-0.5-15A-S	0 - 0.5 ft	9 UJ	9 UJ	9 U	9 U	9 U	9 U	18 U
SD46-0-0.5-15A-S	0 - 0.5 ft	4.2 U	4.2 U	4.2 U	4.2 U	4.2 U	4.2 U	8.5 U
LM-08-13-0-0.5-15A-S	0 - 0.5 ft	5 U	5 U	5 U	5 U	5 U	5 U	10 U

Notes:
(a) Concentration is average of parent sample and duplicate.
ug/Kg = micrograms per kilogram
ft = foot
J = Estimated Value
U = Non detect
Detected concentrations exceeding the screening benchmark are shaded.

Table 5-1
Summary Statistics and Ecological Screening of 2015 Site Surficial Sediment Samples
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

	Site						Background					
		Detected Concentrations			Reporting Limits			Detected Concentrations			Reporting Limits	
Analyte	FOD [a]	Minimum	Mean	Maximum	Minimum	Maximum	FOD [a]	Minimum	Mean	Maximum	Minimum	Maximum
INORGANICS (mg/Kg)												
ARSENIC	14 : 14	4.5	7.8	103	--	--	3 : 3	0.665	1.96	4.1	--	--
BARIUM	14 : 14	140	3392	15300	--	--	3 : 3	15.0	41.0	87.3	--	--
CADMIUM	14 : 14	0.38	1.3	2	--	--	3 : 3	0.063	0.22	0.48	--	--
CHROMIUM	14 : 14	35.4	115	398	--	--	3 : 3	5.2	8.6	15.3	--	--
COPPER	14 : 14	51.4	159	337	--	--	3 : 3	2.7	8.7	18.9	--	--
LEAD	14 : 14	15.7	63	117	--	--	3 : 3	2.9	7.7	16.2	--	--
ZINC	14 : 14	86.1	205	291	--	--	3 : 3	15.3	37.5	77.5	--	--
VOCs (ug/Kg)												
1,3-Dichlorobenzene	4 : 14	76	256.5	620	11	320	0 : 3	--	--	--	4.2	9
1,4-Dichlorobenzene	8 : 14	240	503	990	11	16	0 : 3	--	--	--	4.2	9
Benzene	2 : 14	34	122	210	11	320	0 : 3	--	--	--	4.2	9
Chlorobenzene	13 : 14	2.8	2284	9400	16	16	0 : 3	--	--	--	4.2	9
M,P-Xylenes	2 : 14	28	189	350	11	320	0 : 3	--	--	--	4.2	9
O-Xylene	2 : 14	35	347.5	660	11	320	0 : 3	--	--	--	4.2	9
Xylene (Total)	3 : 14	28	354	1000	22	640	0 : 3	--	--	--	8.5	18

Notes:
Summary statistics are based on detected concentrations only. The minimum and maximum reporting limits are presented for analytes that were not detected in sediment.
ESL - Ecological Screening Level.
FOD - Frequency of Detection.
VOCs - Volatile Organic Compounds.
[a] Number of detected samples : total number of samples.
[b] The number of samples with detected concentrations that are less than the maximum background concentration.
[c] USEPA Region 5 Ecological Screening Levels (available at: http://epa.gov/region5/waste/cars/pdfs/ecological-screening-levels-200308.pdf)
[d] Soil ESLs were used when sediment ESLs are not available.
[e] Total xylene ESL used as a surrogate.

Table 5-1
Summary Statistics and Ecological Screening of 2015 Site Surficial Sediment Samples
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Analyte	Is Max Site > Max Background?	Selected Sediment ESL [c]	COPC Selection	
INORGANICS (mg/Kg)				
ARSENIC	Yes	9.79	YES	Max Detect > ESL
BARIUM	Yes	1.04 [d]	YES	Max Detect > ESL
CADMIUM	Yes	0.99	YES	Max Detect > ESL
CHROMIUM	Yes	43.4	YES	Max Detect > ESL
COPPER	Yes	31.6	YES	Max Detect > ESL
LEAD	Yes	35.8	YES	Max Detect > ESL
ZINC	Yes	121	YES	Max Detect > ESL
VOCs (ug/Kg)				
1,3-Dichlorobenzene	--	1315	NO	Max Detect > ESL
1,4-Dichlorobenzene	--	318	YES	Max Detect > ESL
Benzene	--	142	YES	Max Detect > ESL
Chlorobenzene	--	291	YES	Max Detect > ESL
M,P-Xylenes	--	433 [e]	NO	Max Detect < ESL
O-Xylene	--	433 [e]	YES	Max Detect > ESL
Xylene (Total)	--	433	YES	Max Detect > ESL

Notes:
Summary statistics are based on detected concentrations only. The minimum and maximum reporting limits are presented for analytes that were not detected in sediment.
ESL - Ecological Screening Level.
FOD - Frequency of Detection.
VOCs - Volatile Organic Compounds.
[a] Number of detected samples : total number of samples.
[b] The number of samples with detected concentrations that are less than the maximum background concentration.
[c] USEPA Region 5 Ecological Screening Levels (available at: http://epa.gov/region5/waste/cars/pdfs/ecological-screening-levels-200308.pdf)
[d] Soil ESLs were used when sediment ESLs are not available.
[e] Total xylene ESL used as a surrogate.

Table 5-2
Results as a Percentage of Control and Reference Samples of Sediment Toxicity Testing - Amphipod (*Hyalella azteca*)
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

	Barium (mg/kg)	Mean 10 Day Survival (%)	% of Lab Control	% SD-45 Reference	% Pooled reference	Mean Ash-Free Dry Weight (mg)	% of Lab Control	% SD-45 Reference	% Pooled reference	Biomass (mg)	% of Lab Control	% SD-45 Reference	% Pooled reference
Lab Control	--	93.8				0.11890				0.11100			
SD-45 - reference		92.5				0.12321				0.11750			
SD-46 - reference		100				0.10986				0.10986			
LM-08-13 - reference		98.8				0.13479				0.13300			
Pooled reference		97.0				0.12219				0.11974			
SD-25	140	95.0	101%	103%	98%	0.10626	89%	86%	87%	0.10125	91%	86%	85%
SD-59	217	92.5	99%	100%	95%	0.11897	100%	97%	97%	0.11038	99%	94%	92%
SD-58	286	96.3	103%	104%	99%	0.11266	95%	91%	92%	0.10837	98%	92%	91%
SD-54	750	93.8	100%	101%	97%	0.11953	101%	97%	98%	0.11225	101%	96%	94%
SD-50	961	97.5	104%	105%	100%	0.10009	84%	81%	82%	0.09737	88%	83%	81%
SD-39	1110	93.8	100%	101%	97%	0.10311	87%	84%	84%	0.09625	87%	82%	80%
SD-55	1180	95.0	101%	103%	98%	0.11416	96%	93%	93%	0.10863	98%	92%	91%
SD-40	1500	96.3	103%	104%	99%	0.10340	87%	84%	85%	0.09925	89%	84%	83%
SD-32	2705	91.3	97%	99%	94%	0.11776	99%	96%	96%	0.10775	97%	92%	90%
SD-30	15300	92.5	99%	100%	95%	0.07949	**67%**	**65%**	**65%**	0.07338	**66%**	**62%**	**61%**

Endpoint which is >20% reduced from respective control or the pooled reference sample data is presented in boldface font and shaded
mg = milligram
The pooled reference is the geometric mean of the three reference samples.

Table 5-3
Results as a Percentage of Control and Reference Samples of Sediment Toxicity Testing - Midge (*Chironomus dilutus*)
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

	Barium (mg/kg)	Mean 10 Day Survival (%)	% of Lab Control	% SD-45 Reference	% Pooled reference	Mean Ash-Free Dry Weight (mg)	% of Lab Control	% SD-45 Reference	% Pooled reference	Biomass (mg)	% of Lab Control	% SD-45 Reference	% Pooled reference
Lab Control		97.1				1.3584				1.31711			
SD-45 - reference		92.5				1.52862				1.37185			
SD-46 - reference		91.3				1.21462				1.10463			
LM-08-13 - reference		73.8				1.78601				1.28325			
Pooled reference		85.4				1.4912185				1.2481829			
SD-25	140	96.3	99%	104%	113%	1.23801	91%	81%	83%	1.18753	90%	87%	95%
SD-59	217	92.5	95%	100%	108%	1.29272	95%	85%	87%	1.18825	90%	87%	95%
SD-58	286	90.0	93%	97%	105%	1.21191	89%	**79%**	81%	1.08525	82%	**79%**	87%
SD-54	750	98.8	102%	107%	116%	1.24604	92%	82%	84%	1.22871	93%	90%	98%
SD-50	961	97.5	100%	105%	114%	0.96564	**71%**	**63%**	**65%**	0.93850	**71%**	**68%**	**75%**
SD-39	1110	87.5	90%	95%	102%	1.12747	83%	**74%**	**76%**	0.97663	**74%**	**71%**	**78%**
SD-55	1180	96.3	99%	104%	113%	1.26844	93%	83%	85%	1.21803	92%	89%	98%
SD-40	1500	90.0	93%	97%	105%	1.09135	80%	**71%**	**73%**	0.97706	**74%**	**71%**	**78%**
SD-32	2705	97.5	100%	105%	114%	0.93929	**69%**	**61%**	**63%**	0.91188	**69%**	**66%**	**73%**
SD-30	15300	22.5	**23%**	**24%**	**26%**	0.53854	**40%**	**35%**	**36%**	0.12600	**10%**	**9%**	**10%**

Endpoint which is >20% reduced from respective control or the pooled reference sample data is presented in boldface font and shaded
mg = milligram
The pooled reference is the geometric mean of the three reference samples.

Table 5-4
SEM, AVS, and TOC Evaluation for Site and Reference Samples Collected in 2015
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

	Sample Location	**SD25**		**SD30**		**SD32**		**SD39**	
	Lab Sample ID	**SD25-0-0.5-15A-S**		**SD30-0-0.5-15A-S**		**SD32-0-0.5-15A-S**		**SD39-0-0.5-15A-S**	
	Date Collected	**8/5/2015**		**8/4/2015**		**8/4/2015**		**8/5/2015**	
Chemical	***Units***								
Total organic carbon (TOC)	mg/Kg	6300		78600		59400		52900	
Total organic carbon (TOC)	%	0.63		7.86		5.94		5.29	
Total organic carbon (TOC)	fraction	0.0063		0.08		0.06		0.0529	
Cadmium	umol/g	0.002527		0.01185	J	0.01231	J	0.01163	J
Copper	umol/g	0.05715	J-	0.05094	J	0.4561	J	1.551	J
Lead	umol/g	0.03288		0.5166	J	0.3425	J	0.3743	J
Nickel	umol/g	0.01558		0.3315	J	0.2308	J	0.5496	J
Zinc	umol/g	0.9337		< 3.339	UJ	2.648	J	2.701	J
Silver	umol/g	0.000075		0.0002025		0.00365		0.0025	
Acid volatile sulfide	umol/g	0.18	J-	2.5	J	6.6	J	200	J
Sum SEM	umol/g	1.0		0.9		3.7		5.2	
Sum SEM / AVS	unitless	**5.8**		0.4		0.56		0.0	
Sum SEM - AVS	umol/g	**0.9**		**-1.6**		-2.91		**-194.8**	
[Sum SEM - AVS]/f_{oc}	umol/g_{oc}	136.8		-20.2		-49.0		-3682.7	

Notes:
Non-detect data treated as a zero in calculations.
mg/Kg = milligrams per kilogram.
umol/g = micromoles per gram.
umol/g_{oc} = micromole per gram organic carbon.
J = Estimated.
U = Not Detected.
< = Compound not detected. Value is less than the detection limit presented.
NC = Not Calculated. AVS not detected.
SEM = Simultaneously extracted metals.
AVS = Acid volatile sulfides.

Bold text indicates Sum SEM / AVS is greater than 1 or Sum SEM - AVS is greater than 0.

(a) Reference sample.

USEPA (2005) guidance on metals bioavailability evaluates possible binding of metals by both AVS and organic matter and provides the following scale to evaluate whether or not the organic carbon binding phase (represented as fraction organic carbon or f_{oc}), in conjunction with the AVS, is affecting the bioavailability of divalent metals in sediments:

If the (Sum SEM-AVS)/f_{oc} exceeds 3000 µmol/g_{oc}, the sediments are presumed to be "likely to be toxic";

If the (Sum SEM-AVS)/f_{oc} is between 130 and 3,000 µmol/g_{oc}, predictions of effects are uncertain; and

If the (Sum SEM-AVS)/f_{oc} is less than 130 µmol/g_{oc}, the sediments are presumed to "not likely" be toxic.

Table 5-4
SEM, AVS, and TOC Evaluation for Site and Reference Samples Collected in 2015
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

	Sample Location	**SD40**		**SD40**		**SD50**		**SD54**		**SD55**	
	Lab Sample ID	**SD40-0-0.5-15A-D**		**SD40-0-0.5-15A-S**		**SD50-0-0.5-15A-S**		**SD54-0-0.5-15A-S**		**SD55-0-0.5-15A-S**	
	Date Collected	**8/5/2015**		**8/5/2015**		**8/5/2015**		**8/5/2015**		**8/5/2015**	
		(Duplicate)									
Chemical	***Units***										
Total organic carbon (TOC)	mg/Kg	62000		62000		53500		54500		55300	
Total organic carbon (TOC)	%	6.2		6.2		5.35		5.45		5.53	
Total organic carbon (TOC)	fraction	0.062		0.062		0.0535		0.0545		0.0553	
Cadmium	umol/g	0.01232	J	0.01024		0.007275		0.003426		0.002588	
Copper	umol/g	1.813	J	1.228	J-	0.02541	J-	0.1561	J-	0.04068	J-
Lead	umol/g	0.5243	J	0.4298		0.1733		0.07863		0.06526	
Nickel	umol/g	0.7027	J	0.573		0.1121		0.06268		0.07895	
Zinc	umol/g	3.193	J	2.653		1.561		0.9081		0.7846	
Silver	umol/g	0.00395		0.0027		0.00065		0.0005		0.000175	
Acid volatile sulfide	umol/g	120	J	100	J-	4.2	J-	6.6	J-	5.2	J-
Sum SEM	umol/g	6.2		4.9		1.88		1.21		1.0	
Sum SEM / AVS	unitless	0.1		0.0		0.44740119		0.2		0.2	
Sum SEM - AVS	umol/g	**-113.8**		**-95.1**		**-2.32**		**-5.4**		**-4**	
[Sum SEM - AVS]/f_{oc}	umol/g_{oc}	-1834.8		-1534.0		-43.4		-98.9		-76	

Notes:
Non-detect data treated as a zero in calculations.
mg/Kg = milligrams per kilogram.
umol/g = micromoles per gram.
umol/g_{oc} = micromole per gram organic carbon.
J = Estimated.
U = Not Detected.
< = Compound not detected. Value is less than the detection limit presented.
NC = Not Calculated. AVS not detected.
SEM = Simultaneously extracted metals.
AVS = Acid volatile sulfides.

Bold text indicates Sum SEM / AVS is greater than 1 or Sum SEM - AVS is greater than 0.

(a) Reference sample.

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If the (Sum SEM-AVS)/f_{oc} is less than 130 µmol/g_{oc}, the sediments are presumed to "not likely" be toxic.

Table 5-4
SEM, AVS, and TOC Evaluation for Site and Reference Samples Collected in 2015
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

	Sample Location	**SD58**		**SD59**		**SD45**		**SD46**		**LM-08-13**	
	Lab Sample ID	**SD58-0-0.5-15A-S**		**SD59-0-0.5-15A-S**		**SD45-0-0.5-15A-S**		**SD46-0-0.5-15A-S**		**LM-08-13-0-0.5-15A-S**	
	Date Collected	**8/5/2015**		**8/5/2015**		**8/5/2015**		**8/5/2015**		**8/5/2015**	
						(a)		**(a)**		**(a)**	
Chemical	***Units***										
Total organic carbon (TOC)	mg/Kg	57900		69700		34200		1310		6510	
Total organic carbon (TOC)	%	5.79		6.97		3.42		0.131		0.651	
Total organic carbon (TOC)	fraction	0.0579		0.0697		0.0342		0.00131		0.00651	
Cadmium	umol/g	0.007346		0.002113		0.002957		0.0004734		0.0007774	
Copper	umol/g	0.3917	J-	0.06752	J-	0.1124	J-	0.01982	J-	0.03435	J-
Lead	umol/g	0.1456		0.04532		0.05123		0.009558		0.0123	
Nickel	umol/g	0.1404		0.03507		0.05111		0.01548		0.01447	
Zinc	umol/g	1.852		0.6046		0.5996		0.1268		0.1627	
Silver	umol/g	0.00085		0.0001725		0.0001275		0.00007		0.000075	
Acid volatile sulfide	umol/g	29	J-	5.3	J-	6.7	J-	0.53	J-	0.57	J-
Sum SEM	umol/g	2.54		0.75		0.8		0.2		0.2	
Sum SEM / AVS	unitless	0.1		0.14		0.1		0.3		0.4	
Sum SEM - AVS	umol/g	**-26.5**		**-4.55**		**-5.9**		**-0.4**		**-0.3**	
[Sum SEM - AVS]/f_{oc}	umol/g_{oc}	-457.0		-65.2		-172.0		-273.2		-53.1	

Notes:
Non-detect data treated as a zero in calculations.
mg/Kg = milligrams per kilogram.
umol/g = micromoles per gram.
umol/g_{oc} = micromole per gram organic carbon.
J = Estimated.
U = Not Detected.
< = Compound not detected. Value is less than the detection limit presented.
NC = Not Calculated. AVS not detected.
SEM = Simultaneously extracted metals.
AVS = Acid volatile sulfides.

Bold text indicates Sum SEM / AVS is greater than 1 or Sum SEM - AVS is greater than 0.

(a) Reference sample.

USEPA (2005) guidance on metals bioavailability evaluates possible binding of metals by both AVS and organic matter and provides the following scale to evaluate whether or not the organic carbon binding phase (represented as fraction organic carbon or f_{oc}), in conjunction with the AVS, is affecting the bioavailability of divalent metals in sediments:

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If the (Sum SEM-AVS)/f_{oc} is between 130 and 3,000 µmol/g_{oc}, predictions of effects are uncertain; and

If the (Sum SEM-AVS)/f_{oc} is less than 130 µmol/g_{oc}, the sediments are presumed to "not likely" be toxic.

Table 6-1
MATCs for Amphipod (*Hyalella azteca*)
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

	20% Reduction from Lab Control		
Endpoint	NOEC	LOEC	MATC
Amphipod - survival	15300		15300
Amphipod - growth	2705	15300	6433

	20% Reduction from SD-45		
Endpoint	NOEC	LOEC	MATC
Amphipod - survival	15300		15300
Amphipod - growth	2705	15300	6433

Concentatoins presented are mg/Kg barium.
LOEC = lowest observed effect concentration
NOEC = no observed effect concentration
MATC = maximim acceptable toxicant concentration

Table 6-2
MATCs for Midge (*Chironomus dilutus*)
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

	20% Reduction from Lab Control		
Endpoint	NOEC	LOEC	MATC
Midge - survival	2705	15300	6433
Midge - growth	1500	2705	2014

	20% Reduction from SD-45		
Endpoint	NOEC	LOEC	MATC
Midge - survival	2705	15300	6433
Midge - growth	1180	1500	1330

Concentatoins presented are mg/Kg barium.
LOEC = lowest observed effect concentration
NOEC = no observed effect concentration
MATC = maximim acceptable toxicant concentration

Figures

Map Location

N
W E
S

Site Location
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

0 250 500 1,000 Feet

- Outfall Pipe
- BASF Property Boundary
- Adjacent Offshore Sediment
- Adjacent Nearshore Sediment

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Project # 60217278
October 2015

Figure 1-1

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Map Location

N
W E
S

Site and Sampling Locations from 2011
Lake Macatawa Sediment Baseline Ecological Risk Assessment
and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

0 125 250 500 Feet

- 2011 Sediment Sampling Locations
- Outfall Pipe
- BASF Property Boundary
- Adjacent Offshore Sediment
- Adjacent Nearshore Sediment

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Project # 60217278
November 2015

Figure 1-2

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Map Location

N
W E
S

Site and Sampling Locations from 2015
Lake Macatawa Sediment Baseline Ecological Risk Assessment
and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

0 125 250 500 Feet

- 2015 Sediment Sampling Locations
- 2015 Sediment Core Location
- Outfall Pipe
- BASF Property Boundary
- Adjacent Offshore Sediment
- Adjacent Nearshore Sediment

AECOM

Project # 60217278
November 2015

Figure 2-1

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Map Location

N
W E
S

Toxicity Testing Sampling Locations from 2015
Lake Macatawa Sediment Baseline Ecological Risk Assessment
and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

0 125 250 500 Feet

- Tox Sampling Locations
- Outfall Pipe
- BASF Property Boundary
- Adjacent Offshore Sediment
- Adjacent Nearshore Sediment

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November 2015

Figure 2-2

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Map Location

N
W E
S

Reference Locations from 2015
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

0 500 1,000 2,000 Feet

- Reference Locations - 2015
- Outfall Pipe
- BASF Property Boundary
- Adjacent Offshore Sediment
- Adjacent Nearshore Sediment

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Project # 60217278
November 2015

Figure 2-3

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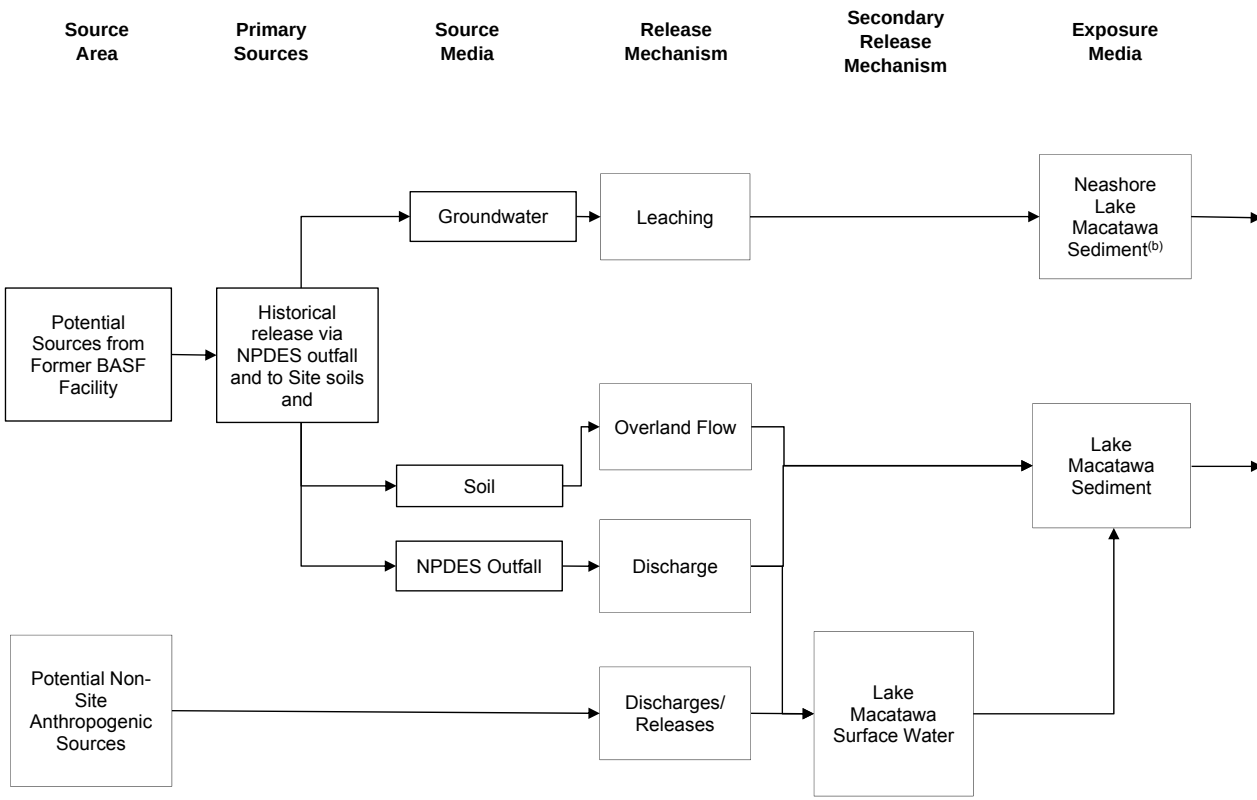
Figure 3-1
Ecological Sediment Conceptual Site Model
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

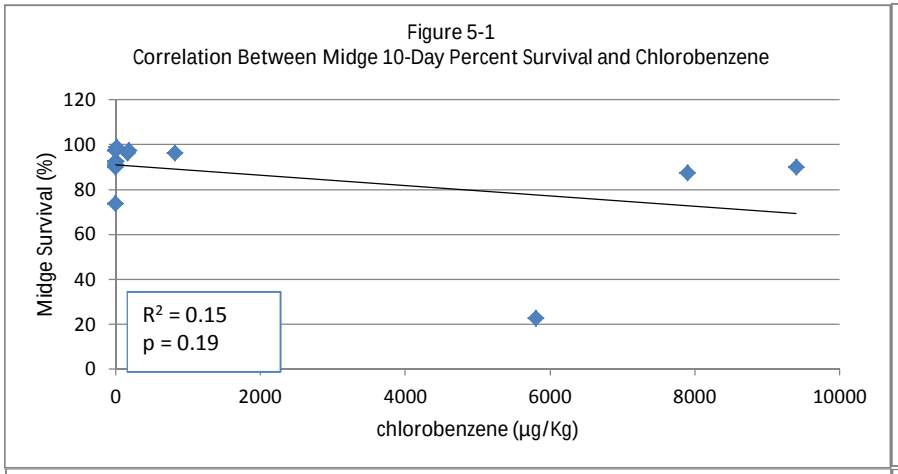


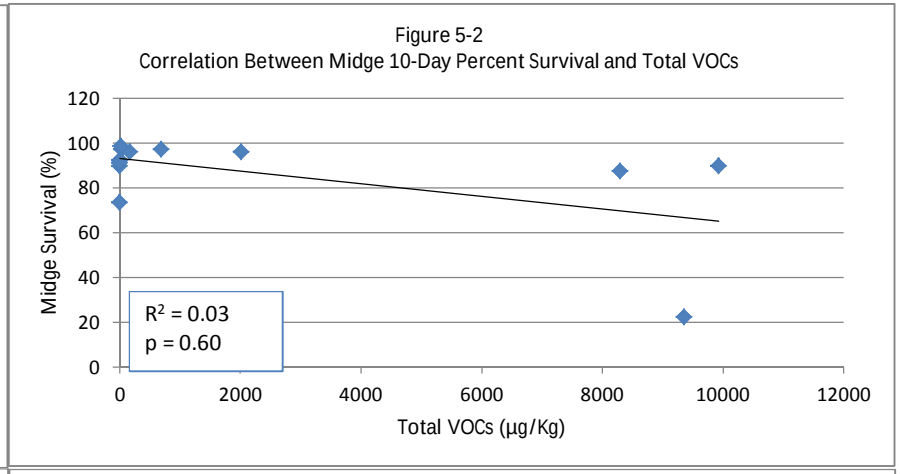
Potential Exposure Route	Potential Ecological Receptors: Benthic Invertebrate Community	Aquatic Invertebrate Community	Finfish Community	Birds and Mammals
Dermal / Direct Contact	¡	¡	¡	¡
Incidental Ingestion	¡	¡	¡	¡
Incidental Ingestion	¡	¡	o	o
Dermal / Direct Contact	I	¡	o	¡
Inhalation (a)	¡	¡	¡	¡
Bioaccumulation	¡	¡	o	o

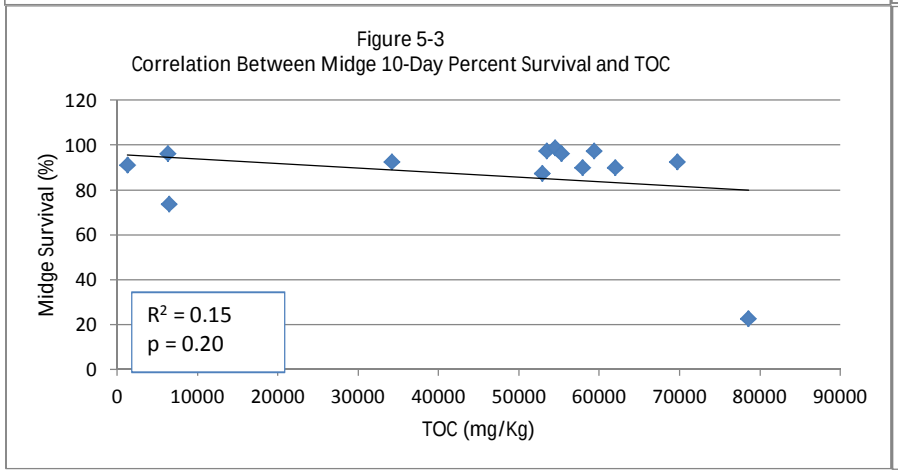
Notes:
I Potentially complete pathway.
¡ Incomplete pathway.
o No unacceptable risk in this pathway determined in Ecological Evaluation.

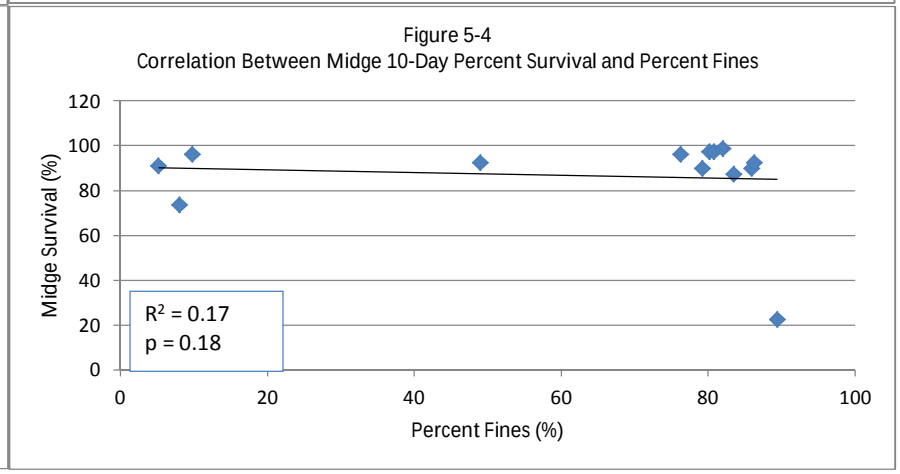
(a) Inhalation of volatiles in outdoor air volatilized from sediment and surface water is likely insignificant.
(b) Groundwater discharge to Lake Macatawa has been addressed by the air sparging system.

Figures 5-1 though 5-4
Correlations Between Midge 10-Day Survival and Selected Potential Stressors: Chlorobenzene, Total VOCs, TOC and Percent Fines
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

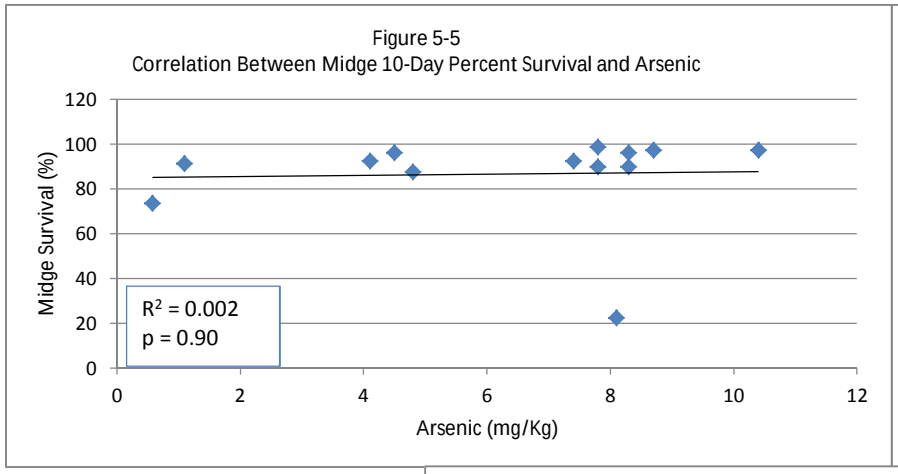


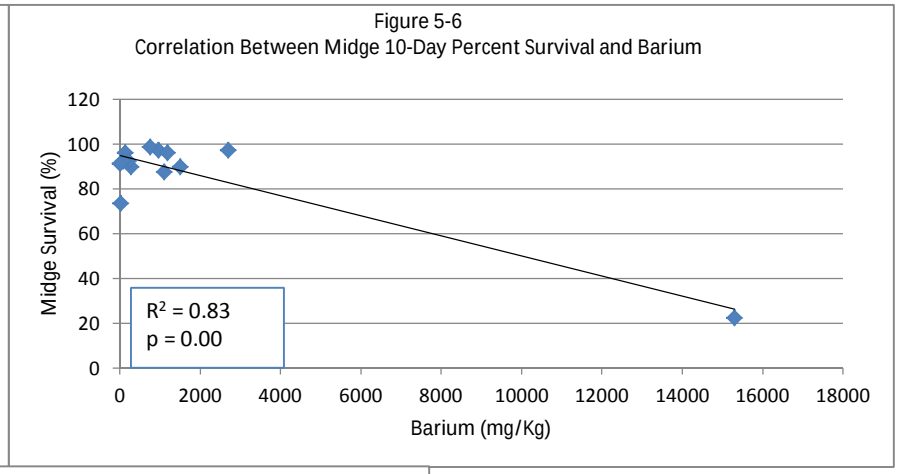


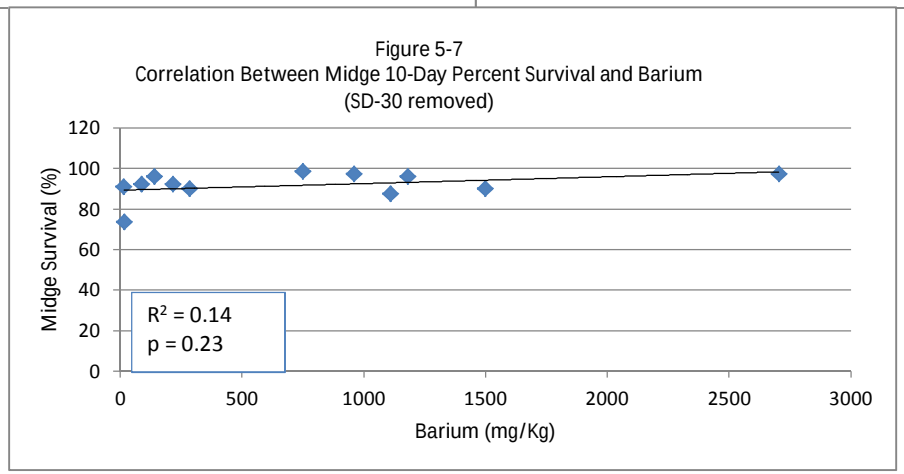




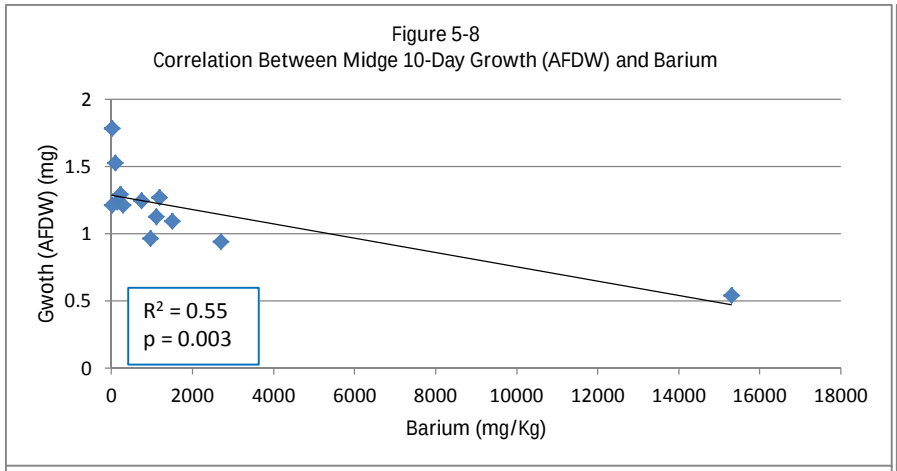
Figures 5-5 through 5-7
Correlations Between Midge 10-Day Survival and Selected Potential Stressors: Barium and Arsenic
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

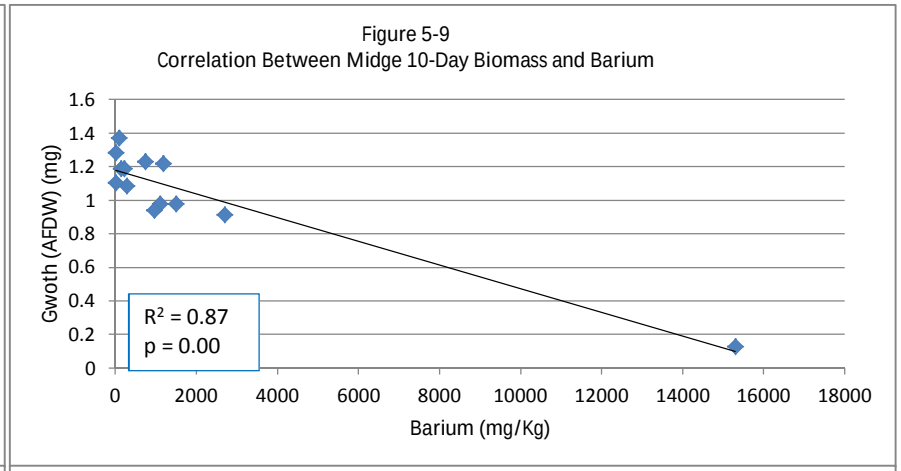


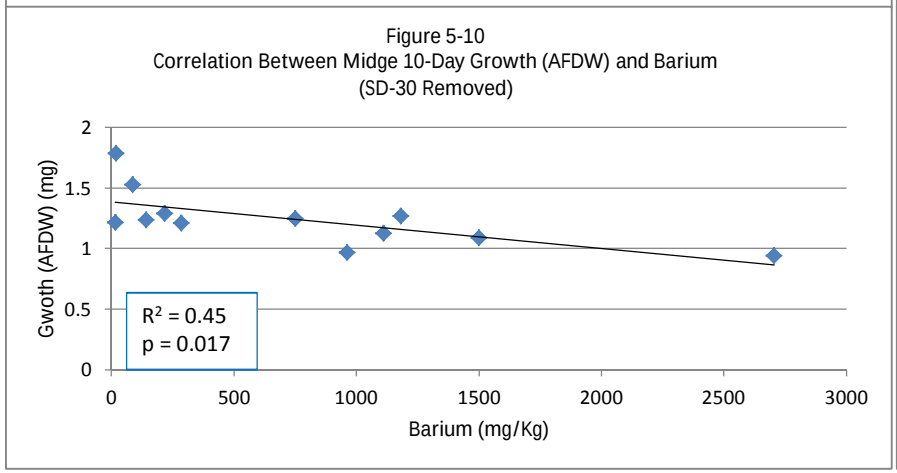


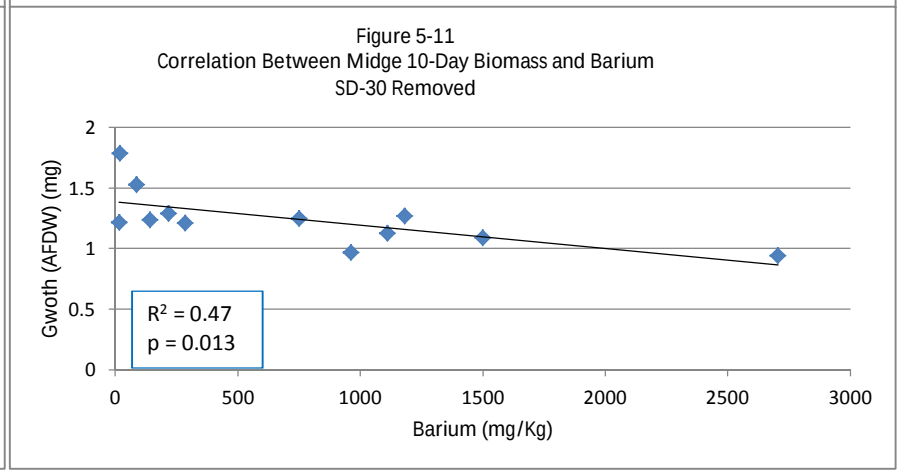


Figures 5-8 through 5-11
Correlations Between Midge 10-Day Growth / Biomss and Barium
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI









Appendix A

Ecological Evaluation

Appendix A

Ecological Evaluation

1.0 Introduction

This appendix presents an evaluation of potential risks to ecological receptors exposed to sediments via the food web pathway in Lake Macatawa near the Former BASF Corporation (BASF) Howard Avenue Facility (the "Site") in Holland, Michigan. This document, which was prepared in response to the United States Environmental Protection Agency (U.S. EPA) Region 5 responses to comments on the Food Web Model for Lake Macatawa (U.S. EPA, 2014), provides an assessment of potential ecological risks associated with potential exposure to bioaccumulative constituents in Lake Macatawa surficial sediments (i.e., sediment depth of 0-6 inches) adjacent to the Site.

This appendix is for the most part identical to the Ecological Evaluation that was submitted to U.S. EPA by BASF in April 2015 and approved by U.S.EPA in June 2015. However, in order to ensure completeness, the document has been updated to include the newly collected 2015 data discussed in the body of the Baseline Ecological Risk Assessment.

1.1 Objectives

A screening-level ecological risk assessment (SLERA) was previously conducted for the sediment in Lake Macatawa in the vicinity of the Site (AECOM, 2012), and a wildlife food web model was developed to further investigate the sediment exposure pathways (AECOM, 2013). This appendix addresses U.S. EPA Region 5 comments (U.S. EPA, 2014) on the food web model. This appendix also includes additional sediment chemistry data collected in August 2015.

This current assessment focuses on potentially complete sediment exposure pathways. Constituents in sediment may be contacted directly by benthic invertebrates living in the sediment. Fish and wildlife foraging in Lake Macatawa in the vicinity of the Site could also be exposed directly to constituents in sediment through incidental ingestion of sediment and indirectly by ingestion of contaminated prey items living in Lake Macatawa in the vicinity of the Site.

The primary objective of this assessment is to evaluate whether constituents of potential concern (COPCs) attributable to past operations have the potential to cause unacceptable adverse risk to ecological receptors. The specific objectives are as follows:

- Determine whether any potentially complete food web exposure pathways associated with exposure to surficial sediment exist at the Site.
- Identify Site-related COPCs for further evaluation for potentially complete exposure pathways by comparing the concentrations of constituents detected in surface sediment to ecological risk-based screening benchmarks.
- Determine potential for unacceptable adverse risk to higher trophic level ecological receptors using food web modeling.

1.2 Approach

The October 8, 2014 U.S. EPA comments were part of the following series of BASF submittals and U.S. EPA responses regarding the 2011 sediment investigation conducted by BASF in Lake Macatawa adjacent to the former BASF facility:

- On September 28, 2012, BASF submitted a Sediment Sampling Report followed by a January 16, 2013 addendum letter summarizing the key findings of the sediment report and recommending a No Action remedy for sediment adjacent to the former BASF facility.
- On March 26, 2013, U.S. EPA provided written comments on the Sediment Sampling Report and No Action addendum letter disagreeing with BASF's No Action remedy and requested a work plan to conduct sediment toxicity testing and an evaluation of potential risks to higher trophic level receptors from exposure to copper and barium detected in sediment.
- On September 9, 2013, BASF submitted a response to U.S. EPA's March 26, 2013 comments including amended pages of the Sediment Sampling Report addressing U.S. EPA's comments and a Sediment Sampling Work Plan Addendum to conduct additional sediment sampling and toxicity testing.
- On October 23, 2013, BASF submitted a Food Web Model for Lake Macatawa that evaluated potential risks to higher trophic level receptors from exposure to surface sediment containing barium and copper.
- On January 23, 2014, U.S. EPA provided additional comments on BASF's Sediment Sampling Report and Work Plan Addendum, as well as comments on BASF's Food Web Model.
- On July 21, 2014, BASF submitted a response to U.S. EPA's January 23, 2014 comments including a revised Food Web Model for Lake Macatawa.
- On October 8, 2014, U.S. EPA provided comments on BASF's July 21, 2014 response to U.S. EPA comments.

This appendix is part of an overall Response to Comment package submitted to U.S. EPA on April 10, 2015, which was prepared to support the response to the final U.S. EPA comments and provides the information requested in the October 8, 2014 letter from U.S. EPA to BASF. On June 12, 2015, U.S. EPA provided BASF with a letter approving the response to comments and the Ecological Evaluation ("RTC Ecological Evaluation"). The Ecological Evaluation presented herein was updated to include additional sediment chemistry data collected in August 2015. The components of this appendix remain the same as those presented in the RTC Ecological Evaluation, except where sediment chemistry datasets were updated to include the August 2015 data.

This appendix presents an evaluation of potential ecological risks from exposure to surficial sediments through the food chain pathway, consistent with the following ERA guidance:

- RRD Operational Memorandum No. 4. Site Characterization and Remediation Verification. Attachment 3 – Sediments (MIDEQ, 2006)
- Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final (U.S. EPA, 1997)
- U.S. EPA Region 5 guidance for ecological risk assessments (http://www.epa.gov/region5/superfund/ecology/)
- Guidelines for Ecological Risk Assessment (U.S. EPA, 1998)
- The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments (U.S. EPA, 2001)

1.3 Document Organization

The remainder of this document is organized into the following sections:

Section 2 – Sediment Benchmark Screening

Section 3 – Fish Dietary Pathway

Section 4 – Food Web Modeling

Section 5 – Uncertainty Evaluation

Section 6 – Summary and Recommendations

Section 7 – References

2.0 Sediment Benchmark Screening

Ecological screening tables for the sediment from the Adjacent Nearshore and Adjacent Offshore areas were prepared in response to Specific Comment 1 (U.S. EPA, 2014). The screening tables originally presented in the RTC Ecological Evaluation are updated in this document to include the August 2015 sediment chemistry data.

2.1 Data Used in Screening

The list of Site and background samples is presented in the BERA. Based on analysis of historic sediment data presented in Section 1.2 of the Sediment Sampling Work Plan, Lake Macatawa in the immediate vicinity of the former BASF facility was operationally divided into the following two study areas (**Figure 2-1** and **Table 2-1** present the site locus and the list of samples presented in this appendix, respectively):

1. **Adjacent Nearshore**. This approximately one-acre study area is characterized by predominantly (greater than 50 percent larger than 75 microns) coarse-grained sediment. The surficial sediment samples evaluated in this ecological risk analysis were collected in the region from the shoreline to approximately 75 linear feet offshore of the Site at depths ranging from zero to one foot below ground surface. This region contains less than 3 feet of overlying water. Analytical chemistry data from twelve surficial sediment samples were available in this region, including six samples collected in 2001 and six samples collected in 2011.

2. **Adjacent Offshore.** This approximately 10-acre study area is located in deeper water approximately 75 to 500 feet offshore and contains more fine-grained, silty sediment. In the Adjacent Offshore, data from 38 surficial sediment samples (collected at depths ranging from zero to one foot below ground surface) were available collected in 2001, 2008, and 2011. In addition, fourteen surficial sediment samples were collected in August 2015 in this area.

Sediment chemistry data from these two areas includes metals, volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs). In order to evaluate a data set that is reflective of current conditions, including operation of the on-Site groundwater treatment plant, VOC and SVOC data from 2001 were not considered in the ERA. Samples collected in 2011 after the groundwater air sparging system was installed demonstrated much lower concentrations of VOCs and SVOCs, as documented in the Sediment Sampling Report (AECOM, 2012). Sediment chemistry data from each area were screened against the U.S. EPA Region 5 Ecological Screening Levels (ESLs)[1] to identify COPCs.

The background and regional background datasets previously identified for the Adjacent Nearshore and Adjacent Offshore areas in the Sediment Sampling Report (AECOM, 2012) were also considered in this BERA (**Figure 2-2** depicts the location of these samples). Two additional background samples (SD45 and SD46) and one additional regional background (LM-08-13) sample were collected in August 2015 and added to the existing background and regional background datasets for a total of:

- Sixteen site-specific background locations collected by BASF in 2001, 2011, and 2015 for comparison with Adjacent Nearshore sediment data; and,

[1] Available at: http://epa.gov/region5/waste/cars/pdfs/ecological-screening-levels-200308.pdf

- Thirty-two regional reference samples collected by Grand Valley State University/Great Lakes National Program Office and Michigan Department of Environmental Quality between 2002 and 2008 and one sample collected by BASF in 2015 for comparison with Adjacent Offshore sediment data.

Table 2-2 provides a list of all background samples used in the Ecological Evaluation. In accordance with U.S. EPA guidance, COPCs were not screened out based on comparison to background concentrations. This evaluation was conducted to help place the Site data in a regional context.

Per U.S. EPA's Specific Comment 1, the data were summarized based on the following parameters:

- Frequency of detection and range of Adjacent Nearshore detected concentrations
- Frequency of detection and range of Adjacent Offshore detected concentrations
- Range of detection limits for non-detected constituents
- Frequency of detection and range of concentrations for background
- The UCL recommended by ProUCL version 5.0 (if more than one UCL was recommended, the higher UCL was selected).

The above statistics are presented for Adjacent Nearshore and Adjacent Offshore areas in **Tables 2-3** and **2-4**, respectively. Data for samples and their duplicates were averaged before summary statistics were calculated, such that a sample and its duplicate were treated as one sample for calculation of summary statistics (including maximum detection and frequency of detection). Where one of the pair was reported as not detected and the other was detected, the detected concentration was used.

2.2 Results

The results of the Adjacent Nearshore sediment screen are presented in **Table 2-3**. This table was previously presented in the RTC Ecological Evaluation. No additional Site data were collected from the Adjacent Nearshore, but the background data were updated with two additional background samples collected in August 2015. Maximum detected concentrations of barium, copper, lead, thallium, vanadium, total PCBs, chlorobenzene, and 1,4-dichlorobenzene in sediment are greater than the Region 5 ESLs and were identified as COPCs.

Adjacent Nearshore and background data were evaluated relative to one-another in boxplots provided in **Attachment A**. Sediment concentrations of lead, thallium, and vanadium are within the range of background concentrations (i.e., the maximum Adjacent Nearshore concentration is less than the maximum background concentration, and the means of each metal are similar). Although these compounds were present at Adjacent Nearshore concentrations consistent with or less than background, they were none-the-less retained as COPCs based on the benchmark screening.

The results of the Adjacent Offshore sediment screen are presented in **Table 2-4**. This table is an update to Table 2 from the RTC Ecological Evaluation and includes additional Site data collected from the Adjacent Offshore and regional background area in August 2015. Maximum concentrations of arsenic, barium, cadmium, chromium, copper, lead, nickel, thallium, vanadium, zinc, total PCBs, 1,3-dichlorobenzene, 1,4-dichlorobenzene, benzene, chlorobenzene, o-xylene, and total xylene in sediment exceed the Region 5 sediment ESLs and were identified as COPCs. These results are consistent with the screening conducted in the RTC Ecological Evaluation.

Boxplot comparisons of Adjacent Offshore and Reference data are presented in **Attachment A**. Sediment concentrations of arsenic and cadmium are within the range of regional reference concentrations (i.e., the maximum Adjacent Offshore concentrations of both arsenic and cadmium are less than maximum background concentrations, the mean concentration of cadmium in background is higher than Adjacent

Offshore, and the mean arsenic concentration in background is lower than Adjacent Nearshore). However, these two compounds were retained as COPCs based on the benchmark screening.

2.3 Summary

The results of this analysis indicate that several Site-related COPCs are present at concentrations that exceed Region 5 ESLs.

In the Adjacent Nearshore sediments, barium, copper, lead, thallium, vanadium, chlorobenzene and 1,4-dichlorobenzene were present at concentrations above ESLs. Concentrations of lead, thallium, and vanadium are similar to background.

In the Adjacent Offshore, arsenic, barium, cadmium, chromium, copper, lead, nickel, zinc, total PCBs, 1,3-dichlorobenzene, 1,4-dichlorobenzene, benzene, chlorobenzene, o-xylene, and total xylene exceed the Region 5 ESLs. Concentrations of arsenic and cadmium are similar to regional background levels.

3.0 Fish Dietary Pathway

In response to Specific Comment #4 (U.S. EPA, 2014), potential dietary exposure pathways for invertivorous fish present in Lake Macatawa were evaluated. This evaluation was previously presented in the RTC Ecological Evaluation and was updated herein based on additional sediment chemistry data collected in August 2015. The following sections present:

- Receptor of concern selection and assessment endpoints
- Dietary exposure assessment
- Dietary effects assessment
- Risk characterization
- Discussion of uncertainties with this pathway
- Summary and conclusions

3.1 Receptor of Concern and Assessment Endpoint

An invertivorous fish species was selected to evaluate fish species that consume primarily invertebrates for their diet. Lake Macatawa supports many freshwater fish species including freshwater drum (*Aplodinotus grunniens*), crappie (family *Pomoxis*), catfish (order *Siluriformes*), sunfish (family *Centrarchidae*), bass (order *Perciformes*), yellow perch (*Perca flavescens*), and pumpkinseed (*Lepomis gibbosus*) (MI DNR, 2015). Freshwater drum (*Aplodinotus grunniens*) feeds at or near the bottom of waterbodies on predominantly invertebrate species (Bur, 1982; GLERL, 2015). Therefore, the freshwater drum was selected as the representative invertivorous fish species for this evaluation.

The assessment endpoint identified for this pathway is protection of fish invertivores from adverse effects on survival, growth, and reproduction associated with exposure to Site-related COPCs. The measurement endpoint for this assessment endpoint is comparison of modeled fish invertivore dietary intakes with literature-based ingestion screening values. Freshwater drum were selected as the representative species for invertivore fish in Lake Macatawa.

All COPCs identified in the Adjacent Nearshore and Adjacent Offshore sediment screen (Section 2) were considered in this pathway with the exception of the VOCs and SVOCs (benzene, chlorobenzenes, and xylenes), which were not included. The VOCs and SVOCs that were detected in sediments have low K_{ow} constants and are generally not considered food web pathway COPCs. COPCs considered for this pathway includes metals (arsenic, barium, cadmium, chromium, copper, lead, nickel, thallium, vanadium, and zinc) and total PCBs.

3.2 Fish Dietary Exposure Assessment

The exposure parameters identified for the fish receptor are presented in **Table 3-1**. The exposure of fish to constituents in sediment and in their prey was evaluated based on an approach presented by Windward (2012) in the East Waterway Operable Unit Baseline Ecological Risk Assessment. This approach weighted the COPC concentrations in prey and sediment according to Equation 1.

Equation 1 $$C_{diet} = (C_{sediment} * Proportion_{sediment}) + (C_{prey} * Proportion_{prey})$$

Where:

C_{diet} = Concentration of COPC in diet

$C_{sediment}$ = Concentration of COPC in sediment

$Proportion_{sediment}$ = Proportion of sediment in the drum diet

C_{prey} = Concentration of COPC in prey

$Proportion_{prey}$ = Proportion of prey in the drum diet

Consistent with the methods provided by Windward (2012), the modeled fish dietary pathway bracketed exposure by modifying the assumptions made with regard to dietary proportions and estimated concentrations of sediment and invertebrates.

- In the first tier evaluation it was assumed that 90% of the drum's diet consists of benthic invertebrate tissue and 10% consists of incidental sediment ingestion. Estimates of incidental sediment ingestion of insectivores such as the freshwater drum were not available. However, Daiber (1952) documented stomach contents of the freshwater drum in Lake Erie and found insects were the greatest percentage of food items (over 95%) whereas "unidentified" stomach contents, which may include sediment, consisted of none to 4.5% for adult and juvenile fish, respectively. Based on these observations and best professional judgment, an incidental sediment ingestion of 10% was conservatively assumed for the pathway. Exposure point concentrations used in the first tier evaluation were maximum detected sediment concentrations and concentrations in invertebrate tissues estimated using maximum detected sediment concentrations and literature derived sediment to invertebrate uptake factors (see Section 4). The first tier evaluation was used to select COPC for this pathway.
- For the second tier of evaluation, the drum's diet was maintained at 90% invertebrates and 10% sediment. However, exposure point concentrations used in the second tier evaluation were the 95% UCL sediment concentrations and modeled concentrations in invertebrate tissues estimated using the UCL sediment concentrations.

It was assumed for both tiers of exposure that the freshwater drum would be able to access 100% of the Adjacent Nearshore and Adjacent Offshore exposure areas, and therefore, an area use factor of 1 was assumed. This may overestimate the area in the Adjacent Nearshore, portions of which may be too shallow for fish foraging. In addition, it was assumed that the freshwater drum is present in the exposure area year-round, resulting in an exposure duration of 1.

The surficial sediment data summarized in Section 2.1 were included in this fish dietary pathway analysis. For the purpose of this risk estimate, the prey for the freshwater drum was assumed to be comprised entirely of benthic invertebrates from the Site. Benthic invertebrate tissue concentrations were modeled based on sediment-to-invertebrate uptake factors (described in detail in Section 4). The sediment exposure point concentrations (EPCs) and the invertebrate EPCs for this pathway are presented in **Tables 3-2** and **3-3**, respectively, and include sediment chemistry data collected in August 2015.

3.3 Fish Dietary Effects Assessment

Per U.S. EPA's comments, the fish dietary exposure pathway for the East Waterway Operable Unit Baseline Ecological Risk Assessment (Windward, 2012) was used as the general basis for this assessment. Windward's methods were followed, and TRVs were reviewed. Windward researched toxicological data based on dietary studies focusing on chronic exposures in a laboratory setting (as opposed to field studies). Because the focus of this investigation was on saltwater fish, several of their derived TRVs were based on saltwater species such as rockfish. However, for the purpose of the Lake Macatawa assessment, when possible, studies based on freshwater species were selected. As needed, additional TRVs were researched from the primary literature. The fish dietary exposure TRVs are presented in **Table 3-4** and summarized as follows:

- There were no studies available for dietary exposures of thallium, so the potential for adverse effects associated with dietary exposures to this COPC is unknown (a literature review was conducted and no fish dietary exposure TRV was found).
- The barium TRV is from a large study of several constituents and is an unbounded no observed adverse effect level (NOAEL) (i.e., there is no LOAEL available from this study or other studies).
- A freshwater rainbow trout study was selected for the evaluation of potential copper exposures.
- The total PCBs TRV is based on the lowest NOAEL from a freshwater dietary exposure study.

3.4 Fish Dietary Pathway Risk Characterization

The first tier evaluation (i.e., the COPC screen) for the fish dietary pathway is presented in **Table 3-5**. The maximum dietary EPC was calculated based on 90% of the maximum invertebrate EPC plus 10% of the maximum sediment EPC. COPCs were retained for this pathway if the maximum dietary EPC exceeded the NOAEL TRV. Dietary EPCs for barium, cadmium, and chromium exceed the NOAEL TRVs. Nickel and thallium TRVs were not available.

In the second tier screen (**Table 3-6**), the dietary EPC was calculated using the same diet assumptions but the upper confidence limit (UCL) was selected as the EPC for sediment and invertebrates. U.S. EPA's ProUCL Version 5.0 software (U.S. EPA, 2013) was used to calculate UCLs on the arithmetic mean. ProUCL provides several parametric and nonparametric UCL computation methods that can be used on uncensored data sets (i.e., full data sets) and data sets containing non-detect values. The output from the program was reviewed to confirm the ProUCL recommended UCL should be selected as the appropriate UCL to be used as the Refined EPC.

Based on information presented in the ProUCL guidance (U.S. EPA, 2013) regarding minimum sample size and frequency of detection, UCLs were calculated where at least 10 samples and at least six detected results were available. Where too few samples or detects were available, the maximum detected concentration was used as the refined EPC. ProUCL output files are presented in **Attachment B**.

Hazard quotients (HQs) were calculated based on the dietary EPC divided by the TRV. All metal dietary EPCs were less than the NOAEL TRVs (for those metals for which TRVs are available) with the exception of cadmium and chromium. Chromium dietary EPCs from the RTC Ecological Evaluation did not exceed the NOAEL TRV. The cadmium dietary EPC exceeded the NOAEL TRV (HQ = 4.9), but was less than the LOAEL TRV (HQ = 0.98). The chromium dietary EPC was slightly higher than the NOAEL TRV (HQ = 1.33). No LOAEL TRV was identified for chromium. Given that the potential risk is bracketed by NOAEL and LOAEL TRVs, it is likely that there is no unacceptable risk for those compounds with TRVs from this exposure pathway.

TRVs were not available for two constituents: nickel and thallium:

- For nickel, no quantitative TRV was established. Studies have evaluated the effects of fish (based on the mulloway species [*Argyrosomus japonicas*]) ingestion of nickel-plated angler hooks (McGrath et al., 2011; McGrath et al., 2014). McGrath et al. (2014) reported that mortalities observed during the study were no higher following fish ingestion of nickel-plated hooks relative to inert hooks, indicating the mortalities were related to hook ingestion (i.e., puncture of organs or stomach lining) rather than from metal absorption following ingestion. High levels of nickel were reported in fish liver tissue, but no effects on mortality or growth related to the dietary exposure of nickel-plated hooks were observed in this study (McGrath et al., 2014).

McGrath et al. (2014) reported that the nickel content of the nickel-plated carbon-steel J hook used in their experiment was approximately 1.95% of the metal composition of the hook. The approximate weight of the hook is 275 mg (weight of hook number 2a [McGrath et al. 2011]). Therefore, the nickel content of the hook is estimated at 5.36 mg/hook. Based on the approximate weight of the mulloway (0.10 kg/fish[a]), the amount of ingested nickel per fish in this study was 53 mg/kg. Based on the maximum and refined sediment EPCs for nickel (10.7 mg/kg dw and 5 mg/kg dw, respectively), and very conservatively assuming that the quantity of sediment a fish such as the mulloway may consume is equal to their body weight, the levels of nickel per fish based on the maximum and refined EPCs are 1.07 and 0.05 mg/kg fish body weight, respectively. Both of these levels are a minimum of an order of magnitude lower than the modeled dose of nickel ingested per fish (53 mg/kg). This suggests that nickel detected in sediment of the exposure area is not at levels that may harm fish through dietary exposure.

- As discussed above, a comprehensive literature search for thallium TRVs was conducted and no TRV for this analyte was located, introducing some uncertainty into the fish dietary exposure pathway.

3.5 Fish Dietary Pathway Summary and Conclusions

This analysis indicates no unacceptable potential risk associated with fish dietary pathway exposures to COPCs in sediment at the Lake Macatawa Site and as such, no further ecological risk evaluation is needed to evaluate potential fish dietary exposure pathways. While modeled dietary exposures for fish using the first tier of evaluation (i.e., maximum sediment concentrations and modeled prey concentrations) for barium, cadmium and chromium indicated a very low potential for risk under the most conservative scenario, the second tier of evaluation (i.e., using 95% UCLs and including LOAEL TRVs) indicated little to no potential for risk. No formal TRVs were available for nickel or thallium, but a study involving ingestion of nickel-plated fish hooks indicated that the levels of nickel ingested by these fish with no adverse effects are much higher than those anticipated based on concentrations from Lake Macatawa sediments. Although there is some limited uncertainty associated with this finding, this analysis indicates no unacceptable potential risk associated with fish dietary exposure pathways to COPCs in sediment at the Lake Macatawa Site.

4.0 Food Web Modeling

The wildlife food web model has been revised and updated in response to October 2014 U.S. EPA Region 5 comments and to include August 2015 sediment chemistry data. This section present details of the food web model and notes where the analysis was updated in response to U.S. EPA comments.

4.1 Resources Potentially at Risk

The exposure areas under evaluation include the entire Lake Macatawa investigation area (Adjacent Nearshore and Adjacent Offshore) and Adjacent Nearshore only (shallow) portions of Lake Macatawa suitable for aquatic species. These areas may contain habitat for a variety of vertebrate wildlife species. In the sections below, the presence of rare species in the vicinity of the Site is discussed and the selection of receptors of concern is presented.

4.2 Rare Species Present or Potentially Present at Site

An updated rare species review request was prepared by the Michigan State University Extension Natural Features Inventory regarding the presence of rare or legally protected species on or near the Site. According to this review (dated January 13, 2015), legally protected species have not been documented within 1.5 miles of the Site in over 50 years (**Attachment C**). Three Special Concern Species are present within 1.5 miles of the Site: whorled mountain mint (*Pycnanthemum verticillatum*), northern appressed clubmoss (*Lycopodiella subappressa*), and bald eagle (*Haliaeetus leucocephalus*). However, records of these species occurring within 1.5 miles of the Site are considered Historic (i.e., over 50 years old). It is unlikely that these species would be found at the Site and therefore they were not considered further in this ecological assessment.

4.3 Selection of Receptors of Concern

Because constituents may bioaccumulate through the food web, representative vertebrate wildlife species from multiple trophic levels were evaluated. These trophic levels include Trophic Level 2 (TL2) herbivores, Trophic Level 3 (TL3) omnivores and insectivores, and Trophic Level 4 (TL4) carnivores and piscivores. Herbivores are primary consumers, ingesting primary producers (vegetation) and analytes from one trophic level. Omnivores consume both primary producers and consumers and ingest analytes from two trophic levels. Insectivores also consume primary consumers (invertebrates). Carnivores and piscivores represent the top of the food web and are potentially exposed to the higher levels of bioaccumulated analytes.

U.S. EPA suggested inclusion of a sandpiper in the food web model. However, as indicated in the Response to comments, the sediment habitat in the Adjacent Nearshore area is not suitable for small shorebirds such as the sandpiper, which forage from the water surface, in shallow water sediments or on the ground, and do not wade into deeper water to forage on submerged benthos or fish. The Adjacent Nearshore area is defined as the submerged sediments nearer the shoreline, not the actual shoreline itself. The water depth in the Adjacent Nearshore area is 1-3 feet deep; too deep for shorebird foraging. Sediment sampling records from the 2001 and 2011 field activities indicate water deeper than 12" for all samples collected in the Adjacent Nearshore. A small shorebird is therefore not included the food web evaluation. The descriptions below describe the avian, mammal, and fish receptors used in the food web models.

- **Belted Kingfisher (*Megaceryle alcyon*)** – The belted kingfisher was selected as a representative avian piscivorous species. Belted kingfishers were assumed to have potential exposure to the entire Lake Macatawa investigation area (e.g., both Adjacent Nearshore and Adjacent Offshore areas were considered in the kingfisher analysis. The kingfisher exists on a diet made up almost

exclusively of fish that swim near the surface of the water; they capture fish by diving either from their tree perch or after hovering in the air. When fish are not readily available, kingfisher may include crayfish, mollusks, amphibians, or other items in their diet. The belted kingfisher commonly inhabits areas along rivers, streams, lakes, and estuaries. Most kingfishers migrate south during the coldest months, although many stay in areas that remain ice-free where fishing is possible (U.S. EPA, 1993). Selection of the belted kingfisher allows evaluation of a TL4 piscivorous exposure pathway in Lake Macatawa.

- **Osprey (*Pandion haliaetus*)** – The osprey was selected as a representative avian piscivorous species. Osprey were assumed to have potential exposure to the whole Lake Macatawa investigation area (e.g., both Adjacent Nearshore and Adjacent Offshore areas were considered in the osprey analysis). Osprey exist on a diet made up almost exclusively of fish, and feed on fish found in shallow waters or that swim near the surface of the water. When fish are not readily available, osprey diet may include birds, frogs, and crustaceans. Ospreys prefer marine environments, but do inhabit larger lakes and reservoirs inland. In the northern temperate zones of the United States, ospreys usually migrate south in late summer and return from the southern hemisphere in March/April (U.S. EPA, 1993). Selection of the osprey allows evaluation of a larger TL4 piscivorous exposure pathway in Lake Macatawa.
- **Great Blue Heron (*Ardea herodias*)** – The great blue heron was selected as a representative avian piscivore for evaluation of potential risks associated with exposure through the ingestion of fish. The great blue heron occupies a variety of freshwater and marine areas, including brackish marshes, coastal wetlands, lakes, and rivers where small fish are abundant in shallow areas. Fish are preferred prey, but they also feed on amphibians, reptiles, insects, crustaceans, birds, and mammals (U.S. EPA, 1993). The great blue heron is a wading bird and not likely to be found in deep water. The great blue heron was therefore assumed to have potential exposure to the Adjacent Nearshore (shallow) area only. Selection of the great blue heron allows evaluation of a TL4 piscivorous exposure pathway for the nearshore of Lake Macatawa (e.g., only Adjacent Nearshore and areas were considered in the heron analysis).
- **Lesser Scaup (*Aythya affinis*)** – The lesser scaup was selected as a representative avian benthivore species. Lesser scaup were assumed to have potential exposure to the whole Lake Macatawa investigation area (e.g., both Adjacent Nearshore and Adjacent Offshore areas were considered in the scaup analysis). It was selected to evaluate potential risks associated with sediment exposure through the ingestion of benthic invertebrates. The lesser scaup is one of the most abundant ducks in North America. Lesser scaup are common on larger lakes during fall and winter and smaller waterbodies in the spring (U.S. EPA, 1993). Selection of the lesser scaup allows evaluation of a TL3 benthivorous exposure pathway of Lake Macatawa. This receptor was not evaluated in the October 29, 2013 submittal and was added to address one of U.S. EPA's specific comments.
- **Mink (*Mustela vison*)** – The mink was selected as a representative mammalian carnivore species. Mink were assumed to have potential exposure to the whole Lake Macatawa investigation area (e.g., both Adjacent Nearshore and Adjacent Offshore areas were considered in the mink analysis). It was selected to evaluate potential risks associated with sediment exposure through the ingestion of fish. The mink is the most abundant and widespread carnivorous mammal in North America. They feed on aquatic prey such as fish, frogs, and invertebrates. Mink are active year-round and are found in a variety of aquatic habitats including rivers, streams, lakes, and swamps (U.S. EPA, 1993). Selection of the mink allows evaluation of a TL4 carnivorous exposure pathway for Lake Macatawa.
- **Raccoon (*Procyon lotor*)** – The raccoon was selected as a representative small omnivorous mammalian wildlife species that may be found within aquatic or terrestrial exposure areas. The raccoon is the most abundant and widespread medium-sized omnivore in North America. Raccoons are commonly found in aquatic habitats, particularly in hardwood swamps, floodplain forests, and freshwater and saltwater marshes. They are also common in suburban residential

areas. Raccoons are omnivorous and feed primarily on insects, small mammals, birds, lizards, and fruits (U.S. EPA, 1993). The raccoon is expected for forage on the nearshore and banks of Lake Macatawa, and is unlikely for forage in deep waters. The raccoon was therefore assumed to have potential exposure to the Adjacent Nearshore (shallow) area only. Selection of the raccoon allows evaluation of a TL3 omnivorous exposure pathway in the nearshore of Lake Macatawa.

4.4 Wildlife Assessment and Measurement Endpoints

Ecologically-based assessment and measurement endpoints were designed to evaluate potential effects associated with exposure to identified COPCs. Assessment endpoints describe the characteristics of an ecosystem that have an intrinsic environmental value that is to be protected (i.e., protection of warm-water fish community; no potential risk to endangered species). Typically, assessment endpoints and receptors are selected for their potential exposure, ecological significance, economic importance, and/or societal relevance.

Because assessment endpoints often cannot be measured directly, a set of surrogate endpoints (measurement endpoints) are generally selected for ecological risk assessment that relate to the assessment endpoints and have measurable attributes (e.g., comparison of media concentrations to screening levels) (U.S. EPA, 1997; 1998). These measurement endpoints provide a quantitative metric for evaluating potential effects of constituents on the ecosystem components potentially at risk. The following assessment endpoint was identified for this Site:

Assessment Endpoint: Protection and maintenance of bird and mammal populations within the study area that are typical of comparable freshwater lake habitats.

The following measurement endpoint was used to assess the potential for unacceptable risk:

Measurement Endpoint: Comparison of modeled dietary intakes using sediment COPC concentrations and modeled tissue COPC concentrations with literature-based ingestion screening values.

4.5 Wildlife Food Web Exposure Assessment

This section presents the approaches to calculate EPCs for the COPCs and the exposure factors selected for use in food web modeling.

4.5.1 Exposure Point Concentrations

The surficial sediment chemistry data summarized in Section 2.1 were included in this analysis for the calculation of EPCs and include data collected in August 2015. EPCs were calculated for the Adjacent Nearshore area and for the entire study area (e.g., Adjacent Nearshore and Adjacent Offshore data sets combined). In U.S. EPA Specific Comment 6 (U.S. EPA, 2014), clarification was requested regarding the EPCs used in the food web analysis. For the purpose of this ERA, “Maximum EPC” was defined as the maximum detected concentration and the “Refined EPC” is the recommended UCL where sufficient samples are available for that calculation. EPCs for the wildlife food web are presented in **Table 4-1**. ProUCL output files are presented in **Attachment B**.

4.5.2 Exposure Parameters

Exposure assumptions (e.g., body weights, food and water ingestion rates, relative consumption of food items, foraging range, exposure duration, etc.) for the selected wildlife species are provided in **Table 4-2**. In

general, these values were obtained from the U.S. EPA's Wildlife Exposure Factors Handbook (U.S. EPA, 1993). Alternate sources were only used when the handbook did not provide sufficient information. Allometric equations (Nagy, 2001; Calder and Braun, 1983) were used to estimate food and water ingestion rates, respectively.[2] Food items for wildlife species evaluated in the food web exposure models included benthic invertebrates, fish, and aquatic plants. All exposure durations were assumed to be 1, consistent with U.S. EPA comments. Summaries of exposure parameters for the individual receptors are presented in **Tables 4-3** through **4-8**.

Bioaccumulation

Prey items for wildlife species evaluated in the food web exposure models include benthic invertebrates, fish, and plants. In the absence of Site-specific tissue data, tissue concentrations were estimated using literature-derived uptake factors. All uptake factors used in the food web models are presented in **Tables 4-9** (fish), **4-10** (benthic invertebrates) and **4-11** (aquatic plants).

Fish BSAFs

The uptake factors used to model fish tissue concentrations are based on empirical (constant) values taken from peer-reviewed literature. The fish BSAF for barium is the highest BSAF calculated of the tissue/sediment ratios for nine streams in the Blackfoot River watershed (Hamilton et al., 2003). The fish BSAFs for the other metals are the highest BSAFs calculated based on the tissue/sediment ratios presented in Krantzberg and Boyd (1992). Due to the small data sets of BSAFs available for metals from peer-reviewed literature, selecting the maximum BSAF for each was deemed appropriate. The fish BSAFs for total PCBs and chlorobenzene compounds are the median BSAFs calculated from the sediment and tissue data available for these compounds in the ECOTOX BSAF database[3]. Due to the large number of data points available from the U.S. EPA-approved source, the median value was selected. BSAFs were calculated assuming a total organic carbon content of 4% for the Adjacent Nearshore and Adjacent Offshore combined, and 1% for the Adjacent Nearshore area. This is consistent with the average organic carbon content of sediment samples from these areas. The fish lipid content was 6.46%. This is the median lipid content value from all studies used to derive a BSAF for PCBs. Uptake factors for thallium and xylene compounds were not available and therefore a value of 1 was used for these COPCs.

Invertebrate BSAFs

Invertebrate tissue concentrations were estimated for most of the metals using biota-sediment accumulation models from the Department of Energy (Bechtel Jacobs, 1998) as the primary source for uptake factors and regression models[4]. No regression or uptake factors were available for barium. Therefore, the uptake factor for sediment to invertebrates for barium was derived from the geometric mean of 16 paired observations of sediment and benthic tissue concentrations available from two United States Geological Survey (USGS) papers (Hamilton et al., 2003 and Garn et al., 2001). The uptake factor for vanadium recommended by U.S. EPA in the development of Ecological Soil Screening Levels (U.S. EPA, 2007) was used. For total PCBs, the median BSAFs calculated from the sediment and tissue data available in the ECOTOX BSAF database assuming a total organic carbon content of 4% for the Adjacent Nearshore and Adjacent Offshore combined, and 1% for the Adjacent Nearshore area. The invertebrate lipid content was calculated based on the lipid content of the samples from the studies used to derive the BSAF. The BSAFs for benzene,

[2] Per Specific Comment 10 (U.S. EPA, 2014), all food ingestion rates and dietary tissue concentrations are presented in dry weight.

[3] http://www.epa.gov/med/Prods_Pubs/bsaf.htm

[4] Per Specific Comment 10 (U.S. EPA, 2014), the regression equations from Bechtel Jacobs (1998) were corrected to include the log base 10 rather than the natural log.

chlorobenzene, and xylene compounds are based on the sediment/soil to invertebrate transfer factors available from Los Alamos National Laboratory (LANL, 2014).

Aquatic Plant Uptake Factors

Aquatic plant tissue concentrations were estimated using the soil to plant uptake factors and regression equations recommended by the U.S. EPA in development of Eco-SSLs (U.S. EPA, 2007). For thallium, total PCBs, benzene, chlorobenzenes, and xylene compounds, the sediment/soil to plant transfer factors available from LANL (2014) were used.

4.5.3 Calculation of Potential Doses

To estimate potential dietary exposure, a total daily dose (TDD) was estimated for each species. The TDD calculation considers the following factors: concentrations of the COPC in the food items that the species would consume, estimated amounts of abiotic media (i.e., sediment) that it would incidentally ingest, the relative amount of different food items in its diet, body weight, exposure duration (ED), species-specific area use factors (AUFs), and food ingestion rates. The ED represents the portion of the year that the receptor is exposed to the Site (e.g., may be modified by migration) and for the purposes of this conservative evaluation was assumed to be 1 (i.e., the food web model conservatively assumed that receptors are present throughout the year).

An AUF is defined as the ratio of the area of organisms' home range to the available habitat area within the Site. Site-specific AUFs for foraging were calculated using the area of the Lake Macatawa portion of the BASF Holland site, and for the Adjacent Nearshore area. For the osprey and raccoon, the site-specific areas were less than 1% of their foraging area. The area use for the heron was calculated to be 4.2% and for the lesser scaup, 7%. To provide a conservative screening level estimate of potential exposure, the AUFs for these four receptors were conservatively estimated to be 10%.

The following generalized Equation 1 was used to evaluate the TDD from all sources (i.e., food or prey item, incidental ingestion) for each COPC:

Equation 1:

$$TDD = \frac{\Sigma([IR_f \times C_f] + [IR_s \times C_s]) \times ED \times AUF}{\text{Body Weight}}$$

Where:

IR_f = Ingestion rate of food (kg/day)

IR_s = Incidental ingestion rate of sediment (kg/day)

C_f = Concentration of COPC in food (mg/kg)
C_s= Concentration of COPC in sediment (mg/kg)
ED = Exposure duration (fraction of time receptor spends within exposure area)
AUF = Area use factor (ratio of the receptor's home range relative to the size of exposure area)

The sum of the doses from the various sources represents the full TDD from each COPC that a receptor may be exposed through as a result of foraging within an exposure area. The risk estimates based on the parameters presented in **Table 4-2** and the uptake factors presented in **Tables 4-9** through **4-11** may be further refined by using, for example: additional location-specific exposure data or location-specific bioavailability factors. Use of such refinements allow the potential for risks to be put in perspective and provide information that the risk manager may use to more accurately characterize risks on a location-specific basis and to communicate the nature of the risks.

The TDD is based on oral routes of exposure (i.e., incidental ingestion of sediment, prey item ingestion). In general, dermal uptake is considered a potentially complete but insignificant exposure pathway for wildlife receptors. Due to the presence of feathers or fur, birds and mammals are not expected to be exposed to significant concentrations of COPC through direct contact. Feathers and fur limit the direct contact of skin with impacted media and reduce the likelihood of significant dermal exposure. Dermal exposure is expected to be negligible relative to the dose from ingestion in most cases (Sample et al., 1997; U.S. EPA, 2005); therefore, dermal exposure is not expected to contribute significantly to overall risk and thus this pathway was not considered in the dose evaluation.

4.6 Ecological Effects Assessment

TRVs can be defined as the daily dose of a constituent that is considered protective of wildlife (mammals and birds) populations or individuals. The dose is expressed in milligram per kilogram body weight per day ($mg/kg_{bw}/day$) and can be based on either a NOAEL or a LOAEL.

Table 4-12 presents the TRVs used for the bird and mammal dietary assessment. TRVs were obtained from:

- The current U.S. EPA Ecological Soil Screening Level (Eco-SSL) documents (available at www.epa.gov/ecotox/ecossl/),
- The Oak Ridge National Laboratory's (ORNL) publication Toxicological Benchmarks for Wildlife: 1996 Revision (Sample et al., 1996), and
- Los Alamo National Laboratory (2012).

The U.S. EPA guidance (U.S. EPA, 1997) specifies that it is preferred for TRVs to represent a NOAEL for chronic exposure to Site-related constituents. Should a NOAEL not be available, the U.S. EPA guidance allows the use of the lowest exposure level shown to produce adverse effects (i.e., the LOAEL) in the development of TRVs. Both upper and lower bound TRVs (LOAEL-based TRVs and NOAEL-based TRVs, respectively) were identified in order to estimate a range of potential risks to mammalian and avian receptors. The NOAEL-based TRVs represent non-hazardous exposure levels for the wildlife species evaluated, while the LOAEL-based TRVs represent potential exposure levels at which adverse effects may become evident.

NOAEL-based TRVs were preferably based on chronic NOAELs, with an emphasis on studies that measured effects on survival, reproduction, and growth endpoints applicable to the protection of wildlife populations. The following steps were followed to select LOAEL-based TRVs after acceptable NOAELs were identified:

- If a LOAEL was reported for the study used to derive the NOAEL-based TRV, that LOAEL value was selected as the LOAEL-based TRV;
- In the case where the geometric mean of several NOAELs for growth and reproductive endpoints was used as the NOAEL-based TRV (i.e., Eco SSL-based TRVs), the geometric mean of the LOAELs for growth and reproduction was calculated and selected as the LOAEL-based TRV;
- For Eco SSL-based TRVs, when the NOAEL-based TRV was based on a single NOAEL and no corresponding LOAEL was available, the upper-bound LOAEL for growth and reproduction was used; and
- For TRVs derived from other sources, when there was no paired LOAEL, a factor of 10 was applied to the NOAEL-based TRV to estimate a LOAEL-based TRV.
- Per Specific Comment 2 (U.S. EPA, 2014), the median avian LOAEL (3.55 mg/kg-d) was selected for the arsenic TRV.

4.7 Wildlife Risk Characterization

The COPCs identified in the sediment screen (Section 2) were evaluated in the wildlife dietary exposure pathway. The wildlife food web models and results for the individual receptors are presented in **Tables 13** through **4-18**. A summary of the HQs is presented in **Table 4-19**.

The results of the food web models indicate that under the most conservative scenarios (e.g., No Effect TRVs, maximum EPC) HQs are less than 1 for all receptors except for the belted kingfisher, lesser scaup, and mink. The lesser scaup did not have any HQ > 1 in the RTC Ecological Evaluation.

- For the belted kingfisher, HQs were greater than 1 for barium, chromium and copper. Chromium HQs were less than 1 in the Ecological Evaluation. Modeled exposures to barium based on the maximum EPC and NOAEL- and LOAEL TRVs resulted in HQs greater than 1 (HQ = 4.4 and 2.2, respectively; slightly higher than the RTC Ecological Evaluation). However, based on the refined EPC (i.e., 95% UCLs), HQs calculated based on both the NOAEL and the LOAEL TRV were less than 1. For chromium and copper, the HQ calculated under the most conservative scenario (i.e., maximum EPC and NOAEL-TRV) exceeded 1 (HQs = 1.6 and 1.1, respectively), but all other chromium and copper HQs were less than 1.
- For lesser scaup, the HQ calculated for barium under the most conservative scenario (i.e., maximum EPC and NOAEL-TRV) exceeded 1 (HQs = 1.66), but all other HQs were less than 1.
- For mink, the total PCB HQ calculated under the most conservative scenario (i.e., maximum EPC and NOAEL-TRV) exceeded 1 (HQ = 1.6), but all other total PCB HQs calculated for mink were less than 1. This result is consistent with the RTC Ecological Evaluation.

This analysis indicates no unacceptable potential risk associated with wildlife food web exposures to COPCs in sediment at the Lake Macatawa Site.

4.8 Wildlife Food Web Modeling Summary and Conclusions

The results of this analysis indicate that no further ecological risk evaluation is needed to evaluate potential food chain exposure pathways. While some modeled dietary exposures for wildlife using the maximum sediment concentrations and modeled prey concentrations indicated a very low potential for risk under the most conservative scenario, it is unlikely that the maximum concentration is the best representation of actual exposure. Using the upper bound estimated of the mean (the UCL of the sediment data), modeled dietary exposures for wildlife (osprey, kingfisher, mink, heron, and lesser scaup) that may use either the Adjacent Nearshore and Adjacent Offshore areas combined or the Adjacent Nearshore area only for foraging are less than no-effect and/or low effect toxicity values.

5.0 Uncertainty Evaluation

The uncertainty evaluation provided in this section includes the food web modeling, fish dietary pathway, and BSAFs only. Additional uncertainty evaluation will be provided in the comprehensive ERA to be provided at a future date.

5.1 Uncertainties Associated with Fish Dietary Pathway Evaluation

There are several sources of uncertainties in the fish dietary exposure pathway evaluation, including the assumptions of dietary components and the availability and selection of TRVs. This section summarizes these sources of uncertainty relative to the risk characterization. Studies from Windward (2012) served as a secondary source for TRVs, but all primary literature cited by Windward were reviewed. As additional TRVs were developed, the primary literature for these values were also reviewed.

The diet of the freshwater drum is predominantly invertebrates, but includes both benthic and aquatic invertebrates as well as small fish and amphibians (Bur, 1982). Relying solely on predicted benthic tissue concentrations may over- or underestimate the actual prey concentrations for the drum. In addition, the assumption of 10% incidental sediment ingestion may overestimate the sediment consumption for this species. Based on stomach content analysis conducted by Daiber (1952), the drum consumes predominantly insects that are located both on the bottom and throughout the water column and likely does not consume large amounts of sediment.

There are several sources of uncertainties related to the TRVs including the relevance of laboratory studies to field conditions, the lack of studies available for the identification of NOAELs, and the lack of LOAELs to bound the no effects levels. All TRVs are based on laboratory studies that may not reflect the field conditions of Lake Macatawa that a freshwater drum could encounter.

No thallium dietary exposure studies were available, and therefore, fish exposure to thallium through the diet is unknown.

Only one study was available for barium, chromium, and vanadium, and two studies available for zinc. The lack of studies available increases the uncertainty of the NOAELs and LOAELs identified for these COPCs. Also, TRVs for barium and chromium are based only on NOAELs that were not bounded by low effects levels and therefore, the relevancy of these NOAELs to concentrations at which growth, reproduction, or survival effects are observed is unknown. The vanadium TRV is based on a LOAEL only and an uncertainty factor of 5 was applied to estimate the NOAEL from the LOAEL.

5.2 Clarification of and Quantitative Uncertainties Associated with BSAFs

As indicated in Specific Comment 2, bioavailability may be underestimated by the use of central tendency biota-sediment accumulation factors (BSAFs). An analysis of the range of BSAFs considered for barium and copper is presented below, in response to Specific Comment 5. Because of the small datasets available for the metals, the maximum BSAF was selected from each source for barium and copper for a conservative estimate of fish and invertebrate tissue concentrations. Alternatively, many paired sediment and fish and invertebrate tissue data are available for total PCBs from the ECOTOX BSAF database[5] (195 paired sediment and fish tissue samples and 31 paired sediment and invertebrate tissue samples). Therefore, the

[5] http://www.epa.gov/med/Prods_Pubs/bsaf.htm

median BSAF was selected to represent the wide range of BSAFs available for PCBs (0.03 to 4.8 for invertebrates and 0.03 to 37 for fish).

In response to Specific Comment 5 (U.S. EPA, 2014), the biota-to-sediment accumulations factors (BSAFs) used in the food web modeling are further described below in terms of the literature review conducted to identify the BSAFs and the range of BSAFs available from each source.

For fish and benthic invertebrates, a literature review was conducted to identify primary research presenting metals concentrations in both sediment and tissue. Krantzberg and Boyd (1992) present an investigation of the relative toxicity of trace metals and PAHs detected in sediment to mayfly nymphs (*Hexagenia limbata*) and fathead minnows (*Pimephales promelas*) at a site located in Hamilton Harbour, Lake Ontario. Concentrations of metals are presented for tissue residue and sediment collected at co-located sampling locations. BSAFs for fish tissue were calculated for each sampling location at which both sediment and fish tissue residue data are available, and the maximum BSAF was selected to estimate fish tissue concentrations of several metals (**Table 4-9**).

Similarly, Hamilton and Buhl (2003) present an analysis of trace metal movement in nine streams in the Blackfoot River watershed in Idaho. Barium concentrations detected in sediment and fish and invertebrate tissue residue samples collected at co-located sampling locations were used to calculate BSAFs. BSAFs were calculated for each sampling location for which both sediment and fish or invertebrate tissue residue data are available, and the maximum BSAF was selected to estimate concentrations of barium in fish tissue (**Table 4-9**) and invertebrate tissue (**Table 4-10**).

The range of BSAFs calculated based on the above sources (Krantzberg and Boyd, 1992; Hamilton and Buhl, 2003) is presented in **Table 5-1** for barium and copper fish tissue concentration estimates. The highest fish tissue concentrations, calculated based on the maximum BSAF, are two to eight times greater than the minimum fish tissue concentrations.

Several regression equations from Bechtel Jacobs (1998) were used to estimate benthic invertebrate tissue concentrations. The regression equation with the highest R^2 value was selected from Table 3 of Bechtel Jacobs (1998). For comparison, invertebrate tissue concentrations for copper were calculated based on the 90th percentile of literature values included in Bechtel Jacobs (1998) and presented in **Table 5-1**. The tissue concentrations for copper based on the 90th percentile are several orders of magnitude greater than the tissue concentrations based on the regression equations.

5.3 Uncertainties Associated with Food Web Modeling

In response to Specific Comments 2 and 7, the uncertainty evaluation for the Food Web Model presented previously has been updated below to provide a more balanced discussion.

Exposure to wildlife receptors has considerable uncertainties related to exposure duration, AUFs, and bioavailability of COPC. The assumptions made in the food web models were selected to approximate realistic Site-specific factors and not overly conservative assumptions. Wide-ranging receptors were also assumed to forage outside of small exposure areas.

Bioavailability in prey items may be overestimated because the food web models assumed that the COPC consumed by wildlife receptors were present in a form that was 100% bioavailable; however, this is unlikely. COPC ingested by wildlife receptors may not be fully absorbed into an organism's system following ingestion (e.g., some fraction of the COPC ingested is likely to be eliminated).

Studies have shown that chitinous exoskeletons, such as those found on some invertebrates, bind inorganic constituents such as cadmium, copper, selenium, and zinc (Reinfelder and Fisher, 1994; Keteles and Fleeger, 2001). Reinfelder and Fisher (1994) found that nearly 60% of the selenium in the body burden of

copepods was present in the exoskeleton and >97% of the cadmium and zinc body burdens were present in the exoskeleton. Keteles and Fleeger (2001) found that grass shrimp exoskeletons contained 11% of the copper body burden, 18% of the zinc body burden, and 26% of the cadmium body burden. While these studies did not include all COPCs, the remaining COPCs could also be bound in the invertebrate exoskeleton. COPC bound in the exoskeleton are not expected to be as bioavailable to the predator as the COPC in the tissues of the prey.

Reinfelder and Fisher (1994) also found that fish fed copepods containing radiolabeled cadmium, selenium, or zinc exhibited assimilation efficiencies ranging from 3% (cadmium) to 29% (selenium), indicating that a significant amount of the COPC that are ingested may be eliminated in fecal pellets. These results indicate that risks to other wildlife receptors may also be overestimated by the assumption of 100% bioavailability.

The TRVs used in the food web models were extrapolated from data on similar species because direct dose-response information was not always available for the representative species. Evaluation against a NOAEL-based TRV identifies levels below which no effect has been seen. Therefore, it is useful to consider the constituent level at which adverse effects start to manifest (i.e., the LOAEL-based TRV). These two approaches are considered to constitute the lower bound (i.e., consistent conservative assumptions and NOAEL-based TRVs) and upper bound (i.e., Site-specific data and LOAEL-based TRVs) (U.S. EPA, 1997). Both NOAEL- and LOAEL-based TRVs were included in the food web models so that the difference in the risk estimates based on the different toxicity-based TRV endpoints could be evaluated and interpreted.

The estimate of uptake and/or bioaccumulation from environmental media into plants and wildlife is a source of uncertainty. Ideally, site-specific plant and animal tissues are available to incorporate into the food web model. In the absence of Site-specific tissue data, uptake factors or regression models available in the literature were used to estimate tissue concentrations. These uptake factors were generally obtained from laboratory studies which may overestimate bioavailability relative to the actual bioavailability of weathered soils and sediments present within the exposure areas. There is some uncertainty in the prediction of tissue concentrations using generic uptake factors and regression models.

In general, although the food web models include some realistic exposure assumptions, a number of conservative assumptions regarding COPC uptake and potential effects were incorporated into the food web models. As a result, it is likely that the food web models over-estimate potential risks to wildlife receptors.

6.0 Summary and Conclusions

The results of this ecological evaluation will be used to determine which COPCs and potentially complete exposure pathways are to be considered for further evaluation at the Site. Three possible decisions can be reached following this evaluation:

- There is enough information to conclude that the potential for ecological risks is acceptable and no further ecological risk evaluation is needed.
- There are data gaps that must be addressed before the presence or absence of risk can be concluded (e.g., additional sampling or analysis) and the ERA will proceed.
- The information indicates a potential for ecological risk, and remediation should be evaluated.

As summarized below, the results of this assessment are consistent with the results presented in the RTC Ecological Evaluation such that inclusion of sediment chemistry data collected in August 2015 into the sediment chemistry screen and the fish and wildlife dietary pathway evaluations did not change the results. These results indicate that: (1) additional evaluation of the potential for adverse risks to benthic invertebrates is warranted (i.e., several Site-related COPCs are present at concentrations in excess of Region 5 ESLs); (2) there are no adverse risks to fish and wildlife from exposure to Site-related COPCs in sediment and no further ecological risk evaluation is needed to evaluate potential food chain exposure pathways.

The results of the ERA are summarized below for each receptor group:

Benthic Invertebrates:

- Based on the updated sediment chemistry dataset (i.e., including August 2015 samples), Site-related COPCs are present at concentrations that exceed Region 5 ESLs:
    - In the Adjacent Nearshore sediments, barium, copper, lead, thallium, vanadium, chlorobenzene and 1,4-dichlorobenzene were present at concentrations above Region 5 ESLs. Concentrations of lead, thallium, and vanadium are similar to background.
    - In the Adjacent Offshore, arsenic, barium, cadmium, chromium, copper, lead, nickel, zinc, total PCBs, 1,3-dichlorobenzene, 1,4-dichlorobenzene, benzene, chlorobenzene, o-xylene, and total xylene exceed the Region 5 ESLs. Concentrations of arsenic and cadmium are similar to regional background levels.
- These COPCs are identical to the list of COPCs presented in the RTC Ecological Evaluation.

Fish Dietary Pathway:

- Based on the updated sediment chemistry dataset, modeled maximum dietary exposures for fish remain are less than no-effect toxicity values for the majority of COPCs.
- For barium and chromium, the second tier evaluation indicated no effects using a 95% UCL exposure. Cadmium exposure was lower than low effect thresholds. Chromium exposure was slightly higher than no effect thresholds and low effect thresholds are not available.
- Therefore, no further ecological risk evaluation is needed for the fish dietary pathway. This is consistent with the results of the Ecological Evaluation.

Wildlife Exposure:

- Based on the updated sediment chemistry dataset, in the exposure area which includes Adjacent Nearshore and Adjacent Offshore areas, combined several HQs were slightly above 1 for the following scenarios using the maximum sediment and prey EPCs:
    - the kingfisher for exposure to barium, chromium, and copper under NOAEL comparison and barium using LOAEL comparison,
    - the lesser scaup for exposure to barium using NOAEL comparison, and
    - the mink for exposure to total PCBs using NOAEL comparison.
- When refined EPCs were considered in the food web modeling, all modeled dietary exposures for wildlife (osprey, kingfisher, mink, and lesser scaup) were less than no-effect and/or low effect toxicity values. Therefore, no further ecological risk evaluation is needed.

Based on the above findings, no unacceptable ecological risks are expected for dietary exposure for fish, birds, or mammalian wildlife. This is consistent with the results of the RTC Ecological Evaluation. Therefore, no additional risk evaluation is required to determine potential risk to these receptors via food web exposure pathways.

Based on the results of the benchmark screening, it is possible that risks to benthic organisms may occur from direct contact exposure to surficial sediments. To address this potential concern, Site-specific laboratory toxicity testing was conducted and is presented in the BERA.

7.0 References

Additional references are found in **Table 7-1**.

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Tables

Appendix A Table 2-1
Site Surface Sediment Samples Included in the Ecological Evaluation
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Sample	Date	Depth (ft)	Type
Adjacent Nearshore Samples			
FBF-SD01-06-S	11/14/2001	0 - 0.5	
FBF-SD02-06-S	11/14/2001	0 - 0.5	
FBF-SD04-06-S	11/15/2001	0 - 0.5	
FBF-SD07-06-S	11/14/2001	0 - 0.5	
FBF-SD08-06-S	11/14/2001	0 - 0.5	
FBF-SD10-06-S	11/14/2001	0 - 0.5	
SD21-0-SD-11A-S	7/15/2011	0 - 0.5	
SD22-0-SD-11A-S	7/15/2011	0 - 0.5	
SD23-0-SD-11A-S	7/15/2011	0 - 0.5	
SD27-0-SD-11A-S	7/14/2011	0 - 0.5	
SD24-0-SD-11A-S	7/13/2011	0 - 0.5	
SD26-0-SD-11A-S	7/14/2011	0 - 0.5	
Adjacent Offshore Samples			
FBF-SD05-06-S	11/14/2001	0 - 0.5	
SD25-0-SD-11A-S	7/18/2011	0 - 0.5	
SD28-0-SD-11A-S	7/14/2011	0 - 0.5	
SD29-0-SD-11A-S	7/14/2011	0 - 0.5	
SD30-0-SD-11A-S	7/15/2011	0 - 0.5	
SD31-0-SD-11A-S	7/15/2011	0 - 0.5	
SD32-0-SD-11A-S	7/13/2011	0 - 0.5	
SD33-0-SD-11A-S	7/13/2011	0 - 0.5	
SD33-0-SD-11A-D	7/13/2011	0 - 0.5	Duplicate
SD34-0-SD-11A-S	7/18/2011	0 - 0.5	
SD35-0-SD-11A-S	7/15/2011	0 - 0.5	
SD36-0-SD-11A-S	7/14/2011	0 - 0.5	
SD36-0-SD-11A-D	7/14/2011	0 - 0.5	Duplicate
SD37-0-SD-11A-S	7/13/2011	0 - 0.5	
SD38-0-SD-11A-S	7/13/2011	0 - 0.5	
SD39-0-SD-11A-S	7/14/2011	0 - 0.5	
SD40-0-SD-11A-S	7/14/2011	0 - 0.5	
SD41-0-SD-11A-S	7/14/2011	0 - 0.5	
SD42-0-SD-11A-S	7/13/2011	0 - 0.5	
SD43-0-SD-11A-S	7/13/2011	0 - 0.5	
SD44-0-SD-11A-S	7/13/2011	0 - 0.5	
SD49-0-SD-11A-S	7/20/2011	0 - 0.5	
SD50-0-SD-11A-S	7/20/2011	0 - 0.5	
SD51-0-SD-11A-S	7/20/2011	0 - 0.5	
SD51-0-SD-11A-D	7/20/2011	0 - 0.5	Duplicate
SD52-0-SD-11A-S	7/20/2011	0 - 0.5	
SD53-0-SD-11A-S	7/20/2011	0 - 0.5	
SD54-0-SD-11A-S	7/20/2011	0 - 0.5	
SD55-0-SD-11A-S	7/20/2011	0 - 0.5	

Appendix A Table 2-1
Site Surface Sediment Samples Included in the Ecological Evaluation
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Sample	Date	Depth (ft)	Type
SD56-0-SD-11A-S	7/20/2011	0 - 0.5	
SD57-0-SD-11A-S	7/21/2011	0 - 0.5	
SD58-0-SD-11A-S	7/21/2011	0 - 0.5	
SD59-0-SD-11A-S	7/21/2011	0 - 0.5	
SD60-0-SD-11A-S	7/21/2011	0 - 0.5	
SD61-0-SD-11A-S	7/21/2011	0 - 0.5	
#14	9/9/2008	0 - 1	
#5	9/9/2008	0 - 1	
#6	9/9/2008	0 - 1	
#7	9/9/2008	0 - 1	
#8	9/9/2008	0 - 1	
#9	9/9/2008	0 - 1	
SD25-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Test Sample
SD28-0-0.5-15A-S	8/4/2015	0 - 0.5	
SD30-0-0.5-15A-S	8/4/2015	0 - 0.5	Toxicity Test Sample
SD31-0-0.5-15A-S	8/4/2015	0 - 0.5	
SD32-0-0.5-15A-S	8/4/2015	0 - 0.5	Toxicity Test Sample
SD32-0-0.5-15A-D	8/4/2015	0 - 0.5	Duplicate
SD36-0-0.5-15A-S	8/4/2015	0 - 0.5	
SD36-0-0.5-15A-D	8/4/2015	0 - 0.5	Duplicate
SD39-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Test Sample
SD39-0-0.5-15A-D	8/5/2015	0 - 0.5	Duplicate
SD40-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Test Sample
SD50-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Test Sample
SD53-0-0.5-15A-S	8/5/2015	0 - 0.5	
SD54-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Test Sample
SD55-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Test Sample
SD58-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Test Sample
SD59-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Test Sample

Notes:
ft - feet

Appendix A Table 2-2
Background and Regional Reference Surface Sediment Samples Included in the Ecological Evaluation
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Sample	Date	Depth (ft)	Type
Site-Specific Background			
FBF-SD11-06-S	11/15/2001	0 - 0.5	
FBF-SD12-06-S	11/15/2001	0 - 0.5	
FBF-SD13-06-S	11/15/2001	0 - 0.5	
FBF-SD14-06-S	11/15/2001	0 - 0.5	
FBF-SD15-06-S	11/15/2001	0 - 0.5	
FBF-SD16-06-S	11/15/2001	0 - 0.5	
FBF-SD17-06-S	11/15/2001	0 - 0.5	
FBF-SD18-06-S	11/15/2001	0 - 0.5	Average of parent and duplicate
FBF-SD19-06-S	11/15/2001	0 - 0.5	
FBF-SD20-06-S	11/15/2001	0 - 0.5	
SD45-0-SD-11A-S	7/15/2011	0 - 0.5	
SD45-0-SD-11A-D	7/15/2011	0 - 0.5	Duplicate
SD46-0-SD-11A-S	7/15/2011	0 - 0.5	
SD47-0-SD-11A-S	7/14/2011	0 - 0.5	
SD48-0-SD-11A-S	7/15/2011	0 - 0.5	
SD45-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Testing Reference Sample
SD46-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Testing Reference Sample
Regional Background / Reference			
#10 0-1	9/9/2008	0 - 1	
#4 0-1	9/9/2008	0 - 1	
LM06-01	9/12/2006	0 - 1	
LM06-02	9/12/2006	0.33 - 0.33	
LM06-03	9/12/2006	0 - 1	
LM-1_CORE_TOP	7/8/2002	0 - 1.67	
LM-1_PONAR	7/10/2002	0 - 0.5	
LM-10_CORE_TOP	7/9/2002	0 - 1.67	
LM-10_PONAR	7/12/2002	0 - 0.5	
LM-11_CORE_TOP	7/9/2002	0 - 1.67	
LM-11_PONAR	7/12/2002	0 - 0.5	
LM-12_CORE_TOP	7/8/2002	0 - 1.67	
LM-12_PONAR	7/12/2002	0 - 0.5	
LM-14_CORE_TOP	7/9/2002	0 - 1.67	
LM-14_PONAR	7/12/2002	0 - 0.5	
LM-15_CORE_TOP	7/9/2002	0 - 1.67	
LM-15_PONAR	7/12/2002	0 - 0.5	
LM-2_CORE_TOP	7/8/2002	0 - 1.67	
LM-2_PONAR	7/10/2002	0 - 0.5	
LM-3_CORE_TOP	7/8/2002	0 - 1.67	
LM-3_PONAR	7/11/2002	0 - 0.5	
LM-4_CORE_TOP	7/8/2002	0 - 1.67	
LM-4_PONAR	7/11/2002	0 - 0.5	
LM-5_CORE_TOP	7/9/2002	0 - 1.67	
LM-6_CORE_TOP	7/9/2002	0 - 1.67	Average of parent and duplicate
LM-6_PONAR	7/11/2002	0 - 0.5	Average of parent and duplicate
LM-7_CORE_TOP	7/9/2002	0 - 1.67	
LM-7_PONAR	7/11/2002	0 - 0.5	
LM-8_CORE_TOP	7/9/2002	0 - 1.67	
LM-8_PONAR	7/11/2002	0 - 0.5	
LM-9_CORE_TOP	7/9/2002	0 - 1.67	
LM-9_PONAR	7/11/2002	0 - 0.5	
LM-08-13-0-0.5-15A-S	8/5/2015	0 - 0.5	Toxicity Testing Reference Sample
LM-08-13-0-0.5-15A-D	8/5/2015	0 - 0.5	Duplicate

Notes:
ft - feet

Appendix A Table 2-3
Summary Statistics and Ecological Screening of Adjacent Nearshore Sediment
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

	Adjacent Nearshore						Background					
		Detected Concentrations			Reporting Limits			Detected Concentrations			Reporting Limits	
Analyte	FOD [a]	Minimum	Mean	Maximum	Minimum	Maximum	FOD [a]	Minimum	Mean	Maximum	Minimum	Maximum
INORGANICS												
ANTIMONY	0 : 6	--	--	--	7.4	62	0 : 10	--	--	--	6.5	36
ARSENIC	12 : 12	880	3115	8200	--	--	16 : 16	890	2944	10600	--	--
BARIUM	12 : 12	7800	96800	489000	--	--	16 : 16	8500	45291	196000	--	--
CADMIUM	12 : 12	54	166	480	--	--	16 : 16	18	225	860	--	--
CHROMIUM	12 : 12	2700	8267	21300	--	--	16 : 16	1600	8719	34000	--	--
COBALT	6 : 6	1000	1417	2500			10 : 10	590	1740	3500	--	--
COPPER	12 : 12	3300	58150	285000	--	--	16 : 16	1100	11738	48700	--	--
LEAD	12 : 12	2700	15092	60800	--	--	16 : 16	1500	29806	306000	--	--
NICKEL	12 : 12	2200	4400	11800	--	--	14 : 14	1400	7239	27000	--	--
SELENIUM	0 : 6	--	--	--	67	180	0 : 10	--	--	--	75	380
SILVER	4 : 6	28	39	55	--	--	6 : 10	38.0	82.2	180	--	--
THALLIUM	5 : 6	32	50.8	92	--	--	6 : 10	36.0	75.3	180	--	--
VANADIUM	6 : 6	3200	3900	5100	--	--	10 : 10	1700	3750	5500	--	--
ZINC	12 : 12	13900	40833.33	113000	--	--	16 : 16	3700	43216	186000	--	--
POLYCHLORINATED BIPHENYLs (PCBs)												
PCB-1016	0 : 6	--	--	--	21	22	NA	--	--	--	--	--
PCB-1221	0 : 6	--	--	--	21	22	NA	--	--	--	--	--
PCB-1232	0 : 6	--	--	--	21	22	NA	--	--	--	--	--
PCB-1242	4 : 6	4.1	29.6	75	--	--	NA	--	--	--	--	--
PCB-1248	0 : 6	--	--	--	21	22	NA	--	--	--	--	--
PCB-1254	5 : 6	6.5	48.3	120	--	--	NA	--	--	--	--	--
PCB-1260	2 : 6	7.8	14.4	77.7	--	--	NA	--	--	--	--	--
Total PCBs	5 : 6	9	77.7	216	--	--	2 : 4	43	97.5	152	--	--
VOLATILE ORGANIC COMPOUNDS (VOCs)												
BENZENE	0 : 6	--	--	--	5	62	0 : 6	--	--	--	4.2	21
CHLOROBENZENE	4 : 6	1.6	262	960	--	--	0 : 6	--	--	--	4.2	21
XYLENE (TOTAL)	0 : 6	--	--	--	5	62	0 : 6	--	--	--	5.5	21
SEMI-VOLATILE ORGANIC COMPOUNDS (SVOCs)												
1,2,4-TRICHLOROBENZENE	0 : 6	--	--	--	5	62	0 : 4	--	--	--	5.5	21
1,3-DICHLOROBENZENE	5 : 6	1.8	29.8	96	--	--	0 : 6	--	--	--	4.2	21
1,4-DICHLOROBENZENE	5 : 6	3.7	307	1400	--	--	0 : 6	--	--	--	4.2	21

Notes:
All units are µg/Kg.
Summary statistics are based on detected concentrations only. The minimum and maximum reporting limits are presented for analytes that were not detected in sediment.
ESL - Ecological Screening Level.
FOD - Frequency of Detection.
NA - Not analyzed.
NC - Not calculated.
ND - Not detected.
NV - No ESL value available.
[a] Number of detected samples : total number of samples.
[b] The number of samples with detected concentrations that are less than the maximum background concentration.
[c] USEPA Region 5 Ecological Screening Levels
(available at: http://epa.gov/region5/waste/cars/pdfs/ecological-screening-levels-200308.pdf)
[d] Soil ESLs were used when sediment ESLs are not available.
[e] An ESL is available for Total PCBs only.

Appendix A Table 2-3
Summary Statistics and Ecological Screening of Adjacent Nearshore Sediment
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Analyte	Is Max Site > Max Background?	Number of Site Samples within Range of Background [b]	Selected Sediment ESL [c]	COPC Determination and Rationale	
				Adjacent Nearshore	
INORGANICS					
ANTIMONY	ND	NC	NV	NO	Not detected
ARSENIC	No	12	9790	NO	Max Detect < ESL
BARIUM	Yes	10	1040 [d]	YES	Max Detect > ESL
CADMIUM	No	12	990	NO	Max Detect < ESL
CHROMIUM	No	12	43400	NO	Max Detect < ESL
COBALT	No	6	50000	NO	Max Detect < ESL
COPPER	Yes	8	31600	YES	Max Detect > ESL
LEAD	No	12	35800	YES	Max Detect > ESL
NICKEL	No	12	22700	NO	Max Detect < ESL
SELENIUM	ND	NC	NV	NO	Not detected
SILVER	No	4	500	NO	Max Detect < ESL
THALLIUM	No	5	56.9 [d]	YES	Max Detect > ESL
VANADIUM	No	6	1590 [d]	YES	Max Detect > ESL
ZINC	No	8	121000	NO	Max Detect < ESL
POLYCHLORINATED BIPHENYLs (PCBs)					
PCB-1016	NC	NC	NV	NO	Not detected
PCB-1221	NC	NC	NV	NO	Not detected
PCB-1232	NC	NC	NV	NO	Not detected
PCB-1242	NC	NC	NV	NC [e]	--
PCB-1248	NC	NC	NV	NO	Not detected
PCB-1254	NC	NC	NV	NC [e]	--
PCB-1260	NC	NC	NV	NC [e]	--
Total PCBs	Yes	5	59.8	YES	Max Detect > ESL
VOLATILE ORGANIC COMPOUNDS (VOCs)					
BENZENE	NC	NC	142	NO	Not detected
CHLOROBENZENE	NC	NC	291	YES	Max Detect > ESL
XYLENE (TOTAL)	NC	NC	433	NO	Not detected
SEMI-VOLATILE ORGANIC COMPOUNDS (SV					
1,2,4-TRICHLOROBENZENE	NC	NC	5062	NO	Not detected
1,3-DICHLOROBENZENE	NC	NC	1315	NO	Max Detect < ESL
1,4-DICHLOROBENZENE	NC	NC	318	YES	Max Detect > ESL

Notes:
All units are µg/Kg.
Summary statistics are based on detected concentrations only. The minimum and maximum reporting limits are presented for analytes that were not detected in sediment.
ESL - Ecological Screening Level.
FOD - Frequency of Detection.
NA - Not analyzed.
NC - Not calculated.
ND - Not detected.
NV - No ESL value available.
[a] Number of detected samples : total number of samples.
[b] The number of samples with detected concentrations that are less than the maximum background concentration.
[c] USEPA Region 5 Ecological Screening Levels
(available at: http://epa.gov/region5/waste/cars/pdfs/ecological-screening-levels-200308.pdf)
[d] Soil ESLs were used when sediment ESLs are not available.
[e] An ESL is available for Total PCBs only.

Appendix A Table 2-4
Summary Statistics and Ecological Screening of Adjacent Offshore Sediment
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

	Adjacent Offshore						Reference Area					
		Detected Concentrations			Reporting Limits			Detected Concentrations			Reporting Limits	
Analyte	FOD [a]	Minimum	Mean	Maximum	Minimum	Maximum	FOD [a]	Minimum	Mean	Maximum	Minimum	Maximum
INORGANICS												
ANTIMONY	0 : 1	--	--	--	3.60E+01	3.60E+01	NA	--	--	--	--	--
ARSENIC	52 : 52	2.70E+03	9.09E+03	1.53E+04	--	--	31 : 31	6.65E+02	7.89E+03	2.00E+04	--	--
BARIUM	52 : 52	2.46E+04	2.02E+06	1.53E+07	--	--	4 : 4	2.08E+04	3.42E+05	8.50E+05	--	--
CADMIUM	46 : 46	1.50E+02	1.18E+03	2.00E+03	--	--	31 : 31	1.10E+02	1.28E+03	2.42E+03	--	--
CHROMIUM	52 : 52	4.90E+03	8.65E+04	3.98E+05	--	--	31 : 31	5.20E+03	7.13E+04	1.34E+05	--	--
COBALT	1 : 1	2.00E+03	--	2.00E+03	--	--	NA	--	--	--	--	--
COPPER	52 : 52	8.80E+03	1.58E+05	8.93E+05	--	--	31 : 31	4.60E+03	5.02E+04	9.16E+04	--	--
LEAD	46 : 46	5.30E+03	6.41E+04	2.19E+05	--	--	31 : 31	3.75E+03	4.48E+04	1.04E+05	--	--
NICKEL	32 : 32	4.60E+03	3.52E+04	9.01E+04	--	--	NA	--	--	--	--	--
SELENIUM	0 : 1	--	--	--	1.30E+02	1.30E+02	NA	--	--	--	--	--
SILVER	1 : 1	4.20E+01	--	4.20E+01	--	--	NA	--	--	--	--	--
THALLIUM	1 : 1	6.80E+01	--	6.80E+01	--	--	NA	--	--	--	--	--
VANADIUM	1 : 1	4.10E+03	--	4.10E+03	--	--	NA	--	--	--	--	--
ZINC	52 : 52	2.67E+04	2.12E+05	3.27E+05	--	--	31 : 31	1.97E+04	2.00E+05	2.62E+05	--	--
PCBs												
PCB-1016	0 : 31	--	--	--	2.30E+01	5.40E+02	--	--	--	--	--	--
PCB-1221	0 : 31	--	--	--	2.30E+01	5.40E+02	--	--	--	--	--	--
PCB-1232	0 : 31	--	--	--	2.30E+01	5.40E+02	--	--	--	--	--	--
PCB-1242	25 : 31	3.20E+01	2.94E+02	2.50E+03	--	--	--	--	--	--	--	--
PCB-1248	5 : 31	1.20E+02	1.92E+02	3.30E+02	--	--	--	--	--	--	--	--
PCB-1254	31 : 31	1.40E+01	4.37E+02	3.80E+03	--	--	--	--	--	--	--	--
PCB-1260	28 : 31	2.10E+01	7.20E+01	2.90E+02	--	--	--	--	--	--	--	--
Total PCBs	37 : 37	1.40E+01	1.43E+03	1.24E+04	--	--	8 : 32	2.60E+02	5.45E+02	8.30E+02	--	--
VOCs/SVOCs												
1,2,4-Trichlorobenzene	8 : 35	6.40	44.43	120.00	--	--	NA	--	--	--	--	--
1,3-Dichlorobenzene	32 : 48	1.00	155.00	2100.00	--	--	0 : 1	--	--	--	5E+00	5E+00
1,4-Dichlorobenzene	38 : 48	0.41	1480.00	48000.00	--	--	0 : 1	--	--	--	5E+00	5E+00
Benzene	4 : 43	4.10	135.00	290.00	--	--	0 : 1	--	--	--	5E+00	5E+00
Chlorobenzene	46 : 48	1.90	8140.00	320000.00	--	--	0 : 1	--	--	--	5E+00	5E+00
M,P-Xylenes	7 : 43	2.50	67.50	350.00	--	--	0 : 1	--	--	--	5E+00	5E+00
O-Xylene	11 : 43	1.15	118.00	660.00	--	--	0 : 1	--	--	--	5E+00	5E+00
Xylene (Total)	10 : 43	2.00	167.00	1000.00	--	--	0 : 1	--	--	--	1.0E+01	1.0E+01

Notes are presented on last page.

Appendix A Table 2-4
Summary Statistics and Ecological Screening of Adjacent Offshore Sediment
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Analyte	Is Max Site > Max Background?	Number of Site Samples within Range of Background [b]	Selected Sediment ESL [c]	COPC Selection	
INORGANICS					
ANTIMONY	--	--	NV	NO	Not detected
ARSENIC	No	52	9.79E+03	YES	Max Detect > ESL
BARIUM	Yes	15	1.04E+03 [d]	YES	Max Detect > ESL
CADMIUM	No	46	9.90E+02	YES	Max Detect > ESL
CHROMIUM	Yes	43	4.34E+04	YES	Max Detect > ESL
COBALT	--	--	5.00E+04	NO	Max Detect < ESL
COPPER	Yes	22	3.16E+04	YES	Max Detect > ESL
LEAD	Yes	43	3.58E+04	YES	Max Detect > ESL
NICKEL	--	--	2.27E+04	YES	Max Detect > ESL
SELENIUM	--	--	NV	NO	Not detected
SILVER	--	--	5.00E+02	NO	Max Detect < ESL
THALLIUM	--	--	56.9 [d]	YES	Max Detect > ESL
VANADIUM	--	--	1590 [d]	YES	Max Detect > ESL
ZINC	Yes	46	1.21E+05	YES	Max Detect > ESL
PCBs					
PCB-1016	--	--	NV	--	Not detected
PCB-1221	--	--	NV	--	Not detected
PCB-1232	--	--	NV	--	Not detected
PCB-1242	--	--	NV	NC [e]	--
PCB-1248	--	--	NV	NC [e]	--
PCB-1254	--	--	NV	NC [e]	--
PCB-1260	--	--	NV	NC [e]	--
Total PCBs	Yes	23	5.98E+01	YES	Max Detect > ESL
VOCs/SVOCs					
1,2,4-Trichlorobenzene	--	--	5.06E+03	NO	Max Detect < ESL
1,3-Dichlorobenzene	--	--	1.32E+03	YES	Max Detect > ESL
1,4-Dichlorobenzene	--	--	3.18E+02	YES	Max Detect > ESL
Benzene	--	--	1.42E+02	YES	Max Detect > ESL
Chlorobenzene	--	--	2.91E+02	YES	Max Detect > ESL
M,P-Xylenes	--	--	4.33E+02 [f]	NO	Max Detect < ESL
O-Xylene	--	--	4.33E+02 [f]	YES	Max Detect > ESL
Xylene (Total)	--	--	4.33E+02	YES	Max Detect > ESL

Notes are presented on last page.

Appendix A Table 2-4
Summary Statistics and Ecological Screening of Adjacent Offshore Sediment
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Notes:
All units are µg/Kg.
Summary statistics are based on detected concentrations only. The minimum and maximum reporting limits are presented for analytes that were not detected in sediment.
ESL - Ecological Screening Level.
FOD - Frequency of Detection.
NA - Not analyzed.
NC - Not calculated.
ND - Not detected.
NV - No ESL value available.
PCB - Polychlorinated biphenyl.
SVOCs - Semi-volatile Organic Compounds.
VOCs - Volatile Organic Compounds.
[a] Number of detected samples : total number of samples.
[b] The number of samples with detected concentrations that are less than the maximum background concentration.
[c] USEPA Region 5 Ecological Screening Levels
(available at: http://epa.gov/region5/waste/cars/pdfs/ecological-screening-levels-200308.pdf)
[d] Soil ESLs were used when sediment ESLs are not available.
[e] An ESL is available for Total PCBs only.
[f] Total xylene ESL used as a surrogate.

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Appendix A Table 3-1
Fish Receptor Exposure Parameters
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Species	Diet	Diet Proportions - COPC Screen	Diet Proportions - Refined Screen	Area Use Factor	Exposure Duration
Freshwater Drum *(Aplodinotus grunniens)*	Invertivore (a)	90% benthic invertebrates (b) 10% sediment	99% benthic invertebrates (c) 1% sediment	1 (d)	1 (e)

Notes:
(a) Diet is composed predominantly of invertebrates (Bur, 1982).
(b) The diet proportions for the COPC screen are conservatively set at 90% consumption of invertebrates and 10% sediment consumption.
(c) The diet proportions for the Refined Screen are set at 99% invertebrate consumption and 1% incidental sediment ingestion.
(d) It is assumed that this representative species would have access to the entire exposure area.
(e) It is assumed that this species is present all year.

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Appendix A Table 3-2
Sediment Exposure Point Concentrations for Fish Dietary Pathway Evaluation
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

COPC	FOD (a)	Maximum Detected Sediment EPC including all site data (mg/kg $_{dw}$) (b)	Refined Sediment EPC including all site data (mg/kg $_{dw}$) (c)	UCL Selected (d)
ARSENIC	64 : 64	15.3	9.7	95% Chebyshev (Mean, Sd) UCL
BARIUM	64 : 64	15300	2219	95% Approximate Gamma UCL
CADMIUM	58 : 58	2	1.3	95% Chebyshev (Mean, Sd) UCL
CHROMIUM	64 : 64	398	108	95% Student's-t UCL
COPPER	64 : 64	893	170.5	95% Approximate Gamma UCL
LEAD	58 : 58	219	74.5	95% Chebyshev (Mean, Sd) UCL
NICKEL	44 : 44	90.1	40.6	95% Chebyshev (Mean, Sd) UCL
THALLIUM	6 : 7	0.092	0.1	--
VANADIUM	7 : 7	5.1	5.1	--
ZINC	64 : 64	327	225.0	95% Chebyshev (Mean, Sd) UCL
TOTAL PCBs	28 : 42	0.708	0.4	95% KM (t) UCL

Notes:
All concentrations are reported in milligrams per kilogram (mg/Kg).
COPC - Chemical of Potential Concern.
EPC - Exposure Point Concentration.
FOD - Frequency of Detection.
PCBs - Polychlorinated Biphenyls.
UCL - Upper Confidence Limit.
(a) Number of samples detected : Total number of samples.
(b) Maximum detected concentration for each COPC. Calculated after results for duplicate samples have been resolved as follows:
(1) where both the sample and the duplicate are detected, the resulting value is the average of the sample and duplicate and
(2) where one of the pair is reported as not detected and the other is detected, the detected concentration is used.
(c) Recommended 95% UCL on the arithmetic mean for each COPC, after duplicates have been treated, calculated using ProUCL Version 5.0 with recommended detection limit substitution method for datasets with nondetects (USEPA, 2013).
(d) UCL recommended for use by ProUCL Version 5.0 (USEPA, 2013). If more than one UCL was recommended, the higher UCL was used.

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Appendix A Table 3-3
Modeled Benthic Invertebrate Concentrations for Fish Dietary Pathway Evaluation
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

COPC	Sediment-to-Invertebrate Uptake Factor [(mg COPC/Kg invertebrate$_{dw}$)/ (mg COPC/Kg sediment$_{dw}$)]		All Site Data Included			
			Sediment 95% UCL EPC (mg/Kg$_{dw}$)	Estimated 95% UCL Maximum Benthic Invertebrate Tissue Concentration (a) (mg/Kg$_{ww}$)	Maximum Sediment EPC (mg/Kg$_{dw}$)	Estimated Maximum Benthic Invertebrate Tissue Concentration (a) (mg/Kg$_{ww}$)
ARSENIC	regression	(b)	10	0.43	15.3	0.64
BARIUM	0.18	(c)	2219	88	15300	606
CADMIUM	regression	(b)	1.3	0.40	2.0	0.54
CHROMIUM	regression	(b)	108	1.97	398	3.17
COPPER	regression	(b)	171	15.16	893	27.46
LEAD	regression	(b)	74	1.12	219	2.27
NICKEL	regression	(b)	41	1.05	90.1	1.82
THALLIUM	1	(d)	0.1	0.022	0.1	0.020
VANADIUM	0.042	(e)	5.1	0.047	5.1	0.047
ZINC	regression	(b)	225	48.05	327	52.6
TOTAL PCBs	1.1	(f)	0.4	0.65	0.7	1.2

Notes:
95% UCL - 95% Upper Confidence Limit of the mean.
BSAF - Biota-Sediment Accumulation Factor.
COPC - Constituent of Potential Concern.
dw - Dry Weight.
EPC - Exposure Point Concentration.
FOD - Frequency of Detection.
PCBs - Polychlorinated Biphenyls.
USEPA - United States Environmental Protection Agency.
ww - Wet Weight.
Invertebrates assumed to be 78% water (USEPA, 1993).
Soil to invertebrate uptake factors used when sediment to invertebrate values were not available.

(a) Tissue concentration calculated as follows, unless otherwise indicated:
COPC invertebrate (mg COPC/kg invertebrate ww) = COPCsediment (mg COPC/kg sediment dw) x Uptake Factor ((mg COPC/kg invertebrate dw)/(mg COPC/kg sediment dw)) x (1-%water)

(b) Regression equations for benthic invertebrates obtained from Bechtel Jacobs (1998). Regression equation with highest R^2 value selected from Table 3 of Bechtel and Jacobs (1998).

arsenic	log(tissue concentration) = 0.873 * log(sediment concentration) - 0.572
cadmium	log(tissue concentration) = 0.668 * log(sediment concentration) + 0.191
chromium	log(tissue concentration) = 0.365 * log(sediment concentration) + 0.2092
copper	log(tissue concentration) = 0.359 * log(sediment concentration) + 1.037
lead	log(tissue concentration) = 0.653 * log(sediment concentration) - 0.515
nickel	log(tissue concentration) = 0.695 * log(sediment concentration) - 0.440
zinc	log(tissue concentration) = 0.242 * log(sediment concentration) + 1.77

(c) This value was derived from concentrations of barium in sediment and invertebrates from nine streams in the Blackfoot River watershed in Indiana reported by Hamilton and Buhl (2003), and from two sites on the Wolf River in Wisconsin reported by Garn et al. (2001). The value is the geometric mean of data from both studies (n = 16).

(d) A value of 1 is designated for COPCs for which BSAFs are not available.

(e) Uptake factor recommended by USEPA in development of Ecological Soil Screening Levels (Table 4a; Attachment 4-1; USEPA 2007a).

(f) Median uptake factor for benthic invertebrates and Total PCBs obtained from EPA BSAF database available at http://www.epa.gov/med/Prods_Pubs/bsaf.htm
Assumes all sediment 4% TOC; Adjacent Nearshore 1% TOC and 6% lipids in invertebrates from studies used to derive BSAF.
PCB tissue calculated as follows:
COPC invertebrate (mg COPC/Kg invertebrate ww) = BSAF (Kg organic carbon/Kg lipid) x [COPCsediment (mg COPC/Kg sediment dw)/fraction organic carbon] x fraction lipid in invertebrates)

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Appendix A Table 3-4
Toxicity Reference Values for Fish Dietary Evaluation
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

COPC	Test Species	NOAEL (mg/kg dw)	LOAEL (mg/kg dw)	Endpoint	Source (a)
ARSENIC	Rainbow trout	20	30	Growth	Oladimeji et al. (1984)
BARIUM	Sheepshead minnow	500	NA	Survival	Heitmuller et al. (1981)
CADMIUM	Rockfish	0.1 (b)	0.5	Growth	Kim et al. (2004); Kang et al. (2005)
CHROMIUM	Grey mullet	9.42	NA	Growth	Walsh et al. (1994)
COPPER	Rainbow trout	500	700	Growth	Lundebye et al. (1999)
LEAD	Rainbow trout	7040	NA	Growth	Goettl et al. (1976)
NICKEL	--	NA	NA	--	--
THALLIUM	--	NA	NA	--	--
VANADIUM	Rainbow trout	2 (b)	10.2	Growth	Hilton and Bettger (1988)
ZINC	Rainbow trout	1900 (c)	2000	Growth	Mount et al. (1994); Takeda and Shimma (1977)
TOTAL PCBs	Rainbow trout	15 (d)	NA	Reproduction	Lieb et al. (1974)

Notes:
All concentrations are reported in milligrams per kilogram (mg/kg).
COPC - Chemical of Potential Concern.
LOAEL - Lowest Observed Adverse Effects Level.
NA - Not available.
NOAEL - No Observed Adverse Effects Level.
PCBs - Polychlorinated Biphenyls.

(a) Toxicity reference values (TRVs) were identified in the East Waterway/Harbor Island Baseline Ecological Risk Assessment (Windward 2012) for all COPCs except barium, nickel, thallium, and total PCBs. No TRVs are available for nickel and thallium.
(b) An uncertainty factor of 5 was used to estimate the NOAEL from the LOAEL.
(c) The highest NOAEL identified was used instead of the NOAEL available from Takeda and Shimma (1977), which was 1000 mg/kg dw.
(d) Based on dietary exposure to Aroclor 1254.

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Appendix A Table 3-5
Identification of Fish COPCs for Dietary Exposure
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

COPC	Maximum Sediment EPC (a)	Maximum Estimated Prey EPC (b)	Maximum Dietary EPC (c)	NOAEL TRV (d)	Retained as COPC? (e)
ARSENIC	15.3	0.64	2.1	20	No
BARIUM	15300	606	2075.3	500	Yes
CADMIUM	2	0.54	0.7	0.1	Yes
CHROMIUM	398	3.2	42.6	9.42	Yes
COPPER	893	27.5	114.0	500	No
LEAD	219	2.27	23.9	7040	No
NICKEL	90.1	1.82	10.7	NA	NC
THALLIUM	0.092	0.020	0.0	NA	NC
VANADIUM	5.1	0.047	0.6	2	No
ZINC	327	52.6	80.0	1900	No
TOTAL PCBs	0.708	1.2	1.1	15	No

Notes:
All concentrations are reported in milligrams per kilogram (mg/Kg dw).
COPC - Chemical of Potential Concern.
dw - dry weight.
EPC - Exposure Point Concentration.
NA - Not available for this COPC.
NC - Not calculated due to no TRV available for this COPC.
NOAEL - No Observed Adverse Effects Level.
PCBs - Polychlorinated Biphenyls.
TRV - Toxicity Reference Value.
(a) Maximum detected sediment concentration.
(b) Maximum estimated benthic invertebrate concentration modeled with sediment-to-invertebrate uptake factors.
(c) Calculated assuming diet composed 90% invertebrate tissue and 10% sediment ingestion.
(d) NOAEL TRVs presented in Table 4.
(e) COPCs were retained if the maximum dietary EPC exceeded the NOAEL TRV.

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Appendix A Table 3-6
Refined Screen of Fish Dietary Exposure
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

COPC	Refined Sediment EPC (a)	Refined Estimated Prey EPC (b)	Refined Dietary EPC (c)	NOAEL TRV (d)	NOAEL HQ (e)	LOAEL TRV (d)	LOAEL HQ (e)
BARIUM	2219	87.9	301	500	0.6	NA	NC
CADMIUM	1.281	0.40	0.49	0.1	4.9	0.5	0.98
CHROMIUM	107.7	2.0	12.5	9.42	1.33	NA	NC
NICKEL	40.6	1.05	5.0	NA	NC	NA	NC
THALLIUM	0.092	0.022	0.029	NA	NC	NA	NC

Notes:
All concentrations are reported in milligrams per kilogram (mg/Kg dw).
HQs greater than 1 are in bold.
COPC - Chemical of Potential Concern.
dw - dry weight.
EPC - Exposure Point Concentration.
HQ - Hazard Quotient.
LOAEL - Lowest Observed Adverse Effects Level.
NOAEL - No Observed Adverse Effects Level.
TRV - Toxicity Reference Value.
UCL - Upper Confidence Limit.
(a) Refined sediment concentration based on 95% UCL. The maximum detected concentration was used when insufficient samples were available for the UCL calculation.
(b) Refined estimated benthic invertebrate concentration modeled with sediment-to-invertebrate uptake factors.
(c) Calculated assuming diet composed of 90% invertebrate tissue and 10% sediment.
(d) NOAEL and LOAEL TRVs are presented in Table 4.
(e) HQs are calculated by dividing the EPC by the TRV.

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Appendix A Table 4-1
Summary of Sediment Analytical Data for Wildlife Food Web Model
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

COPC	ALL SITE COPC?	FOD (a)	Maximum Detected Sediment EPC including all site data (mg/Kg $_{dw}$) (b)	Refined Sediment EPC including all site data (mg/Kg $_{dw}$) (c)	UCL Selected (d)	NEARSHORE COPC?	FOD (a)	Maximum Detected Concentration Sediment EPC - Adjacent Nearshore only (mg/Kg $_{dw}$) (b)	Refined Sediment EPC - Adjacent Nearshore (mg/Kg $_{dw}$) (c)	UCL Selected (d)
ARSENIC	YES	64 : 64	15.3	9.72	95% Chebyshev (Mean, Sd) UCL	NO	--	--	--	--
BARIUM	YES	64 : 64	15300	2219	95% Approximate Gamma UCL	YES	12 : 12	489	228.1	95% Adjusted Gamma UCL
CADMIUM	YES	58 : 58	2.0	1.28	95% Chebyshev (Mean, Sd) UCL	NO	--	--	--	--
CHROMIUM	YES	64 : 64	398	107.7	95% Chebyshev (Mean, Sd) UCL	NO	--	--	--	--
COPPER	YES	64 : 64	893	170.5	95% Approximate Gamma UCL	YES	12 : 12	285	146.6	95% Adjusted Gamma UCL
LEAD	YES	58 : 58	219	74.46	95% Chebyshev (Mean, Sd) UCL	YES	12 : 12	60.8	31.12	95% Adjusted Gamma UCL
NICKEL	YES	44 : 44	90.1	40.6	95% Chebyshev (Mean, Sd) UCL	NO	--	--	--	--
THALLIUM	YES	6 : 7	0.092	NC	MAX	YES	5 : 6	0.092	NC	--
VANADIUM	YES	7 : 7	5.1	NC	MAX	YES	6 : 6	5.1	NC	--
ZINC	YES	64 : 64	327	225	95% Chebyshev (Mean, Sd) UCL	NO	--	--	--	--
TOTAL PCBs	YES	28 : 42	0.708	0.39	95% KM (t) UCL	YES	5 : 6	0.216	NC	--
BENZENE	YES	4 : 45	0.29	0.0329	95% KM (t) UCL	NO	--	--	--	--
CHLOROBENZENE	YES	50 : 54	320	65.9	99% KM (Chebyshev) UCL	YES	4 : 6	0.96	NC	---
O-XYLENE	YES	11 : 45	0.66	0.22	99% KM (Chebyshev) UCL	NO	--	--	--	--
XYLENE (TOTAL)	YES	10 : 49	1.0	0.28	99% KM (Chebyshev) UCL	NO	--	--	--	--
1,3-DICHLOROBENZENE	YES	37 : 54	2.1	0.36	97.5% KM (Chebyshev) UCL	NO	--	--	--	--
1,4-DICHLOROBENZENE	YES	43 : 54	48	9.91	99% KM (Chebyshev) UCL	YES	5 : 6	1.4	NC	--

Notes:
All concentrations are reported in milligrams per kilogram (mg/Kg).
COPC - Chemical of Potential Concern.
EPC - Exposure Point Concentration.
FOD - Frequency of Detection.
NC - Not calculated due to low FOD. At least 10 samples, including 6 detected samples, are required to run a UCL.
PCBs - Polychlorinated Biphenyls.
UCL - Upper Confidence Limit.
(a) Number of samples detected : Total number of samples.
(b) Maximum detected concentration for each COPC. Calculated after results for duplicate samples have been resolved as follows:
(1) where both the sample and the duplicate are detected, the resulting value is the average of the sample and duplicate and
(2) where one of the pair is reported as not detected and the other is detected, the detected concentration is used.
(c) Recommended 95% UCL on the arithmetic mean for each COPC, after duplicates have been treated, calculated using ProUCL Version 5.0 with recommended detection limit substitution method for datasets with nondetects (USEPA, 2013).
(d) UCL recommended for use by ProUCL Version 5.0 (USEPA, 2013). If more than one UCL was recommended, the higher UCL was used.

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Appendix A Table 4-2
Exposure Parameters for Wildlife Receptors
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Receptor Species	Exposure Area	Body Weight (Kg)	Assumed Diet Fraction of diet as %; Amount as Kg_{dw}/day				Food Ingestion Rate (Kg_{dw}/day)	Fraction Sediment in Diet (%) Amount as Kg_{dw}/day	Water Intake Rate (Kg/day)	Home Range (units indicated in notes below)	Exposure Duration (unitless)
			Units	Fish	Aquatic Plants	Benthic Invertebrates					
Piscivores											
Belted Kingfisher (*Ceryle alcyon*)	All site	0.142 (a)	% Kg_{dw}/day	100% 0.0227 (b)	-- -- (b)	-- -- [b]	0.0227 (c)	1% 0.00023 (d)	0.0160 (e)	0.72 (f)	1 (g)
Osprey (*Pandion haliaetus*)	All site	1.6 (a)	% Kg_{dw}/day	100% 0.1130 (b)	-- -- (b)	-- -- [b]	0.1130 (c)	0.0% 0.0000 (d)	0.0808 (e)	907 (f)	1 (g)
Mink (*Mustela vison*)	All site	0.852 (a)	% Kg_{dw}/day	90% 0.0383 (b)	-- -- (b)	10% 0.0043 [b]	0.0425 (c)	2.0% 0.0009 (d)	0.0857 (e)	14.1 (f)	1 (g)
Great Blue Heron (*Ardea herodias*)	Nearshore	2.336 (a)	% Kg_{dw}/day	95% (b) 0.1380	-- -- (b)	5% 0.0073 [b]	0.1453 (c)	5% 0.0073	0.1042 (e)	4.5 (f)	1 (g)
Omnivores											
Raccoon (*Procyon lotor*)	Nearshore	5.7 (a)	% Kg_{dw}/day	24% 0.0365 (b)	34% 0.0517 (b)	42% 0.0639 [b]	0.1520 (c)	9.4% 0.0143 (d)	0.4742 (e)	156 (f)	1 (g)
Aquatic Insectivore											
Lesser Scaup (*Aythya affinis*)	All site	0.8 (a)	% Kg_{dw}/day	-- -- (b)	-- -- (b)	100% 0.0723 [b]	0.0723 (c)	5% 0.0036 (d)	0.0514 (e)	89 (f)	1 (g)

General Notes:

Food ingestion rates are dry weight for food items and for sediment/soil ingestion.
The fractions of assumed diet is based on 100% food diet (i.e., the total of % fractions equals 100%). The percentage of ingested sediment is separate from the food diet, and therefore, the total of diet and ingested sediment is greater than 100%.
See individual organism notes for source, units, and conversion.

BW - Body Weight. FIR - Food Ingestion Rate.
dw - Dry Weight. ha - hectare.
USEPA - United States Environmental Protection Agency.

Footnotes for individual species parameters and assumptions presented on next pages.

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Appendix A Table 4-2
Exposure Parameters for Wildlife Receptors
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Notes for Belted Kingfisher (*Ceryle alcyon*):

(a) Average body weight of male and female kingfisher in Pennsylvania study (USEPA, 1993)
(b) Diet assumed to be all fish.
(c) Food ingestion rate calculated using algorithm for carnivorous birds developed by Nagy, 2001 [FIR (g_{dw}/day) = $0.849*BW^{0.663}$].
(d) Assumption for diving bird based on best professional judgement.
(e) Water ingestion rate calculated using algorithm for all birds developed by Calder and Braun, 1983 [WIR (Kg/day) = $0.059*BW^{0.67}$].
(f) Territory size based on studies conducted in Pennsylvania and Ohio streams (USEPA, 1993). Value is average shoreline distance in miles.
(g) Belted kingfisher assumed to be present and actively foraging year-round.

Notes for Osprey (*Pandion haliaetus*):

(a) Average body weight of adult male and female osprey in Massachusetts (USEPA, 1993).
(b) Diet assumed to be exclusively fish.
(c) Food ingestion rate calculated using algorithm for carnivorous birds developed by Nagy, 2001 [FIR (g_{dw}/day) = $0.849*BW^{0.663}$].
(d) Assumption for osprey based on best professional judgement.
(e) Water ingestion rate calculated using algorithm for all birds developed by Calder and Braun, 1983 [WIR (Kg/day) = $0.059*BW^{0.67}$].
(f) Average foraging range (in ha) in Minnesota based on a foraging radius of 1.7 kilometers (USEPA, 1993).
(g) Osprey assumed to be present and actively foraging year-round.

Notes for Mink (*Mustela vison*):

(a) Average summer and fall body weight ofadult male and female mink from Montana (USEPA, 1993).
(b) Diet assumed to mostly fish based on lake study in Michigan (USEPA 1993).
(c) Food ingestion rate calculated using algorithm for carnivorous mammals developed by Nagy, 2001 [FIR (g_{dw}/day) = $0.153*BW^{0.834}$].
(d) Estimated value. Mink consume small portion of diet as invertebrates.
(e) Water ingestion rate calculated using algorithm for all mammals developed by Calder and Braun, 1983 [WIR (Kg/day) = $0.099*BW^{0.90}$].
(f) Mean home range size (ha) from study in Montana (USEPA, 1993).
(g) Mink assumed to be present and actively foraging year-round.

Notes for Great Blue Heron (*Ardea herodias*):

(a) Average body weight of adult male and female herons (USEPA, 1993).
(b) Diet assumed to mostly fish based on lake study in Michigan (USEPA 1993).
(c) Food ingestion rate calculated using algorithm for carnivorous birds developed by Nagy, 2001 [FIR (g_{dw}/day) = $0.849*BW^{0.663}$].
(d) Assumption for wading bird based on best professional judgement.
(e) Water ingestion rate calculated using algorithm for all birds developed by Calder and Braun, 1983 [WIR (Kg/day) = $0.059*BW^{0.67}$].
(f) Average feeding territory size (ha) based on studies conducted in freshwater marsh and estuary in Oregon (USEPA, 1993).
(g) Heron assumed to be present and actively foraging year-round.

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Appendix A Table 4-2
Exposure Parameters for Wildlife Receptors
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Notes for Raccoon (*Procyon lotor*):

(a) Average body weight of adult male and female raccoons in Illinois, Missouri, and Alabama studies (USEPA, 1993).
(b) Approximate dietary composition for raccoons in New York study (USEPA, 1993). Terrestrial food items not included.
(c) Food ingestion rate calculated using algorithm for omnivorous mammals developed by Nagy, 2001 [FIR (g_{dw}/day) = $0.432*BW^{0.678}$].
(d) Value for raccoon soil consumption (Table 4-4; USEPA, 1993).
(e) Water ingestion rate calculated using algorithm for all mammals developed by Calder and Braun, 1983 [WIR (Kg/day) = $0.099*BW^{0.90}$].
(f) Mean of home ranges (in ha) from Michigan study (USEPA, 1993).
(g) Raccoon assumed to be present and actively foraging year-round.

Notes for Lesser Scaup (*Aythya affinis*):

(a) Average body weight of adult male and female lesser scaup in United States studies (USEPA, 1993).
(b) Diet assumed to be exclusively benthic invertebrates.
(c) Food ingestion rate calculated using algorithm for carnivorous birds developed by Nagy, 2001 [FIR (g_{dw}/day) = $0.849*BW^{0.663}$].
(d) Value for sediment consumption conservatively set at 5%; most duck ingestion <2% (Table 4-4; USEPA, 1993).
(e) Water ingestion rate calculated using algorithm for all birds developed by Calder and Braun, 1983 [WIR (Kg/day) = $0.059*BW^{0.67}$].
(f) Mean home range size (in ha) from study in Manitoba, Canada (USEPA, 1993).
(g) Lesser scaup assumed to be present and actively foraging year-round.

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Appendix A Table 4-3
Food Chain Assumptions for Belted Kingfisher
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Parameters	Value	Units
Sediment Ingestion Rate	0.00023	(Kg_{dw}/day)
Fish Consumption Rate	0.0227	(Kg_{dw}/day)
Body Weight	0.142	(Kg)
Exposure Duration	1.00	(unitless)
Area Use Factor	0.42	(unitless)
[based on shoreline of 0.3 miles]		

Notes:
Kg = kilogram
Kg_{dw}/day = kilograms dry weight per day
Kg/day = kilograms per day
Exposure area of site shoreline is 0.3 miles.

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Appendix A Table 4-4
Food Chain Assumptions for Osprey
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Parameters	Value	Units
Fish Consumption Rate	0.1130	(Kg_{dw}/day)
Body Weight	1.600	(Kg)
Exposure Duration	1.00	(unitless)
Area Use Factor - rounded up from calculated to 10%	0.10	(unitless)
[based on exposure area acreage of 5.79 ha]	0.0064	(unitless)

Notes:
ha = hectare
Kg = kilogram
Kg_{dw}/day = kilograms dry weight per day
Kg/day = kilograms per day
Exposure area of site is 5.79 ha.

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Appendix A Table 4-5
Food Chain Assumptions for Mink
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Parameters	Value	Units
Sediment Ingestion Rate	0.0009	(Kg_{dw}/day)
Benthic Invertebrate Consumption Rate	0.0043	(Kg_{dw}/day)
Fish Consumption Rate	0.0383	(Kg_{dw}/day)
Body Weight	0.852	(Kg)
Exposure Duration	1	(unitless)
Area Use Factor [based on exposure area acreage of 5.79 ha]	0.41	(unitless)

Notes:
ha = hectare
Kg = kilogram
Kg_{dw}/day = kilograms dry weight per day
Kg/day = kilograms per day
Exposure area of site is 5.79 ha.

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Appendix A Table 4-6
Food Chain Assumptions for Great Blue Heron
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Parameters	Value	Units
Sediment Ingestion Rate	0.0073	(Kg_{dw}/day)
Benthic Invertebrate Consumption Rate	0.0073	(Kg_{dw}/day)
Fish Consumption Rate	0.1380	(Kg_{dw}/day)
Body Weight	2.336	(Kg)
Exposure Duration	1	(unitless)
Area Use Factor - rounded up from calculated to 10%	0.10	(unitless)
[based on exposure area acreage of 0.19 ha]	0.042	

Notes:
ha = hectare
Kg = kilogram
Kg_{dw}/day = kilograms dry weight per day
Kg/day = kilograms per day
Exposure area of Adjacent Nearshore is 0.19 ha.

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Appendix A Table 4-7
Food Chain Assumptions for Raccoon
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Parameters	Value	Units
Sediment Ingestion Rate	0.014	(Kg_{dw}/day)
Fish Consumption Rate	0.04	(Kg_{dw}/day)
Aquatic Plants Consumption Rate	0.05	(Kg_{dw}/day)
Benthic Invertebrates Consumption Rate	0.064	(Kg_{dw}/day)
Body Weight	5.7	(Kg)
Exposure Duration	1.00	(unitless)
Area Use Factor - rounded up from calculated to 10%	0.10	(unitless)
[based on exposure area acreage of 0.19 ha]	0.00122	(unitless)

Notes:
ha = hectare
Kg = kilogram
Kg_{dw}/day = kilograms dry weight per day
Kg/day = kilograms per day
Exposure area of Adjacent Nearshore is 0.19 ha.

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Appendix A Table 4-8

Food Chain Assumptions for Lesser Scaup

Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

Parameters	Value	Units
Sediment Ingestion Rate	0.00361	(Kg_{dw}/day)
Benthic Invertebrate Consumption Rate	0.0723	(Kg_{dw}/day)
Body Weight	0.815	(Kg)
Exposure Duration	1.00	(unitless)
Area Use Factor - rounded up from calculated to 10%	0.10	(unitless)
[based on exposure area acreage of 5.79 ha]	0.065	

Notes:
ha = hectare
Kg = kilogram
Kg_{dw}/day = kilograms dry weight per day
Kg/day = kilograms per day
Exposure area of site is 5.79 ha.

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Appendix A Table 4-9
Calculation of Fish Tissue Concentrations
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

COPC	Sediment-to-Fish Uptake Factor [(mg COPC/Kg $fish_{dw}$)/ (mg COPC/Kg $sediment_{dw}$)]		All Site Data Included				Adjacent Nearshore Data Only			
			Sediment 95% UCL EPC (mg/Kg_{dw})	Estimated 95% UCL Maximum Fish Tissue Concentration (a) (mg/Kg_{dw})	Maximum Sediment EPC (mg/Kg_{dw})	Estimated Maximum Fish Tissue Concentration (a) (mg/Kg_{dw})	Sediment 95% UCL EPC (mg/Kg_{dw})	Estimated 95% UCL Maximum Fish Tissue Concentration (a) (mg/Kg_{dw})	Maximum Sediment EPC (mg/Kg_{dw})	Estimated Maximum Fish Tissue Concentration (a) (mg/Kg_{dw})
ARSENIC	0.1	(b)	9.7	1.0	15.3	1.53	No COPC	--	No COPC	--
BARIUM	0.08	(c)	2219	177.5	15300	1224.00	228.1	18.2	489	39.1
CADMIUM	0.2	(b)	1.3	0.3	2.0	0.40	No COPC	--	No COPC	--
CHROMIUM	0.1	(b)	108	10.8	398	39.80	No COPC	--	No COPC	--
COPPER	0.1	(b)	171	17.1	893	89.30	146.6	14.7	285	28.5
LEAD	0.1	(b)	74	7.4	219	21.90	31.1	3.1	60.8	6.1
NICKEL	0.3	(b)	41	12.2	90.1	27.03	No COPC	--	No COPC	--
THALLIUM	1	(d)	0.10	0.1	0.092	0.09	NC	--	0.092	0.1
VANADIUM	0.2	(c)	5.1	1.0	5.1	1.02	NC	--	5.1	1.0
ZINC	0.1	(b)	225.0	22.5	327	32.70	No COPC	--	No COPC	--
TOTAL PCBs	2.52	(e)	0.39	6.4	0.71	11.5	NC	--	0.22	14.1
BENZENE	0.0202	(g)	0.03	0.0005	0.29	0.004	No COPC	--	No COPC	--
CHLOROBENZENE	0.0202	(g)	66	0.920	320	4.470	NC	--	0.96	0.054
O-XYLENE	1	(d)	0.22	0.2	0.66	0.66	No COPC	--	No COPC	--
XYLENE (TOTAL)	1	(d)	0.28	0.3	1.00	1.00	No COPC	--	No COPC	--
1,3-DICHLOROBENZENE	0.0202	(f)	0.36	0.005	2.1	0.029	No COPC	--	No COPC	--
1,4-DICHLOROBENZENE	0.0136	(f)	9.9	0.093	48	0.452	NC	--	1.4	0.05

Notes:
95% UCL - 95% Upper Confidence Limit of the mean.
BSAF - Biota-Sediment Accumulation Factor.
COPC - Constituent of Potential Concern.
dw - Dry Weight.
EPC - Exposure Point Concentration.
FOD - Frequency of Detection.
NC - Not calculated due to low FOD. At least 10 samples, including 6 detected samples, are required to run a UCL.
No COPC - Not identified as a COPC in the Nearshore Area.
PCBs - Polychlorinated Biphenyls.
USEPA - United States Environmental Protection Agency.
Fish assumed to be 75% water (USEPA, 1993).
(a) Tissue concentration calculated as follows, unless otherwise indicated:
COPC fish (mg COPC/Kg fish dw) = COPCsediment (mg COPC/Kg sediment dw) x Uptake Factor ((mg COPC/Kg fish dw)/(mg COPC/Kg sediment dw))
(b) Uptake factors calculated based on sediment and fish tissue concentrations presented in Krantzberg and Boyd (1992). The highest BSAF calculated from the results presented was used.
(c) Uptake factors calculated based on sediment and fish tissue concentrations from nine streams in the Blackfoot River watershed reported by Hamilton and Buhl (2003). The highest BSAF calculated from the results presented was used.
(d) A value of 1 is designated for COPCs for which BSAFs are not available.
(e) Median BSAF calculated for Total PCBs, EPA BSAF database available at: http://www.epa.gov/med/Prods_Pubs/bsaf.htm.
Assumes all sediment 4% TOC; Adjacent Nearshore 1% TOC. Fish lipid is 6.46% from EPA BSAF database.
PCB tissue calculated as follows: COPC fish (mg COPC/Kg fish dw) = BSAF (Kg organic carbon/kg lipid) x [COPCsediment (mg COPC/Kg sediment dw)/fraction organic carbon] x fraction lipid in fish) / (1-moisture content)
(f) Median BSAF calculated from EPA BSAF database available at: http://www.epa.gov/med/Prods_Pubs/bsaf.htm.
Assumes all site sediment is 4% TOC; Adjacent Nearshore is 1% TOC. Average fish lipid is 0.69% based on three fish tissue samples included in BSAF calculation. Tissue calculation presented in note "e" for Total PCBs.
(g) Maximum BSAF of 1,3-dichlorobenzene and 1,4-dichlorobenzene used as a surrogate.

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Appendix A Table 4-10

Calculation of Benthic Invertebrate Concentrations

Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

COPC	Sediment-to-Invertebrate Uptake Factor [(mg COPC/Kg invertebrate$_{dw}$)/(mg COPC/Kg sediment$_{dw}$)]		All Site Data Included				Adjacent Nearshore Data Only			
			Sediment 95% UCL EPC (mg/Kg$_{dw}$)	Estimated 95% UCL Maximum Benthic Invertebrate Tissue Concentration (a) (mg/Kg$_{dw}$)	Maximum Sediment EPC (mg/Kg$_{dw}$)	Estimated Maximum Benthic Invertebrate Tissue Concentration (a) (mg/Kg$_{dw}$)	Sediment 95% UCL EPC (mg/Kg$_{dw}$)	Estimated 95% UCL Maximum Benthic Invertebrate Tissue Concentration (a) (mg/Kg$_{dw}$)	Maximum Sediment EPC (mg/Kg$_{dw}$)	Estimated Maximum Benthic Invertebrate Tissue Concentration (a) (mg/Kg$_{dw}$)
ARSENIC	0.127	(b)	9.7	1.95	15.3	2.90	No COPC	--	No COPC	--
BARIUM	0.18	(c)	2219	399	15300	2,754	228.1	41	489	88
CADMIUM	3.073	(b)	1.3	1.83	2.0	2.47	No COPC	--	No COPC	--
CHROMIUM	0.468	(b)	108	8.93	398	14.39	No COPC	--	No COPC	--
COPPER	regression	(b)	171	51.22	893	81.16	146.6	49.11	285	59.08
LEAD	0.066	(b)	74	5.10	219	10.31	31.1	2.88	60.8	4.47
NICKEL	regression	(b)	41	4.76	90.1	8.29	No COPC	--	No COPC	--
THALLIUM	1	(d)	0.1	0.100	0.1	0.092	NC	--	0.1	0.09
VANADIUM	0.042	(e)	5.1	0.214	5.1	0.214	NC	--	5.1	0.21
ZINC	regression	(b)	225	153.59	327	161.00	No COPC	--	No COPC	--
TOTAL PCBs	1.1	(f)	0.39	2.93	0.7	5.31	NC	--	0.2	6.48
BENZENE	2.68	(g)	0.03	0.088	0.3	0.777	No COPC	--	No COPC	--
CHLOROBENZENE	16.9	(h)	66	1,113.034	320.0	5,408.000	NC	--	1.0	16.2
O-XYLENE	7.24	(i)	0.22	1.593	0.7	4.778	No COPC	--	No COPC	--
XYLENE (TOTAL)	7.24	(g)	0.28	2.034	1.0	7.240	No COPC	--	No COPC	--
1,3-DICHLOROBENZENE	16.9	(g)	0.36	6.000	2.1	35.490	No COPC	--	No COPC	--
1,4-DICHLOROBENZENE	14.1	(g)	9.9	139.759	48.0	676.800	NC	--	1.4	19.7

Notes:
95% UCL - 95% Upper Confidence Limit of the mean.
BSAF - Biota-Sediment Accumulation Factor.
COPC - Constituent of Potential Concern.
dw - Dry Weight.
EPC - Exposure Point Concentration.
FOD - Frequency of Detection.
NC - Not calculated due to low FOD. At least 10 samples, including 6 detected samples, are required to run a UCL.
No COPC - Not identified as a COPC in the Nearshore Area.
PCBs - Polychlorinated Biphenyls.
USEPA - United States Environmental Protection Agency.
Soil to invertebrate uptake factors used when sediment to invertebrate values were not available.

(a) Tissue concentration calculated as follows, unless otherwise indicated:

COPC invertebrate (mg COPC/Kg invertebrate dw) = COPCsediment (mg COPC/Kg sediment dw) x Uptake Factor ((mg COPC/Kg invertebrate dw)/(mg COPC/Kg sediment dw))

(b) Literature-derived BSAFs for benthic invertebrates selected from Table 2 of Bechtel and Jacobs (1998).

arsenic	Median literature-literature derived BSAF for non-depurated organisms
cadmium	90th percentile literature-literature derived BSAF for depurated organisms
chromium	90th percentile literature-literature derived BSAF for all organisms
copper	Regression equation for all organisms: log(tissue concentration) = 0.278 * log(sediment concentration) + 1.089
lead	Median literature-literature derived BSAF for non-depurated organisms
nickel	Regression equation for depurated organisms: log(tissue concentration) = 0.695 * log(sediment concentration) - 0.440
zinc	Regression equation for depurated organisms: log(tissue concentration) = 0.126 * log(sediment concentration) + 1.89

(c) This value was derived from concentrations of barium in sediment and invertebrates from nine streams in the Blackfoot River watershed in Indiana reported by Hamilton and Buhl (2003), and from two sites on the Wolf River in Wisconsin reported by Garn et al. (2001). The value is the geometric mean of data from both studies (n = 16).

(d) A value of 1 is designated for COPCs for which BSAFs are not available.

(e) Uptake factor recommended by USEPA in development of Ecological Soil Screening Levels (Table 4a; Attachment 4-1; USEPA 2007a).

Appendix A Table 4-10

Calculation of Benthic Invertebrate Concentrations

Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

(f) Median uptake factor for benthic invertebrates and Total PCBs obtained from EPA BSAF database available at http://www.epa.gov/med/Prods_Pubs/bsaf.htm
Assumes all sediment 4% TOC; Adjacent Nearshore 1% TOC and 6% lipids in invertebrates from studies used to derive BSAF.
PCB tissue calculated as follows:
COPC invertebrate (mg COPC/kg invertebrate) = BSAF (kg organic carbon/kg lipid) x [COPCsediment (mg COPC/kg sediment dw)/fraction organic carbon] x fraction lipid in invertebrates) / (1-moisture content)
(g) Sediment/soil to invertebrate transfer factors from the LANL Ecorisk Database (Release 3.2) (LANL, 2014).
(h) Value for 1,3-dichlorobenzene used as a surrogate due to structural similarity.
(i) Value for total xylene used as a surrogate due to structural similarity.

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Appendix A Table 4-11
Calculation of Aquatic Plant Concentrations
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

COPC	Sediment-to-Plant Uptake Factor [(mg COPC/Kg plant$_{dw}$)/(mg COPC/Kg sediment$_{dw}$)]		All Site Data Included				Adjacent Nearshore Data Only			
			Sediment 95% UCL EPC (mg/Kg$_{dw}$)	Estimated 95% UCL Maximum Aquatic Plant Tissue Concentration (a) (mg/Kg$_{dw}$)	Maximum Sediment EPC (mg/Kg$_{dw}$)	Estimated Maximum Aquatic Plant Tissue Concentration (a) (mg/Kg$_{dw}$)	Sediment 95% UCL EPC (mg/Kg$_{dw}$)	Estimated 95% UCL Maximum Aquatic Plant Tissue Concentration (a) (mg/Kg$_{dw}$)	Maximum Sediment EPC (mg/Kg$_{dw}$)	Estimated Maximum Aquatic Plant Tissue Concentration (a) (mg/Kg$_{dw}$)
ARSENIC	0.03752	(b)	9.7	0.36	15.3	0.57	No COPC	--	No COPC	--
BARIUM	0.156	(b)	2,219	346	15,300	2,387	228.1	35.6	489.0	76.3
CADMIUM	regression	(b)	1.3	0.71	2.0	0.91	No COPC	--	No COPC	--
CHROMIUM	0.041	(b)	108	4.42	398	16.32	No COPC	--	No COPC	--
COPPER	regression	(b)	170.5	14.8	893	28.4	146.6	13.9	285.0	18.1
LEAD	regression	(b)	74.5	2.97	219	5.45	31.1	1.82	60.8	2.65
NICKEL	regression	(b)	40.6	1.73	90.1	3.14	No COPC	--	No COPC	--
THALLIUM	0.0040	(c)	0.1	0.000400	0.092	0.000368	NC	--	0.1	0.000368
VANADIUM	0.0049	(b)	5.1	0.0247	5.1	0.0247	NC	--	5.1	0.024735
ZINC	regression	(b)	225.0	97.1	327	119.4	No COPC	--	No COPC	--
TOTAL PCBs	0.162	(c)	0.4	0.0633	0.708	0.11	NC	--	0.2	0.034992
BENZENE	8.26	(c)	0.03	0.27	0.29	2.40	No COPC	--	No COPC	--
CHLOROBENZENE	2.43	(d)	65.9	160.0	320	778	NC	--	1.0	2.332800
O-XYLENE	3.28	(e)	0.220	0.72	0.66	2.2	No COPC	--	No COPC	--
XYLENE (TOTAL)	3.28	(c)	0.28	0.92	1.00	3.3	No COPC	--	No COPC	--
1,3-DICHLOROBENZENE	2.23	(c)	0.36	0.79	2.1	4.7	No COPC	--	No COPC	--
1,4-DICHLOROBENZENE	2.43	(c)	9.9	24.1	48	117	NC	--	1.4	3.402000

Notes:
95% UCL - 95% Upper Confidence Limit of the mean.
COPC - Constituent of Potential Concern.
dw - Dry Weight.
EPC - Exposure Point Concentration.
FOD - Frequency of Detection.
NC - Not calculated due to low FOD. At least 10 samples, including 6 detected samples, are required to run a UCL.
No COPC - Not identified as a COPC in the Nearshore Area.
PCBs - Polychlorinated Biphenyls.
USEPA - United States Environmental Protection Agency.
(a) Tissue concentration calculated as follows, unless otherwise indicated:
COPCplant (mg COPC/Kg plant dw) = COPCsediment(mg COPC/Kg sediment dw) x Uptake Factor ((mg COPC/Kg plant dw)/(mgCOPC/Kg sediment dw))
(b) Soil to plant uptake factors and regression equations recommended by USEPA in development of Ecological Soil Screening Levels (USEPA, 2007).
Regression models recommended by USEPA (Table 4a; Attachment 4-1; USEPA, 2007)

cadmium	ln(tissue concentration) = 0.546 * ln(soil concentration) - 0.475
copper	ln(tissue concentration) = 0.394 * ln(sediment concentration) + 0.668
lead	ln(tissue concentration) = 0.561 * ln(sediment concentration) - 1.328
nickel	ln(tissue concentration) = 0.748 * ln(soil concentration) - 2.223
zinc	ln(tissue concentration) = 0.554 * ln(soil concentration) + 1.575

(c) Sediment/soil to plant transfer factors from the Los Alamos National Laboratory (LANL) Ecorisk Database (Release 3.2) (LANL, 2014). Median selected if multiple values were presented [Values for Aroclor 1248 used for Total PCBs].
(d) Value for 1,4-dichlorobenzene used as a surrogate due to structural similarity.
(e) Value for total xylene used as a surrogate due to structural similarity.

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Appendix A Table 4-12
Wildlife Toxicity Reference Values
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

COPC		Target Species	Test Species	Test NOAEL ($mg/Kg_{bw}/day$)	NOAEL Test Endpoint	NOAEL-based TRV ($mg/Kg_{bw}/day$)	Test Species	Test LOAEL ($mg/Kg_{bw}/day$)	LOAEL Test Endpoint	LOAEL-based TRV ($mg/Kg_{bw}/day$)
ARSENIC	(a)	Mammal	Dog	1.0	Growth	1.0	Dog	1.7	Growth	1.7
	(a)	Bird	Chicken	2.2	Growth	2.2	Mallard	3.6	NA	3.6
BARIUM	(a)	Mammal	Multiple species	51.8	NA	51.8	Multiple species	80.5	NA	80.5
	(b)	Bird	Chick	20.8	Mortality	20.8	Chick	41.7	Mortality	41.7
CADMIUM	(a)	Mammal	Rat	0.77	Growth	0.77	Rat	7.7	Growth	7.7
	(a)	Bird	Multiple species	1.5	NA	1.5	Multiple species	6.4	NA	6.4
CHROMIUM	(a)	Mammal	Multiple species	2.4	NA	2.4	Multiple species	9.6	NA	9.6
	(a)	Bird	Multiple species	2.7	NA	2.7	Multiple species	16	NA	16
COPPER	(a)	Mammal	Pig	5.6	Growth	5.6	Pig	9.3	Growth	9.3
	(a)	Bird	Chicken	4.1	Reproduction	4.1	Chicken	12.1	Reproduction	12.1
LEAD	(a)	Mammal	Rat	4.7	Growth	4.7	Rat	8.9	Growth	8.9
	(a)	Bird	Chicken	1.6	Reproduction and growth	1.6	Chicken	3.3	Reproduction and growth	3.3
NICKEL	(a)	Mammal	Mouse	1.7	Reproduction	1.7	Mouse	3.4	Reproduction	3.4
	(a)	Bird	Multiple species	6.7	NA	6.7	Multiple species	19	NA	19
THALLIUM	(b)	Mammal	Rat	0.0074	Reduced sperm mobility	0.0074	Rat	0.074	Reduced sperm mobility	0.074
	(c,d)	Bird	Starling	0.35	Mortality	0.35	Starling	3.5	Mortality	3.5
VANADIUM	(a)	Mammal	Mouse	4.2	Reproduction	4.2	Mouse	8.3	Reproduction	8.3
	(a)	Bird	Chicken	0.34	Growth	0.34	Chicken	0.69	Growth	0.69
ZINC	(a)	Mammal	Multiple species	75	NA	75	Multiple species	298	NA	298
	(a)	Bird	Multiple species	66	NA	66	Multiple species	187	NA	187
TOTAL PCBs	(b,e)	Mammal	Mink	0.14	Reproduction	0.14	Mink	0.69	Reproduction	0.69
	(b)	Bird	Ring-necked pheasant	1.80	Reproduction	1.8	Ring-necked pheasant	7.2	Reproduction	7.2
1,3-DICHLOROBENZENE	(b,f)	Mammal	Mouse	26.4	Reproduction	26.4	Mouse	263.6	Reproduction	263.6
1,4-DICHLOROBENZENE	(b,f)	Mammal	Mouse	26.4	Reproduction	26.4	Mouse	263.6	Reproduction	263.6
BENZENE	(b,g)	Mammal	Mouse	26.4	Reproduction	26.4	Mouse	263.6	Reproduction	263.6
CHLOROBENZENE	(b,f)	Mammal	Mouse	26.4	Reproduction	26.4	Mouse	263.6	Reproduction	263.6
O-Xylene	(b)	Mammal	Mouse	2.1	Reproduction	2.1	Mouse	2.6	Reproduction	2.6
	(c,h)	Bird	Quail	106.7	Mortality	106.7	Quail	1067	Mortality	1067.0
XYLENE (TOTAL)	(b)	Mammal	Mouse	2.1	Reproduction	2.1	Mouse	2.6	Reproduction	2.6
	(c,d)	Bird	Quail	106.7	Mortality	106.7	Quail	1067	Mortality	1067.0

Notes:
Avian TRVs are not available for 1,3-dichlorobenzene, 1,4-dichlorobenzene, benzene, and chlorobenzene.
BW - Body Weight.
COPC - Constituent of Potential Concern.
LOAEL - Lowest Observed Adverse Effects Level.
NA - Not Available or Applicable.
NOAEL - No Observed Adverse Effects Level.
PCBs - Polychlorinated Biphenyls.
TRV - Toxicity Reference Value.

TRV sources -
(a) TRVs derived by USEPA during development of Eco-SSLs. See individual Eco-SSL documents for details (http://www.epa.gov/ecotox/ecossl).
The process for derivation of wildlife TRVs is described in Attachment 4-5 of USEPA (2007). The LOAEL is identified from the same study as the selected NOAEL TRV or is the lowest bounded LOAEL value that is higher than the selected NOAEL.
(b) TRVs derived by Oak Ridge National Laboratory (Sample, et al., 1996).
(c) TRV derived by LANL (2012).
(d) The NOAEL was multiplied by 10 to derive an estimated LOAEL.

Appendix A Table 4-12
Wildlife Toxicity Reference Values
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

(e) Aroclor 1254 used as a surrogate.
(f) Benzene TRV used as a surrogate.
(g) NOAEL was not identified in the literature. The LOAEL was divided by 10 to derive an estimated NOAEL.
(h) Total xylene TRV used as a surrogate.

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Appendix A Table 4-13
Potential Risks to the Belted Kingfisher
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

COPC	Site Concentrations - All Site Data Included		Potential Daily Dose ($mg/Kg_{bw}/day$)			NOAEL-based TRV ($mg/Kg_{bw}/day$)	NOAEL-based HQ	LOAEL-based TRV ($mg/Kg_{bw}/day$)	LOAEL-based HQ
	Sediment (mg/Kg_{dw})	Estimated Fish Tissue (mg/Kg_{dw})	Sediment	Fish Tissue	Total				
Maximum EPC									
ARSENIC	1.53E+01	1.53E+00	1.02E-02	1.02E-01	1.12E-01	2.24E+00	5.00E-02	3.55E+00	3.16E-02
BARIUM	1.53E+04	1.22E+03	1.02E+01	8.15E+01	9.17E+01	2.08E+01	**4.41E+00**	4.17E+01	**2.20E+00**
CADMIUM	2.00E+00	4.00E-01	1.33E-03	2.66E-02	2.80E-02	1.47E+00	1.90E-02	6.35E+00	4.40E-03
CHROMIUM	3.98E+02	3.98E+01	2.65E-01	2.65E+00	2.92E+00	2.66E+00	**1.10E+00**	1.56E+01	1.87E-01
COPPER	8.93E+02	8.93E+01	5.95E-01	5.95E+00	6.54E+00	4.05E+00	**1.61E+00**	1.21E+01	5.41E-01
LEAD	2.19E+02	2.19E+01	1.46E-01	1.46E+00	1.60E+00	1.63E+00	9.84E-01	3.26E+00	4.92E-01
NICKEL	9.01E+01	2.70E+01	6.00E-02	1.80E+00	1.86E+00	6.71E+00	2.77E-01	1.86E+01	1.00E-01
THALLIUM	9.20E-02	9.20E-02	6.13E-05	6.13E-03	6.19E-03	3.50E-01	1.77E-02	3.50E+00	1.77E-03
VANADIUM	5.10E+00	1.02E+00	3.40E-03	6.79E-02	7.13E-02	3.44E-01	2.07E-01	6.88E-01	1.04E-01
ZINC	3.27E+02	3.27E+01	2.18E-01	2.18E+00	2.40E+00	6.61E+01	3.62E-02	1.87E+02	1.28E-02
TOTAL PCBs	7.08E-01	1.15E+01	4.71E-04	7.67E-01	7.68E-01	1.80E+00	4.27E-01	7.20E+00	1.07E-01
BENZENE	2.90E-01	4.05E-03	1.93E-04	2.70E-04	4.63E-04	NA	NC	NA	NC
CHLOROBENZENE	3.20E+02	4.47E+00	2.13E-01	2.98E-01	5.11E-01	NA	NC	NA	NC
O-XYLENE	6.60E-01	6.60E-01	4.39E-04	4.39E-02	4.44E-02	1.07E+02	4.16E-04	1.07E+03	4.16E-05
XYLENE (TOTAL)	1.00E+00	1.00E+00	6.66E-04	6.66E-02	6.73E-02	1.07E+02	6.30E-04	1.07E+03	6.30E-05
1,3-DICHLOROBENZENE	2.10E+00	2.93E-02	1.40E-03	1.95E-03	3.35E-03	NA	NC	NA	NC
1,4-DICHLOROBENZENE	4.80E+01	4.52E-01	3.20E-02	3.01E-02	6.20E-02	NA	NC	NA	NC
Refined EPC									
ARSENIC	9.72E+00	9.72E-01	6.47E-03	6.47E-02	7.12E-02	2.24E+00	3.18E-02	3.55E+00	2.00E-02
BARIUM	2.22E+03	1.78E+02	1.48E+00	1.18E+01	1.33E+01	2.08E+01	6.39E-01	4.17E+01	3.19E-01
CADMIUM	1.28E+00	2.56E-01	8.53E-04	1.71E-02	1.79E-02	1.47E+00	1.22E-02	6.35E+00	2.82E-03
CHROMIUM	1.08E+02	1.08E+01	7.17E-02	7.17E-01	7.89E-01	2.66E+00	2.97E-01	1.56E+01	5.06E-02
COPPER	1.71E+02	1.71E+01	1.14E-01	1.14E+00	1.25E+00	4.05E+00	3.08E-01	1.21E+01	1.03E-01
LEAD	7.45E+01	7.45E+00	4.96E-02	4.96E-01	5.45E-01	1.63E+00	3.35E-01	3.26E+00	1.67E-01
NICKEL	4.06E+01	1.22E+01	2.70E-02	8.11E-01	8.38E-01	6.71E+00	1.25E-01	1.86E+01	4.51E-02
THALLIUM	1.00E-01	1.00E-01	6.66E-05	6.66E-03	6.73E-03	3.50E-01	1.92E-02	3.50E+00	1.92E-03
VANADIUM	5.10E+00	1.02E+00	3.40E-03	6.79E-02	7.13E-02	3.44E-01	2.07E-01	6.88E-01	1.04E-01
ZINC	2.25E+02	2.25E+01	1.50E-01	1.50E+00	1.65E+00	6.61E+01	2.49E-02	1.87E+02	8.81E-03
TOTAL PCBs	3.91E-01	6.37E+00	2.60E-04	4.24E-01	4.24E-01	1.80E+00	2.36E-01	7.20E+00	5.89E-02
BENZENE	3.29E-02	4.60E-04	2.19E-05	3.06E-05	5.25E-05	NA	NC	NA	NC
CHLOROBENZENE	6.59E+01	9.20E-01	4.39E-02	6.13E-02	1.05E-01	NA	NC	NA	NC
O-Xylene	2.20E-01	2.20E-01	1.46E-04	1.46E-02	1.48E-02	1.07E+02	1.39E-04	1.07E+03	1.39E-05
XYLENE (TOTAL)	2.81E-01	2.81E-01	1.87E-04	1.87E-02	1.89E-02	1.07E+02	1.77E-04	1.07E+03	1.77E-05
1,3-DICHLOROBENZENE	3.55E-01	4.96E-03	2.36E-04	3.30E-04	5.67E-04	NA	NC	NA	NC
1,4-DICHLOROBENZENE	9.91E+00	9.32E-02	6.60E-03	6.21E-03	1.28E-02	NA	NC	NA	NC

Notes:
BW - Body Weight.
COPC - Constituent of Potential Concern.
dw - Dry Weight.
EPC - Exposure Point Concentration.
HQ - Hazard Quotient (Dose/TRV).
LOAEL - Lowest Observed Adverse Effects Level.
NA - Not Available. Avian TRV not available for this COPC.
NC - Not Calculated.
NOAEL - No Observed Adverse Effects Level.
PCBs - Polychlorinated Biphenyls.
TRV - Toxicity Reference Value.

HQs above 1 are bolded and highlighted.
Maximum EPC - Maximum detected concentration.
Refined EPC - 95% Upper Confidence Limit of the mean.

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Appendix A Table 4-14
Potential Risks to the Osprey
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

COPC	Site Concentrations - All Site Data Included	Potential Daily Dose ($mg/Kg_{bw}/day$)		NOAEL-based TRV ($mg/Kg_{bw}/day$)	NOAEL-based HQ	LOAEL-based TRV ($mg/Kg_{bw}/day$)	LOAEL-based HQ
	Estimated Fish Tissue (mg/Kg_{dw})	Fish Tissue	Total				
Maximum EPC							
ARSENIC	1.53E+00	1.08E-02	1.08E-02	2.24E+00	4.82E-03	3.55E+00	3.04E-03
BARIUM	1.22E+03	8.64E+00	8.64E+00	2.08E+01	4.16E-01	4.17E+01	2.07E-01
CADMIUM	4.00E-01	2.83E-03	2.83E-03	1.47E+00	1.92E-03	6.35E+00	4.45E-04
CHROMIUM	3.98E+01	2.81E-01	2.81E-01	2.66E+00	1.06E-01	1.56E+01	1.80E-02
COPPER	8.93E+01	6.31E-01	6.31E-01	4.05E+00	1.56E-01	1.21E+01	5.21E-02
LEAD	2.19E+01	1.55E-01	1.55E-01	1.63E+00	9.49E-02	3.26E+00	4.74E-02
NICKEL	2.70E+01	1.91E-01	1.91E-01	6.71E+00	2.84E-02	1.86E+01	1.03E-02
THALLIUM	9.20E-02	6.50E-04	6.50E-04	3.50E-01	1.86E-03	3.50E+00	1.86E-04
VANADIUM	1.02E+00	7.20E-03	7.20E-03	3.44E-01	2.09E-02	6.88E-01	1.05E-02
ZINC	3.27E+01	2.31E-01	2.31E-01	6.61E+01	3.49E-03	1.87E+02	1.23E-03
TOTAL PCBs	1.15E+01	8.14E-02	8.14E-02	1.80E+00	4.52E-02	7.20E+00	1.13E-02
BENZENE	4.05E-03	2.86E-05	2.86E-05	NA	NC	NA	NC
CHLOROBENZENE	4.47E+00	3.16E-02	3.16E-02	NA	NC	NA	NC
O-Xylene	6.60E-01	4.66E-03	4.66E-03	1.07E+02	4.37E-05	1.07E+03	4.37E-06
XYLENE (TOTAL)	1.00E+00	7.06E-03	7.06E-03	1.07E+02	6.62E-05	1.07E+03	6.62E-06
1,3-DICHLOROBENZENE	2.93E-02	2.07E-04	2.07E-04	NA	NC	NA	NC
1,4-DICHLOROBENZENE	4.52E-01	3.19E-03	3.19E-03	NA	NC	NA	NC
Refined EPC							
ARSENIC	9.72E-01	6.86E-03	6.86E-03	2.24E+00	3.06E-03	3.55E+00	1.93E-03
BARIUM	1.78E+02	1.25E+00	1.25E+00	2.08E+01	6.03E-02	4.17E+01	3.01E-02
CADMIUM	2.56E-01	1.81E-03	1.81E-03	1.47E+00	1.23E-03	6.35E+00	2.85E-04
CHROMIUM	1.08E+01	7.61E-02	7.61E-02	2.66E+00	2.86E-02	1.56E+01	4.88E-03
COPPER	1.71E+01	1.20E-01	1.20E-01	4.05E+00	2.97E-02	1.21E+01	9.95E-03
LEAD	7.45E+00	5.26E-02	5.26E-02	1.63E+00	3.23E-02	3.26E+00	1.61E-02
NICKEL	1.22E+01	8.60E-02	8.60E-02	6.71E+00	1.28E-02	1.86E+01	4.62E-03
THALLIUM	1.00E-01	7.06E-04	7.06E-04	3.50E-01	2.02E-03	3.50E+00	2.02E-04
VANADIUM	1.02E+00	7.20E-03	7.20E-03	3.44E-01	2.09E-02	6.88E-01	1.05E-02
ZINC	2.25E+01	1.59E-01	1.59E-01	6.61E+01	2.40E-03	1.87E+02	8.50E-04
TOTAL PCBs	6.37E+00	4.50E-02	4.50E-02	1.80E+00	2.50E-02	7.20E+00	6.24E-03
BENZENE	4.60E-04	3.25E-06	3.25E-06	NA	NC	NA	NC
CHLOROBENZENE	9.20E-01	6.50E-03	6.50E-03	NA	NC	NA	NC
O-XYLENE	2.20E-01	1.55E-03	1.55E-03	1.07E+02	1.46E-05	1.07E+03	1.46E-06
XYLENE (TOTAL)	2.81E-01	1.98E-03	1.98E-03	1.07E+02	1.86E-05	1.07E+03	1.86E-06
1,3-DICHLOROBENZENE	4.96E-03	3.50E-05	3.50E-05	NA	NC	NA	NC
1,4-DICHLOROBENZENE	9.32E-02	6.59E-04	6.59E-04	NA	NC	NA	NC

Notes:
BW - Body Weight.
COPC - Constituent of Potential Concern.
dw - Dry Weight.
EPC - Exposure Point Concentration.
HQ - Hazard Quotient (Dose/TRV).
LOAEL - Lowest Observed Adverse Effects Level.
NA - Not Available. Avian TRV not available for this COPC.
NC - Not Calculated.
NOAEL - No Observed Adverse Effects Level.
PCBs - Polychlorinated Biphenyls.
TRV - Toxicity Reference Value.

HQs above 1 are bolded and highlighted.
Maximum EPC - Maximum detected concentration.
Refined EPC - 95% Upper Confidence Limit of the mean.

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Appendix A Table 4-15
Potential Risks to the Mink
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

COPC	Site Concentrations - All Site Data Included			Potential Daily Dose ($mg/Kg_{bw}/day$)				NOAEL-based TRV ($mg/Kg_{bw}/day$)	NOAEL-based HQ	LOAEL-based TRV ($mg/Kg_{bw}/day$)	LOAEL-based HQ
	Sediment (mg/Kg_{dw})	Estimated Benthic Invertebrate Tissue (mg/Kg_{dw})	Estimated Fish Tissue (mg/Kg_{dw})	Sediment	Benthic Invertebrate	Fish Tissue	Total				
Maximum EPC											
ARSENIC	1.53E+01	2.90E+00	1.53E+00	6.27E-03	5.94E-03	2.82E-02	4.04E-02	1.04E+00	3.89E-02	1.66E+00	2.44E-02
BARIUM	1.53E+04	2.75E+03	1.22E+03	6.27E+00	5.64E+00	2.26E+01	3.45E+01	5.18E+01	6.66E-01	8.05E+01	4.29E-01
CADMIUM	2.00E+00	2.47E+00	4.00E-01	8.20E-04	5.06E-03	7.38E-03	1.33E-02	7.70E-01	1.72E-02	7.70E+00	1.72E-03
CHROMIUM	3.98E+02	1.44E+01	3.98E+01	1.63E-01	2.95E-02	7.34E-01	9.27E-01	2.40E+00	3.86E-01	9.62E+00	9.63E-02
COPPER	8.93E+02	8.12E+01	8.93E+01	3.66E-01	1.66E-01	1.65E+00	2.18E+00	5.60E+00	3.89E-01	9.34E+00	2.33E-01
LEAD	2.19E+02	1.03E+01	2.19E+01	8.98E-02	2.11E-02	4.04E-01	5.15E-01	4.70E+00	1.10E-01	8.90E+00	5.79E-02
NICKEL	9.01E+01	8.29E+00	2.70E+01	3.69E-02	1.70E-02	4.99E-01	5.53E-01	1.70E+00	3.25E-01	3.40E+00	1.63E-01
THALLIUM	9.20E-02	9.20E-02	9.20E-02	3.77E-05	1.89E-04	1.70E-03	1.92E-03	7.40E-03	2.60E-01	7.40E-02	2.60E-02
VANADIUM	5.10E+00	2.14E-01	1.02E+00	2.09E-03	4.39E-04	1.88E-02	2.13E-02	4.16E+00	5.13E-03	8.31E+00	2.57E-03
ZINC	3.27E+02	1.61E+02	3.27E+01	1.34E-01	3.30E-01	6.03E-01	1.07E+00	7.54E+01	1.42E-02	2.98E+02	3.58E-03
TOTAL PCBs	7.08E-01	5.31E+00	1.15E+01	2.90E-04	1.09E-02	2.13E-01	2.24E-01	1.40E-01	**1.60E+00**	6.90E-01	3.24E-01
BENZENE	2.90E-01	7.77E-01	4.05E-03	1.19E-04	1.59E-03	7.47E-05	1.79E-03	2.64E+01	6.78E-05	2.64E+02	6.78E-06
CHLOROBENZENE	3.20E+02	5.41E+03	4.47E+00	1.31E-01	1.11E+01	8.25E-02	1.13E+01	2.64E+01	4.29E-01	2.64E+02	4.29E-02
O-XYLENE	6.60E-01	4.78E+00	6.60E-01	2.71E-04	9.79E-03	1.22E-02	2.22E-02	2.10E+00	1.06E-02	2.60E+00	8.55E-03
XYLENE (TOTAL)	1.00E+00	7.24E+00	1.00E+00	4.10E-04	1.48E-02	1.84E-02	3.37E-02	2.10E+00	1.60E-02	2.60E+00	1.30E-02
1,3-DICHLOROBENZENE	2.10E+00	3.55E+01	2.93E-02	8.61E-04	7.27E-02	5.41E-04	7.41E-02	2.64E+01	2.81E-03	2.64E+02	2.81E-04
1,4-DICHLOROBENZENE	4.80E+01	6.77E+02	4.52E-01	1.97E-02	1.39E+00	8.33E-03	1.42E+00	2.64E+01	5.37E-02	2.64E+02	5.37E-03
Refined EPC											
ARSENIC	9.72E+00	1.95E+00	9.72E-01	3.98E-03	4.00E-03	1.79E-02	2.59E-02	1.04E+00	2.49E-02	1.66E+00	1.56E-02
BARIUM	2.22E+03	3.99E+02	1.78E+02	9.10E-01	8.19E-01	3.27E+00	5.00E+00	5.18E+01	9.66E-02	8.05E+01	6.21E-02
CADMIUM	1.28E+00	1.83E+00	2.56E-01	5.25E-04	3.75E-03	4.73E-03	9.01E-03	7.70E-01	1.17E-02	7.70E+00	1.17E-03
CHROMIUM	1.08E+02	8.93E+00	1.08E+01	4.41E-02	1.83E-02	1.99E-01	2.61E-01	2.40E+00	1.09E-01	9.62E+00	2.71E-02
COPPER	1.71E+02	5.12E+01	1.71E+01	6.99E-02	1.05E-01	3.15E-01	4.89E-01	5.60E+00	8.74E-02	9.34E+00	5.24E-02
LEAD	7.45E+01	5.10E+00	7.45E+00	3.05E-02	1.04E-02	1.37E-01	1.78E-01	4.70E+00	3.79E-02	8.90E+00	2.00E-02
NICKEL	4.06E+01	4.76E+00	1.22E+01	1.66E-02	9.76E-03	2.25E-01	2.51E-01	1.70E+00	1.48E-01	3.40E+00	7.38E-02
THALLIUM	1.00E-01	1.00E-01	1.00E-01	4.10E-05	2.05E-04	1.84E-03	2.09E-03	7.40E-03	2.83E-01	7.40E-02	2.83E-02
VANADIUM	5.10E+00	2.14E-01	1.02E+00	2.09E-03	4.39E-04	1.88E-02	2.13E-02	4.16E+00	5.13E-03	8.31E+00	2.57E-03
ZINC	2.25E+02	1.54E+02	2.25E+01	9.22E-02	3.15E-01	4.15E-01	8.22E-01	7.54E+01	1.09E-02	2.98E+02	2.76E-03
TOTAL PCBs	3.91E-01	2.93E+00	6.37E+00	1.60E-04	6.01E-03	1.17E-01	1.24E-01	1.40E-01	8.83E-01	6.90E-01	1.79E-01
BENZENE	3.29E-02	8.82E-02	4.60E-04	1.35E-05	1.81E-04	8.48E-06	2.03E-04	2.64E+01	7.69E-06	2.64E+02	7.69E-07
CHLOROBENZENE	6.59E+01	1.11E+03	9.20E-01	2.70E-02	2.28E+00	1.70E-02	2.33E+00	2.64E+01	8.82E-02	2.64E+02	8.82E-03
O-Xylene	2.20E-01	1.59E+00	2.20E-01	9.02E-05	3.26E-03	4.06E-03	7.41E-03	2.10E+00	3.53E-03	2.60E+00	2.85E-03
XYLENE (TOTAL)	2.81E-01	2.03E+00	2.81E-01	1.15E-04	4.17E-03	5.18E-03	9.47E-03	2.10E+00	4.51E-03	2.60E+00	3.64E-03
1,3-DICHLOROBENZENE	3.55E-01	6.00E+00	4.96E-03	1.46E-04	1.23E-02	9.15E-05	1.25E-02	2.64E+01	4.75E-04	2.64E+02	4.75E-05
1,4-DICHLOROBENZENE	9.91E+00	1.40E+02	9.32E-02	4.06E-03	2.86E-01	1.72E-03	2.92E-01	2.64E+01	1.11E-02	2.64E+02	1.11E-03

Notes:
BW - Body Weight.
COPC - Constituent of Potential Concern.
dw - Dry Weight.
EPC - Exposure Point Concentration.
HQ - Hazard Quotient (Dose/TRV).
LOAEL - Lowest Observed Adverse Effects Level.
NA - Not Available. Avian TRV not available for this COPC.
NC - Not Calculated.
NOAEL - No Observed Adverse Effects Level.
PCBs - Polychlorinated Biphenyls.
TRV - Toxicity Reference Value.

HQs above 1 are bolded and highlighted.
Maximum EPC - Maximum detected concentration.
Refined EPC - 95% Upper Confidence Limit of the mean.

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Appendix A Table 4-16
Potential Risks to the Great Blue Heron
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

COPC	Site Concentrations - Adjacent Nearshore Data Only			Potential Daily Dose ($mg/Kg_{bw}/day$)				NOAEL-based TRV ($mg/Kg_{bw}/day$)	NOAEL-based HQ	LOAEL-based TRV ($mg/Kg_{bw}/day$)	LOAEL-based HQ
	Sediment (mg/Kg_{dw})	Estimated Benthic Invertebrate Tissue (mg/Kg_{dw})	Estimated Fish Tissue (mg/Kg_{dw})	Sediment	Benthic Invertebrate	Fish Tissue	Total				
Maximum EPC											
BARIUM	4.89E+02	8.80E+01	3.91E+01	1.52E-01	2.74E-02	2.31E-01	4.11E-01	2.08E+01	1.97E-02	4.17E+01	9.85E-03
COPPER	2.85E+02	5.91E+01	2.85E+01	8.86E-02	1.84E-02	1.68E-01	2.75E-01	4.05E+00	6.80E-02	1.21E+01	2.28E-02
LEAD	6.08E+01	4.47E+00	6.08E+00	1.89E-02	1.39E-03	3.59E-02	5.62E-02	1.63E+00	3.45E-02	3.26E+00	1.72E-02
THALLIUM	9.20E-02	9.20E-02	9.20E-02	2.86E-05	2.86E-05	5.44E-04	6.01E-04	3.50E-01	1.72E-03	3.50E+00	1.72E-04
VANADIUM	5.10E+00	2.14E-01	1.02E+00	1.59E-03	6.66E-05	6.03E-03	7.68E-03	3.44E-01	2.23E-02	6.88E-01	1.12E-02
TOTAL PCBs	2.16E-01	6.48E+00	1.41E+01	6.72E-05	2.01E-03	8.31E-02	8.52E-02	1.80E+00	4.73E-02	7.20E+00	1.18E-02
CHLOROBENZENE	9.60E-01	1.62E+01	5.36E-02	2.99E-04	5.04E-03	3.17E-04	5.66E-03	NA	NC	NA	NC
1,4-DICHLOROBENZENE	1.40E+00	1.97E+01	5.27E-02	4.35E-04	6.14E-03	3.11E-04	6.88E-03	NA	NC	NA	NC
Refined EPC											
BARIUM	2.28E+02	4.11E+01	1.82E+01	7.09E-02	1.28E-02	1.08E-01	1.92E-01	2.08E+01	9.21E-03	4.17E+01	4.59E-03
COPPER	1.47E+02	4.91E+01	1.47E+01	4.56E-02	1.53E-02	8.66E-02	1.47E-01	4.05E+00	3.64E-02	1.21E+01	1.22E-02
LEAD	3.11E+01	2.88E+00	3.11E+00	9.68E-03	8.97E-04	1.84E-02	2.90E-02	1.63E+00	1.78E-02	3.26E+00	8.88E-03

Notes:
BW - Body Weight.
COPC - Constituent of Potential Concern.
dw - Dry Weight.
EPC - Exposure Point Concentration.
HQ - Hazard Quotient (Dose/TRV).
LOAEL - Lowest Observed Adverse Effects Level.
NA - Not Available. Avian TRV not available for this COPC.
NC - Not Calculated.
NOAEL - No Observed Adverse Effects Level.
TRV - Toxicity Reference Value.

HQs above 1 are bolded and highlighted.
Maximum EPC - Maximum detected concentration.
Refined EPC - 95% Upper Confidence Limit of the mean.
Refined EPCs were not calculated for thallium, vanadium, chlorobenzene, and 1,4-dichlorobenzene for the Adjacent Nearshore Area due to an insufficient number of samples available (i.e., less than six detected samples and ten samples total).

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Appendix A Table 4-17
Potential Risks to the Raccoon
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

COPC	Site Concentrations - Adjacent Nearshore Data Only				Potential Daily Dose ($mg/Kg_{bw}/day$)					NOAEL-based TRV ($mg/Kg_{bw}/day$)	NOAEL-based HQ	LOAEL-based TRV ($mg/Kg_{bw}/day$)	LOAEL-based HQ
	Sediment (mg/Kg_{dw})	Estimated Benthic Invertebrate Tissue (mg/Kg_{dw})	Estimated Plant Tissue (mg/Kg_{dw})	Estimated Fish Tissue (mg/Kg_{dw})	Sediment	Benthic Invertebrate	Plant Tissue	Fish Tissue	Total				
Maximum EPC													
BARIUM	4.89E+02	8.80E+01	7.63E+01	3.91E+01	1.23E-01	9.86E-02	6.92E-02	2.50E-02	3.15E-01	5.18E+01	6.09E-03	8.05E+01	3.92E-03
COPPER	2.85E+02	5.91E+01	1.81E+01	2.85E+01	7.15E-02	6.62E-02	1.64E-02	1.82E-02	1.72E-01	5.60E+00	3.08E-02	9.34E+00	1.84E-02
LEAD	6.08E+01	4.47E+00	2.65E+00	6.08E+00	1.52E-02	5.00E-03	2.41E-03	3.89E-03	2.65E-02	4.70E+00	5.65E-03	8.90E+00	2.98E-03
THALLIUM	9.20E-02	9.20E-02	3.68E-04	9.20E-02	2.31E-05	1.03E-04	3.34E-07	5.89E-05	1.85E-04	7.40E-03	2.50E-02	7.40E-02	2.50E-03
VANADIUM	5.10E+00	2.14E-01	2.47E-02	1.02E+00	1.28E-03	2.40E-04	2.24E-05	6.53E-04	2.19E-03	4.16E+00	5.27E-04	8.31E+00	2.64E-04
TOTAL PCBs	2.16E-01	6.48E+00	3.50E-02	1.41E+01	5.42E-05	7.26E-03	3.17E-05	9.00E-03	1.63E-02	1.40E-01	1.17E-01	6.90E-01	2.37E-02
CHLOROBENZENE	9.60E-01	1.62E+01	2.33E+00	5.36E-02	2.41E-04	1.82E-02	2.12E-03	3.43E-05	2.06E-02	2.64E+01	7.80E-04	2.64E+02	7.80E-05
1,4-DICHLOROBENZENE	1.40E+00	1.97E+01	3.40E+00	5.27E-02	3.51E-04	2.21E-02	3.09E-03	3.37E-05	2.56E-02	2.64E+01	9.71E-04	2.64E+02	9.71E-05
Refined EPC													
BARIUM	2.28E+02	4.11E+01	3.56E+01	1.82E+01	5.72E-02	4.60E-02	3.23E-02	1.17E-02	1.47E-01	5.18E+01	2.84E-03	8.05E+01	1.83E-03
COPPER	1.47E+02	4.91E+01	1.39E+01	1.47E+01	3.68E-02	5.50E-02	1.26E-02	9.39E-03	1.14E-01	5.60E+00	2.03E-02	9.34E+00	1.22E-02
LEAD	3.11E+01	2.88E+00	1.82E+00	3.11E+00	7.80E-03	3.23E-03	1.65E-03	1.99E-03	1.47E-02	4.70E+00	3.12E-03	8.90E+00	1.65E-03

Notes:
BW - Body Weight.
COPC - Constituent of Potential Concern.
dw - Dry Weight.
EPC - Exposure Point Concentration.
HQ - Hazard Quotient (Dose/TRV).
LOAEL - Lowest Observed Adverse Effects Level.
NOAEL - No Observed Adverse Effects Level.
TRV - Toxicity Reference Value.

HQs above 1 are bolded and highlighted.
Maximum EPC - Maximum detected concentration.
Refined EPC - 95% Upper Confidence Limit of the mean.
Refined EPCs were not calculated for thallium, vanadium, chlorobenzene, and 1,4-dichlorobenzene for the Adjacent Nearshore Area due to an insufficient number of samples available (i.e., less than six detected samples and ten samples total).

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Appendix A Table 4-18
Potential Risks to the Lesser Scaup
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

COPC	Site Concentrations - All Site Data Included		Potential Daily Dose ($mg/Kg_{bw}/day$)			NOAEL-based TRV ($mg/Kg_{bw}/day$)	NOAEL-based HQ	LOAEL-based TRV ($mg/Kg_{bw}/day$)	LOAEL-based HQ
	Sediment (mg/Kg_{dw})	Estimated Benthic Invertebrate Tissue (mg/Kg_{dw})	Sediment	Benthic Invertebrate	Total				
Maximum EPC									
ARSENIC	1.53E+01	2.90E+00	6.78E-03	2.57E-02	3.25E-02	2.24E+00	1.45E-02	3.55E+00	9.15E-03
BARIUM	1.53E+04	2.75E+03	1.02E+01	2.44E+01	3.46E+01	2.08E+01	**1.66E+00**	4.17E+01	8.30E-01
CADMIUM	2.00E+00	2.47E+00	1.33E-03	2.19E-02	2.32E-02	1.47E+00	1.58E-02	6.35E+00	3.65E-03
CHROMIUM	3.98E+02	1.44E+01	2.65E-01	1.28E-01	3.93E-01	2.66E+00	1.48E-01	1.56E+01	2.52E-02
COPPER	8.93E+02	8.12E+01	5.95E-01	7.20E-01	1.31E+00	4.05E+00	3.25E-01	1.21E+01	1.09E-01
LEAD	2.19E+02	1.03E+01	1.46E-01	9.14E-02	2.37E-01	1.63E+00	1.46E-01	3.26E+00	7.28E-02
NICKEL	9.01E+01	8.29E+00	6.00E-02	7.35E-02	1.34E-01	6.71E+00	1.99E-02	1.86E+01	7.18E-03
THALLIUM	9.20E-02	9.20E-02	6.13E-05	8.16E-04	8.77E-04	3.50E-01	2.51E-03	3.50E+00	2.51E-04
VANADIUM	5.10E+00	2.14E-01	3.40E-03	1.90E-03	5.30E-03	3.44E-01	1.54E-02	6.88E-01	7.70E-03
ZINC	3.27E+02	1.61E+02	2.18E-01	1.43E+00	1.65E+00	6.61E+01	2.49E-02	1.87E+02	8.80E-03
TOTAL PCBs	7.08E-01	5.31E+00	4.71E-04	4.71E-02	4.76E-02	1.80E+00	2.64E-02	7.20E+00	6.61E-03
BENZENE	2.90E-01	7.77E-01	1.93E-04	6.89E-03	7.09E-03	NA	NC	NA	NC
CHLOROBENZENE	3.20E+02	5.41E+03	2.13E-01	4.80E+01	4.82E+01	NA	NC	NA	NC
O-XYLENE	6.60E-01	4.78E+00	4.39E-04	4.24E-02	4.28E-02	1.07E+02	4.01E-04	1.07E+03	4.01E-05
XYLENE (TOTAL)	1.00E+00	7.24E+00	6.66E-04	6.42E-02	6.49E-02	1.07E+02	6.08E-04	1.07E+03	6.08E-05
1,3-DICHLOROBENZENE	2.10E+00	3.55E+01	1.40E-03	3.15E-01	3.16E-01	NA	NC	NA	NC
1,4-DICHLOROBENZENE	4.80E+01	6.77E+02	3.20E-02	6.00E+00	6.03E+00	NA	NC	NA	NC
Refined EPC									
ARSENIC	9.72E+00	1.95E+00	4.31E-03	1.73E-02	2.16E-02	2.24E+00	9.64E-03	3.55E+00	6.08E-03
BARIUM	2.22E+03	3.99E+02	9.84E-01	3.54E+00	4.53E+00	2.08E+01	2.18E-01	4.17E+01	1.09E-01
CADMIUM	1.28E+00	1.83E+00	5.68E-04	1.62E-02	1.68E-02	1.47E+00	1.14E-02	6.35E+00	2.65E-03
CHROMIUM	1.08E+02	8.93E+00	4.78E-02	7.92E-02	1.27E-01	2.66E+00	4.77E-02	1.56E+01	8.14E-03
COPPER	1.71E+02	5.12E+01	7.56E-02	4.54E-01	5.30E-01	4.05E+00	1.31E-01	1.21E+01	4.38E-02
LEAD	7.45E+01	5.10E+00	3.30E-02	4.52E-02	7.82E-02	1.63E+00	4.80E-02	3.26E+00	2.40E-02
NICKEL	4.06E+01	4.76E+00	1.80E-02	4.22E-02	6.02E-02	6.71E+00	8.98E-03	1.86E+01	3.24E-03
THALLIUM	1.00E-01	1.00E-01	4.43E-05	8.87E-04	9.31E-04	3.50E-01	2.66E-03	3.50E+00	2.66E-04
VANADIUM	5.10E+00	2.14E-01	2.26E-03	1.90E-03	4.16E-03	3.44E-01	1.21E-02	6.88E-01	6.05E-03
ZINC	2.25E+02	1.54E+02	9.98E-02	1.36E+00	1.46E+00	6.61E+01	2.21E-02	1.87E+02	7.82E-03
TOTAL PCBs	3.91E-01	2.93E+00	1.73E-04	2.60E-02	2.62E-02	1.80E+00	1.45E-02	7.20E+00	3.64E-03
BENZENE	3.29E-02	8.82E-02	1.46E-05	7.82E-04	7.97E-04	NA	NC	NA	NC
CHLOROBENZENE	6.59E+01	1.11E+03	2.92E-02	9.87E+00	9.90E+00	NA	NC	NA	NC
O-Xylene	2.20E-01	1.59E+00	9.76E-05	1.41E-02	1.42E-02	1.07E+02	1.33E-04	1.07E+03	1.33E-05
XYLENE (TOTAL)	2.81E-01	2.03E+00	1.25E-04	1.80E-02	1.82E-02	1.07E+02	1.70E-04	1.07E+03	1.70E-05
1,3-DICHLOROBENZENE	3.55E-01	6.00E+00	1.57E-04	5.32E-02	5.34E-02	NA	NC	NA	NC
1,4-DICHLOROBENZENE	9.91E+00	1.40E+02	4.40E-03	1.24E+00	1.24E+00	NA	NC	NA	NC

Notes:
BW - Body Weight.
COPC - Constituent of Potential Concern.
dw - Dry Weight.
EPC - Exposure Point Concentration.
HQ - Hazard Quotient (Dose/TRV).
LOAEL - Lowest Observed Adverse Effects Level.
NA - Not Available. Avian TRV not available for this COPC.
NC - Not Calculated.
NOAEL - No Observed Adverse Effects Level.
PCBs - Polychlorinated Biphenyls.
TRV - Toxicity Reference Value.

HQs above 1 are bolded and highlighted.
Maximum EPC - Maximum detected concentration.
Refined EPC - 95% Upper Confidence Limit of the mean.

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Appendix A Table 4-19
Summary of Potential Risks to Aquatic Wildlife
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

	NOAEL-based HQ						LOAEL-based HQ					
COPC	**Kingfisher**	**Osprey**	**Mink**	**Lesser Scaup**	**Heron**	**Raccoon**	**Kingfisher**	**Osprey**	**Mink**	**Lesser Scaup**	**Heron**	**Raccoon**
MAXIMUM EPC												
	All Site Data Included				**Adjacent Nearshore Data Only**		**All Site Data Included**				**Adjacent Nearshore Data Only**	
ARSENIC	5.00E-02	4.82E-03	3.89E-02	1.45E-02	No COPC	No COPC	3.16E-02	3.04E-03	2.44E-02	9.15E-03	No COPC	No COPC
BARIUM	**4.41E+00**	4.16E-01	6.66E-01	**1.66E+00**	1.97E-02	6.09E-03	**2.20E+00**	2.07E-01	4.29E-01	8.30E-01	9.85E-03	3.92E-03
CADMIUM	1.90E-02	1.92E-03	1.72E-02	1.58E-02	No COPC	No COPC	4.40E-03	4.45E-04	1.72E-03	3.65E-03	No COPC	No COPC
CHROMIUM	**1.10E+00**	1.06E-01	3.86E-01	1.48E-01	No COPC	No COPC	1.87E-01	1.80E-02	9.63E-02	2.52E-02	No COPC	No COPC
COPPER	**1.61E+00**	1.56E-01	3.89E-01	3.25E-01	6.80E-02	3.08E-02	5.41E-01	5.21E-02	2.33E-01	1.09E-01	2.28E-02	1.84E-02
LEAD	9.84E-01	9.49E-02	1.10E-01	1.46E-01	3.45E-02	5.65E-03	4.92E-01	4.74E-02	5.79E-02	7.28E-02	1.72E-02	2.98E-03
NICKEL	2.77E-01	2.84E-02	3.25E-01	1.99E-02	No COPC	No COPC	1.00E-01	1.03E-02	1.63E-01	7.18E-03	No COPC	No COPC
THALLIUM	1.77E-02	1.86E-03	2.60E-01	2.51E-03	1.72E-03	2.50E-02	1.77E-03	1.86E-04	2.60E-02	2.51E-04	1.72E-04	2.50E-03
VANADIUM	2.07E-01	2.09E-02	5.13E-03	1.54E-02	2.23E-02	5.27E-04	1.04E-01	1.05E-02	2.57E-03	7.70E-03	1.12E-02	2.64E-04
ZINC	3.62E-02	3.49E-03	1.42E-02	2.49E-02	No COPC	No COPC	1.28E-02	1.23E-03	3.58E-03	8.80E-03	No COPC	No COPC
TOTAL PCBs	4.27E-01	4.52E-02	**1.60E+00**	2.64E-02	No COPC	No COPC	1.07E-01	1.13E-02	3.24E-01	6.61E-03	No COPC	No COPC
BENZENE	NC	NC	6.78E-05	NC	No COPC	No COPC	NC	NC	6.78E-06	NC	No COPC	No COPC
CHLOROBENZENE	NC	NC	4.29E-01	NC	NC	7.80E-04	NC	NC	4.29E-02	NC	NC	7.80E-05
O-Xylene	4.16E-04	4.37E-05	1.06E-02	4.01E-04	No COPC	No COPC	4.16E-05	4.37E-06	8.55E-03	4.01E-05	No COPC	No COPC
XYLENE (TOTAL)	6.30E-04	6.62E-05	1.60E-02	6.08E-04	No COPC	No COPC	6.30E-05	6.62E-06	1.30E-02	6.08E-05	No COPC	No COPC
1,3-DICHLOROBENZENE	NC	NC	2.81E-03	NC	No COPC	No COPC	NC	NC	2.81E-04	NC	No COPC	No COPC
1,4-DICHLOROBENZENE	NC	NC	5.37E-02	NC	NC	9.71E-04	NC	NC	5.37E-03	NC	NC	9.71E-05
REFINED EPC												
	Including all site data				**Adjacent Nearshore only**		**Including all site data**				**Adjacent Nearshore only**	
ARSENIC	3.18E-02	3.06E-03	2.49E-02	9.64E-03	No COPC	No COPC	2.00E-02	1.93E-03	1.56E-02	6.08E-03	No COPC	No COPC
BARIUM	6.39E-01	6.03E-02	9.66E-02	2.18E-01	9.21E-03	2.84E-03	3.19E-01	3.01E-02	6.21E-02	1.09E-01	4.59E-03	1.83E-03
CADMIUM	1.22E-02	1.23E-03	1.17E-02	1.14E-02	No COPC	No COPC	2.82E-03	2.85E-04	1.17E-03	2.65E-03	No COPC	No COPC
CHROMIUM	2.97E-01	2.86E-02	1.09E-01	4.77E-02	No COPC	No COPC	5.06E-02	4.88E-03	2.71E-02	8.14E-03	No COPC	No COPC
COPPER	3.08E-01	2.97E-02	8.74E-02	1.31E-01	3.64E-02	2.03E-02	1.03E-01	9.95E-03	5.24E-02	4.38E-02	1.22E-02	1.22E-02
LEAD	3.35E-01	3.23E-02	3.79E-02	4.80E-02	1.78E-02	3.12E-03	1.67E-01	1.61E-02	2.00E-02	2.40E-02	8.88E-03	1.65E-03
NICKEL	1.25E-01	1.28E-02	1.48E-01	8.98E-03	No COPC	No COPC	4.51E-02	4.62E-03	7.38E-02	3.24E-03	No COPC	No COPC
THALLIUM	1.92E-02	2.02E-03	2.83E-01	2.66E-03	NC (a)	NC (a)	1.92E-03	2.02E-04	2.83E-02	2.66E-04	NC (a)	NC (a)
VANADIUM	2.07E-01	2.09E-02	5.13E-03	1.21E-02	NC (a)	NC (a)	1.04E-01	1.05E-02	2.57E-03	6.05E-03	NC (a)	NC (a)
ZINC	2.49E-02	2.40E-03	1.09E-02	2.21E-02	No COPC	No COPC	8.81E-03	8.50E-04	2.76E-03	7.82E-03	No COPC	No COPC
TOTAL PCBs	2.36E-01	2.50E-02	8.83E-01	1.45E-02	No COPC	No COPC	5.89E-02	6.24E-03	1.79E-01	3.64E-03	No COPC	No COPC
BENZENE	NC	NC	7.69E-06	NC	No COPC	No COPC	NC	NC	7.69E-07	NC	No COPC	No COPC
CHLOROBENZENE	NC	NC	8.82E-02	NC	NC (a)	NC (a)	NC	NC	8.82E-03	NC	NC (a)	NC (a)
O-XYLENE	1.39E-04	1.46E-05	3.53E-03	1.33E-04	No COPC	No COPC	1.39E-05	1.46E-06	2.85E-03	1.33E-05	No COPC	No COPC
XYLENE (TOTAL)	1.77E-04	1.86E-05	4.51E-03	1.70E-04	No COPC	No COPC	1.77E-05	1.86E-06	3.64E-03	1.70E-05	No COPC	No COPC
1,3-DICHLOROBENZENE	NC	NC	4.75E-04	NC	No COPC	No COPC	NC	NC	4.75E-05	NC	No COPC	No COPC
1,4-DICHLOROBENZENE	NC	NC	1.11E-02	NC	NC (a)	NC (a)	NC	NC	1.11E-03	NC	NC (a)	NC (a)

Notes:
COPC - Constituent of Potential Concern.
EPC - Exposure Point Concentration.
HQ - Hazard Quotient (Dose/TRV).
LOAEL - Lowest Observed Adverse Effects Level.
NC - Not Calculated. Avian TRV not available for this COPC.
NOAEL - No Observed Adverse Effects Level.
No COPC - Not identified as a COPC in the Adjacent Nearshore Area.
TRV - Toxicity Reference Value.

HQs above 1 are bolded and highlighted.
Nearshore Data Only - Refers to only sediment samples located within the "adjacent nearshore" area at water depths less than 1m.
(a) Refined EPCs were not calculated for thallium, vanadium, chlorobenzene, and 1,4-dichlorobenzene for the Adjacent Nearshore Area due to an insufficient number of samples available (i.e., less than six detected samples and ten samples total).

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Appendix A Table 5-1
Evaluation of BSAFs Selected For Barium and Copper
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

COPC	Source	Sediment-to-Fish Uptake Factor [(mg COPC/Kg $fish_{dw}$)/ (mg COPC/Kg $sediment_{dw}$)]			All Site Data Included: Sediment 95% UCL EPC (mg/Kg_{dw})	Estimated 95% UCL Maximum Fish Tissue Concentration (a) (mg/Kg_{dw})			Maximum Sediment EPC (mg/Kg_{dw})	Estimated Maximum Fish Tissue Concentration (a) (mg/Kg_{dw})		
		Mininum	Median	Maximum		Mininum	Median	Maximum		Mininum	Median	Maximum
Barium	(a)	0.01	0.03	0.08	2219	22.2	66.6	178	15300	153.0	459	1224
Copper	(b)	0.03	0.06	0.11	171	5.8	9.5	18.8	893	30.3	49.5	98.2

COPC	Source	Sediment-to-Invertebrate Uptake Factor [(mg COPC/Kg $invertebrate_{dw}$)/ (mg COPC/Kg $sediment_{dw}$)]		All Site Data Included: Sediment 95% UCL EPC (mg/Kg_{dw})	Estimated 95% UCL Maximum Benthic Invertebrate Tissue Concentration (a) (mg/Kg_{dw})		Maximum Sediment EPC (mg/Kg_{dw})	Estimated Maximum Benthic Invertebrate Tissue Concentration (a) (mg/Kg_{dw})	
		Regression	90th Percentile		Regression	90th Percentile		Regression	90th Percentile
Copper	(c)	log(tissue concentration) = 0.359 * log(sediment concentration) + 1.037	7.957	171	68.9	1357	893	125	7106

Notes:
95% UCL - 95% Upper Confidence Limit of the mean.
BSAF - Biota-Sediment Accumulation Factor.
COPC - Constituent of Potential Concern.
dw - Dry Weight.
EPC - Exposure Point Concentration.
(a) Uptake factors calculated based on sediment and fish tissue concentrations from nine streams in the Blackfoot River watershed reported by Hamilton and Buhl (2003). The highest BSAF calculated from the results presented was used.
(b) Uptake factors calculated based on sediment and fish tissue concentrations presented in Krantzberg and Boyd (1992). The highest BSAF calculated from the results presented was used.
(c) Regression equations for benthic invertebrates obtained from Bechtel Jacobs (1998). Regression equation with highest R^2 value selected from Table 3 of Bechtel and Jacobs (1998). The highest 90th percentile of the three datasets (all, non-depurated, and depurated) was selected from Table 2.

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Appendix A Table 7-1
References Cited In Fish and Wildlife Food Chain Models
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

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Figures

Map Location

N
W E
S

Site Location
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

0 250 500 1,000 Feet

- Outfall Pipe
- BASF Property Boundary
- Adjacent Offshore Sediment
- Adjacent Nearshore Sediment

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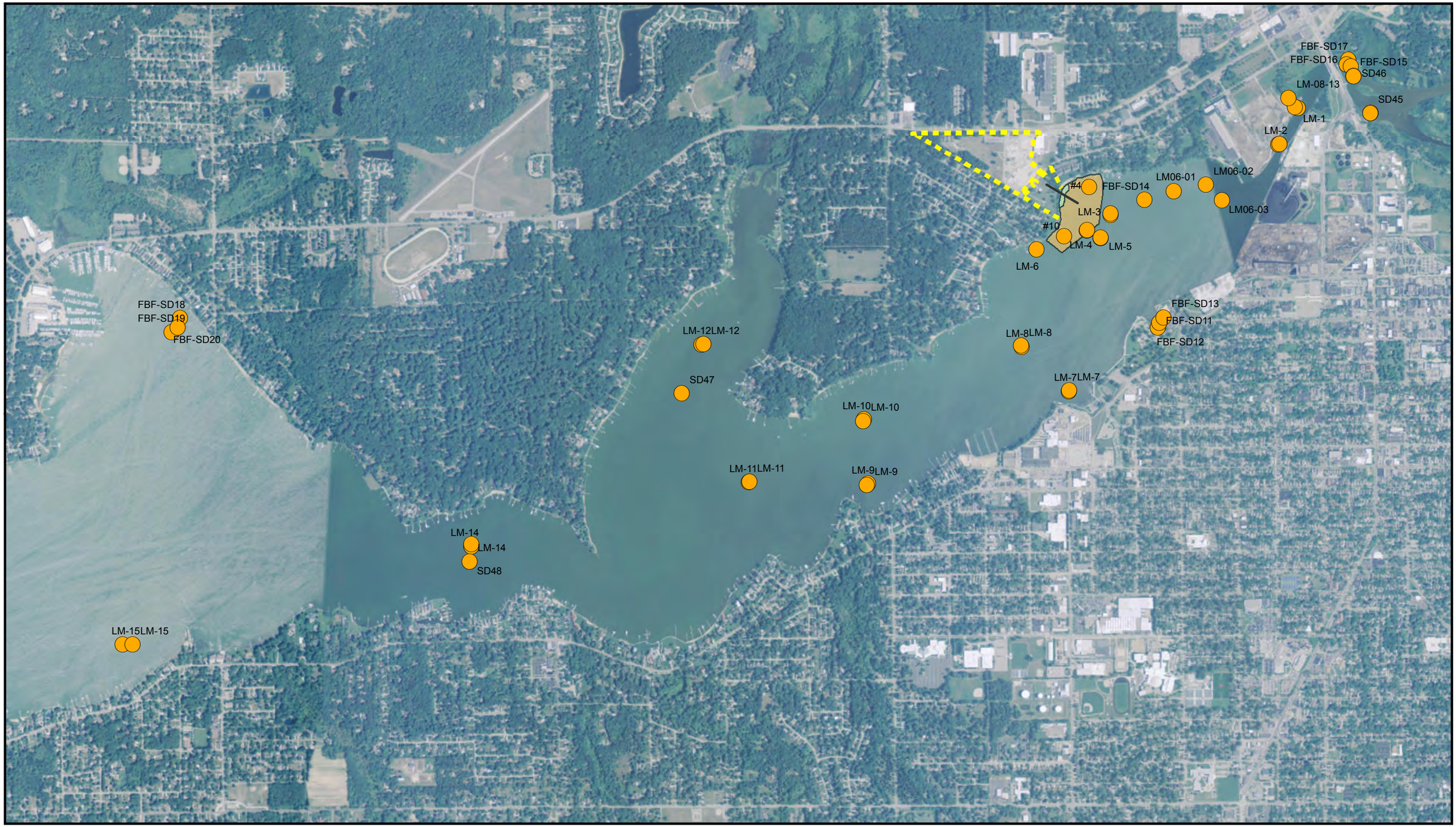
Project # 60217278
October 2015

Appendix A
Figure 2-1

P:\Projects\Jobs\Indl_Service\Project Files\BASF-0760\Holland 0760-044\2011 Field Program\Sediment_Figures\GIS\BERA_2015_Figure1-1_SiteLocation.mxd



Map Location

N
W E
S

Background and Reference Sediment Sampling Locations
Lake Macatawa Sediment Baseline Ecological Risk Assessment
and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

0 1,250 2,500 5,000 Feet

- Reference and Background Locations
- Outfall Pipe
- BASF Property Boundary
- Adjacent Offshore Sediment
- Adjacent Nearshore Sediment

AECOM

Project # 60217278
November 2015

Appendix A
Figure 2-2

C:\Users\sylvesterk\Desktop\BERA_2015_Figure3-2_REFSamplingLocs.mxd

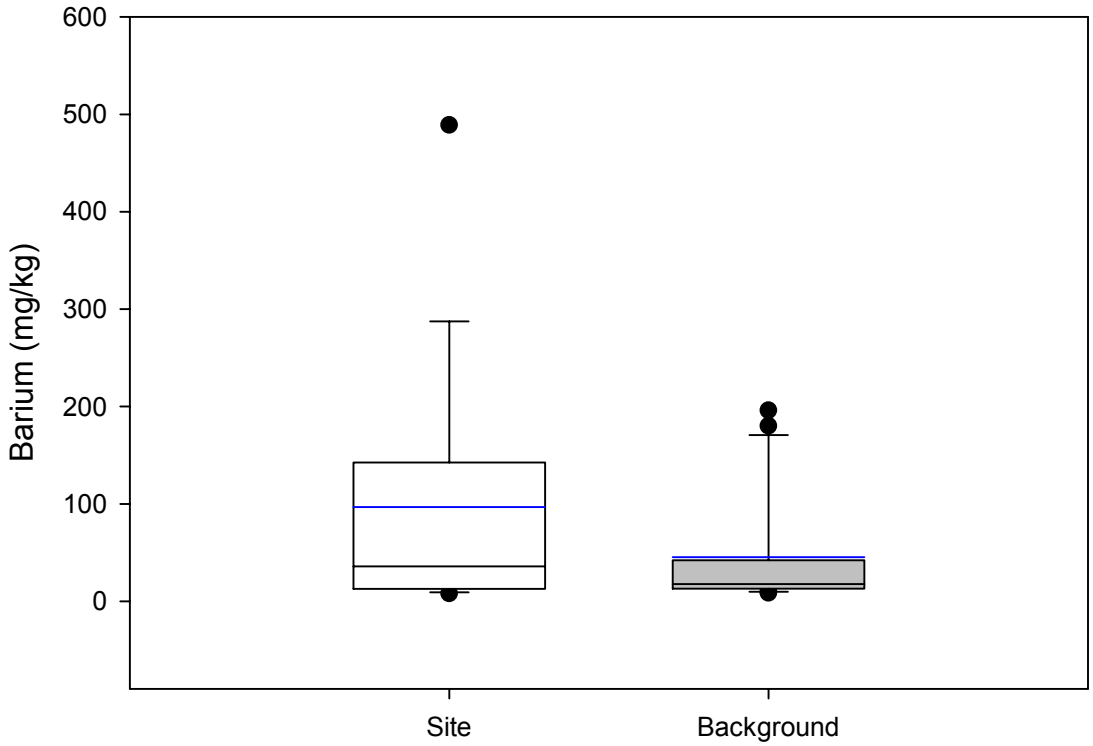
Attachment A

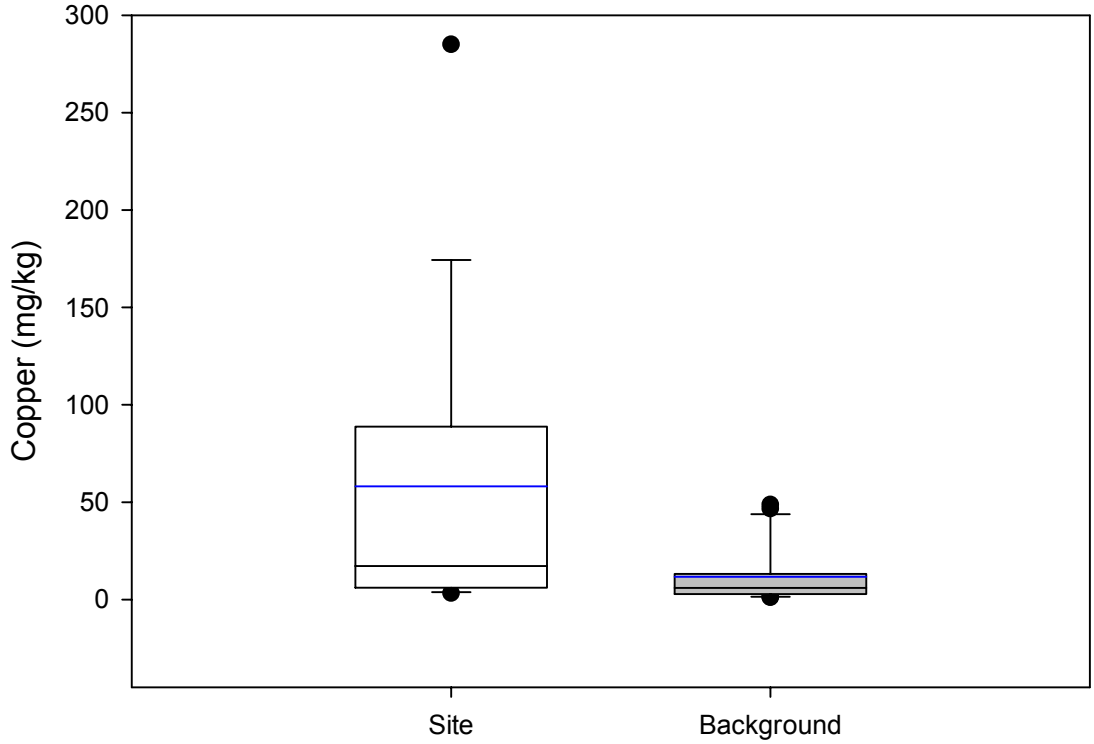
Boxplot Comparisons of Site and Background Sediment Chemistry

February 2015

AECOM

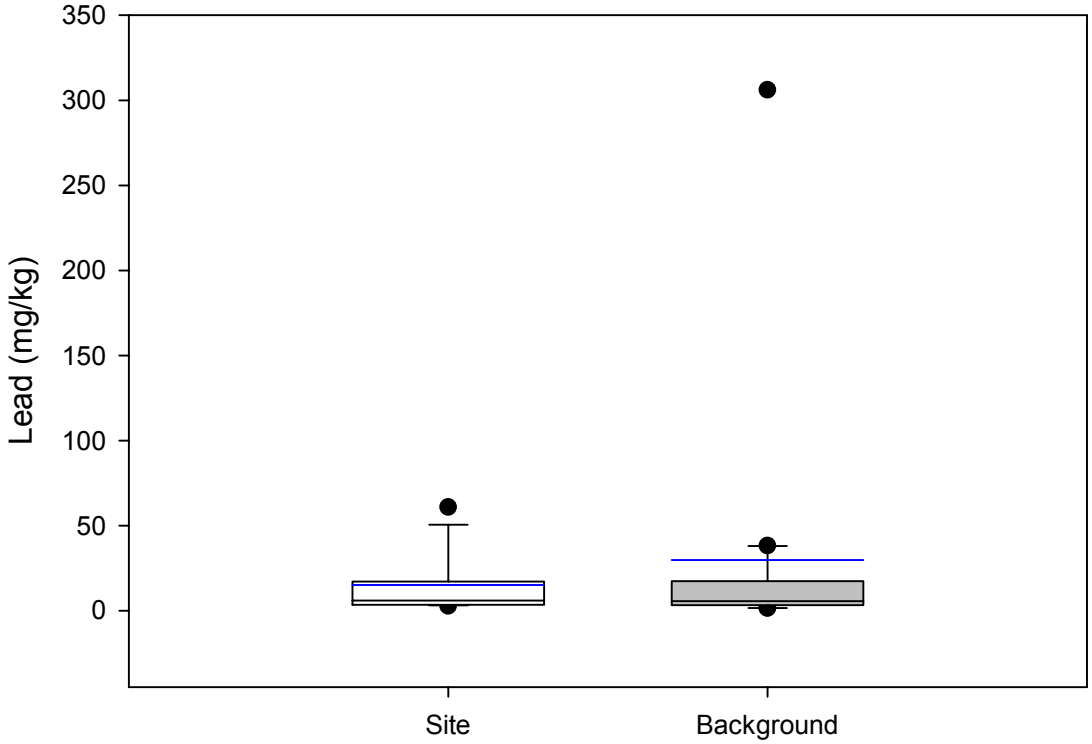
Comparisons of sediment collected in the Adjacent Nearshore portion of the Site with background data.

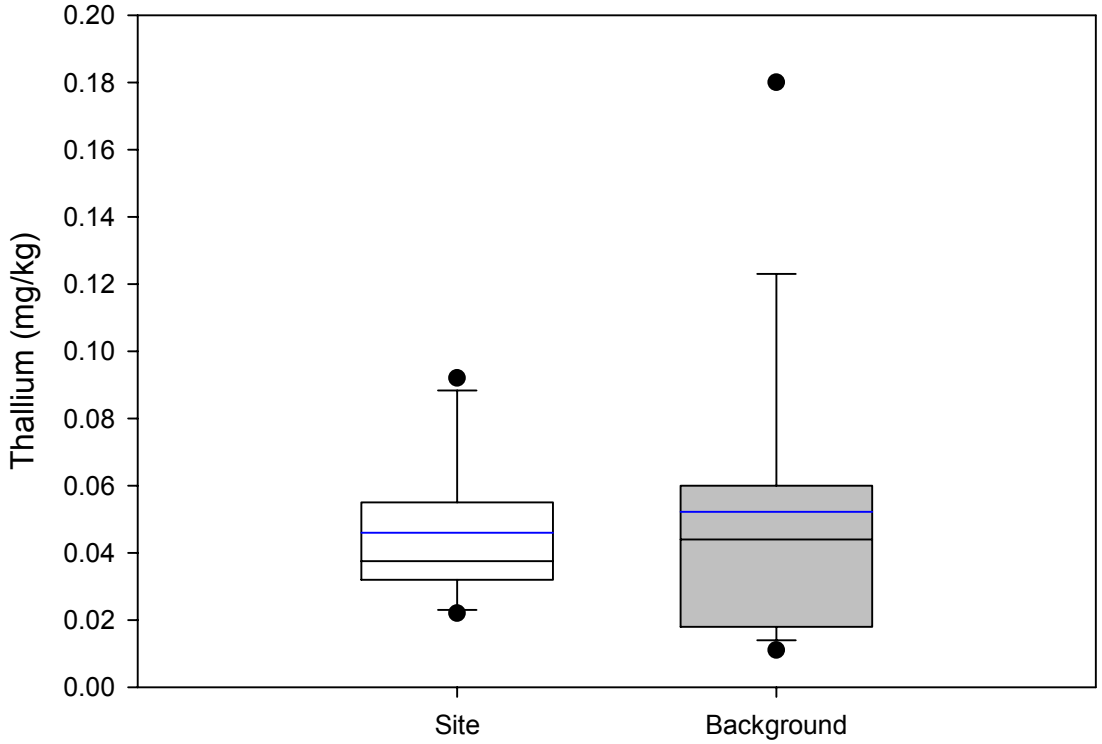




Non-detected concentrations are included as the value of the detection limit.

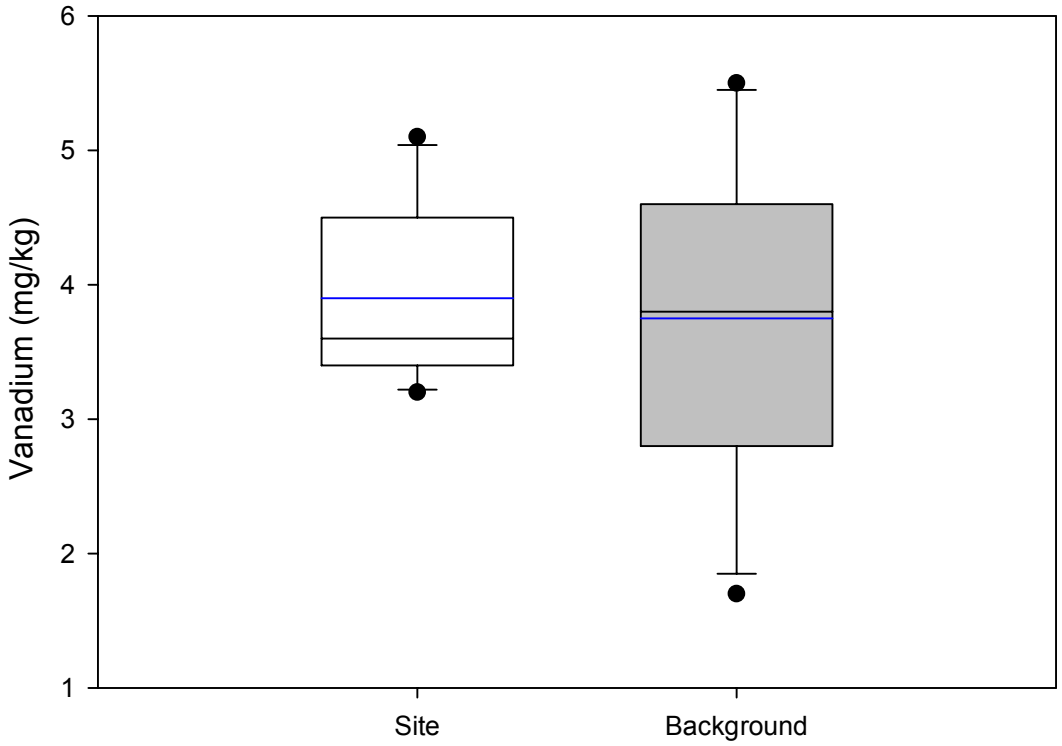
Comparisons of sediment collected in the Adjacent Nearshore portion of the Site with background data.

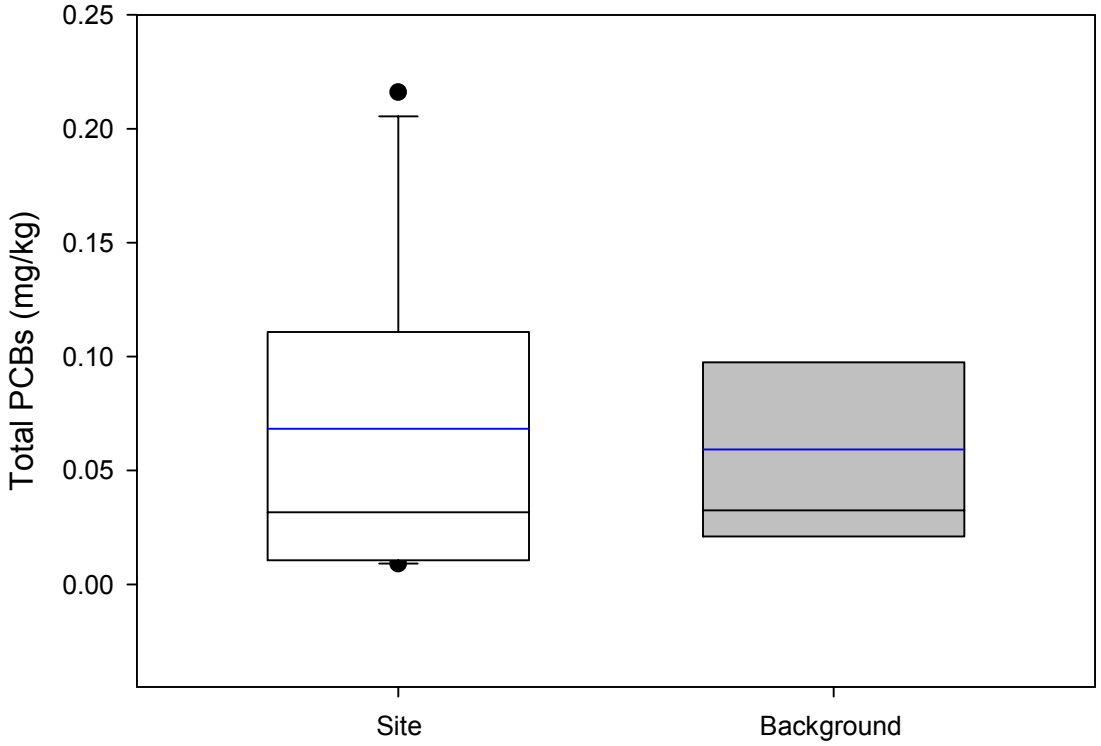




Non-detected concentrations are included as the value of the detection limit.

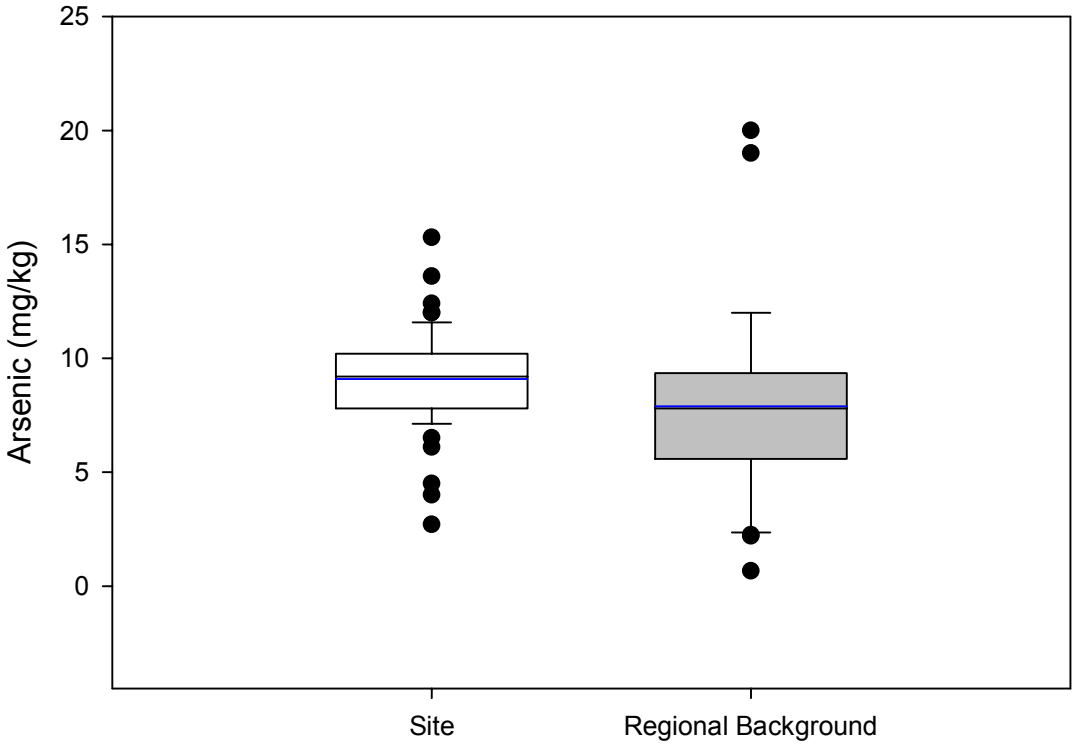
Comparisons of sediment collected in the Adjacent Nearshore portion of the Site with background data.

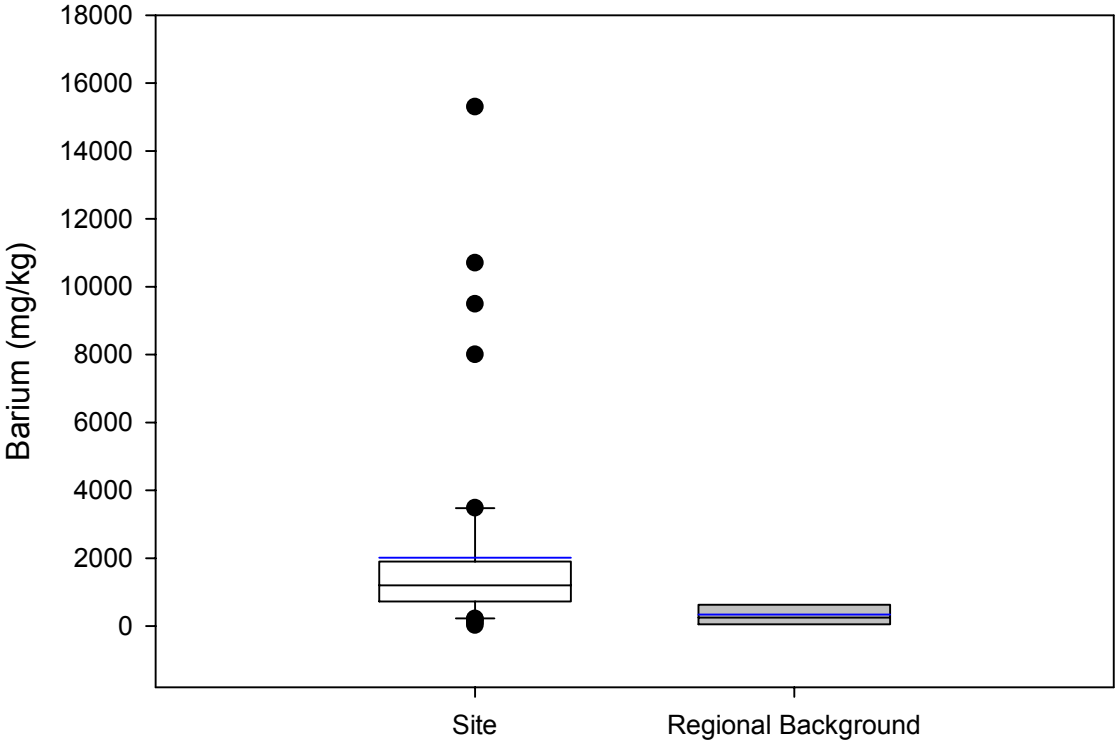




Non-detected concentrations are included as the value of the detection limit.

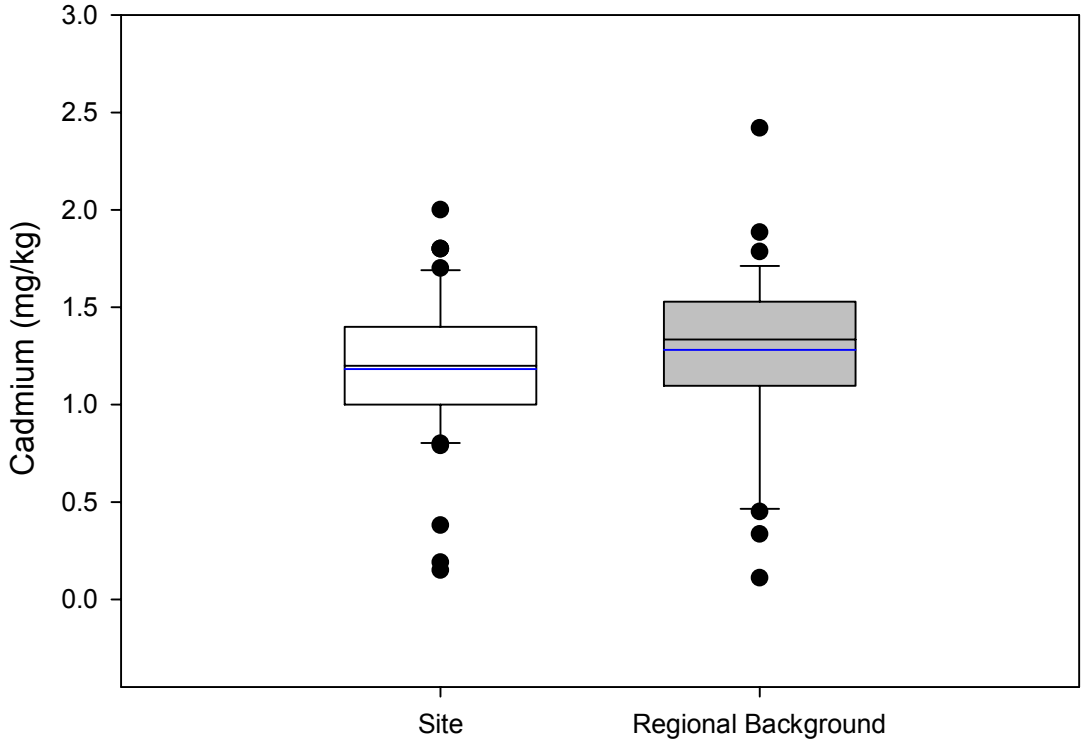
Comparisons of sediment collected in the Adjacent Offshore portion of the Site with regional background data.

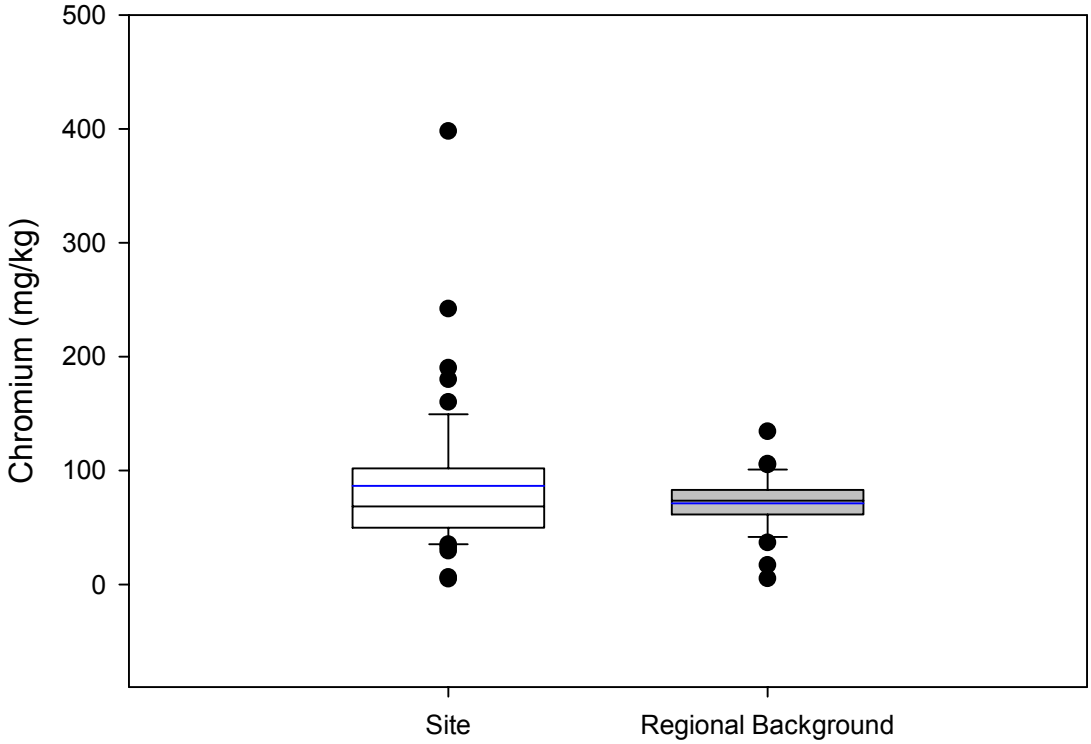




Non-detected concentrations are included as the value of the detection limit.

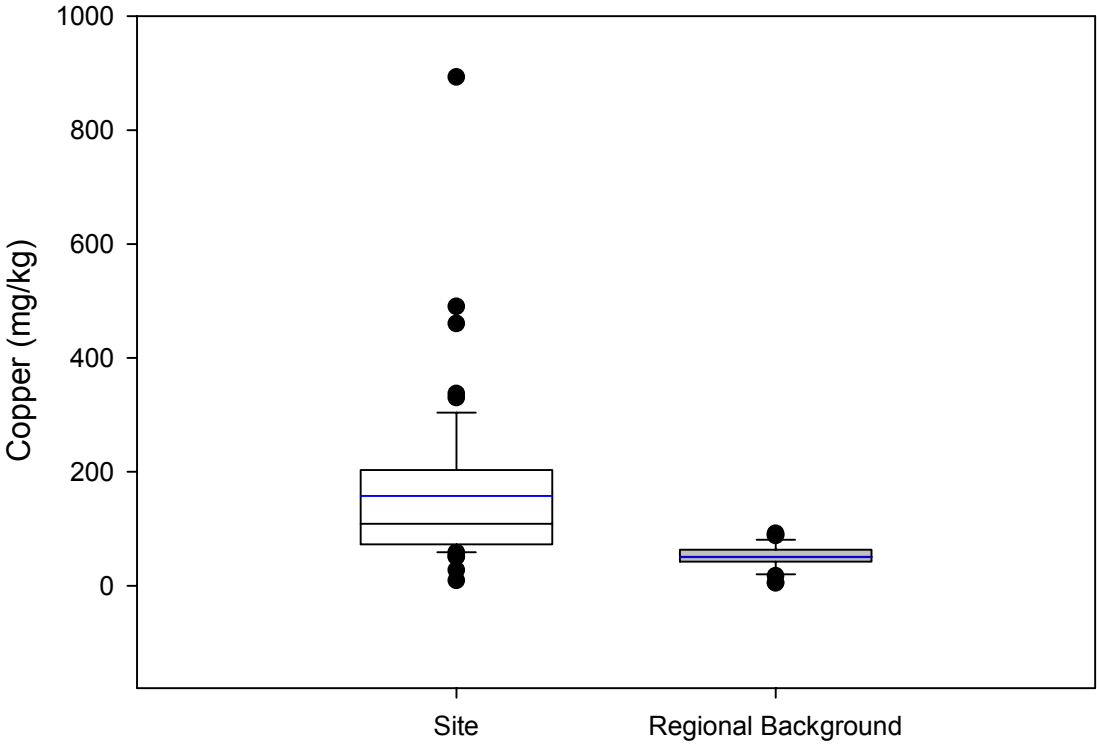
Comparisons of sediment collected in the Adjacent Offshore portion of the Site with regional background data.

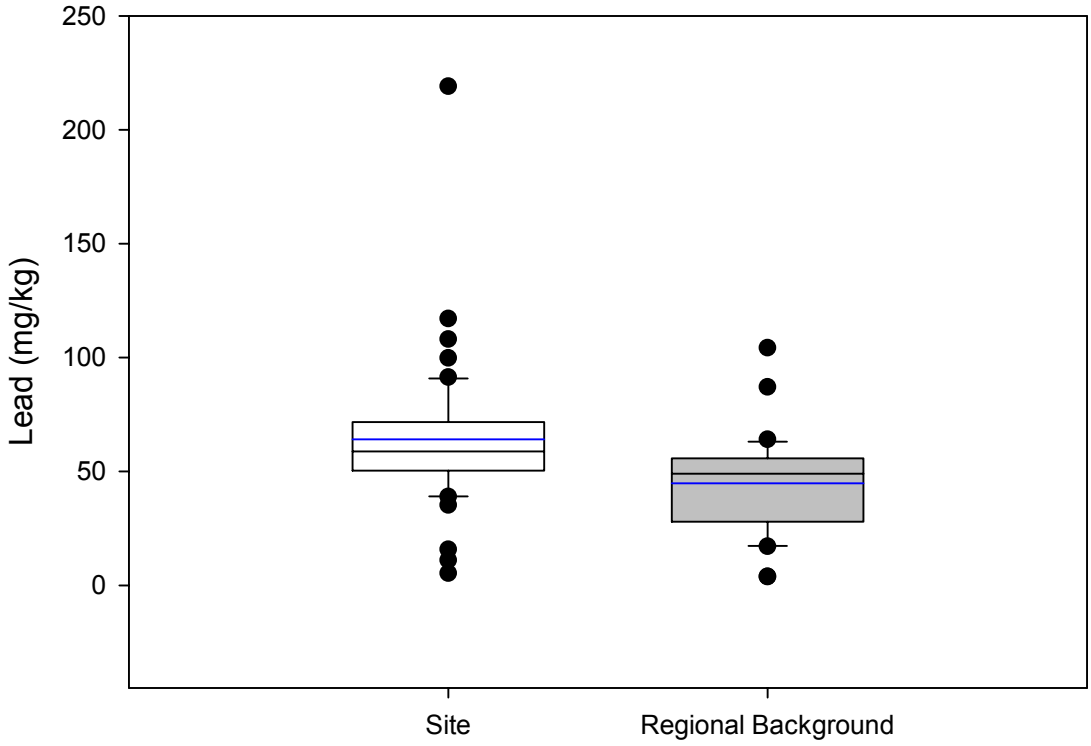




Non-detected concentrations are included as the value of the detection limit.

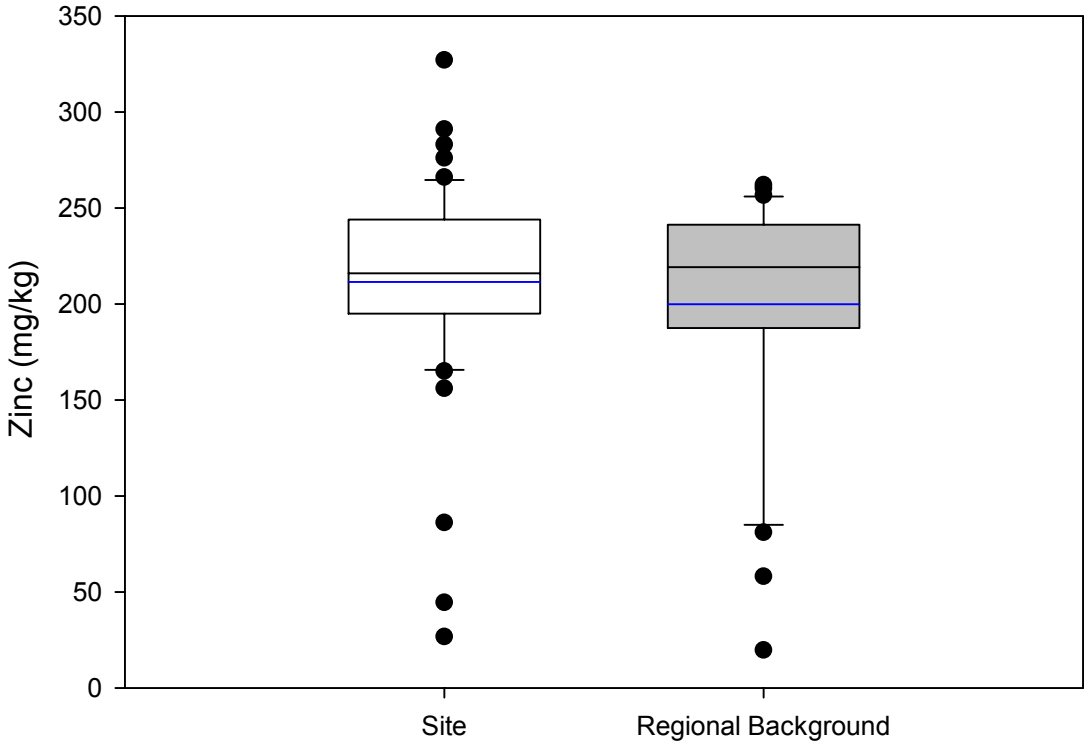
Comparisons of sediment collected in the Adjacent Offshore portion of the Site with regional background data.

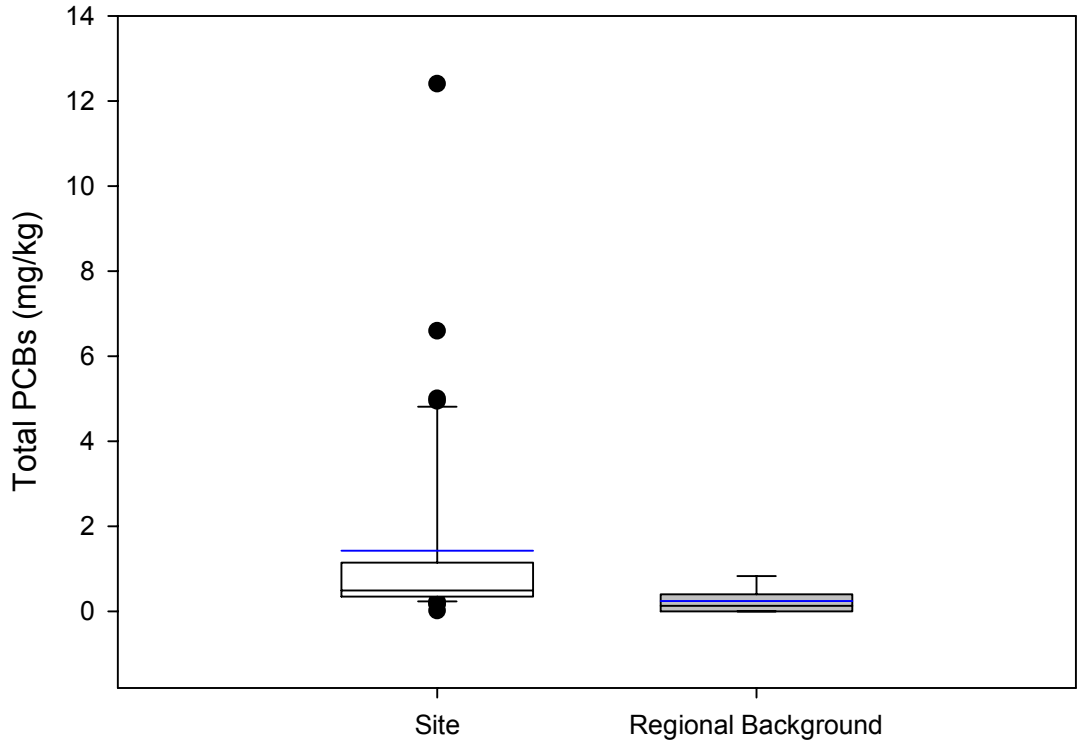




Non-detected concentrations are included as the value of the detection limit.

Comparisons of sediment collected in the Adjacent Offshore portion of the Site with regional background data.





Non-detected concentrations are included as the value of the detection limit.

Attachment B

ProUCL Output

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	9/25/2015 2:17:05 PM
From File	Input_Allsite_092515.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

ARSENIC

General Statistics

Total Number of Observations	64	Number of Distinct Observations	48
		Number of Missing Observations	0
Minimum	0.88	Mean	7.97
Maximum	15.3	Median	8.55
SD	3.202	Std. Error of Mean	0.4
Coefficient of Variation	0.402	Skewness	-0.593

Normal GOF Test

Shapiro Wilk Test Statistic	0.927	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	9.2763E-4	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.179	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.111	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	8.638	95% Adjusted-CLT UCL (Chen-1995)	8.597
		95% Modified-t UCL (Johnson-1978)	8.633

Gamma GOF Test

A-D Test Statistic	4.312	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.755	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.261	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.112	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.881	k star (bias corrected MLE)	3.71
Theta hat (MLE)	2.053	Theta star (bias corrected MLE)	2.148
nu hat (MLE)	496.8	nu star (bias corrected)	474.9
MLE Mean (bias corrected)	7.97	MLE Sd (bias corrected)	4.138
		Approximate Chi Square Value (0.05)	425.3
Adjusted Level of Significance	0.0463	Adjusted Chi Square Value	424.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	8.898	95% Adjusted Gamma UCL (use when n<50)	8.921

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.781	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	1.151E-12	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.289	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.111	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.128	Mean of logged Data	1.941
Maximum of Logged Data	2.728	SD of logged Data	0.611

Assuming Lognormal Distribution

95% H-UCL	9.751	90% Chebyshev (MVUE) UCL	10.43
95% Chebyshev (MVUE) UCL	11.37	97.5% Chebyshev (MVUE) UCL	12.67
99% Chebyshev (MVUE) UCL	15.22		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	8.628	95% Jackknife UCL	8.638
95% Standard Bootstrap UCL	8.638	95% Bootstrap-t UCL	8.592
95% Hall's Bootstrap UCL	8.598	95% Percentile Bootstrap UCL	8.643
95% BCA Bootstrap UCL	8.625		
90% Chebyshev(Mean, Sd) UCL	9.171	95% Chebyshev(Mean, Sd) UCL	9.715
97.5% Chebyshev(Mean, Sd) UCL	10.47	99% Chebyshev(Mean, Sd) UCL	11.95

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	9.715

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be
reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

BARIUM

General Statistics

Total Number of Observations	64	Number of Distinct Observations	61
		Number of Missing Observations	0
Minimum	7.8	Mean	1658
Maximum	15300	Median	1055
SD	2652	Std. Error of Mean	331.5
Coefficient of Variation	1.599	Skewness	3.47

Normal GOF Test

Shapiro Wilk Test Statistic	0.578	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.283	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.111	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2212	95% Adjusted-CLT UCL (Chen-1995)	2357
		95% Modified-t UCL (Johnson-1978)	2235

Gamma GOF Test

A-D Test Statistic	0.962	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.806	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.115	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.117	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.603	k star (bias corrected MLE)	0.585
Theta hat (MLE)	2751	Theta star (bias corrected MLE)	2834
nu hat (MLE)	77.16	nu star (bias corrected)	74.88
MLE Mean (bias corrected)	1658	MLE Sd (bias corrected)	2168
		Approximate Chi Square Value (0.05)	55.95
Adjusted Level of Significance	0.0463	Adjusted Chi Square Value	55.57

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	2219	95% Adjusted Gamma UCL (use when n<50)	2234

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.915	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	1.6188E-4	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.175	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.111	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.054	Mean of logged Data	6.389
Maximum of Logged Data	9.636	SD of logged Data	1.749

Assuming Lognormal Distribution

95% H-UCL	5042	90% Chebyshev (MVUE) UCL	5041
95% Chebyshev (MVUE) UCL	6148	97.5% Chebyshev (MVUE) UCL	7683
99% Chebyshev (MVUE) UCL	10700		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2203	95% Jackknife UCL	2212
95% Standard Bootstrap UCL	2208	95% Bootstrap-t UCL	2568
95% Hall's Bootstrap UCL	2500	95% Percentile Bootstrap UCL	2243
95% BCA Bootstrap UCL	2368		
90% Chebyshev(Mean, Sd) UCL	2653	95% Chebyshev(Mean, Sd) UCL	3103
97.5% Chebyshev(Mean, Sd) UCL	3728	99% Chebyshev(Mean, Sd) UCL	4956

Suggested UCL to Use

95% Approximate Gamma UCL	2219

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

CADMIUM

General Statistics

Total Number of Observations	58	Number of Distinct Observations	35
		Number of Missing Observations	6
Minimum	0.054	Mean	0.973
Maximum	2	Median	1.1
SD	0.538	Std. Error of Mean	0.0707
Coefficient of Variation	0.553	Skewness	-0.413

Normal GOF Test

Shapiro Wilk Test Statistic	0.906	Shapiro Wilk GOF Test
5% Shapiro Wilk P Value	1.2326E-4	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.153	Lilliefors GOF Test
5% Lilliefors Critical Value	0.116	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.091	95% Adjusted-CLT UCL (Chen-1995)	1.085
		95% Modified-t UCL (Johnson-1978)	1.09

Gamma GOF Test

A-D Test Statistic	4.659	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.767	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.256	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.119	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.677	k star (bias corrected MLE)	1.601
Theta hat (MLE)	0.58	Theta star (bias corrected MLE)	0.607
nu hat (MLE)	194.5	nu star (bias corrected)	185.8
MLE Mean (bias corrected)	0.973	MLE Sd (bias corrected)	0.769
		Approximate Chi Square Value (0.05)	155.2
Adjusted Level of Significance	0.0459	Adjusted Chi Square Value	154.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.164	95% Adjusted Gamma UCL (use when n<50)	1.169

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.756	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk P Value	1.910E-12	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.288	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.116	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.919	Mean of logged Data	-0.355
Maximum of Logged Data	0.693	SD of logged Data	1.018

Assuming Lognormal Distribution

95% H-UCL	1.621	90% Chebyshev (MVUE) UCL	1.716
95% Chebyshev (MVUE) UCL	1.966	97.5% Chebyshev (MVUE) UCL	2.314
99% Chebyshev (MVUE) UCL	2.998		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	1.089	95% Jackknife UCL	1.091
95% Standard Bootstrap UCL	1.086	95% Bootstrap-t UCL	1.087
95% Hall's Bootstrap UCL	1.089	95% Percentile Bootstrap UCL	1.085
95% BCA Bootstrap UCL	1.095		
90% Chebyshev(Mean, Sd) UCL	1.185	95% Chebyshev(Mean, Sd) UCL	1.281
97.5% Chebyshev(Mean, Sd) UCL	1.414	99% Chebyshev(Mean, Sd) UCL	1.676

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	1.281

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

CHROMIUM

General Statistics

Total Number of Observations	64	Number of Distinct Observations	62
		Number of Missing Observations	0
Minimum	2.7	Mean	71.85
Maximum	398	Median	56.5
SD	65.83	Std. Error of Mean	8.228
Coefficient of Variation	0.916	Skewness	2.349

Normal GOF Test

Shapiro Wilk Test Statistic	0.816	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.252E-10	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.147	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.111	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	85.59	95% Adjusted-CLT UCL (Chen-1995)	87.97
		95% Modified-t UCL (Johnson-1978)	85.99

Gamma GOF Test

A-D Test Statistic	0.977	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.776	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.119	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.114	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.166	k star (bias corrected MLE)	1.122
Theta hat (MLE)	61.62	Theta star (bias corrected MLE)	64.05
nu hat (MLE)	149.3	nu star (bias corrected)	143.6
MLE Mean (bias corrected)	71.85	MLE Sd (bias corrected)	67.84
		Approximate Chi Square Value (0.05)	116.9
Adjusted Level of Significance	0.0463	Adjusted Chi Square Value	116.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	88.26	95% Adjusted Gamma UCL (use when n<50)	88.68

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.891	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	5.0951E-6	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.183	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.111	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.993	Mean of logged Data	3.788
Maximum of Logged Data	5.986	SD of logged Data	1.176

Assuming Lognormal Distribution

95% H-UCL	123.1	90% Chebyshev (MVUE) UCL	134.1
95% Chebyshev (MVUE) UCL	155.7	97.5% Chebyshev (MVUE) UCL	185.5
99% Chebyshev (MVUE) UCL	244.2		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	85.39	95% Jackknife UCL	85.59
95% Standard Bootstrap UCL	85.39	95% Bootstrap-t UCL	89.75
95% Hall's Bootstrap UCL	92.06	95% Percentile Bootstrap UCL	86.88
95% BCA Bootstrap UCL	88.81		
90% Chebyshev(Mean, Sd) UCL	96.54	95% Chebyshev(Mean, Sd) UCL	107.7
97.5% Chebyshev(Mean, Sd) UCL	123.2	99% Chebyshev(Mean, Sd) UCL	153.7

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	107.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

COPPER

General Statistics

Total Number of Observations	64	Number of Distinct Observations	63
		Number of Missing Observations	0
Minimum	3.3	Mean	139
Maximum	893	Median	97.75
SD	141.6	Std. Error of Mean	17.69
Coefficient of Variation	1.018	Skewness	2.93

Normal GOF Test

Shapiro Wilk Test Statistic	0.746	Shapiro Wilk GOF Test
5% Shapiro Wilk P Value	1.144E-14	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.194	Lilliefors GOF Test
5% Lilliefors Critical Value	0.111	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	168.6	95% Adjusted-CLT UCL (Chen-1995)	175.1
		95% Modified-t UCL (Johnson-1978)	169.6

Gamma GOF Test

A-D Test Statistic	0.747	Anderson-Darling Gamma GOF Test
5% A-D Critical Value	0.776	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.121	Kolmogrov-Smirnoff Gamma GOF Test
5% K-S Critical Value	0.114	Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.183	k star (bias corrected MLE)	1.138
Theta hat (MLE)	117.5	Theta star (bias corrected MLE)	122.1
nu hat (MLE)	151.5	nu star (bias corrected)	145.7
MLE Mean (bias corrected)	139	MLE Sd (bias corrected)	130.3
		Approximate Chi Square Value (0.05)	118.8
Adjusted Level of Significance	0.0463	Adjusted Chi Square Value	118.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	170.5	95% Adjusted Gamma UCL (use when n<50)	171.3

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.91	Shapiro Wilk Lognormal GOF Test
5% Shapiro Wilk P Value	8.2783E-5	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.179	Lilliefors Lognormal GOF Test
5% Lilliefors Critical Value	0.111	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.194	Mean of logged Data	4.456
Maximum of Logged Data	6.795	SD of logged Data	1.142

Assuming Lognormal Distribution

95% H-UCL	229.1	90% Chebyshev (MVUE) UCL	248.6
95% Chebyshev (MVUE) UCL	287.5	97.5% Chebyshev (MVUE) UCL	341.5
99% Chebyshev (MVUE) UCL	447.5		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	168.1	95% Jackknife UCL	168.6
95% Standard Bootstrap UCL	168.2	95% Bootstrap-t UCL	178.4
95% Hall's Bootstrap UCL	193.6	95% Percentile Bootstrap UCL	169.8
95% BCA Bootstrap UCL	177.8		
90% Chebyshev(Mean, Sd) UCL	192.1	95% Chebyshev(Mean, Sd) UCL	216.1
97.5% Chebyshev(Mean, Sd) UCL	249.5	99% Chebyshev(Mean, Sd) UCL	315.1

Suggested UCL to Use

95% Approximate Gamma UCL	170.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

LEAD

General Statistics

Total Number of Observations	58	Number of Distinct Observations	58
		Number of Missing Observations	6
Minimum	2.7	Mean	53.94
Maximum	219	Median	55.85
SD	35.86	Std. Error of Mean	4.709
Coefficient of Variation	0.665	Skewness	1.536

Normal GOF Test

Shapiro Wilk Test Statistic	0.873	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.7908E-6	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.121	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.116	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	61.81	95% Adjusted-CLT UCL (Chen-1995)	62.7
		95% Modified-t UCL (Johnson-1978)	61.97

Gamma GOF Test

A-D Test Statistic	3.435	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.768	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.213	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.119	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.58	k star (bias corrected MLE)	1.51
Theta hat (MLE)	34.13	Theta star (bias corrected MLE)	35.72
nu hat (MLE)	183.3	nu star (bias corrected)	175.2
MLE Mean (bias corrected)	53.94	MLE Sd (bias corrected)	43.89
		Approximate Chi Square Value (0.05)	145.6
Adjusted Level of Significance	0.0459	Adjusted Chi Square Value	144.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	64.91	95% Adjusted Gamma UCL (use when n<50)	65.22

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.796	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	1.686E-10	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.267	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.116	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.993	Mean of logged Data	3.639
Maximum of Logged Data	5.389	SD of logged Data	1.04

Assuming Lognormal Distribution

95% H-UCL	90.99	90% Chebyshev (MVUE) UCL	96.01
95% Chebyshev (MVUE) UCL	110.3	97.5% Chebyshev (MVUE) UCL	130.1
99% Chebyshev (MVUE) UCL	169.1		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	61.68	95% Jackknife UCL	61.81
95% Standard Bootstrap UCL	61.58	95% Bootstrap-t UCL	63.11
95% Hall's Bootstrap UCL	64.49	95% Percentile Bootstrap UCL	61.87
95% BCA Bootstrap UCL	63.21		
90% Chebyshev(Mean, Sd) UCL	68.06	95% Chebyshev(Mean, Sd) UCL	74.46
97.5% Chebyshev(Mean, Sd) UCL	83.34	99% Chebyshev(Mean, Sd) UCL	100.8

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	74.46

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

ZINC

General Statistics

Total Number of Observations	64	Number of Distinct Observations	59
		Number of Missing Observations	0
Minimum	13.9	Mean	179.6
Maximum	327	Median	205.5
SD	83.45	Std. Error of Mean	10.43
Coefficient of Variation	0.465	Skewness	-0.856

Normal GOF Test

Shapiro Wilk Test Statistic	0.855	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	2.6849E-8	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.198	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.111	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	197	95% Adjusted-CLT UCL (Chen-1995)	195.5
		95% Modified-t UCL (Johnson-1978)	196.8

Gamma GOF Test

A-D Test Statistic	6.864	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.761	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.287	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.113	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.335	k star (bias corrected MLE)	2.236
Theta hat (MLE)	76.91	Theta star (bias corrected MLE)	80.31
nu hat (MLE)	298.9	nu star (bias corrected)	286.2
MLE Mean (bias corrected)	179.6	MLE Sd (bias corrected)	120.1
		Approximate Chi Square Value (0.05)	248
Adjusted Level of Significance	0.0463	Adjusted Chi Square Value	247.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	207.2	95% Adjusted Gamma UCL (use when n<50)	207.9

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.709	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	1.110E-16	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.318	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.111	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.632	Mean of logged Data	4.961
Maximum of Logged Data	5.79	SD of logged Data	0.842

Assuming Lognormal Distribution

95% H-UCL	255.1	90% Chebyshev (MVUE) UCL	274.6
95% Chebyshev (MVUE) UCL	307.4	97.5% Chebyshev (MVUE) UCL	353
99% Chebyshev (MVUE) UCL	442.6		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	196.7	95% Jackknife UCL	197
95% Standard Bootstrap UCL	196.3	95% Bootstrap-t UCL	195.3
95% Hall's Bootstrap UCL	195.4	95% Percentile Bootstrap UCL	196.4
95% BCA Bootstrap UCL	196.7		
90% Chebyshev(Mean, Sd) UCL	210.9	95% Chebyshev(Mean, Sd) UCL	225
97.5% Chebyshev(Mean, Sd) UCL	244.7	99% Chebyshev(Mean, Sd) UCL	283.4

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 225

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	9/25/2015 2:19:56 PM
From File	Input_Allsite_092515.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzene

General Statistics

Total Number of Observations	45	Number of Distinct Observations	27
		Number of Missing Observations	19
Number of Detects	4	Number of Non-Detects	41
Number of Distinct Detects	4	Number of Distinct Non-Detects	25
Minimum Detect	0.0041	Minimum Non-Detect	0.0062
Maximum Detect	0.29	Maximum Non-Detect	0.32
Variance Detects	0.019	Percent Non-Detects	91.11%
Mean Detects	0.135	SD Detects	0.138
Median Detects	0.122	CV Detects	1.025
Skewness Detects	0.243	Kurtosis Detects	-4.185
Mean of Logged Detects	-2.919	SD of Logged Detects	1.96

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.896	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.267	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.443	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.0169	Standard Error of Mean	0.00949
SD	0.0531	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.0329	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.0325	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.0454	95% KM Chebyshev UCL	0.0583
97.5% KM Chebyshev UCL	0.0762	99% KM Chebyshev UCL	0.111

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.325	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.674	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.286	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.407	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.666	k star (bias corrected MLE)	0.333
Theta hat (MLE)	0.202	Theta star (bias corrected MLE)	0.404
nu hat (MLE)	5.331	nu star (bias corrected)	2.666
MLE Mean (bias corrected)	0.135	MLE Sd (bias corrected)	0.233

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.102	nu hat (KM)	9.184
Approximate Chi Square Value (9.18, α)	3.438	Adjusted Chi Square Value (9.18, β)	3.322
95% Gamma Approximate KM-UCL (use when n>=50)	0.0453	95% Gamma Adjusted KM-UCL (use when n<50)	0.0468

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0041	Mean	0.0223
Maximum	0.29	Median	0.01
SD	0.0508	CV	2.281
k hat (MLE)	0.984	k star (bias corrected MLE)	0.934
Theta hat (MLE)	0.0226	Theta star (bias corrected MLE)	0.0239
nu hat (MLE)	88.59	nu star (bias corrected)	84.02
MLE Mean (bias corrected)	0.0223	MLE Sd (bias corrected)	0.023
		Adjusted Level of Significance (β)	0.0447
Approximate Chi Square Value (84.02, α)	63.89	Adjusted Chi Square Value (84.02, β)	63.31
95% Gamma Approximate UCL (use when n>=50)	0.0293	95% Gamma Adjusted UCL (use when n<50)	N/A

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.906	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.256	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.443	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0164	Mean in Log Scale	-5.353
SD in Original Scale	0.052	SD in Log Scale	1.181
95% t UCL (assumes normality of ROS data)	0.0295	95% Percentile Bootstrap UCL	0.0309
95% BCA Bootstrap UCL	0.0371	95% Bootstrap t UCL	0.128
95% H-UCL (Log ROS)	0.0151		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-5.224	95% H-UCL (KM -Log)	0.0117
KM SD (logged)	0.946	95% Critical H Value (KM-Log)	2.312
KM Standard Error of Mean (logged)	0.176		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0523	Mean in Log Scale	-3.901
SD in Original Scale	0.0665	SD in Log Scale	1.452
95% t UCL (Assumes normality)	0.0689	95% H-Stat UCL	0.11

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0329	95% KM (Percentile Bootstrap) UCL	N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

CHLOROBENZENE

General Statistics

Total Number of Observations	54	Number of Distinct Observations	50
		Number of Missing Observations	10
Number of Detects	50	Number of Non-Detects	4
Number of Distinct Detects	47	Number of Distinct Non-Detects	4
Minimum Detect	0.0016	Minimum Non-Detect	0.005
Maximum Detect	320	Maximum Non-Detect	0.016
Variance Detects	2040	Percent Non-Detects	7.407%
Mean Detects	7.509	SD Detects	45.16
Median Detects	0.155	CV Detects	6.014
Skewness Detects	7.038	Kurtosis Detects	49.68
Mean of Logged Detects	-1.845	SD of Logged Detects	2.59

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.17	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.443	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.125	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	6.953	Standard Error of Mean	5.92
SD	43.07	95% KM (BCA) UCL	18.88
95% KM (t) UCL	16.86	95% KM (Percentile Bootstrap) UCL	18.7
95% KM (z) UCL	16.69	95% KM Bootstrap t UCL	166.8
90% KM Chebyshev UCL	24.71	95% KM Chebyshev UCL	32.76
97.5% KM Chebyshev UCL	43.92	99% KM Chebyshev UCL	65.86

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	5.833	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.92	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.266	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.139	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.192	k star (bias corrected MLE)	0.194
Theta hat (MLE)	39.14	Theta star (bias corrected MLE)	38.78
nu hat (MLE)	19.18	nu star (bias corrected)	19.37
MLE Mean (bias corrected)	7.509	MLE Sd (bias corrected)	17.06

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.0261	nu hat (KM)	2.815
Approximate Chi Square Value (2.82, α)	0.32	Adjusted Chi Square Value (2.82, β)	0.301
95% Gamma Approximate KM-UCL (use when n>=50)	61.2	95% Gamma Adjusted KM-UCL (use when n<50)	64.96

Gamma (KM) may not be used when k hat (KM) is < 0.1

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0016	Mean	6.954
Maximum	320	Median	0.125
SD	43.47	CV	6.251
k hat (MLE)	0.187	k star (bias corrected MLE)	0.188
Theta hat (MLE)	37.28	Theta star (bias corrected MLE)	36.89
nu hat (MLE)	20.14	nu star (bias corrected)	20.36
MLE Mean (bias corrected)	6.954	MLE Sd (bias corrected)	16.02
		Adjusted Level of Significance (β)	0.0456
Approximate Chi Square Value (20.36, α)	11.11	Adjusted Chi Square Value (20.36, β)	10.93
95% Gamma Approximate UCL (use when n>=50)	12.74	95% Gamma Adjusted UCL (use when n<50)	12.96

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.976	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0673	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.125	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	6.953	Mean in Log Scale	-2.13
SD in Original Scale	43.47	SD in Log Scale	2.69
95% t UCL (assumes normality of ROS data)	16.86	95% Percentile Bootstrap UCL	18.64
95% BCA Bootstrap UCL	25.33	95% Bootstrap t UCL	167.8
95% H-UCL (Log ROS)	25.57		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-2.136	95% H-UCL (KM -Log)	24.05
KM SD (logged)	2.676	95% Critical H Value (KM-Log)	4.725
KM Standard Error of Mean (logged)	0.368		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	6.953	Mean in Log Scale	-2.124
SD in Original Scale	43.47	SD in Log Scale	2.685
95% t UCL (Assumes normality)	16.86	95% H-Stat UCL	25.22

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

99% KM (Chebyshev) UCL	65.86

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

O-Xylene

General Statistics

Total Number of Observations	45	Number of Distinct Observations	33
		Number of Missing Observations	19
Number of Detects	11	Number of Non-Detects	34
Number of Distinct Detects	11	Number of Distinct Non-Detects	22
Minimum Detect	0.00115	Minimum Non-Detect	0.0062
Maximum Detect	0.66	Maximum Non-Detect	0.32
Variance Detects	0.0541	Percent Non-Detects	75.56%
Mean Detects	0.118	SD Detects	0.233
Median Detects	0.0042	CV Detects	1.974
Skewness Detects	1.981	Kurtosis Detects	2.665
Mean of Logged Detects	-4.468	SD of Logged Detects	2.339

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.574	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.379	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.267	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.0321	Standard Error of Mean	0.0189
SD	0.12	95% KM (BCA) UCL	0.0668
95% KM (t) UCL	0.0638	95% KM (Percentile Bootstrap) UCL	0.0656
95% KM (z) UCL	0.0632	95% KM Bootstrap t UCL	0.241
90% KM Chebyshev UCL	0.0888	95% KM Chebyshev UCL	0.114
97.5% KM Chebyshev UCL	0.15	99% KM Chebyshev UCL	0.22

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.215	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.822	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.34	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.276	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.297	k star (bias corrected MLE)	0.276
Theta hat (MLE)	0.397	Theta star (bias corrected MLE)	0.427
nu hat (MLE)	6.523	nu star (bias corrected)	6.078
MLE Mean (bias corrected)	0.118	MLE Sd (bias corrected)	0.224

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.0712	nu hat (KM)	6.409
Approximate Chi Square Value (6.41, α)	1.852	Adjusted Chi Square Value (6.41, β)	1.772
95% Gamma Approximate KM-UCL (use when n>=50)	0.111	95% Gamma Adjusted KM-UCL (use when n<50)	0.116

Gamma (KM) may not be used when k hat (KM) is < 0.1

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00115	Mean	0.0369
Maximum	0.66	Median	0.01
SD	0.12	CV	3.256
k hat (MLE)	0.512	k star (bias corrected MLE)	0.493
Theta hat (MLE)	0.0722	Theta star (bias corrected MLE)	0.075
nu hat (MLE)	46.07	nu star (bias corrected)	44.34
MLE Mean (bias corrected)	0.0369	MLE Sd (bias corrected)	0.0526
		Adjusted Level of Significance (β)	0.0447
Approximate Chi Square Value (44.34, α)	30.06	Adjusted Chi Square Value (44.34, β)	29.67
95% Gamma Approximate UCL (use when n>=50)	0.0545	95% Gamma Adjusted UCL (use when n<50)	0.0552

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.842	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.288	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.267	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.032	Mean in Log Scale	-5.405
SD in Original Scale	0.121	SD in Log Scale	1.389
95% t UCL (assumes normality of ROS data)	0.0624	95% Percentile Bootstrap UCL	0.0642
95% BCA Bootstrap UCL	0.0821	95% Bootstrap t UCL	0.295
95% H-UCL (Log ROS)	0.0214		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0666	Mean in Log Scale	-4.017
SD in Original Scale	0.124	SD in Log Scale	1.696
95% t UCL (Assumes normality)	0.0978	95% H-Stat UCL	0.175

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

99% KM (Chebyshev) UCL	0.22

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

XYLENES (TOTAL)

General Statistics

Total Number of Observations	49	Number of Distinct Observations	42
		Number of Missing Observations	15
Number of Detects	10	Number of Non-Detects	39
Number of Distinct Detects	10	Number of Distinct Non-Detects	34
Minimum Detect	0.002	Minimum Non-Detect	0.005
Maximum Detect	1	Maximum Non-Detect	0.64
Variance Detects	0.118	Percent Non-Detects	79.59%
Mean Detects	0.167	SD Detects	0.343
Median Detects	0.00905	CV Detects	2.048
Skewness Detects	2.124	Kurtosis Detects	3.779
Mean of Logged Detects	-3.999	SD of Logged Detects	2.18

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.564	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.45	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.28	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.0383	Standard Error of Mean	0.0244
SD	0.161	95% KM (BCA) UCL	0.079
95% KM (t) UCL	0.0792	95% KM (Percentile Bootstrap) UCL	0.078
95% KM (z) UCL	0.0784	95% KM Bootstrap t UCL	0.59
90% KM Chebyshev UCL	0.111	95% KM Chebyshev UCL	0.145
97.5% KM Chebyshev UCL	0.191	99% KM Chebyshev UCL	0.281

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.204	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.812	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.329	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.287	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.31	k star (bias corrected MLE)	0.284
Theta hat (MLE)	0.54	Theta star (bias corrected MLE)	0.59
nu hat (MLE)	6.201	nu star (bias corrected)	5.674
MLE Mean (bias corrected)	0.167	MLE Sd (bias corrected)	0.314

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.0563	nu hat (KM)	5.522
Approximate Chi Square Value (5.52, α)	1.4	Adjusted Chi Square Value (5.52, β)	1.339
95% Gamma Approximate KM-UCL (use when n>=50)	0.151	95% Gamma Adjusted KM-UCL (use when n<50)	0.158

Gamma (KM) may not be used when k hat (KM) is < 0.1

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.002	Mean	0.0421
Maximum	1	Median	0.01
SD	0.162	CV	3.839
k hat (MLE)	0.485	k star (bias corrected MLE)	0.469
Theta hat (MLE)	0.0868	Theta star (bias corrected MLE)	0.0898
nu hat (MLE)	47.57	nu star (bias corrected)	45.99
MLE Mean (bias corrected)	0.0421	MLE Sd (bias corrected)	0.0615
		Adjusted Level of Significance (β)	0.0451
Approximate Chi Square Value (45.99, α)	31.43	Adjusted Chi Square Value (45.99, β)	31.07
95% Gamma Approximate UCL (use when n>=50)	0.0616	95% Gamma Adjusted UCL (use when n<50)	0.0624

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.861	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.215	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.28	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0373	Mean in Log Scale	-5.295
SD in Original Scale	0.163	SD in Log Scale	1.218
95% t UCL (assumes normality of ROS data)	0.0763	95% Percentile Bootstrap UCL	0.078
95% BCA Bootstrap UCL	0.1	95% Bootstrap t UCL	1.046
95% H-UCL (Log ROS)	0.0166		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-5.266	95% H-UCL (KM -Log)	0.0188
KM SD (logged)	1.271	95% Critical H Value (KM-Log)	2.649
KM Standard Error of Mean (logged)	0.256		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0871	Mean in Log Scale	-3.842
SD in Original Scale	0.176	SD in Log Scale	1.686
95% t UCL (Assumes normality)	0.129	95% H-Stat UCL	0.193

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

99% KM (Chebyshev) UCL	0.281

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

1,3-DICHLOROBENZENE

General Statistics

Total Number of Observations	54	Number of Distinct Observations	41
		Number of Missing Observations	10
Number of Detects	37	Number of Non-Detects	17
Number of Distinct Detects	33	Number of Distinct Non-Detects	12
Minimum Detect	0.001	Minimum Non-Detect	0.005
Maximum Detect	2.1	Maximum Non-Detect	0.32
Variance Detects	0.126	Percent Non-Detects	31.48%
Mean Detects	0.138	SD Detects	0.354
Median Detects	0.029	CV Detects	2.574
Skewness Detects	5.032	Kurtosis Detects	27.68
Mean of Logged Detects	-3.69	SD of Logged Detects	1.992

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.4	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.936	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.35	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.146	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.1	Standard Error of Mean	0.0409
SD	0.296	95% KM (BCA) UCL	0.183
95% KM (t) UCL	0.168	95% KM (Percentile Bootstrap) UCL	0.171
95% KM (z) UCL	0.167	95% KM Bootstrap t UCL	0.3
90% KM Chebyshev UCL	0.223	95% KM Chebyshev UCL	0.278
97.5% KM Chebyshev UCL	0.355	99% KM Chebyshev UCL	0.507

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.399	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.838	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.161	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.156	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.387	k star (bias corrected MLE)	0.374
Theta hat (MLE)	0.355	Theta star (bias corrected MLE)	0.368
nu hat (MLE)	28.67	nu star (bias corrected)	27.68
MLE Mean (bias corrected)	0.138	MLE Sd (bias corrected)	0.225

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.114	nu hat (KM)	12.35
Approximate Chi Square Value (12.35, α)	5.46	Adjusted Chi Square Value (12.35, β)	5.334
95% Gamma Approximate KM-UCL (use when n>=50)	0.226	95% Gamma Adjusted KM-UCL (use when n<50)	0.232

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.001	Mean	0.098
Maximum	2.1	Median	0.01
SD	0.298	CV	3.042
k hat (MLE)	0.404	k star (bias corrected MLE)	0.394
Theta hat (MLE)	0.242	Theta star (bias corrected MLE)	0.249
nu hat (MLE)	43.67	nu star (bias corrected)	42.58
MLE Mean (bias corrected)	0.098	MLE Sd (bias corrected)	0.156
		Adjusted Level of Significance (β)	0.0456
Approximate Chi Square Value (42.58, α)	28.62	Adjusted Chi Square Value (42.58, β)	28.3
95% Gamma Approximate UCL (use when n>=50)	0.146	95% Gamma Adjusted UCL (use when n<50)	0.147

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.94	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.936	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.137	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.146	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0971	Mean in Log Scale	-4.108
SD in Original Scale	0.298	SD in Log Scale	1.805
95% t UCL (assumes normality of ROS data)	0.165	95% Percentile Bootstrap UCL	0.173
95% BCA Bootstrap UCL	0.224	95% Bootstrap t UCL	0.307
95% H-UCL (Log ROS)	0.194		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-4.178	95% H-UCL (KM -Log)	0.246
KM SD (logged)	1.919	95% Critical H Value (KM-Log)	3.541
KM Standard Error of Mean (logged)	0.283		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.112	Mean in Log Scale	-3.749
SD in Original Scale	0.297	SD in Log Scale	1.862
95% t UCL (Assumes normality)	0.18	95% H-Stat UCL	0.323

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	0.355

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

1,4-DICHLOROBENZENE

General Statistics

Total Number of Observations	54	Number of Distinct Observations	43
		Number of Missing Observations	10
Number of Detects	43	Number of Non-Detects	11
Number of Distinct Detects	38	Number of Distinct Non-Detects	8
Minimum Detect	4.1000E-4	Minimum Non-Detect	0.005
Maximum Detect	48	Maximum Non-Detect	0.28
Variance Detects	53.15	Percent Non-Detects	20.37%
Mean Detects	1.344	SD Detects	7.29
Median Detects	0.19	CV Detects	5.426
Skewness Detects	6.541	Kurtosis Detects	42.85
Mean of Logged Detects	-2.47	SD of Logged Detects	2.117

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.18	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.943	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.474	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.135	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	1.073	Standard Error of Mean	0.888
SD	6.452	95% KM (BCA) UCL	2.873
95% KM (t) UCL	2.56	95% KM (Percentile Bootstrap) UCL	2.848
95% KM (z) UCL	2.534	95% KM Bootstrap t UCL	29.06
90% KM Chebyshev UCL	3.738	95% KM Chebyshev UCL	4.945
97.5% KM Chebyshev UCL	6.62	99% KM Chebyshev UCL	9.912

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.993	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.882	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.305	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.148	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.256	k star (bias corrected MLE)	0.254
Theta hat (MLE)	5.251	Theta star (bias corrected MLE)	5.299
nu hat (MLE)	22.01	nu star (bias corrected)	21.81
MLE Mean (bias corrected)	1.344	MLE Sd (bias corrected)	2.669

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.0276	nu hat (KM)	2.985
Approximate Chi Square Value (2.98, α)	0.368	Adjusted Chi Square Value (2.98, β)	0.347
95% Gamma Approximate KM-UCL (use when n>=50)	8.702	95% Gamma Adjusted KM-UCL (use when n<50)	9.229

Gamma (KM) may not be used when k hat (KM) is < 0.1

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	4.1000E-4	Mean	1.072
Maximum	48	Median	0.0245
SD	6.513	CV	6.075
k hat (MLE)	0.24	k star (bias corrected MLE)	0.239
Theta hat (MLE)	4.461	Theta star (bias corrected MLE)	4.479
nu hat (MLE)	25.96	nu star (bias corrected)	25.85
MLE Mean (bias corrected)	1.072	MLE Sd (bias corrected)	2.191
		Adjusted Level of Significance (β)	0.0456
Approximate Chi Square Value (25.85, α)	15.26	Adjusted Chi Square Value (25.85, β)	15.04
95% Gamma Approximate UCL (use when n>=50)	1.816	95% Gamma Adjusted UCL (use when n<50)	1.843

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.949	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.943	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.16	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.135	Detected Data Not Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.072	Mean in Log Scale	-3.006
SD in Original Scale	6.513	SD in Log Scale	2.193
95% t UCL (assumes normality of ROS data)	2.555	95% Percentile Bootstrap UCL	2.843
95% BCA Bootstrap UCL	3.8	95% Bootstrap t UCL	29.66
95% H-UCL (Log ROS)	1.801		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-3.02	95% H-UCL (KM -Log)	2.02
KM SD (logged)	2.233	95% Critical H Value (KM-Log)	4.007
KM Standard Error of Mean (logged)	0.323		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.075	Mean in Log Scale	-2.894
SD in Original Scale	6.512	SD in Log Scale	2.13
95% t UCL (Assumes normality)	2.559	95% H-Stat UCL	1.65

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

99% KM (Chebyshev) UCL	9.912

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	All
Date/Time of Computation	12/3/2014 11:23:38 AM
From File	Input_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

NICKEL

General Statistics

Total Number of Observations	44	Number of Distinct Observations	38
		Number of Missing Observations	0
Minimum	2.2	Mean	26.81
Maximum	90.1	Median	26.95
SD	21.05	Std. Error of Mean	3.174
Coefficient of Variation	0.785	Skewness	1.004

Normal GOF Test

Shapiro Wilk Test Statistic	0.884	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.944	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.155	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.134	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	32.15	95% Adjusted-CLT UCL (Chen-1995)	32.54
		95% Modified-t UCL (Johnson-1978)	32.23

Gamma GOF Test

A-D Test Statistic	1.798	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.772	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.221	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.136	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.269	k star (bias corrected MLE)	1.198
Theta hat (MLE)	21.12	Theta star (bias corrected MLE)	22.38
nu hat (MLE)	111.7	nu star (bias corrected)	105.4
MLE Mean (bias corrected)	26.81	MLE Sd (bias corrected)	24.49
		Approximate Chi Square Value (0.05)	82.72
Adjusted Level of Significance	0.0445	Adjusted Chi Square Value	82.04

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	34.16	95% Adjusted Gamma UCL (use when n<50)	34.45

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.855	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.944	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.266	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.134	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.788	Mean of logged Data	2.846
Maximum of Logged Data	4.501	SD of logged Data	1.106

Assuming Lognormal Distribution

95% H-UCL	48.25	90% Chebyshev (MVUE) UCL	49.68
95% Chebyshev (MVUE) UCL	58.12	97.5% Chebyshev (MVUE) UCL	69.84
99% Chebyshev (MVUE) UCL	92.86		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	32.03	95% Jackknife UCL	32.15
95% Standard Bootstrap UCL	32	95% Bootstrap-t UCL	32.72
95% Hall's Bootstrap UCL	32.82	95% Percentile Bootstrap UCL	31.69
95% BCA Bootstrap UCL	32.1		
90% Chebyshev(Mean, Sd) UCL	36.33	95% Chebyshev(Mean, Sd) UCL	40.64
97.5% Chebyshev(Mean, Sd) UCL	46.63	99% Chebyshev(Mean, Sd) UCL	58.39

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	40.64

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Total PCBs

General Statistics

Total Number of Observations	42	Number of Distinct Observations	42
		Number of Missing Observations	8
Number of Detects	28	Number of Non-Detects	14
Number of Distinct Detects	28	Number of Distinct Non-Detects	14
Minimum Detect	0.014	Minimum Non-Detect	0.836
Maximum Detect	0.708	Maximum Non-Detect	12.4
Variance Detects	0.0377	Percent Non-Detects	33.33%
Mean Detects	0.329	SD Detects	0.194
Median Detects	0.342	CV Detects	0.59
Skewness Detects	0.0315	Kurtosis Detects	-0.484
Mean of Logged Detects	-1.482	SD of Logged Detects	1.146

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.959	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.924	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.0927	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.167	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.329	Standard Error of Mean	0.0367
SD	0.191	95% KM (BCA) UCL	0.388
95% KM (t) UCL	0.391	95% KM (Percentile Bootstrap) UCL	0.39
95% KM (z) UCL	0.389	95% KM Bootstrap t UCL	0.391
90% KM Chebyshev UCL	0.439	95% KM Chebyshev UCL	0.489
97.5% KM Chebyshev UCL	0.558	99% KM Chebyshev UCL	0.694

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.676	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.763	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.207	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.168	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.493	k star (bias corrected MLE)	1.357
Theta hat (MLE)	0.22	Theta star (bias corrected MLE)	0.242
nu hat (MLE)	83.63	nu star (bias corrected)	76.01
MLE Mean (bias corrected)	0.329	MLE Sd (bias corrected)	0.282

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	2.981	nu hat (KM)	250.4
Approximate Chi Square Value (250.44, α)	214.8	Adjusted Chi Square Value (250.44, β)	213.6
95% Gamma Approximate KM-UCL (use when n>=50)	0.384	95% Gamma Adjusted KM-UCL (use when n<50)	0.386

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.014	Mean	0.314
Maximum	0.708	Median	0.284
SD	0.159	CV	0.506
k hat (MLE)	2.156	k star (bias corrected MLE)	2.018
Theta hat (MLE)	0.146	Theta star (bias corrected MLE)	0.156
nu hat (MLE)	181.1	nu star (bias corrected)	169.5
MLE Mean (bias corrected)	0.314	MLE Sd (bias corrected)	0.221
		Adjusted Level of Significance (β)	0.0443
Approximate Chi Square Value (169.49, α)	140.4	Adjusted Chi Square Value (169.49, β)	139.4
95% Gamma Approximate UCL (use when n>=50)	0.379	95% Gamma Adjusted UCL (use when n<50)	0.382

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.752	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.924	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.238	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.167	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.295	Mean in Log Scale	-1.482
SD in Original Scale	0.165	SD in Log Scale	0.93
95% t UCL (assumes normality of ROS data)	0.338	95% Percentile Bootstrap UCL	0.337
95% BCA Bootstrap UCL	0.342	95% Bootstrap t UCL	0.342
95% H-UCL (Log ROS)	0.488		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.742	Mean in Log Scale	-0.975
SD in Original Scale	1.111	SD in Log Scale	1.284
95% t UCL (Assumes normality)	1.031	95% H-Stat UCL	1.475

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.391	95% KM (Percentile Bootstrap) UCL	0.39

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	2/18/2015 3:36:46 PM
From File	Input_rev021815.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

COPPER

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	3.3	Mean	58.15
Maximum	285	Median	17.25
SD	82.96	Std. Error of Mean	23.95
Coefficient of Variation	1.427	Skewness	2.144

Normal GOF Test

Shapiro Wilk Test Statistic	0.711	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.271	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.256	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	101.2	95% Adjusted-CLT UCL (Chen-1995)	113.4
		95% Modified-t UCL (Johnson-1978)	103.6

Gamma GOF Test

A-D Test Statistic	0.53	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.774	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.224	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.256	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.642	k star (bias corrected MLE)	0.537
Theta hat (MLE)	90.58	Theta star (bias corrected MLE)	108.3
nu hat (MLE)	15.41	nu star (bias corrected)	12.89
MLE Mean (bias corrected)	58.15	MLE Sd (bias corrected)	79.35
		Approximate Chi Square Value (0.05)	5.818
Adjusted Level of Significance	0.029	Adjusted Chi Square Value	5.111

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	128.8	95% Adjusted Gamma UCL (use when n<50)	146.6

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.931	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.157	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.256	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.194	Mean of logged Data	3.11
Maximum of Logged Data	5.652	SD of logged Data	1.502

Assuming Lognormal Distribution

95% H-UCL	404.8	90% Chebyshev (MVUE) UCL	142.5
95% Chebyshev (MVUE) UCL	180.4	97.5% Chebyshev (MVUE) UCL	233.1
99% Chebyshev (MVUE) UCL	336.5		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	97.54	95% Jackknife UCL	101.2
95% Standard Bootstrap UCL	95.77	95% Bootstrap-t UCL	149.8
95% Hall's Bootstrap UCL	239.1	95% Percentile Bootstrap UCL	102.7
95% BCA Bootstrap UCL	112.6		
90% Chebyshev(Mean, Sd) UCL	130	95% Chebyshev(Mean, Sd) UCL	162.5
97.5% Chebyshev(Mean, Sd) UCL	207.7	99% Chebyshev(Mean, Sd) UCL	296.4

Suggested UCL to Use

95% Adjusted Gamma UCL	146.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

LEAD

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	2.7	Mean	15.09
Maximum	60.8	Median	5.95
SD	18.97	Std. Error of Mean	5.477
Coefficient of Variation	1.257	Skewness	1.857

Normal GOF Test

Shapiro Wilk Test Statistic	0.692	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.292	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.256	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	24.93	95% Adjusted-CLT UCL (Chen-1995)	27.24
		95% Modified-t UCL (Johnson-1978)	25.42

Gamma GOF Test

A-D Test Statistic	0.877	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.757	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.223	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.252	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.001	k star (bias corrected MLE)	0.806
Theta hat (MLE)	15.08	Theta star (bias corrected MLE)	18.72
nu hat (MLE)	24.02	nu star (bias corrected)	19.35
MLE Mean (bias corrected)	15.09	MLE Sd (bias corrected)	16.81
		Approximate Chi Square Value (0.05)	10.37
Adjusted Level of Significance	0.029	Adjusted Chi Square Value	9.386

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	28.15	95% Adjusted Gamma UCL (use when n<50)	31.12

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.886	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.198	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.256	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.993	Mean of logged Data	2.138
Maximum of Logged Data	4.108	SD of logged Data	1.058

Assuming Lognormal Distribution

95% H-UCL	38.93	90% Chebyshev (MVUE) UCL	27.59
95% Chebyshev (MVUE) UCL	33.8	97.5% Chebyshev (MVUE) UCL	42.4
99% Chebyshev (MVUE) UCL	59.31		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	24.1	95% Jackknife UCL	24.93
95% Standard Bootstrap UCL	23.76	95% Bootstrap-t UCL	44.64
95% Hall's Bootstrap UCL	65.31	95% Percentile Bootstrap UCL	24.91
95% BCA Bootstrap UCL	26.95		
90% Chebyshev(Mean, Sd) UCL	31.52	95% Chebyshev(Mean, Sd) UCL	38.97
97.5% Chebyshev(Mean, Sd) UCL	49.3	99% Chebyshev(Mean, Sd) UCL	69.59

Suggested UCL to Use

95% Adjusted Gamma UCL	31.12

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

BARIUM

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	7.8	Mean	96.8
Maximum	489	Median	35.95
SD	139.3	Std. Error of Mean	40.22
Coefficient of Variation	1.439	Skewness	2.346

Normal GOF Test

Shapiro Wilk Test Statistic	0.677	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.315	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.256	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	169	95% Adjusted-CLT UCL (Chen-1995)	192.1
		95% Modified-t UCL (Johnson-1978)	173.6

Gamma GOF Test

A-D Test Statistic	0.59	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.767	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.243	**Kolmogrov-Smirnoff Gamma GOF Test**
5% K-S Critical Value	0.255	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.736	k star (bias corrected MLE)	0.608
Theta hat (MLE)	131.4	Theta star (bias corrected MLE)	159.2
nu hat (MLE)	17.67	nu star (bias corrected)	14.59
MLE Mean (bias corrected)	96.8	MLE Sd (bias corrected)	124.2
		Approximate Chi Square Value (0.05)	6.977
Adjusted Level of Significance	0.029	Adjusted Chi Square Value	6.19

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	202.4	95% Adjusted Gamma UCL (use when n<50)	228.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.938	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.16	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.256	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.054	Mean of logged Data	3.758
Maximum of Logged Data	6.192	SD of logged Data	1.331

Assuming Lognormal Distribution

95% H-UCL	432.2	90% Chebyshev (MVUE) UCL	208.4
95% Chebyshev (MVUE) UCL	261	97.5% Chebyshev (MVUE) UCL	334
99% Chebyshev (MVUE) UCL	477.4		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	163	95% Jackknife UCL	169
95% Standard Bootstrap UCL	160.5	95% Bootstrap-t UCL	255.4
95% Hall's Bootstrap UCL	394.4	95% Percentile Bootstrap UCL	166.4
95% BCA Bootstrap UCL	202		
90% Chebyshev(Mean, Sd) UCL	217.5	95% Chebyshev(Mean, Sd) UCL	272.1
97.5% Chebyshev(Mean, Sd) UCL	348	99% Chebyshev(Mean, Sd) UCL	497

Suggested UCL to Use

95% Adjusted Gamma UCL	228.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.
For additional insight the user may want to consult a statistician.

Attachment C

Updated Rare Species Review by Michigan Natural Features Inventory

February 2015

AECOM

MICHIGAN STATE UNIVERSITY | Extension

Ms. Kimberly Armour, PE
AECOM
5555 Glenwood Hills Parkway SE
Suite 300
Grand Rapids, MI 49512
616.940.4440

January 13, 2015

Re: Rare Species Review #1560 – BASF Sediment Collection, 471 Howard Avenue, Holland, MI T5N R15W Sections 19 & 30; T5N R16W Sections 24 & 25.

Hello:

The location for the proposed project was checked against known localities for rare species and unique natural features, which are recorded in the Michigan Natural Features Inventory (MNFI) natural heritage database. This continuously updated database is a comprehensive source of existing data on Michigan's endangered, threatened, or otherwise significant plant and animal species, natural plant communities, and other natural features. Records in the database indicate that a qualified observer has documented the presence of special natural features. The absence of records in the database for a particular site may mean that the site has not been surveyed. The only way to obtain a definitive statement on the status of natural features is to have a competent biologist perform a complete field survey.

Under Act 451 of 1994, the Natural Resources and Environmental Protection Act, Part 365, Endangered Species Protection, "a person shall not take, possess, transport, …fish, plants, and wildlife indigenous to the state and determined to be endangered or threatened," unless first receiving an Endangered Species Permit from the Michigan Department of Natural Resources (MDNR), Wildlife Division. Responsibility to protect endangered and threatened species is not limited to the lists below. Other species may be present that have not been recorded in the database.

According to the natural heritage database legally protected species have been documented within 1.5 miles of the project site. However, all of these records are considered **Historic** (i.e., > 50 years old) therefore, it is **not likely** that negative impacts will occur. Keep in mind that **MNFI cannot fully evaluate this project without visiting the project site.** MNFI offers several levels of Rare Species Reviews, including field surveys which I would be happy to discuss with you.

Sincerely,

Michael

Michael A. Sanders
Rare Species Review Specialist
Michigan Natural Features Inventory

MSU EXTENSION

Michigan Natural Features Inventory

PO Box 13036
Lansing MI 48901

(517) 284-6200
Fax (517) 373-9566

mnfi.anr.msu.edu

MSU is an affirmative-action, equal-opportunity employer.

Comments for Rare Species Review #1560: It is important to note that it is the applicant's responsibility to comply with both state and federal threatened and endangered species legislation. Therefore, if a state listed species occurs at a project site, and you think you need an endangered species permit please contact: Lori Sargent, Nongame Wildlife Biologist, Wildlife Division, Michigan Department of Natural Resources, P.O. Box 30444, Lansing, MI 48909, 517-284-6216, or SargentL@michigan.gov. If a federally listed species is involved and, you think a permit is needed, please contact Barb Hosler, Endangered Species Program, U.S. Fish and Wildlife Service, East Lansing office, 517-351-6326, or Barbara_Hosler@fws.gov.

Special concern species and natural communities are not protected under endangered species legislation but efforts should be taken to minimize any or all impacts. Species classified as special concern are species whose numbers are getting smaller in the state. If these species continue to decline they would be recommended for reclassification to threatened or endangered status. Please note the special concern **bald eagle** (*Haliaeetus leucocephalus*) is protected under the Bald and Golden Eagle Protection Act: Bald Eagle which prohibits anyone from "taking" bald eagles, including their parts, eggs or nests.

Please consult MNFI's Rare Species Explorer for additional information regarding the listed species: http://mnfi.anr.msu.edu/explorer/search.cfm.

Table 1: Legally protected species within 1.5 miles of RSR #1560

SNAME	SCOMNAME	G_RANK	S_RANK	Firstobs	Lastobs	USESA	SPROT	ELCAT
Pyganodon subgibbosa	Round lake floater	G1Q	S1	187?	1930		T	Animal
Zizania aquatica var. aquatica	Wild rice	G5T5	S2S3	1910	1910-08-04		T	Plant
Rallus elegans	King rail	G4	S1	1894	1894-06-13		E	Animal

Table 2: Special Concern Species and other Rare Natural Features within 1.5 miles of RSR #1560

SNAME	SCOMNAME	G_RANK	S_RANK	Firstobs	Lastobs	USESA	SPROT	ELCAT
Pycnanthemum verticillatum	Whorled mountain mint	G5	S2	1910	1910-08-04		SC	Plant
Lycopodiella subappressa	Northern appressed clubmoss	G2	S2	1871	1871-05-15		SC	Plant
Haliaeetus leucocephalus	Bald eagle	G5	S4	1993	1995		SC	Animal

Codes to accompany Tables 1 and 2:

State Protection Status Code Definitions (SPROT)
E: Endangered
T: Threatened
SC: Special concern

Federal Protection Status Code Definitions (USESA)
LE = listed endangered
LT = listed threatened
LELT = partly listed endangered and partly listed threatened
PDL = proposed delist
E(S/A) = endangered based on similarities/appearance
PS = partial status (federally listed in only part of its range)
C = species being considered for federal status

Global Heritage Status Rank Definitions (GRANK)
The priority assigned by NatureServe's national office for data collection and protection based upon the element's status throughout its entire world-wide range. Criteria not based only on number of occurrences; other critical factors also apply. Note that ranks are frequently combined.
G1 = critically imperiled globally because of extreme rarity (5 or fewer occurrences range-wide or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.
G2 = imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.
G3: Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g. a single western state, a physiographic region in the East) or because of other factor(s) making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100.
G4: Apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery.
G5: Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.
Q: Taxonomy uncertain

State Heritage Status Rank Definitions (SRANK)
The priority assigned by the Michigan Natural Features Inventory for data collection and protection based upon the element's status within the state. Criteria not based only on number of occurrences; other critical factors also apply. Note that ranks are frequently combined.
S1: Critically imperiled in the state because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation in the state.
S2: Imperiled in state because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state.
S3: Rare or uncommon in state (on the order of 21 to 100 occurrences).
S4 = apparently secure in state, with many occurrences.
S5 = demonstrably secure in state and essentially ineradicable under present conditions.
SX = apparently extirpated from state.

Appendix B

Laboratory Toxicity Test Reports

Great Lakes Environmental Center

Applied Environmental Sciences
www.glec.com

Traverse City Operations
739 Hastings St.
Traverse City
MI 49686

231 941-2230
231 941-2240 fax

Columbus Operations
1295 King Ave.
Columbus
OH 43212

614 487-1040
614 487-1920 fax

October 15, 2015

Randy Ellis, Senior Project Manager
Midwest District
AECOM Environment
220 Parkway Avenue
Kalamazoo, MI 49001

SUBJECT: Whole Sediment Toxicity Testing Results
10-day Toxicity Tests using *Hyalella azteca* and *Chironomus dilutus*
Former BASF Howard Avenue Facility
Lake Macatawa, Holland, Michigan
GLEC Project Number: 2264

Dear Mr. Ellis:

Great Lakes Environmental Center, Inc. (GLEC) has completed our analysis of the *Chironomus dilutus* and *Hyalella azteca* 10-day survival and growth whole sediment toxicity tests. These tests were performed with thirteen sediment samples that were collected by GLEC and AECOM personnel on August 4th and 5th, 2015 in conjunction with the Final Sediment Sampling Work Plan Addendum, Former BASF Howard Avenue facility, Lake Macatawa, Holland, Michigan (dated June 15, 2015).

The sample identification numbers, survival, and growth test results for the thirteen sediment samples and a laboratory control sediment are summarized and provided in the following tables:

- Table 1: 10-Day *Chironomus dilutus* (*C. dilutus*) Average Percent Survival
- Table 2: 10-Day *C. dilutus* Average Growth and Biomass Estimates (expressed as average ash-free-dry-weight (AFDW))
- Table 3: 10-Day *Hyalella azteca* (*H. azteca*) Average Percent Survival
- Table 4: 10-Day *H. azteca* Average Growth and Biomass Estimates

Water quality data for the overlying water for each sediment sample tested are summarized in Table 5 for the *C. dilutus* tests and Table 6 for the *H. azteca* tests. Summaries of the statistically significant differences (p=0.05) between the GLEC laboratory control and all thirteen investigative sediment samples collected from the BASF facility, Lake Macatawa are provided in Table 7 for the *C. dilutus* tests and in Table 8 for the *H. azteca* tests. Four additional statistical comparisons were requested by AECOM and are also summarized in Tables 7 and 8. The additional statistical

comparisons are as follows; the three individual reference sites: SD-45, SD-46, and LM-08-13 were compared to each of the other twelve sediment samples, and the "pooled" reference site data (SD-45, SD-46, and LM-08-13 combined) was compared to each of the other ten individual sediment samples.

A detailed summary of the overlying water quality measurements is provided in Appendices B1 (*C. dilutus*) and B2 (*H. azteca*). The survival, growth, and statistical data sheets and summaries for the *C. dilutus* and *H. azteca* tests are shown in Appendices C1 through C5 and D1 through D5, respectively. The daily laboratory bench data sheets are kept on file at GLEC and are also provided on the enclosed compact diskettes. Chain of Custody forms and reference toxicant data are provided in Appendices A and E, respectively.

METHODS

The whole sediment toxicity tests were conducted at our Traverse City, Michigan laboratory following GLEC's written Standard Operating Procedures (SOPs) which are based on the procedures outlined in U.S. EPA Method, EPA/600/R-99/064 *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates*, Second Edition and American Society for Testing and Materials (ASTM) 1706-95B, *Standard Test Methods for Measuring the Toxicity of Sediment Associated Contaminants with Freshwater Invertebrates* (ASTM 2000).

Thirteen sediment samples were collected and delivered by GLEC personnel. The sediment samples were received at GLEC, where they were assigned a unique GLEC laboratory identification number and stored at 0 to ≤ 6°C (but not frozen) until test initiation (see table below).

Sample I.D.	Sample Description	GLEC Lab. ID Number	Date Sampled	Date Received
SD-25	Site Sample	10,579	August 05, 2015	August 06, 2015
SD-30	Site Sample	10,580	August 04, 2015	August 06, 2015
SD-32	Site Sample	10,581	August 04, 2015	August 06, 2015
SD-39	Site Sample	10,582	August 05, 2015	August 06, 2015
SD-40	Site Sample	10,583	August 05, 2015	August 06, 2015
SD-50	Site Sample	10,584	August 05, 2015	August 06, 2015
SD-54	Site Sample	10,585	August 05, 2015	August 06, 2015
SD-55	Site Sample	10,586	August 05, 2015	August 06, 2015
SD-58	Site Sample	10,587	August 05, 2015	August 06, 2015
SD-59	Site Sample	10,588	August 05, 2015	August 06, 2015
SD-45	Reference Site	10,589	August 05, 2015	August 06, 2015
SD-46	Reference Site	10,590	August 05, 2015	August 06, 2015
LM-08-13	Reference Site	10,591	August 05, 2015	August 06, 2015

The 10-day *C. dilutus* and *H. azteca* toxicity tests were initiated on August 11, 2015 for each of the thirteen BASF, Lake Macatawa sediment samples, one GLEC laboratory control sediment and one water only exposure, per test organism.

Summary of Test Procedures: 10-Day *Chironomus dilutus* and *Hyalella azteca* Whole Sediment Toxicity Tests

Second to third instar *C. dilutus* (10-11 days old at test initiation; provided by an outside supplier: Aquatic Bio Systems) and *H. azteca* (9-10 days old, provided by an outside supplier: Aquatic Bio Systems) were used to initiate the 10-day whole sediment toxicity tests and water only exposures. *C. dilutus* and *H. azteca* were continuously exposed for 10 days to each of the thirteen sediment samples, one laboratory control sediment and one water only exposure.

In the water only exposures, test organisms were exposed to the overlying water with no sediment. There were eight replicate test chambers for each sediment sample, water only exposure, and the GLEC laboratory control sediment; each replicate contained 10 test organisms. The GLEC laboratory control sediment is a reference sediment that is collected from the Boardman River, a local river that has a primarily forested watershed in the Pere Marquette State Forest.

The *C. dilutus* and *H. azteca* were exposed in 470 mL glass test chambers, each containing 100 mL of whole sediment and 175 mL of overlying water.

Prior to adding the whole sediment to each test chamber, the control as well as each of the thirteen sediment samples were thoroughly homogenized using a pre-cleaned stainless steel mixer or spoon until a uniform color and texture was achieved.

The homogenized sediment was then added to each test chamber using a pre-cleaned stainless steel spoon. After the addition of the sediment to the test chambers, the overlying water was immediately added; and this was considered to be the test day prior to day 0 (test day -1; August 10, 2015 for the *C. dilutus* tests and for the *H. azteca* tests). Test organisms were randomly added to each replicate test chamber the following day (test day 0).

Fresh, test water was intermittently supplied to each test chamber at least twice daily (once every 12-hours) via a static-renewal water delivery system. The test water (overlying water) for each sediment sample, the laboratory control sediment and the water only exposure consisted of de-chlorinated municipal (Traverse City, Michigan) tap (Lake Michigan sourced) water, with an average hardness of 129 mg/L and an average alkalinity of 96 mg/L. Temperature, dissolved oxygen, pH, and specific conductance of the test water was measured daily prior to use.

The *C. dilutus* test chambers were fed 1.5 mL of Tetrafin® goldfish food slurry (4 mg/mL dry solids) once daily. The *H. azteca* test chambers were fed 1.0 mL mixture of yeast, trout food, and cerophyl (YTC; ~1800 (1700-1900 +/- 5%) mg/L solids) once daily.

The test chambers were placed in a temperature controlled water bath under the specified conditions of 23 ± 1°C; photoperiod 16 hours light: eight hours dark; and light intensity of 100-1000 lux.

Temperature and the dissolved oxygen (DO) concentration of the overlying water in the test chambers were measured daily in two alternating replicates for each test sediment, and the results were recorded on the laboratory bench data sheets. If the DO dropped below 2.5 mg/L, the number of daily overlying water renewals was increased (up to 4 times per day) for all treatments until the DO increased to greater than 3.0 mg/L. Once the DO had increased to above 3.0 mg/L, additional water renewals were suspended unless the DO values dropped back below 2.5 mg/L, at which time the additional water renewals were re-initiated.

There was one instance in the *C. dilutus* whole sediment toxicity tests of decreased DO and increased overlying water renewals; this instance is discussed in the section titled "Noted Exceptions to the Protocol."

Alkalinity, hardness, pH, conductance, and total ammonia (as N) were measured in the overlying water at test initiation and termination (test days 0, 9, and/or10 for both the *C. dilutus* (Table 5 and Appendix B1) and *H. azteca* (Table 6 and Appendix B2) tests. These results were also recorded on the laboratory bench data sheets.

Observations of organism behavior and anomalies observed within the sediment were made daily for each test chamber and recorded on the laboratory bench data sheets.

The number of *C. dilutus* surviving in each replicate test chamber was recorded at test termination (10 days), and a summary of the percent survival at test termination is provided in Tables 1, 2, and 7. *C. dilutus* growth, measured as average ash free dry weight [AFDW in milligrams (mg)] of the surviving organisms for each *C. dilutus* replicate, and as biomass [AFDW (mg) of the surviving organisms divided by the initial number of organisms] was also determined at test termination, and the results are summarized in Table 2.

The number of surviving *H. azteca* in each replicate chamber was recorded at test termination (10 days) and the survival data are summarized in Tables 3, 4, and 8. *H. azteca* growth, measures as average dry weight [in milligrams (mg)] of the surviving organisms for each *H. azteca* replicate, and as biomass [dry weight (mg) of the surviving organisms divided by the initial number of organisms] was also determined at test termination, and the data are summarized in Table 4.

A statistical procedure, using the program TOXCALC (version 5.0.32) and following statistical guidelines provided in U.S. EPA Method 600/R-99/064 and ASTM Method 1706-95B (2000), was used to compare the 10-day survival and growth data from the sediment samples to survival and growth data from the laboratory control sediment or the reference site sediment samples. Prior to analysis, all percent survival data were transformed using an arc sine-square root transformation. All transformed data were then tested using either the homoscedastic or heteroscedastic t-tests, which are used for comparing a single treatment to a single control.

The homoscedastic t-test assumes the data are normally distributed (Shapiro-Wilk Test or Kolmogorov D Test) and the variances are equal (F-test). If the variances are not equal, the data are analyzed using the heteroscedastic t-test. If the data are not normally distributed, then the data are analyzed using a nonparametric t-test (e.g., Steel's Many-One Rank Test or Wilcoxon Rank Sum Test with Bonferroni's Adjustment).

Growth data were initially evaluated for normal distribution and homogeneity of variances. In those cases where the data were not normally distributed or homogenous, the data were analyzed using either the heteroscedastic t-test or the nonparametric test.

The survival and growth data for *C. dilutus* and *H. azteca* for each BASF Lake Macatawa sediment sample were compared statistically (p= 0.05) to the GLEC laboratory control sediment sample, between the individual reference site results and individual sediment sample results, and with the "pooled" reference site results. The control and reference sites are listed below.

1. GLEC's laboratory control sediment sample (GLC Number: CS#129);

2. SD-45 (GLC Number: 10,589) reference site sample, compared to the other twelve sediment samples;

3. SD-46 (GLC Number: 10,590) reference site sample, compared to the other twelve sediment samples;

4. LM-08-13 (GLC Number: 10,591) reference site sample, compared to the other twelve sediment samples; and

5. "Pooled" reference site results; combined data from SD-45, SD-46, and LM-08-13, compared to each of the other ten sediment samples.

Organisms exposed to the GLEC laboratory control sediment and the water only exposure achieved acceptable survival and growth, as specified in the U.S. EPA /600/R-99/064. GLEC's laboratory control sediment and water only exposure results confirmed test acceptability and the health of the test organisms.

RESULTS

10-Day *Chironomus dilutus*

The organisms exposed to the GLEC laboratory control sediment and to the water only exposure exceeded the minimum survival (70 percent) and growth (0.48 mg AFDW at test termination) criteria for acceptable controls for the *C. dilutus* tests (Tables 1 and 2). The acceptability requirements for survival and growth for the *C. dilutus* test can be found in U.S. EPA Method 600/R-99/064, Table 12.1.

The overlying water quality measurements (Table 5) were also within the acceptable limits following the U.S. EPA testing protocol. Daily mean temperatures were 23°C ± 1 °C, dissolved oxygen (DO) was maintained above 2.5 mg/L in the overlying water; and there were no variations greater than 50% in overlying water hardness or alkalinity measurements within each test type. Total ammonia over ten days, varied between 0.11 mg/L and 3.62 mg/L in the overlying water among all sediment types. Consequently, the *C. dilutus* whole sediment toxicity tests were conducted following the standard protocols and are valid assessments of sediment toxicity, with the following exception:

Noted Exceptions to the Protocol:

On August 19, 2015 the DO measured in at least one of two replicates of the following sediment sample fell below the acceptable dissolved oxygen limit of 2.5 mg/L:

- CS#129 GLEC Laboratory Control; (4.3 and 1.9 mg/L).

In response to the drop in August 19, 2015, a third overlying water renewal was initiated with all of the control and investigative test sediment replicates. On August 20, 2015, the DO had increased to above 3.0 mg/L and the additional water renewal was suspended. The brief drop in DO was unlikely to have affected the test results (see EPA /600/R-99/064 manual, section 12.3.6.2.2).

All test chambers were observed daily to assess organism behavior and no unusual observations were noted with the test organisms in these sediment samples.

Statistical Analysis for 10-Day *Chironomus dilutus* Tests

GLEC Laboratory Control Sediment Sample Compared to BASF Lake Macatawa Sediment Samples

C. dilutus survival and growth results from the GLEC laboratory control sediment sample (CS#129) were compared statistically to each of the thirteen BASF Lake Macatawa sediment samples. When compared to the GLEC laboratory control sediment sample (see

Table 1 and Appendix C1), there was a statistically significant reduction ($p < 0.05$) in *C. dilutus* survival in four sediment samples, including:

- SD-30 (GLC Number: 10,580);
- SD-39 (GLC Number: 10,582);
- SD-58 (GLC Number: 10,587); and
- LM-08-13 (GLC Number: 10,591).

When compared to the GLEC laboratory control sediment sample (see Table 2 and Appendix C1), *C. dilutus* growth AFDW) was significantly reduced ($p<0.05$) in eight sediment samples, including:

- SD-25 (GLC Number: 10,579);
- SD-30 (GLC Number: 10,580);
- SD-32 (GLC Number: 10,581);
- SD-39 (GLC Number: 10,582);
- SD-40 (GLC Number: 10,583);
- SD-50 (GLC Number: 10,584);
- SD-55 (GLC Number: 10,586); and
- SD-58 (GLC Number: 10,587).

Additionally, when the investigative sediment samples were compared to the GLEC laboratory control sediment sample (see Table 2 and Appendix C1), *C. dilutus* growth measured as biomass (AFDW) was significantly reduced ($p<0.05$) in ten sediment samples, including:

- SD-25 (GLC Number: 10,579);
- SD-30 (GLC Number: 10,580);
- SD-32 (GLC Number: 10,581);
- SD-39 (GLC Number: 10,582);
- SD-40 (GLC Number: 10,583);
- SD-50 (GLC Number: 10,584);
- SD-55 (GLC Number: 10,586);
- SD-58 (GLC Number: 10,587);
- SD-59 (GLC Number: 10,588); and
- SD-46 (GLC Number: 10,590).

Reference Sample: SD-45 Compared to Twelve BASF Lake Macatawa Sediment Samples

C. dilutus survival and growth results from the reference sample: SD-45 (GLC Number: 10,589) were compared statistically to the other twelve individual sediment samples: SD-25, SD-30, SD-32, SD-39, SD-40, SD-50, SD-54, SD-55, SD-58, SD-59, SD-46, and LM-08-13.

When the reference sample SD-45 was compared to each of the twelve individual sediment samples (see Table 1 and Appendix C2), there was a statistically significant reduction ($p < 0.05$) in *C. dilutus* survival in two sediment samples; SD-30 (GLC Number: 10,580) and LM-08-13 (Reference Site, GLC Number: 10,591).

Growth was significantly reduced ($p < 0.05$), after 10 days of exposure when compared to the reference sample SD-45 in the following five sediment samples.

- SD-30 (GLC Number: 10,580);
- SD-32 (GLC Number: 10,581);
- SD-39 (GLC Number: 10,582);
- SD-40 (GLC Number: 10,583); and
- SD-50 (GLC Number: 10,584).

Additionally, growth measured as biomass was significantly reduced ($p < 0.05$) in the following eight sediment samples, when compared to the reference sample SD-45 (Table 2 and Appendix C2).

- SD-25 (GLC Number: 10,579);
- SD-30 (GLC Number: 10,580);
- SD-32 (GLC Number: 10,581);
- SD-39 (GLC Number: 10,582);
- SD-40 (GLC Number: 10,583);
- SD-50 (GLC Number: 10,584);
- SD-58 (GLC Number: 10,587); and
- SD-46 (GLC Number: 10,590).

Reference Sample: SD-46 Compared to Twelve BASF Lake Macatawa Sediment Samples

C. dilutus survival and growth results from the reference sample: SD-46 (GLC Number: 10,590) were compared statistically to the other twelve individual sediment samples: SD-25, SD-30, SD-32, SD-39, SD-40, SD-50, SD-54, SD-55, SD-58, SD-59, SD-45, and LM-08-13.

When the reference sample SD-46 was compared to each of the twelve sediment samples (see Table 1 and Appendix C3), there was a statistically significant reduction ($p < 0.05$) in *C. dilutus* survival in two sediment samples; SD-30 (GLC Number: 10,580) and LM-08-13 (GLC Number: 10,591).

Growth measured as average dry weight of surviving organisms (mg) and as biomass had a statistically significant reduction ($p < 0.05$), after 10 days of exposure when compared to the reference sample SD-46 in the following three sediment samples.

- SD-30 (GLC Number: 10,580);
- SD-32 (GLC Number: 10,581); and
- SD-50 (GLC Number: 10,584).

Reference Sample: LM-08-13 Compared to Twelve BASF Lake Macatawa Sediment Samples

C. dilutus survival and growth results from the reference sample: LM-08-13 (GLC Number: 10,591) were compared statistically to the other twelve individual sediment samples: SD-25, SD-30, SD-32, SD-39, SD-40, SD-50, SD-54, SD-55, SD-58, SD-59, SD-45, and SD-46.

When the reference sample LM-08-13 was compared to the other twelve sediment samples (see Table 1 and Appendix C4), there was a statistically significant reduction ($p < 0.05$) in *C. dilutus* survival in the sediment sample; SD-30 (GLC Number: 10,580).

Growth, measured as AFDW of surviving organisms (mg) was significantly reduced ($p < 0.05$), after 10 days of exposure when compared to the reference sample LM-08-13 in the following eleven sediment samples.

- SD-25 (GLC Number: 10,579);
- SD-30 (GLC Number: 10,580);
- SD-32 (GLC Number: 10,581);
- SD-39 (GLC Number: 10,582);
- SD-40 (GLC Number: 10,583);
- SD-50 (GLC Number: 10,584);
- SD-54 (GLC Number: 10,585);

- SD-55 (GLC Number: 10,586);
- SD-58 (GLC Number: 10,587);
- SD-59 (GLC Number: 10,588); and
- SD-46 (GLC Number: 10,590).

Additionally, growth measured as biomass was significantly reduced ($p < 0.05$) in the following six sediment samples, when compared to the reference sample LM-08-13 (Table 2 and Appendix C4).

- SD-30 (GLC Number: 10,580);
- SD-32 (GLC Number: 10,581);
- SD-39 (GLC Number: 10,582);
- SD-40 (GLC Number: 10,583);
- SD-50 (GLC Number: 10,584); and
- SD-58 (GLC Number: 10,587).

Pooled Reference Samples: SD-45, SD-46, and LM-08-13 Compared to Ten BASF Lake Macatawa Sediment Samples

Pooled *C. dilutus* survival and growth results from the reference site samples: SD-45, SD-46, and LM-08-13 (GLC Numbers: 10,589, 10590, and 10,591, respectively) were compared statistically to the other ten individual sediment samples: SD-25, SD-30, SD-32, SD-39, SD-40, SD-50, SD-54, SD-55, SD-58, and SD-59.

When the "pooled" reference site sample results were compared to the other ten sediment samples (see Table 1 and Appendix C5), there was a statistically significant reduction ($p < 0.05$) in *C. dilutus* survival in the sediment sample; SD-30 (GLC Number: 10,580).

Growth measured as AFDW of surviving organisms (mg) was significantly reduced ($p < 0.05$), after 10 days of exposure when compared to the "pooled" reference site sample results in all of the ten sediment samples.

- SD-25 (GLC Number: 10,579);
- SD-30 (GLC Number: 10,580);
- SD-32 (GLC Number: 10,581);
- SD-39 (GLC Number: 10,582);
- SD-40 (GLC Number: 10,583);
- SD-50 (GLC Number: 10,584);
- SD-54 (GLC Number: 10,585);
- SD-55 (GLC Number: 10,586);
- SD-58 (GLC Number: 10,587); and
- SD-59 (GLC Number: 10,588).

Additionally, growth measured as biomass was significantly reduced ($p < 0.05$) in the following six sediment samples, when compared to the pooled reference site sample results (Table 2 and Appendix C5).

- SD-30 (GLC Number: 10,580);
- SD-32 (GLC Number: 10,581);
- SD-39 (GLC Number: 10,582);
- SD-40 (GLC Number: 10,583);
- SD-50 (GLC Number: 10,584); and
- SD-58 (GLC Number: 10,587).

Outputs for the survival and growth statistical analyses for the *C. dilutus* whole sediment toxicity tests are provided in Appendices C1 through C5.

10-Day *Hyalella azteca*

The *H. azteca* test organisms exposed to the GLEC laboratory control sediment and to the overlying water exceeded the minimum survival criteria (80%), and displayed acceptable measurable growth (Tables 3 and 4). The requirements for acceptable survival and growth for the *H. azteca* can be found in U.S. EPA /600/R-99/064, Table 11.2.

The overlying water quality measurements (Table 6) were also within the acceptable limits following the U.S. EPA testing protocol. Daily mean temperatures were 23 ± 1 °C, DO was maintained above 2.5 mg/L in the overlying water; and there were no variations greater than 50% in overlying water hardness or alkalinity measurements within each test type. Total ammonia over a ten day period, varied between 0.11 mg/L and 3.62 mg/L in the overlying water among all sediment types.

All test chambers were checked daily to assess organism behavior and no unusual observations were noted with the test organisms in the sediment samples. Consequently, the *H. azteca* whole sediment toxicity tests were completed following the standard protocols and are valid assessments of sediment toxicity.

Statistical Analysis for 10-Day *Hyalella azteca* Tests

GLEC Laboratory Control Sediment Sample Compared to BASF Lake Macatawa Sediment Samples

H. azteca 10-day survival and growth results from the GLEC laboratory control sediment sample were compared statistically to each of the thirteen BASF Lake Macatawa sediment samples. When compared to the GLEC laboratory control sediment sample (see Table 3 and

Appendix D1), *H. azteca* survival was not significantly reduced ($p \geq 0.05$) in any of the thirteen sediment samples.

H. azteca growth (average dry weight) was significantly reduced ($p < 0.05$) in four of the thirteen sediment samples, after 10 days of exposure when compared to the GLEC laboratory control sediment (Table 4 and Appendix D1).

- SD-30 (GLC Number: 10,580);
- SD-39 (GLC Number: 10,582);
- SD-40 (GLC Number: 10,583); and
- SD-50 (GLC Number: 10,584).

H. azteca growth measured as biomass was significantly reduced ($p < 0.05$) in two of the thirteen sediment samples, after 10 days of exposure when compared to the GLEC laboratory control sediment (Table 4 and Appendix D1).

- SD-30 (GLC Number: 10,580); and
- SD-39 (GLC Number: 10,582).

Reference Sample: SD-45 Compared to Twelve BASF Lake Macatawa Sediment Samples

H. azteca survival and growth results from the reference sample SD-45 (GLC Number: 10,589) were compared statistically to the following twelve individual sediment samples: SD-25, SD-30, SD-32, SD-39, SD-40, SD-50, SD-54, SD-55, SD-58, SD-59, SD-46, and LM-08-13.

When the reference sample SD-45 was compared to the other twelve sediment samples (see Table 3 and Appendix D2), there was no significant reduction ($p \geq 0.05$) in *H. azteca* survival to any of the twelve sediment samples.

Growth measured as average dry weight of surviving organisms (mg) and as biomass had a statistically significant reduction ($p < 0.05$) in one sediment sample; SD-30 (GLC Number: 10,580), after 10 days of exposure when compared to the reference sample SD-45 (Table 4 and Appendix D2).

Reference Sample: SD-46 Compared to Twelve BASF Lake Macatawa Sediment Samples

H. azteca survival and growth results from the reference sample SD-46 (GLC Number: 10,590) were compared statistically to the other twelve individual sediment samples: SD-25, SD-30, SD-32, SD-39, SD-40, SD-50, SD-54, SD-55, SD-58, SD-59, SD-45, and LM-08-13.

H. azteca survival had a statistically significantly reduction ($p < 0.05$) in eight of the twelve sediment samples when compared to reference sample SD-46 (see Table 3 and Appendix D3).

- SD-25 (GLC Number: 10,579);
- SD-30 (GLC Number: 10,580);
- SD-32 (GLC Number: 10,581);
- SD-39 (GLC Number: 10,582);
- SD-40 (GLC Number: 10,583);
- SD-54 (GLC Number: 10,585);
- SD-59 (GLC Number: 10,588); and
- SD-45 (GLC Number: 10,589).

Growth measured as average dry weight of surviving organisms (mg) and as biomass had a statistically significant reduction ($p < 0.05$) in one sediment sample SD-30 (GLC Number: 10,580), after 10 days of exposure when compared to the reference sample SD-46 (Table 4 and Appendix D3).

Reference Sample: LM-08-13 Compared to Twelve BASF Lake Macatawa Sediment Samples

H. azteca survival and growth results from the reference sample LM-08-13 (GLC Number: 10,591) were compared statistically to the other twelve individual sediment samples: SD-25, SD-30, SD-32, SD-39, SD-40, SD-50, SD-54, SD-55, SD-58, SD-59, SD-45, and SD-46.

When the reference sample LM-08-13 was compared to the other twelve sediment samples (see Table 3 and Appendix D4), there was a statistically significant reduction ($p<0.05$) in *H. azteca* survival for the following five sediment samples.

- SD-30 (GLC Number: 10,580);
- SD-32 (GLC Number: 10,581);
- SD-39 (GLC Number: 10,582);
- SD-59 (GLC Number: 10,588); and
- SD-45 (GLC Number: 10,589).

H. azteca growth was significantly reduced ($p < 0.05$) in ten of the twelve sediment samples, after 10 days of exposure when compared to the reference sediment LM-08-13 (Table 4 and Appendix D4).

- SD-25 (GLC Number: 10,579);
- SD-30 (GLC Number: 10,580);
- SD-39 (GLC Number: 10,582);
- SD-40 (GLC Number: 10,583);

- SD-50 (GLC Number: 10,584);
- SD-54 (GLC Number: 10,585);
- SD-55 (GLC Number: 10,586);
- SD-58 (GLC Number: 10,587);
- SD-59 (GLC Number: 10,588); and
- SD-46 (GLC Number: 10,590).

H. azteca growth measured as biomass was significantly reduced ($p < 0.05$) in eleven of the twelve sediment samples, after 10 days of exposure when compared to the reference sediment LM-08-13 (Table 4 and Appendix D4).

- SD-25 (GLC Number: 10,579);
- SD-30 (GLC Number: 10,580);
- SD-32 (GLC Number: 10,581);
- SD-39 (GLC Number: 10,582);
- SD-40 (GLC Number: 10,583);
- SD-50 (GLC Number: 10,584);
- SD-54 (GLC Number: 10,585);
- SD-55 (GLC Number: 10,586);
- SD-58 (GLC Number: 10,587);
- SD-59 (GLC Number: 10,588); and
- SD-46 (GLC Number: 10,590).

Pooled Reference Samples: SD-45, SD-46, and LM-08-13 Compared to Ten BASF Lake Macatawa Sediment Samples

Pooled *H. azteca* survival and growth results from the reference samples SD-45, SD-46, and LM-08-13 (GLC Numbers: 10,589, 105,90, and 10,591, respectively) were compared statistically to the other ten individual sediment samples: SD-25, SD-30, SD-32, SD-39, SD-40, SD-50, SD-54, SD-55, SD-58, and SD-59.

H. azteca survival was significantly reduced ($p < 0.05$) in three sediment samples when compared to the "pooled" reference site results (see Table 3 and Appendix D5).

- SD-30 (GLC Number: 10,580);
- SD-32 (GLC Number: 10,581); and
- SD-59 (GLC Number: 10,588).

There was a significant reduction in growth measured as average dry weight (mg) and as biomass (mg) for five sediment samples, when compared to the pooled reference site results (see Table 4 and Appendix D5).

- SD-25 (GLC Number: 10,579);
- SD-30 (GLC Number: 10,580);
- SD-39 (GLC Number: 10,582);
- SD-40 (GLC Number: 10,583); and
- SD-50 (GLC Number: 10,584).

Outputs for the survival and growth statistical analyses for the *H. azteca* whole sediment toxicity tests are provided in Appendices D1 through D5.

Summary

In summary, GLEC completed whole sediment toxicity testing and analysis of thirteen sediment samples. Each whole sediment toxicity test was performed following acceptable methods, without exception, and is accurate and complete. Whole sediment toxicity test results are in compliance with the requirements of the National Environmental Laboratory Accreditation Conference (NELAC).

Statistical analyses were completed for the whole sediment toxicity tests with *C. dilutus* and *H. azteca*. All data are summarized in the following tables and raw data reported in the appendices to this report.

C. dilutus survival was significantly reduced in four of the thirteen sediment samples when compared to the GLEC laboratory control sediment sample. *C. dilutus* growth, expressed as average AFDW and biomass was significantly reduced in eight and ten sediment samples, respectively, when compared to GLEC laboratory control sediment sample (Table 7).

However, the following investigative sediment sample; SD-58 (GLC Number: 10,587) had 90 percent survival; within 10 percent of the laboratory control and it is of GLEC's opinion that this sample is not considered biologically significant.

When compared to reference sediment SD-45 (GLC Number: 10,589), *C. dilutus* survival was significantly reduced in two sediment samples. While *C. dilutus* growth (average AFDW) and biomass, was significantly reduced in five and eight sediment samples, respectively; when compared to reference sediment sample SD-45 (Table 7).

C. dilutus survival was significantly reduced in two sediment samples when compared to the reference sample SD-46 (GLC Number: 10,590). *C. dilutus* growth (expressed as average AFDW and biomass) was significantly reduced in three sediment samples when compared to reference sediment sample SD-46 (Table 7).

When compared to reference sediment LM-08-13 (GLC Number: 10,591), *C. dilutus* survival was significantly reduced in one sediment sample. *C. dilutus* growth (average AFDW) and biomass was significantly reduced in eleven and six sediment samples, respectively; when compared to reference sediment sample LM-08-13 (Table 7).

C. dilutus survival was significantly reduced in one sediment sample when compared to the "pooled" reference sites (SD-45, SD-46, and LM-08-13, combined). *C. dilutus* growth, expressed as average AFDW and biomass was significantly reduced in ten and six sediment samples, respectively when compared to the "pooled" reference sites.

H. azteca survival was not significantly reduced in any of the thirteen investigative site samples when compared to the GLEC laboratory control sediment sample. *H. azteca* growth expressed as average dry weight and biomass was significantly reduced in four and three sediment samples, respectively when compared to the GLEC laboratory control sediment sample (Table 8).

After 10-days of exposure, *H. azteca* survival was not significantly reduced in any of the other twelve sediment samples when compared to reference sediment SD-45 (GLC Number: 10,589). However, *H. azteca* growth (expressed average dry weight and biomass) was significantly reduced in one sediment sample when compared to the SD-45 reference sediment sample.

H. azteca survival was significantly reduced in eight of the sediment samples when compared to the reference sediment SD-46 (GLC Number: 10,590). *H. azteca* growth (expressed average dry weight and biomass) was significantly reduced in one sediment sample when compared to SD-46 reference sediment sample (Table 8).

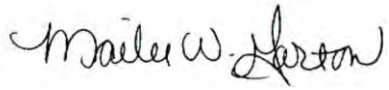
When compared to reference sediment LM-08-13 (GLC Number: 10,591), *H. azteca* survival was significantly reduced in five sediment samples (Table 8). *H. azteca* growth expressed average dry weight and biomass, was significantly reduced in ten and eleven sediment samples, respectively; when compared to reference sediment sample LM-08-13.

H. azteca survival was significantly reduced in three sediment samples when compared to the "pooled" reference sites results (SD-45, SD-46, and LM-08-13). *H. azteca* growth (expressed as average dry weight and biomass) was significantly reduced in five sediment samples when compared to the "pooled" reference sites (Table 8).

After 10-days, *H. azteca* survival, in all thirteen sediment samples was greater than 90 percent. Eight of the thirteen sediment samples demonstrated a significant difference in survival when compared to either the laboratory control or to the reference site samples. Because there was less than 10 percent mortality and because the reduction in *H. azteca* survival was within 10 percent of the laboratory control and reference sediment samples, it is of GLEC's opinion that the investigative sediments are not biologically significant.

If you have any questions, or if you would like additional information, please contact either myself or Dennis McCauley at (231) 941-2230, or John Barkach at (248) 538-0900. Thank you for the opportunity to provide this service to AECOM. We look forward to continue providing environmental services to you in the future.

Sincerely,



Mailee W. Garton
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TABLE 1.
Page (1 of 2)

Comparison of Number of Surviving *Chironomus dilutus* per Replicate[r] and Percent Survival between the Following; Laboratory Control Sediment and the Investigative Sediments Samples; *Chironomus dilutus* 10-Day Whole Sediment Toxicity Tests Conducted August 11-August 21, 2015; AECOM Lake Macatawa (BASF).

Replicate Number GLC Number	Laboratory Control CS# 129	SD-25 10,579	SD-30 10,580	SD-32 10,581	SD-39 10,582	SD-40 10,583	SD-50 10,584
1	10	10	1	10	8	10	10
2	9	10	1	10	9	9	10
3	T.E.	9	3	10	9	9	10
4	10	10	3	10	8	9	9
5	10	10	3	9	10	7	10
6	10	9	2	10	9	8	10
7	9	9	2	10	8	10	9
8	10	10	3	9	9	10	10
10-Day Whole Sediment Toxicity Test Percent Survival[r]	**97.1**	**96.3**	**[a,b,c,d,e,] 22.5**	**97.5**	**[a] 87.5**	**90.0**	**97.5**

[r] Replicates initiated with 10 organisms each

[a] Significantly different ($p < 0.05$) from laboratory control CS#129.

[b] Significantly different ($p < 0.05$) from reference site SD-45 (GLC Number: 10,589).

[c] Significantly different ($p < 0.05$) from reference site SD-46 (GLC Number: 10,590).

[d] Significantly different ($p < 0.05$) from reference site LM-08-13 (GLC Number: 10,591).

[e] Significantly different ($p < 0.05$) from combined reference sites: SD-45, SD-46, and LM-08-13.

T.E.: Technician Error

TABLE 1. **Comparison of Number of Surviving *Chironomus dilutus* per Replicate[r] and Percent Survival between the Following; Laboratory Control Sediment and the Investigative Sediments Samples; *Chironomus dilutus* 10-Day Whole Sediment Toxicity Tests Conducted August 11-August 21, 2015; AECOM Lake Macatawa (BASF).**

Replicate Number GLC Number	SD-54 10,585	SD-55 10,586	SD-58 10,587	SD-59 10,588	SD-45 10,589	SD-46 10,590	LM-08-13 10,591	Water Only Secondary Control
1	10	10	10	10	10	10	7	8
2	10	10	8	8	9	10	8	8
3	10	10	8	10	9	9	6	10
4	10	10	8	10	10	8	8	9
5	10	8	10	8	7	8	7	10
6	9	9	10	8	10	10	8	10
7	10	10	9	10	9	9	7	10
8	10	10	9	10	10	9	8	9
10-Day Whole Sediment Toxicity Test Percent Survival[r]	**98.8**	**96.3**	**90.0**[a]	**92.5**	**92.5**	**91.3**	**73.8**[a,b,c]	**92.5**

[r] Replicates initiated with 10 organisms each

[a] Significantly different ($p < 0.05$) from laboratory control CS#129.

[b] Significantly different ($p < 0.05$) from reference site SD-45 (GLC Number: 10,589).

[c] Significantly different ($p < 0.05$) from reference site SD-46 (GLC Number: 10,590).

[d] Significantly different ($p < 0.05$) from reference site LM-08-13 (GLC Number: 10,591).

[e] Significantly different ($p < 0.05$) from combined reference sites: SD-45, SD-46, and LM-08-13.

TABLE 2 (page 1 of 3) **Comparison of Average[1] Dry Weight (mg), Biomass[2] (mg) and Percent Survival between the Following; Laboratory Control Sediment and the Investigative Sediments Samples; *Chironomus dilutus* 10-Day Whole Sediment Toxicity Tests Conducted August 11-August 21, 2015; AECOM Lake Macatawa (BASF).**

GLC Number	Laboratory Control CS#129		SD-25 10,579		SD-30 10,580		SD-32 10,581		SD-39 10,582	
Replicate Number	**Average[1] Weight (mg)**	**Biomass[2] Weight (mg)**	**Average[1] Weight (mg)**	**Biomass[2] Weight (mg)**	**Average[1] Weight (mg)**	**Biomass[2] Weight (mg)**	**Average[1] Weight (mg)**	**Biomass[2] Weight (mg)**	**Average[1] Weight (mg)**	**Biomass[2] Weight (mg)**
1	1.41700	1.41700	1.11700	1.11700	0.60000	0.06000	0.76700	0.76700	1.29500	1.03600
2	1.38750	1.23333	1.18000	1.18000	0.19000	0.01900	0.88100	0.88100	0.98889	0.89000
3	T.E.	T.E.	1.44889	1.30400	0.19000	0.05700	0.90500	0.90500	1.16778	1.05100
4	1.21700	1.21700	1.00700	1.00700	1.21333	0.36400	0.94400	0.94400	1.13143	0.88000
5	1.43300	1.43300	1.33900	1.33900	0.64667	0.19400	1.18444	1.06600	0.81600	0.81600
6	1.34100	1.34100	1.27889	1.15100	0.24500	0.04900	0.99900	0.99900	1.21111	1.09000
7	1.34889	1.21400	1.31111	1.18000	1.02000	0.20400	0.82500	0.82500	1.18625	0.94900
8	1.36444	1.36444	1.22222	1.22222	0.20333	0.06100	1.00889	0.90800	1.22333	1.10100
Average[1] Ash-Free-Dry Weight (AFDW) (mg)	**1.35840**		a,d,e **1.23801**		a,b,c,d,e, **0.53854**		a,b,c,d,e, **0.93929**		a,b,d,e **1.12747**	
Biomass[2] Weight (AFDW) (mg)		**1.31711**		a,b **1.18753**		b,a,c,d,e, **0.12600**		a,b,c,d,e, **0.91188**		a,b,d,e **0.97663**
10-Day Percent Survival	**97.1**		**96.3**		a,b,c,d,e, **22.5**		**97.5**		a **87.5**	

Note: Average Ash-Free-Dry Weight (AFDW) of *Chironomus dilutus* at test initiation = 0.17650 mg.

[1] Average Ash-Free-Dry-Weight (AFDW) is the total ash-free-dry weight of surviving organisms

[2] Biomass weight is the total Ash-Free-Dry-Weight of surviving organisms divided by the initial number of organisms.

[a] Significantly different ($p < 0.05$) from laboratory control CS#129.

[b] Significantly different ($p < 0.05$) from reference site SD-45 (GLC Number: 10,589).

[c] Significantly different ($p < 0.05$) from reference site SD-46 (GLC Number: 10,590).

[d] Significantly different ($p < 0.05$) from reference site LM-08-13 (GLC Number: 10,591).

[e] Significantly different ($p < 0.05$) from combined reference sites: SD-45, SD-46, and LM-08-13.

T.E.: Technician Error

TABLE 2 (page 2 of 3) **Comparison of Average[1] Dry Weight (mg), Biomass[2] (mg) and Percent Survival between the Following; Laboratory Control Sediment and the Investigative Sediments Samples; *Chironomus dilutus* 10-Day Whole Sediment Toxicity Tests Conducted August 11-August 21, 2015; AECOM Lake Macatawa (BASF).**

GLC Number	SD-40 10,583		SD-50 10,584		SD-54 10,585		SD-55 10,586	
Replicate Number	Average[1] Weight (mg)	Biomass[2] Weight (mg)	Average[1] Weight (mg)	Biomass[2] Weight (mg)	Average[1] Weight (mg)	Biomass[2] Weight (mg)	Average[1] Weight (mg)	Biomass[2] Weight (mg)
1	1.03700	1.03700	0.88333	0.88333	1.06100	1.06100	1.18800	1.18800
2	1.02556	0.92300	0.85600	0.85600	1.04000	1.04000	1.17300	1.17300
3	1.13556	1.02200	1.08600	1.08600	1.09400	1.09400	1.23300	1.23300
4	1.37750	1.22444	1.03778	0.93400	1.60000	1.60000	1.13222	1.13222
5	1.03571	0.72500	0.94400	0.94400	1.28000	1.28000	1.33000	1.06400
6	1.17250	0.93800	0.87900	0.87900	1.38667	1.24800	1.37333	1.23600
7	0.93900	0.93900	1.02000	0.90667	1.26667	1.26667	1.45500	1.45500
8	1.00800	1.00800	1.01900	1.01900	1.24000	1.24000	1.26300	1.26300
Average[1] Ash-Free-Dry Weight (AFDW) (mg)	a,b,d,e **1.09135**		a.b.c.d.e **0.96564**		d,e **1.24604**		a.d.e **1.26844**	
Biomass[2] Weight (AFDW) (mg)		a,b,d,e **0.97706**		a,b,c,d,e **0.93850**		**1.22871**		a **1.21803**
10-Day Percent Survival	**90.0**		**97.5**		**98.8**		**96.3**	

Note: Average Ash-Free-Dry Weight (AFDW) of *Chironomus dilutus* at test initiation = 0.17650 mg.

[1] Average Ash-Free-Dry-Weight (AFDW) is the total ash-free-dry weight of surviving organisms

[2] Biomass weight is the total Ash-Free-Dry-Weight of surviving organisms divided by the initial number of organisms.

[a] Significantly different ($p < 0.05$) from laboratory control CS#129.

[b] Significantly different ($p < 0.05$) from reference site SD-45 (GLC Number: 10,589).

[c] Significantly different ($p < 0.05$) from reference site SD-46 (GLC Number: 10,590).

[d] Significantly different ($p < 0.05$) from reference site LM-08-13 (GLC Number: 10,591).

[e] Significantly different ($p < 0.05$) from combined reference sites: SD-45, SD-46, and LM-08-13.

TABLE 2 (page 3 of 3) **Comparison of Average[1] Dry Weight (mg), Biomass[2] (mg) and Percent Survival between the Following; Laboratory Control Sediment and the Investigative Sediments Samples; *Chironomus dilutus* 10-Day Whole Sediment Toxicity Tests Conducted August 11-August 21, 2015; AECOM Lake Macatawa (BASF).**

GLC Number	SD-58 10,587		SD-59 10,588		SD-45 10,589		SD-46 10,590		LM-08-13 10,591		Water Only Secondary Control	
Replicate Number	Average[1] Weight (mg)	Biomass[2] Weight (mg)	Average[1] Weight (mg)	Biomass[2] Weight (mg)	Average[1] Weight (mg)	Biomass[2] Weight (mg)	Average[1] Weight (mg)	Biomass[2] Weight (mg)	Average[1] Weight (mg)	Biomass[2] Weight (mg)	Average[1] Weight (mg)	Biomass[2] Weight (mg)
1	1.01500	1.01500	1.03300	1.03300	1.47111	1.47111	1.07600	1.07600	1.65857	1.16100	0.79000	0.63200
2	1.30875	1.04700	1.37375	1.09900	1.31222	1.18100	1.23500	1.23500	1.61875	1.29500	0.78250	0.62600
3	1.33625	1.06900	1.34600	1.34600	1.52556	1.37300	1.22667	1.10400	1.56167	0.93700	0.68400	0.68400
4	1.11125	0.88900	1.13800	1.13800	1.25667	1.25667	1.25125	1.00100	1.60875	1.28700	0.62778	0.56500
5	1.19500	1.19500	1.45125	1.16100	2.80286	1.96200	1.30250	1.04200	2.53800	1.58625	0.74200	0.74200
6	1.10900	1.10900	1.35375	1.08300	1.34800	1.34800	1.16000	1.16000	1.89167	1.41875	0.72100	0.72100
7	1.26333	1.13700	1.20000	1.20000	1.29556	1.16600	1.67556	1.50800	1.47571	1.03300	0.75600	0.75600
8	1.35667	1.22100	1.44600	1.44600	1.21700	1.21700	0.79000	0.71100	1.93500	1.54800	0.75889	0.68300
Average[1] Ash-Free-Dry Weight (AFDW) (mg)	a,d,e **1.21191**		d,e **1.29272**		**1.52862**		d **1.21462**		**1.78601**		**0.73277**	
Biomass[2] Weight (AFDW) (mg)		a,b,d,e **1.08525**		a **1.18825**		**1.37185**		a,b **1.10463**		**1.28325**		**0.67613**
10-Day Percent Survival	a **90.0**		**92.5**		**92.5**		**91.3**		a,b,c **73.8**		**92.5**	

Note: Average Ash-Free-Dry Weight (AFDW) of *Chironomus dilutus* at test initiation = 0.17650 mg.

[1] Average Ash-Free-Dry-Weight (AFDW) is the total ash-free-dry weight of surviving organisms

[2] Biomass weight is the total Ash-Free-Dry-Weight of surviving organisms divided by the initial number of organisms.

[a] Significantly different ($p < 0.05$) from laboratory control CS#129.

[b] Significantly different ($p < 0.05$) from reference site SD-45 (GLC Number: 10,589).

[c] Significantly different ($p < 0.05$) from reference site SD-46 (GLC Number: 10,590).

[d] Significantly different ($p < 0.05$) from reference site LM-08-13 (GLC Number: 10,591).

[e] Significantly different ($p < 0.05$) from combined reference sites: SD-45, SD-46, and LM-08-13.

TABLE 3.
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Comparison of Number of Surviving *Hyalella azteca* per Replicate[r] and Percent Survival between the Following; Laboratory Control Sediment and the Investigative Sediments Samples; *Hyalella azteca* 10-Day Whole Sediment Toxicity Tests Conducted August 11-August 21, 2015; AECOM Lake Macatawa (BASF).

Replicate Number GLC Number	Laboratory Control CS# 129	SD-25 10,579	SD-30 10,580	SD-32 10,581	SD-39 10,582	SD-40 10,583	SD-50 10,584
1	10	9	10	10	10	9	10
2	10	9	8	8	9	10	8
3	10	10	9	10	9	10	10
4	10	10	10	10	9	9	10
5	9	10	9	10	9	9	10
6	8	9	9	9	10	10	10
7	10	10	9	8	10	10	10
8	8	9	10	8	9	10	10
10-Day Whole Sediment Toxicity Test Percent Survival[r]	**93.8**	**95.0**[c]	**92.5**[c,d,e]	**91.3**[c,d,e]	**93.8**[c,d]	**96.3**[c]	**97.5**

[r] Replicates initiated with 10 organisms each

[a] Significantly different ($p < 0.05$) from laboratory control CS#129.

[b] Significantly different ($p < 0.05$) from reference site SD-45 (GLC Number: 10,589).

[c] Significantly different ($p < 0.05$) from reference site SD-46 (GLC Number: 10,590).

[d] Significantly different ($p < 0.05$) from reference site LM-08-13 (GLC Number: 10,591).

[e] Significantly different ($p < 0.05$) from combined reference sites: SD-45, SD-46, and LM-08-13.

TABLE 3.
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Comparison of Number of Surviving *Hyalella azteca* per Replicate[r] and Percent Survival between the Following; Laboratory Control Sediment and the Investigative Sediments Samples; *Hyalella azteca* 10-Day Whole Sediment Toxicity Tests Conducted August 11-August 21, 2015; AECOM Lake Macatawa (BASF).

Replicate Number GLC Number	SD-54 10,585	SD-55 10,586	SD-58 10,587	SD-59 10,588	SD-45 10,589	SD-46 10,590	LM-08-13 10,591	Water Only Secondary Control
1	9	8	10	9	8	10	10	10
2	8	10	9	9	10	10	10	10
3	9	10	10	8	10	10	10	10
4	10	10	10	9	9	10	10	10
5	10	10	8	9	10	T.E.	10	10
6	10	10	10	10	9	10	10	10
7	9	8	10	10	9	10	9	10
8	10	10	10	10	9	10	10	10
10-Day Whole Sediment Toxicity Test Percent Survival[r]	[c] **93.8**	**95.0**	**96.3**	[c,d,e] **92.5**	[c,d] **92.5**	**100.0**	**98.8**	**100.0**

[r] Replicates initiated with 10 organisms each

[a] Significantly different ($p < 0.05$) from laboratory control CS#129.

[b] Significantly different ($p < 0.05$) from reference site SD-45 (GLC Number: 10,589).

[c] Significantly different ($p < 0.05$) from reference site SD-46 (GLC Number: 10,590).

[d] Significantly different ($p < 0.05$) from reference site LM-08-13 (GLC Number: 10,591).

[e] Significantly different ($p < 0.05$) from combined reference sites: SD-45, SD-46, and LM-08-13.

T.E.: Technician Error

TABLE 4
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Comparison of Average[1] Dry Weight (mg), Biomass[2] (mg) and Percent Survival between the Following; Laboratory Control Sediment and the Investigative Sediments Samples; *Hyalella azteca* 10-Day Whole Sediment Toxicity Tests Conducted August 11-August 21, 2015; AECOM Lake Macatawa (BASF).

GLC Number	Laboratory Control CS#129		SD-25 10,579		SD-30 10,580		SD-32 10,581		SD-39 10,582	
Replicate Number	Average[1] Weight (mg)	Biomass[2] Weight (mg)	Average[1] Weight (mg)	Biomass[2] Weight (mg)	Average[1] Weight (mg)	Biomass[2] Weight (mg)	Average[1] Weight (mg)	Biomass[2] Weight (mg)	Average[1] Weight (mg)	Biomass[2] Weight (mg)
1	0.12800	0.12800	0.10778	0.09700	0.07500	0.07500	0.11900	0.11900	0.10000	0.10000
2	0.13000	0.13000	0.06222	0.05600	0.08000	0.06400	0.09875	0.07900	0.09667	0.08700
3	0.12600	0.12600	0.11100	0.11100	0.08667	0.07800	0.08500	0.08500	0.10000	0.09000
4	0.11900	0.11900	0.11100	0.11100	0.07200	0.07200	0.11200	0.11200	0.11889	0.10700
5	0.12444	0.11200	0.11400	0.11400	0.07556	0.06800	0.17500	0.17500	0.12000	0.10800
6	0.12000	0.09600	0.10333	0.09300	0.06556	0.05900	0.10111	0.09100	0.09100	0.09100
7	0.07000	0.07000	0.11300	0.11300	0.10111	0.09100	0.12875	0.10300	0.08500	0.08500
8	0.13375	0.10700	0.12778	0.11500	0.08000	0.08000	0.12250	0.09800	0.11333	0.10200
Average[1] Dry Weight (mg)	**0.11890**		**[d,e] 0.10626**		**[a,b,c,d,e] 0.07949**		**0.11776**		**[a,d,e] 0.10311**	
Average Biomass[2] Weight (mg)		**0.11100**		**[d,e] 0.10125**		**[a,b,c,d,e] 0.07338**		**[d] 0.10775**		**[a, d,e] 0.09625**
10-Day Percent Survival	**93.8**		**[c] 95.0**		**92.5**	**[c,d,e]**	**91.3**	**[c,d,e]**	**93.8**	**[c,d]**

Note: Average Dry Weight of *Hyallela azteca* at test initiation = 0.03363 mg.

[1] Average Dry Weight is the total dry weight of surviving organisms

[2] Biomass weight is the total dry weight of surviving organisms divided by the initial number of organisms.

[a] Significantly different ($p < 0.05$) from laboratory control CS#129.

[b] Significantly different ($p < 0.05$) from reference site SD-45 (GLC Number: 10,589).

[c] Significantly different ($p < 0.05$) from reference site SD-46 (GLC Number: 10,590).

[d] Significantly different ($p < 0.05$) from reference site LM-08-13 (GLC Number: 10,591).

[e] Significantly different ($p < 0.05$) from combined reference sites: SD-45, SD-46, and LM-08-13.

TABLE 4
(page 2 of 3)

Comparison of Average[1] Dry Weight (mg), Biomass[2] (mg) and Percent Survival between the Following; Laboratory Control Sediment and the Investigative Sediments Samples; *Hyalella azteca* 10-Day Whole Sediment Toxicity Tests Conducted August 11-August 21, 2015; AECOM Lake Macatawa (BASF).

GLC Number	SD-40 10,583		SD-50 10,584		SD-54 10,585		SD-55 10,586	
Replicate Number	**Average[1] Weight (mg)**	**Biomass[2] Weight (mg)**	**Average[1] Weight (mg)**	**Biomass[2] Weight (mg)**	**Average[1] Weight (mg)**	**Biomass[2] Weight (mg)**	**Average[1] Weight (mg)**	**Biomass[2] Weight (mg)**
1	0.11444	0.10300	0.09800	0.09800	0.12333	0.11100	0.09250	0.07400
2	0.10000	0.10000	0.10875	0.08700	0.11000	0.08800	0.10200	0.10200
3	0.10500	0.10500	0.10500	0.10500	0.12222	0.11000	0.10400	0.10400
4	0.12000	0.10800	0.10700	0.10700	0.12000	0.12000	0.10800	0.10800
5	0.09778	0.08800	0.09700	0.09700	0.12200	0.12200	0.12300	0.12300
6	0.07700	0.07700	0.09900	0.09900	0.13100	0.13100	0.11100	0.11100
7	0.10200	0.10200	0.10500	0.10500	0.11667	0.10500	0.12875	0.10300
8	0.11100	0.11100	0.08100	0.08100	0.11100	0.11100	0.14400	0.14400
Average[1] Dry Weight (mg)	a,d,e **0.10340**		a,d,e **0.10009**		d **0.11953**		d **0.11416**	
Average Biomass[2] Weight (mg)		d,e **0.09925**		d,e **0.09737**		d **0.11225**		d **0.10863**
10-Day Percent Survival	c **96.3**		**97.5**		c **93.8**		**95.0**	

Note: Average Dry Weight of *Hyallela azteca* at test initiation = 0.03363 mg.

[1] Average Dry Weight is the total dry weight of surviving organisms

[2] Biomass weight is the total dry weight of surviving organisms divided by the initial number of organisms.

[a] Significantly different ($p < 0.05$) from laboratory control CS#129.

[b] Significantly different ($p < 0.05$) from reference site SD-45 (GLC Number: 10,589).

[c] Significantly different ($p < 0.05$) from reference site SD-46 (GLC Number: 10,590).

[d] Significantly different ($p < 0.05$) from reference site LM-08-13 (GLC Number: 10,591).

[e] Significantly different ($p < 0.05$) from combined reference sites: SD-45, SD-46, and LM-08-13.

TABLE 4 (page 3 of 3) **Comparison of Average[1] Dry Weight (mg), Biomass[2] (mg) and Percent Survival between the Following; Laboratory Control Sediment and the Investigative Sediments Samples; *Hyalella azteca* 10-Day Whole Sediment Toxicity Tests Conducted August 11-August 21, 2015; AECOM Lake Macatawa (BASF).**

GLC Number	SD-58 10,587		SD-59 10,588		SD-45 10,589		SD-46 10,590		LM-08-13 10,591		Water Only Secondary Control	
Replicate Number	Average[1] Weight (mg)	Biomass[2] Weight (mg)	Average[1] Weight (mg)	Biomass[2] Weight (mg)	Average[1] Weight (mg)	Biomass[2] Weight (mg)	Average[1] Weight (mg)	Biomass[2] Weight (mg)	Average[1] Weight (mg)	Biomass[2] Weight (mg)	Average[1] Weight (mg)	Biomass[2] Weight (mg)
1	0.09200	0.09200	0.11667	0.10500	0.23625	0.18900	0.12800	0.12800	0.12100	0.12100	0.11200	0.11200
2	0.10000	0.09000	0.11222	0.10100	0.09700	0.09700	0.11500	0.11500	0.14100	0.14100	0.11300	0.11300
3	0.13100	0.13100	0.11375	0.09100	0.10900	0.10900	0.12600	0.12600	0.15000	0.15000	0.12200	0.12200
4	0.12900	0.12900	0.11333	0.10200	0.11000	0.09900	T.E.	T.E.	0.11800	0.11800	0.10700	0.10700
5	0.12125	0.09700	0.11778	0.10600	0.09900	0.09900	0.07300	0.07300	0.13400	0.13400	0.08500	0.08500
6	0.11700	0.11700	0.13200	0.13200	0.11889	0.10700	0.10200	0.10200	0.12800	0.12800	0.09200	0.09200
7	0.11300	0.11300	0.12600	0.12600	0.09444	0.08500	0.10500	0.10500	0.14333	0.12900	0.12100	0.12100
8	0.09800	0.09800	0.12000	0.12000	0.12111	0.10900	0.12000	0.12000	0.14300	0.14300	0.10200	0.10200
Average[1] Dry Weight (mg)	**0.11266**[d]		**0.11897**[d]		**0.12321**		**0.10986**[d]		**0.13479**		**0.10675**	
Average Biomass[2] Weight (mg)		**0.10837**[d]		**0.11038**[d]		**0.11175**		**0.10986**[d]		**0.13300**		**0.10675**
10-Day Percent Survival	**96.3**		**92.5**[c,d,e]		**92.5**[c,d]		**100.0**		**98.8**		**100.0**	

Note: Average Dry Weight of *Hyallela azteca* at test initiation = 0.03363 mg.

[1] Average Dry Weight is the total dry weight of surviving organisms

[2] Biomass weight is the total dry weight of surviving organisms divided by the initial number of organisms.

[a] Significantly different ($p < 0.05$) from laboratory control CS#129.

[b] Significantly different ($p < 0.05$) from reference site SD-45 (GLC Number: 10,589).

[c] Significantly different ($p < 0.05$) from reference site SD-46 (GLC Number: 10,590).

[d] Significantly different ($p < 0.05$) from reference site LM-08-13 (GLC Number: 10,591).

[e] Significantly different ($p < 0.05$) from combined reference sites: SD-45, SD-46, and LM-08-13.

T.E.: Technician Error

TABLE 5. Summary of Mean Water Quality Parameters of Overlying Water Collected Prior to Renewal; *Chironomus dilutus* 10-Day Whole Sediment Toxicity Tests Conducted August 11-August 21, 2015; AECOM Lake Macatawa (BASF).

Sample ID GLC No.	Temperature (°C) (range) n=22	pH (s.u.) (range) n=4	Dissolved Oxygen (mg/L) (range) n=22	Specific Conductivity (µmhos/cm) (range) n=4	Hardness (CaCO3 mg/L) (range) n=2, n=3 GLC No. 10583, 10,586, n=4 GLC No. 10,591	Alkalinity (CaCO3 mg/L) (range) n=2, n=4 GLC No. 10,586, 10,591	Ammonia (mg/L as N) (range) n=2, n=3 GLC No. 10583, 10,584, n=4 GLC No. 10,591
Laboratory Control CS#129	**22.6** (22.3-22.9)	**7.55** (7.43-7.66)	**3.9** (1.9-6)	**318** (310-322)	**148** (140-156)	**110** (108-112)	**0.78** (0.37-1.19)
Water Only Control NA	**22.6** (22.3-22.9)	**7.88** (7.68-8.1)	**6.3** (4.6-8.7)	**300** (292.5-307)	**118** (112-124)	**99** (98-100)	**0.42** (0.11-0.72)
SD-25 10579	**22.6** (22.4-22.8)	**7.69** (7.58-7.79)	**4.3** (2.8-6.8)	**338** (331-348)	**138** (136-140)	**106** (104-108)	**0.47** (0.37-0.57)
SD-30 10580	**22.6** (22.1-22.8)	**7.58** (7.53-7.63)	**5.0** (4-6.5)	**350** (308-391)	**136** (136-136)	**110** (104-116)	**2.22** (1.33-3.1)
SD-32 10581	**22.5** (22.1-22.8)	**7.56** (7.53-7.58)	**4.6** (2.8-6)	**366** (323-414)	**138** (136-140)	**114** (102-126)	**2.16** (0.94-3.37)
SD-39 10582	**22.5** (22.2-22.8)	**7.65** (7.59-7.79)	**4.5** (3.1-6.3)	**373** (338-410)	**138** (136-140)	**119** (112-126)	**2.61** (1.59-3.62)
SD-40 10583	**22.5** (22.1-22.8)	**7.56** (7.48-7.61)	**4.9** (3.6-6.2)	**357** (325-392)	**139** (132-148)	**115** (104-126)	**1.95** (1.14-3.52)
SD-50 10584	**22.5** (22.1-22.8)	**7.65** (7.55-7.75)	**4.7** (3.5-6.8)	**359** (331-385)	**140** (140-140)	**114** (106-122)	**2.35** (0.77-3.16)
SD-54 10585	**22.4** (22.1-22.8)	**7.58** (7.57-7.59)	**4.4** (3.1-6.3)	**356** (318-397)	**140** (140-140)	**117** (108-126)	**2.08** (1.03-3.12)
SD-55 10586	**22.4** (22.1-22.8)	**7.63** (7.57-7.7)	**4.6** (3.3-6.5)	**370** (339-404)	**145** (136-152)	**119** (106-132)	**2.23** (1-3.46)
SD-58 10587	**22.4** (22.1-22.8)	**7.58** (7.52-7.63)	**4.4** (2.7-6.2)	**354** (319-396)	**144** (144-144)	**112** (102-122)	**1.88** (1.21-2.55)
SD-59 10588	**22.9** (22.6-23.5)	**7.60** (7.55-7.65)	**4.2** (2.8-6.4)	**357** (317-392)	**142** (140-144)	**121** (106-136)	**1.94** (1.15-2.72)
SD-45 10589	**23.0** (22.8-23.6)	**7.63** (7.5-7.74)	**4.5** (3.2-7)	**364** (324-411)	**158** (152-164)	**119** (104-134)	**1.35** (0.46-2.24)
SD-46 10590	**23.0** (22.6-23.7)	**7.73** (7.62-7.81)	**5.2** (3.7-7)	**322** (317-330)	**136** (136-136)	**107** (104-110)	**0.47** (0.42-0.51)
LM-08-13 10591	**23.1** (22.8-23.7)	**7.66** (7.51-7.74)	**4.4** (2.7-6.9)	**342** (324-365)	**136** (132-140)	**109** (106-112)	**0.63** (0.44-0.82)

n=Number of observations

TABLE 6. Summary of Mean Water Quality Parameters of Overlying Water Collected Prior to Renewal; *Hyalella azteca* 10-Day Whole Sediment Toxicity Tests Conducted August 11-August 21, 2015; AECOM Lake Macatawa (BASF).

Sample ID GLC No.	**Temperature (°C)** (range) n=22	**pH (s.u.)** (range) n=4	**Dissolved Oxygen (mg/L)** (range) n=22	**Specific Conductivity (µmhos/cm)** (range) n=4	**Hardness (CaCO3 mg/L)** (range) n=2, n=3 GLC No. 10582, n=4 GLC No. 10,591	**Alkalinity (CaCO3 mg/L)** (range) n=2, n=3 GLC No. 10581, n=4 GLC No. 10,591	**Ammonia (mg/L as N)** (range) n=2, n=3 GLC No. 10583, 10,584, n=4 GLC No. 10,591
Laboratory Control CS#129	**22.6** (22.1-23)	**7.63** (7.57-7.69)	**5.4** (4.6-6.4)	**316** (310-319)	**144** (140-148)	**116** (112-120)	**0.68** (0.37-0.98)
Water Only Control NA	**22.7** (22.2-23.2)	**8.00** (7.9-8.05)	**7.4** (6.9-8.2)	**300** (293.4-306)	**126** (124-128)	**99** (98-100)	**0.40** (0.11-0.68)
SD-25 10579	**22.7** (22.3-23.2)	**8.06** (7.77-8.38)	**6.0** (5.3-6.5)	**344** (339-349)	**146** (136-156)	**111** (108-114)	**0.42** (0.37-0.46)
SD-30 10580	**22.7** (22.3-23.1)	**7.60** (7.57-7.63)	**5.8** (5.2-6.4)	**340** (303-379)	**132** (128-136)	**106** (96-116)	**1.77** (0.44-3.1)
SD-32 10581	**22.6** (22.3-22.9)	**7.95** (7.51-8.33)	**5.7** (4.9-6.3)	**363** (328-401)	**140** (140-140)	**112** (104-126)	**1.97** (0.56-3.37)
SD-39 10582	**22.6** (22.2-23)	**8.06** (7.58-8.58)	**5.7** (4.8-6.3)	**363** (343-383)	**144** (136-148)	**121** (116-126)	**2.35** (1.07-3.62)
SD-40 10583	**22.6** (22.1-22.8)	**7.92** (7.58-8.26)	**5.6** (5.1-6.4)	**364** (328-402)	**148** (148-148)	**118** (110-126)	**1.64** (0.69-3.52)
SD-50 10584	**22.6** (22.1-22.9)	**8.16** (7.59-8.75)	**5.7** (5.1-6.3)	**358** (333-381)	**142** (140-144)	**118** (114-122)	**2.30** (0.63-3.16)
SD-54 10585	**22.7** (22.1-23)	**8.08** (7.58-8.58)	**5.6** (4.6-6.6)	**357** (330-379)	**148** (140-156)	**121** (116-126)	**1.84** (0.55-3.12)
SD-55 10586	**22.6** (22.1-23)	**8.07** (7.55-8.63)	**5.5** (4.2-6.4)	**366** (341-395)	**150** (148-152)	**127** (124-130)	**2.00** (0.54-3.46)
SD-58 10587	**22.5** (22-22.8)	**8.23** (7.6-8.86)	**5.8** (4.6-6.4)	**357** (334-383)	**144** (144-144)	**119** (116-122)	**1.68** (0.8-2.55)
SD-59 10588	**22.9** (22.4-23.5)	**7.97** (7.53-8.42)	**5.7** (4.9-6.8)	**358** (334-383)	**148** (144-152)	**126** (116-136)	**1.65** (0.58-2.72)
SD-45 10589	**23.0** (22.6-23.7)	**7.91** (7.66-8.23)	**5.9** (5.1-6.6)	**372** (323-433)	**158** (152-164)	**126** (118-134)	**1.33** (0.42-2.24)
SD-46 10590	**23.0** (22.6-23.7)	**7.92** (7.74-8.09)	**6.5** (6-7)	**322** (314-328)	**142** (136-148)	**107** (104-110)	**0.40** (0.28-0.51)
LM-08-13 10591	**23.0** (22.5-23.7)	**8.15** (7.67-8.66)	**6.0** (5.1-6.9)	**350** (343-361)	**149** (132-172)	**119** (110-126)	**0.57** (0.32-0.82)

n=Number of observations

Table 7. **Summary of Statistically Significant Differences (p< 0.05) Between the Following; Laboratory Control Sediment and the Investigative Sediments Samples; *Chironomus dilutus* 10-Day Whole Sediment Toxicity Tests Conducted August 11-August 21, 2015; AECOM Lake Macatawa (BASF).**

Sample ID GLC No.	10-Day Survival	10-Day Growth[1] (AFDW)	10-Day Biomass[2] (AFDW)
SD-25 10,579		**a,d,e**	**a,b**
SD-30 10,580	**a,b,c,d,e**	**a,b,c,d,e**	**a,b,c,d,e**
SD-32 10,581		**a,b,c,d,e**	**a,b,c,d,e**
SD-39 10,582	**a**	**a,b,d,e**	**a,b,d,e**
SD-40 10,583		**a,b,d,e**	**a,b,d,e**
SD-50 10,584		**a,b,c,d,e**	**a,b,c,d,e**
SD-54 10,585		**d,e**	
SD-55 10,586		**a,d,e**	**a**
SD-58 10,587	**a**	**a,d,e**	**a,b,d,e**
SD-59 10,588		**d,e**	**a**
SD-45 10,589			
SD-46 10,590		**d**	**a,b**
LM-08-13 10,591	**a,b,c**		

[1] Average Ash-Free-Dry-Weight (AFDW) is the total ash-free-dry weight of surviving organisms

[2] Biomass weight is the total Ash-Free-Dry-Weight of surviving organisms divided by the initial number of organisms

[a] Significantly different (p< 0.05) from laboratory control CS#129.

[b] Significantly different (p< 0.05) from reference site SD-45 (GLC Number: 10,589).

[c] Significantly different (p< 0.05) from reference site SD-46 (GLC Number: 10,590).

[d] Significantly different (p< 0.05) from reference site LM-08-13 (GLC Number: 10,591).

[e] Significantly different (p< 0.05) from combined reference sites: SD-45, SD-46, and LM-08-13.

Table 8. **Summary of Statistically Significant Differences (p< 0.05) Between the Following; Laboratory Control Sediment and the Investigative Sediments Samples; *Hyalella azteca* 10-Day Whole Sediment Toxicity Tests Conducted August 11-August 21, 2015; AECOM Lake Macatawa (BASF).**

Sample ID GLC No.	10-Day Survival	10-Day Growth[1]	10-Day Biomass[2]
SD-25 10,579	**c**	**d,e**	**d,e**
SD-30 10,580	**c,d,e**	**a,b,c,d,e**	**a,b,c,d,e**
SD-32 10,581	**c,d,e**		**d**
SD-39 10,582	**c,d**	**a,d,e**	**a,d,e**
SD-40 10,583	**c**	**a,d,e**	**d,e**
SD-50 10,584		**a,d,e**	**d,e**
SD-54 10,585	**c**	**d**	**d**
SD-55 10,586		**d**	**d**
SD-58 10,587		**d**	**d**
SD-59 10,588	**c,d,e**	**d**	**d**
SD-45 10,589	**c,d**		
SD-46 10,590		**d**	**d**
LM-08-13 10,591			

[1] Average Dry Weight is the total dry weight of surviving organisms

[2] Biomass weight is the total dry weight of surviving organisms divided by the initial number of organisms.

[a] Significantly different (p< 0.05) from laboratory control CS#129.

[b] Significantly different (p< 0.05) from reference site SD-45 (GLC Number: 10,589).

[c] Significantly different (p< 0.05) from reference site SD-46 (GLC Number: 10,590).

[d] Significantly different (p< 0.05) from reference site LM-08-13 (GLC Number: 10,591).

[e] Significantly different (p< 0.05) from combined reference sites: SD-45, SD-46, and LM-08-13.

Appendix A
Chain of Custodies

GLEC
Great Lakes Environmental Center

GREAT LAKES ENVIRONMENTAL CENTER, INC.

TRAVERSE CITY, MI - LABORATORY
739 Hastings Street
Traverse City, MI 49686

www.glec.com
Phone (231)941-2230
Fax (231)941-2240

CHAIN OF CUSTODY RECORD

Submitting Company: AECOM BASF
Report Results To: RANDY Ellis
Address:
Phone:
E-mail:

Project Name: AECOM BASF
Project Number: 2264-00
P.O.#:
Sampled by: DS initials
☒ GLEC ☐ Client

Requested Analysis: 10 day Sed tox

#	GLEC No.	Sample Identification	Sample Information Date	Time	Matrix	Grab or Composite	Preservative	Sample Containers Type	Size	No.
1	10579	SD-25	8/5/15	1120	Sed	GRAB	ICE	bucket 1gal	1gal	3
2	10580	SD-30	8/4/15							
3	10581	SD-32	8/4/15							
4	10582	SD-39	8/5/15	1155						
5	10583	SD-40	8/5/15	1215						
6	10584	SD-50	8/5/15	810						
7	10585	SD-54	8/5/15	1250						
8	10586	SD-55	8/5/15	1315	Sed	GRAB	ICE	bucket 1gal	1gal	3

Client Notes:

RELEASED BY / ORGANIZATION	DATE	TIME	RECEIVED BY / ORGANIZATION	DATE	TIME
Print Name & Organization: Dan Smith, GLEC	8/6/15	900	Print Name & Organization: Dan Smith GLEC	8/6/15	900
Signature: [signature]			Signature: [signature]		
Print Name & Organization			Print Name & Organization		
Signature			Signature		

FOR LAB USE ONLY
Temperature of Samples: 0.1 – 0.8 °C
☒ Received on Wet Ice
Notes/Anomalies/Discrepancies: none

MATRIX CODES:			
	S = SEDIMENT	E = EFFLUENT	WW = WASTEWATER	SL = SLUDGE
	SW = SURFACE WATER	GW = GROUNDWATER	BT = BIOLOGICAL TISSUE	AO = AQUATIC ORGANISM

GLEC
Great Lakes Environmental Center

GREAT LAKES ENVIRONMENTAL CENTER, INC.

CHAIN OF CUSTODY RECORD

TRAVERSE CITY, MI - LABORATORY
739 Hastings Street
Traverse City, MI 49686

www.glec.com
Phone (231)941-2230
Fax (231)941-2240

Submitting Company: AECOM BASF
Report Results To: RANDY Ellis
Address:
Phone:
E-mail:

Project Name: AECOM BASF
Project Number: 2264
P.O.#:
Sampled by: Initials
☒ GLEC DS ☐ Client

Requested Analysis: 10 day Sed tox

#	GLEC No.	Sample Identification	Sample Information Date	Time	Matrix	Grab or Composite	Preservative	Sample Containers Type	Size	No.
1	10587	SD-58	8/6/15	1405	Sed	G	Ice	Bucket	1 gal	3
2	10588	SD-59	8/6/15	1430						
3	10589	SD-45	8/6/15	1610						
4	10590	SD-46	8/6/15	1630						
5	10591	LM-08-13	8/6/15	1515	Sed	G	Ice	Bucket	1 gal	3
6										
7										
8										

Client Notes:

RELEASED BY / ORGANIZATION	DATE	TIME	RECEIVED BY / ORGANIZATION	DATE	TIME
Print Name & Organization: Dan Smith GLEC	8/6/15	900	Print Name & Organization: Dan Smith	8/6/15	900
Signature: [signature]			Signature: [signature]		
Print Name & Organization			Print Name & Organization		
Signature			Signature		

FOR LAB USE ONLY
Temperature of Samples: 0.1 - 0.8 °C
☒ Received on Wet Ice
Notes/Anomalies/Discrepancies: None

MATRIX CODES:	S = SEDIMENT	E = EFFLUENT	WW = WASTEWATER	SL = SLUDGE
	SW = SURFACE WATER	GW = GROUNDWATER	BT = BIOLOGICAL TISSUE	AO = AQUATIC ORGANISM

Sediment Sampling Field Sheet
AECOM BASF Lake Macatawa
Holland, MI

9 of 12 tubes
19 catchers
18 caps

Date: 8/4/15
GLEC Personnel: Dan Smith Mitch Mort
Weather (temperature, precipitation, etc.): 75 Sunny none
Project Number: 2264

Sample Designation	Latitude	Longitude	Water Depth (feet)	Soft Sediment Thickness (1.5" aluminum rod)	Percent Recovery	Penetration (feet)	Total Pipe Length (feet)	Sample Methodology (Gravity Corer/Ponar/Drive Core/Vibracore)	Core Sample Length (inches)	Core Tube Diameter (inches)	Core Tube Material (CAB, Lexan)	Field Observations	
SD-28	42.79487	86.12681	7.25	5'		9'	6	Drive Core	100"	4"	CAB	ORS silt sand coarse	0-65" 65-100"
SD-30	42.79457	86.12697	6.75	6.5'		11'	1	Drive Core / Ponar	121"	4"	CAB	ORS silt sand coarse	0-95" 95-121"
SD-31	42.79434	86.12700	7.5'	6'		10.5'		Drive Core	108"	4"	CAB	ORS/silt sand	0-96" 96-108"
SD 32	42.79420	86.12711	7.5	6'		10'		Drive core / Ponar	97"	4"	CAB	ORS/silt sand	0-94" 94-97"
SD 36	42.79432	86.12681	7.9	5.5'		12'		DRIVE CORE	122"	4"	CAB	ORS/silt dark silt + ORS lighter clay	0-90" 90-115" 115"-122"

1215

Great Lakes Environmental Center, Inc.
739 Hastings Street
Traverse City, Michigan 49686
Phone: 231.941.2230
Fax: 231.941.2240

Notes:

GLEC
Great Lakes Environmental Center

Sediment Sampling Field Sheet
AECOM BASF Lake Macatawa
Holland, MI

Date: 8/5/14
GLEC Personnel: Dan Smith Mitch MORT
Weather (temperature, precipitation, etc.): 70's Clear None
Project Number: 2264

Sample Designation	Latitude	Longitude	Water Depth (feet)	Soft Sediment Thickness (1.5" aluminum rod)	Percent Recovery	Penetration (feet)	Total Pipe Length (feet)	Sample Methodology (Gravity Corer/Ponar/Drive Core/Vibracore)	Core Sample Length (inches)	Core Tube Diameter (inches)	Core Tube Material (CAB, Lexan)	Field Observations	
SD-50	42.79504	86.12613	7.8	5'		8.5'		~~DRIVE CORE~~ PONAR	90"	4	CAB	Silt ORS 0-46" Sand Fine 46-90"	8:10
SD-53	42.79392	86.12614	8.25	6'		11'		DRIVE CORE	109"	4	CAB	Dark Silt ORS 0-70" Lighter silt ORS 70-109"	9:00
SD-25	42.79476	86.12714	6	3"	/	/	/	PONAR	/	/	/	SANDY/silt	1120
SD-39	42.70447	86.12618	7.5	6'	/	/	/	PONAR	/	/	/	Silt/ORS	1155
SD 40	42.79423	86.12627	8.25	6'	/	/	/	PONAR	/	/	/	silt/ORS	1215
SD 54	42.79362	86.12628	9.5'	5.5'	/	/	/	PONAR	/	/	/	silt/ORS	1250

Notes:

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Fax: 231.941.2240

GLEC
Great Lakes Environmental Center

Sediment Sampling Field Sheet
AECOM BASF Lake Macatawa
Holland, MI

Date: 8/5/15
GLEC Personnel: Dan Smith Mitch Mort
Weather (temperature, precipitation, etc.): SUNNY 70'S NOVE
Project Number: 2264

Sample Designation	Latitude	Longitude	Water Depth (feet)	Soft Sediment Thickness (1.8" aluminum rod)	Percent Recovery	Penetration (feet)	Total Pipe Length (feet)	Sample Methodology (Gravity Corer/Ponar/Drive Corer/Vibracore)	Core Sample Length (inches)	Core Tube Diameter (inches)	Core Tube Material (CAB, Lexan)	Field Observations	
SD 55	42. 79383	86. 12600	9.25'	5.25'	/	/	/	PONAR	/	/	/	silt ORS	1315
SD 58	42. 79451	86. 12530	9.5'	6'	/	/	/	PONAR	/	/	/	Silt ORS	1405
SD 59	42. 79401	86. 12540	9.5'	6'	/	/	/	PONAR	/	/	/	silt ORS	1430
LM-08 -13	42. 79897	86. 11407	5'	1'	/	/	/	PONAR	/	/	/	SAND woody, silt	1515
SD 45	42. 79827	86 10923	5'	2'	/	/	/	PONAR	/	/	/	SAND silt ORS	1610
SD 46	42. 79457	86. 11028	4.5'	1.5'	/	/	/	PONAR	/	/	/	SAND	1630

Notes:

Great Lakes Environmental Center, Inc.
739 Hastings Street
Traverse City, Michigan 49686
Phone: 231.941.2230
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GLEC
Great Lakes Environmental Center

Appendix B1
Overlying Water Quality Summaries

- *Chironomus dilutus*

Project Name: AECOM Macatawa
Project Number: 2264-00

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Chironomus dilutus*

100% Data Entry

Date	Initials	Data Entered
8/13/2015	MWG	day 0-2
8/18/2015	MWG	day 3-6
8/24/2015	DS	day 7-10 all

100% Data Quality Check

Date	Initials	Data QC'ed	Errors Found Y	Errors Corrected:Y
8/18/2015	ES	Day 0-6	N	
			Y: 10579	
8/26/2015	mwg	day 7-10	day 10	Y

100% Error Corrected Quality Check

Date	Initials	Data QC'ed
8/28/2015	KS	10579 day 10

Data QC 10%

Date	Initials	Data QC'ed
8/28/2015	KS	all

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID:
GLEC ID:

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Chironomus dilutus*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.7	7.66	6.0	322	140	112	0.37
		22.7	7.58	6.0	310			
12-Aug-15	1	22.6		4.3				
		22.6		4.4				
13-Aug-15	2	22.6		3.8				
		22.6		3.6				
14-Aug-15	3	22.4		2.5				
		22.5		2.9				
15-Aug-15	4	22.6		3.1				
		22.6		3.2				
16-Aug-15	5	22.5		4.5				
		22.6		4.1				
17-Aug-15	6	22.9		3.3				
		22.9		3.4				
18-Aug-15	7	22.6		4.8				
		22.6		3.6				
19-Aug-15	8	22.3		4.3				
		22.5		1.9				
20-Aug-15	9	22.4		4.0				
		22.5		3.3				
21-Aug-15	10	22.6	7.53	4.2	318	156	108	1.19
		22.6	7.43	4.1	322			
MEAN		**22.6**	**7.55**	**3.9**	**318.0**	**148.0**	**110.0**	**0.78**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.3**	**7.43**	**1.9**	**310**	**140**	**108**	**0.37**
Max #		**22.9**	**7.66**	**6.0**	**322**	**156**	**112**	**1.19**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID:
GLEC ID:

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Chironomus dilutus*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.7	8.03	8.3	293	124	98	0.11
		22.7	8.10	8.7	294			
12-Aug-15	1	22.6		6.6				
		22.7		7.1				
13-Aug-15	2	22.7		6.4				
		22.6		6.6				
14-Aug-15	3	22.5		4.6				
		22.6		5.1				
15-Aug-15	4	22.6		5.0				
		22.6		5.3				
16-Aug-15	5	22.6		6.7				
		22.6		6.9				
17-Aug-15	6	22.9		7.3				
		22.9		7.4				
18-Aug-15	7	22.6		5.9				
		22.7		6.0				
19-Aug-15	8	22.4		6.0				
		22.6		6.0				
20-Aug-15	9	22.3		5.9				
		22.5		5.5				
21-Aug-15	10	22.6	7.68	5.5	307	112	100	0.72
		22.7	7.70	6.0	306			
MEAN		**22.6**	**7.88**	**6.3**	**299.8**	**118.0**	**99.0**	**0.42**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.3**	**7.68**	**4.6**	**293**	**112**	**98**	**0.11**
Max #		**22.9**	**8.10**	**8.7**	**307**	**124**	**100**	**0.72**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-25**
GLEC ID: **10579**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Chironomus dilutus*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.8	7.74	6.8	343	136	108	0.37
		22.8	7.79	6.5	348			
12-Aug-15	1	22.6		4.5				
		22.6		4.6				
13-Aug-15	2	22.7		4.7				
		22.7		4.4				
14-Aug-15	3	22.4		2.8				
		22.5		3.3				
15-Aug-15	4	22.6		4.0				
		22.6		4.5				
16-Aug-15	5	22.7		4.9				
		22.7		4.6				
17-Aug-15	6	22.8		5.0				
		22.8		4.4				
18-Aug-15	7	22.4		3.8				
		22.7		3.8				
19-Aug-15	8	22.5		3.1				
		22.6		3.3				
20-Aug-15	9	22.4		3.7				
		22.5		3.7				
21-Aug-15	10	22.6	7.58	4.0	331	140	104	0.57
		22.6	7.65	4.3	331			
MEAN		**22.6**	**7.69**	**4.3**	**338.3**	**138.0**	**106.0**	**0.47**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.4**	**7.58**	**2.8**	**331**	**136**	**104**	**0.37**
Max #		**22.8**	**7.79**	**6.8**	**348**	**140**	**108**	**0.57**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-30**
GLEC ID: **10580**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Chironomus dilutus*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.7	7.63	6.5	389	136	116	3.10
		22.7	7.61	5.8	391			
12-Aug-15	1	22.6		4.9				
		22.6		4.8				
13-Aug-15	2	22.7		4.8				
		22.7		5.0				
14-Aug-15	3	22.2		4.0				
		22.1		4.4				
15-Aug-15	4	22.6		5.0				
		22.6		4.8				
16-Aug-15	5	22.7		4.8				
		22.7		4.7				
17-Aug-15	6	22.8		5.4				
		22.8		5.3				
18-Aug-15	7	22.6		4.9				
		22.7		5.2				
19-Aug-15	8	22.5		5.1				
		22.6		4.5				
20-Aug-15	9	22.4		4.4				
		22.5		4.8				
21-Aug-15	10	22.5	7.54	5.7	310	136	104	1.33
		22.5	7.53	5.3	308			
MEAN		**22.6**	**7.58**	**5.0**	**349.5**	**136.0**	**110.0**	**2.22**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.1**	**7.53**	**4.0**	**308**	**136**	**104**	**1.33**
Max #		**22.8**	**7.63**	**6.5**	**391**	**136**	**116**	**3.10**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-32**
GLEC ID: **10581**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Chironomus dilutus*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.7	7.58	6.0	402	140	126	3.37
		22.6	7.58	5.8	414			
12-Aug-15	1	22.6		4.7				
		22.6		4.9				
13-Aug-15	2	22.6		4.9				
		22.7		4.9				
14-Aug-15	3	22.2		3.6				
		22.1		4.2				
15-Aug-15	4	22.3		3.0				
		22.4		5.0				
16-Aug-15	5	22.7		4.4				
		22.7		4.6				
17-Aug-15	6	22.8		6.0				
		22.8		5.5				
18-Aug-15	7	22.5		4.2				
		22.6		4.3				
19-Aug-15	8	22.6		3.4				
		22.6		2.8				
20-Aug-15	9	22.3		4.6				
		22.3		4.3				
21-Aug-15	10	22.4	7.53	5.3	324	136	102	0.94
		22.4	7.53	3.9	323			
MEAN		**22.5**	**7.56**	**4.6**	**365.8**	**138.0**	**114.0**	**2.16**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.1**	**7.53**	**2.8**	**323**	**136**	**102**	**0.94**
Max #		**22.8**	**7.58**	**6.0**	**414**	**140**	**126**	**3.37**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-39**
GLEC ID: **10582**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Chironomus dilutus*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.6	7.59	6.3	400	136	126	3.62
		22.5	7.59	6.0	410			
12-Aug-15	1	22.5		5.3				
		22.6		4.8				
13-Aug-15	2	22.5		3.8				
		22.6		4.2				
14-Aug-15	3	22.3		3.7				
		22.3		3.8				
15-Aug-15	4	22.4		4.9				
		22.3		4.4				
16-Aug-15	5	22.6		4.1				
		22.6		4.6				
17-Aug-15	6	22.7		5.8				
		22.8		5.5				
18-Aug-15	7	22.5		4.6				
		22.6		4.2				
19-Aug-15	8	22.5		4.1				
		22.6		3.1				
20-Aug-15	9	22.3		4.4				
		22.4		4.3				
21-Aug-15	10	22.2	7.61	3.7	343	140	112	1.59
		22.3	7.79	3.8	338			
MEAN		**22.5**	**7.65**	**4.5**	**372.8**	**138.0**	**119.0**	**2.61**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.2**	**7.59**	**3.1**	**338**	**136**	**112**	**1.59**
Max #		**22.8**	**7.79**	**6.3**	**410**	**140**	**126**	**3.62**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-40**
GLEC ID: **10583**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Chironomus dilutus*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.7	7.56	6.2	392	148	126	3.52
		22.6	7.58	6.2	384			
12-Aug-15	1	22.6		5.0				
		22.6		4.7				
13-Aug-15	2	22.5		4.8				
		22.5		5.3				
14-Aug-15	3	22.1		4.5				
		22.3		4.1				
15-Aug-15	4	22.1		5.2				
		22.1		4.7				
16-Aug-15	5	22.5		4.9				
		22.5		5.0				
17-Aug-15	6	22.8		5.4				
		22.8		5.1				
18-Aug-15	7	22.6		4.7				
		22.6		4.1				
19-Aug-15	8	22.5		4.1				
		22.6		3.6				
20-Aug-15	9	22.3		5.4				
		22.3		4.8				
21-Aug-15	10	22.3	7.61	5.6	328	132	104	1.14
		22.3	7.48	4.4	325	136		1.18
MEAN		**22.5**	**7.56**	**4.9**	**357.3**	**138.7**	**115.0**	**1.95**
N=		**22**	**4**	**22**	**4**	**3**	**2**	**3**
Min #		**22.1**	**7.48**	**3.6**	**325**	**132**	**104**	**1.14**
Max #		**22.8**	**7.61**	**6.2**	**392**	**148**	**126**	**3.52**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-50**
GLEC ID: **10584**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Chironomus dilutus*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.7	7.55	6.8	381	140	122	3.12
		22.6	7.62	5.8	385			3.16
12-Aug-15	1	22.5		4.8				
		22.6		4.9				
13-Aug-15	2	22.5		5.1				
		22.5		5.2				
14-Aug-15	3	22.3		3.9				
		22.2		3.9				
15-Aug-15	4	22.2		4.4				
		22.3		4.5				
16-Aug-15	5	22.5		5.0				
		22.5		5.0				
17-Aug-15	6	22.8		5.9				
		22.8		5.6				
18-Aug-15	7	22.7		4.7				
		22.6		4.8				
19-Aug-15	8	22.5		3.6				
		22.6		3.5				
20-Aug-15	9	22.4		5.1				
		22.4		3.8				
21-Aug-15	10	22.2	7.69	3.7	331	140	106	0.77
		22.1	7.75	3.8	338			
MEAN		**22.5**	**7.65**	**4.7**	**358.8**	**140.0**	**114.0**	**2.35**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**3**
Min #		**22.1**	**7.55**	**3.5**	**331**	**140**	**106**	**0.77**
Max #		**22.8**	**7.75**	**6.8**	**385**	**140**	**122**	**3.16**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-54**
GLEC ID: **10585**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Chironomus dilutus*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.5	7.57	6.2	383	140	126	3.12
		22.5	7.59	6.3	397			
12-Aug-15	1	22.6		4.6				
		22.4		4.3				
13-Aug-15	2	22.6		5.2				
		22.5		5.0				
14-Aug-15	3	22.3		3.6				
		22.1		4.0				
15-Aug-15	4	22.3		4.2				
		22.3		4.2				
16-Aug-15	5	22.4		4.4				
		22.4		4.6				
17-Aug-15	6	22.7		5.7				
		22.8		5.1				
18-Aug-15	7	22.5		3.5				
		22.5		3.3				
19-Aug-15	8	22.5		3.4				
		22.6		3.4				
20-Aug-15	9	22.3		4.3				
		22.3		3.1				
21-Aug-15	10	22.2	7.58	4.2	326	140	108	1.03
		22.1	7.57	3.2	318			
MEAN		**22.4**	**7.58**	**4.4**	**356.0**	**140.0**	**117.0**	**2.08**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.1**	**7.57**	**3.1**	**318**	**140**	**108**	**1.03**
Max #		**22.8**	**7.59**	**6.3**	**397**	**140**	**126**	**3.12**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-55**
GLEC ID: **10586**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Chironomus dilutus*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.5	7.57	6.4	404	148	130	3.46
		22.6	7.60	6.5	399	152	132	
12-Aug-15	1	22.4		4.6				
		22.4		4.5				
13-Aug-15	2	22.5		5.1				
		22.6		4.8				
14-Aug-15	3	22.2		4.8				
		22.2		3.7				
15-Aug-15	4	22.2		5.1				
		22.3		4.7				
16-Aug-15	5	22.3		5.2				
		22.3		5.0				
17-Aug-15	6	22.7		5.8				
		22.8		5.4				
18-Aug-15	7	22.4		3.9				
		22.6		3.9				
19-Aug-15	8	22.6		3.4				
		22.6		3.3				
20-Aug-15	9	22.3		3.4				
		22.4		3.7				
21-Aug-15	10	22.1	7.66	3.9	339	136	106	1.00
		22.1	7.70	4.1	339		108	
MEAN		**22.4**	**7.63**	**4.6**	**370.3**	**145.3**	**119.0**	**2.23**
N=		**22**	**4**	**22**	**4**	**3**	**4**	**2**
Min #		**22.1**	**7.57**	**3.3**	**339**	**136**	**106**	**1.00**
Max #		**22.8**	**7.70**	**6.5**	**404**	**152**	**132**	**3.46**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-58**
GLEC ID: **10587**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Chironomus dilutus*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.5	7.62	6.2	396	144	122	2.55
		22.6	7.63	6.1	379			
12-Aug-15	1	22.4		4.9				
		22.5		4.4				
13-Aug-15	2	22.6		5.1				
		22.6		4.8				
14-Aug-15	3	22.1		3.9				
		22.1		4.6				
15-Aug-15	4	22.3		4.2				
		22.3		4.4				
16-Aug-15	5	22.2		4.4				
		22.2		4.7				
17-Aug-15	6	22.8		5.8				
		22.8		5.6				
18-Aug-15	7	22.5		3.8				
		22.6		4.1				
19-Aug-15	8	22.6		3.4				
		22.6		3.3				
20-Aug-15	9	22.3		4.0				
		22.3		4.3				
21-Aug-15	10	22.1	7.52	3.0	323	144	102	1.21
		22.3	7.55	2.7	319			
MEAN		**22.4**	**7.58**	**4.4**	**354.3**	**144.0**	**112.0**	**1.88**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.1**	**7.52**	**2.7**	**319**	**144**	**102**	**1.21**
Max #		**22.8**	**7.63**	**6.2**	**396**	**144**	**122**	**2.55**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-59**
GLEC ID: **10588**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Chironomus dilutus*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.9	7.65	6.4	388	144	136	2.72
		22.9	7.63	6.4	392			
12-Aug-15	1	23.5		4.4				
		23.5		4.4				
13-Aug-15	2	23.0		4.4				
		23.1		4.8				
14-Aug-15	3	22.7		3.8				
		22.8		3.5				
15-Aug-15	4	22.6		3.9				
		22.7		4.2				
16-Aug-15	5	22.7		4.7				
		22.8		4.6				
17-Aug-15	6	23.2		4.8				
		23.2		4.8				
18-Aug-15	7	22.7		3.5				
		22.8		3.6				
19-Aug-15	8	23.0		3.5				
		23.1		3.5				
20-Aug-15	9	22.6		3.1				
		22.9		3.6				
21-Aug-15	10	22.7	7.55	3.0	317	140	106	1.15
		22.9	7.58	2.8	329			
MEAN		**22.9**	**7.60**	**4.2**	**356.5**	**142.0**	**121.0**	**1.94**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.6**	**7.55**	**2.8**	**317**	**140**	**106**	**1.15**
Max #		**23.5**	**7.65**	**6.4**	**392**	**144**	**136**	**2.72**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-45**
GLEC ID: **10589**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Chironomus dilutus*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	23.0	7.66	7.0	395	152	134	2.24
		22.9	7.74	6.7	411			
12-Aug-15	1	23.6		4.2				
		23.6		4.3				
13-Aug-15	2	23.0		4.4				
		23.1		4.3				
14-Aug-15	3	22.9		3.2				
		23.0		3.3				
15-Aug-15	4	22.9		4.2				
		22.9		4.6				
16-Aug-15	5	22.8		5.1				
		22.9		5.2				
17-Aug-15	6	23.2		5.4				
		23.3		5.0				
18-Aug-15	7	22.8		3.8				
		23.0		4.0				
19-Aug-15	8	23.0		4.0				
		23.1		4.2				
20-Aug-15	9	23.0		4.6				
		23.0		4.8				
21-Aug-15	10	23.0	7.61	3.9	324	164	104	0.46
		23.0	7.50	3.8	326			
MEAN		**23.0**	**7.63**	**4.5**	**364.0**	**158.0**	**119.0**	**1.35**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.8**	**7.50**	**3.2**	**324**	**152**	**104**	**0.46**
Max #		**23.6**	**7.74**	**7.0**	**411**	**164**	**134**	**2.24**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-46**
GLEC ID: **10590**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Chironomus dilutus*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	23.0	7.80	7.0	323	136	110	0.51
		22.9	7.81	6.6	330			
12-Aug-15	1	23.7		4.5				
		23.7		4.4				
13-Aug-15	2	23.1		4.4				
		23.1		4.6				
14-Aug-15	3	22.9		3.7				
		23.0		3.8				
15-Aug-15	4	22.9		5.0				
		23.0		5.3				
16-Aug-15	5	22.9		6.1				
		22.9		5.7				
17-Aug-15	6	23.2		6.3				
		23.2		6.2				
18-Aug-15	7	23.0		4.8				
		23.0		4.8				
19-Aug-15	8	22.6		6.2				
		22.9		4.5				
20-Aug-15	9	22.9		5.3				
		23.0		5.4				
21-Aug-15	10	23.0	7.62	4.9	318	136	104	0.42
		23.0	7.67	4.9	317			
MEAN		**23.0**	**7.73**	**5.2**	**322.0**	**136.0**	**107.0**	**0.47**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.6**	**7.62**	**3.7**	**317**	**136**	**104**	**0.42**
Max #		**23.7**	**7.81**	**7.0**	**330**	**136**	**110**	**0.51**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **LM-08-13**
GLEC ID: **10591**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Chironomus dilutus*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.8	7.74	6.9	353	132	112	0.80
		22.9	7.72	6.4	365	132	110	0.82
12-Aug-15	1	23.7		5.2				
		23.7		4.5				
13-Aug-15	2	23.2		4.0				
		23.0		4.0				
14-Aug-15	3	22.9		3.0				
		22.8		3.4				
15-Aug-15	4	22.9		5.0				
		22.9		4.6				
16-Aug-15	5	22.9		4.3				
		22.9		4.4				
17-Aug-15	6	23.3		6.0				
		23.3		5.7				
18-Aug-15	7	23.0		3.9				
		23.1		4.1				
19-Aug-15	8	23.0		4.4				
		23.1		3.3				
20-Aug-15	9	22.9		3.8				
		22.9		4.1				
21-Aug-15	10	23.0	7.51	2.7	324	140	106	0.44
		22.9	7.66	3.5	324	140	108	0.46
MEAN		**23.1**	**7.66**	**4.4**	**341.5**	**136.0**	**109.0**	**0.63**
N=		**22**	**4**	**22**	**4**	**4**	**4**	**4**
Min #		**22.8**	**7.51**	**2.7**	**324**	**132**	**106**	**0.44**
Max #		**23.7**	**7.74**	**6.9**	**365**	**140**	**112**	**0.82**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Appendix B2
Overlying Water Quality Summaries

- *Hyalella azteca*

Project Name: AECOM Macatawa
Project Number: 2264-00

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Hyalella azteca*

100% Data Entry

Date	Initials	Data Entered
8/13/2015	MWG	day 0-2
8/18/2015	MWG	Day 3-6
8/24/2015	DS	Day 7-10 no ammonia
8/25/2015	DS	day 10 ammonia

100% Data Quality Check

Date	Initials	Data QC'ed	Errors Found; Y or N	Errors Corrected: Y or N
8/18/2015	ES	Day 0-6		
8/25/2015	mwg	day 7-10	Y:	Y
			10580 days 7/8	Y
			10582 day 8	Y
			10589 day9	Y

100% Error Corrected Quality Check

Date	Initials	Data QC'ed
8/27/2015	KS	10580 days 7/8
		10582 day 8
		10589 day9

Data QC 10%

Date	Initials	Data QC'ed
8/28/2015	KS	all

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID:
GLEC ID:

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Hyalella azteca*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.8	7.63	5.7	315	140	112	0.37
		22.9	7.57	6.0	310			
12-Aug-15	1	22.7		5.4				
		22.8		5.2				
13-Aug-15	2	22.5		5.5				
		22.6		5.6				
14-Aug-15	3	22.3		4.6				
		22.4		4.7				
15-Aug-15	4	23.0		4.9				
		22.6		5.4				
16-Aug-15	5	23.0		5.5				
		23.0		5.6				
17-Aug-15	6	22.7		5.9				
		22.8		5.9				
18-Aug-15	7	22.7		4.7				
		22.8		4.6				
19-Aug-15	8	22.5		6.0				
		22.5		5.5				
20-Aug-15	9	22.1		6.4				
		22.2		4.8				
21-Aug-15	10	22.3	7.64	5.5	319	148	120	0.98
		22.4	7.69	5.4	319			
MEAN		**22.6**	**7.63**	**5.4**	**315.8**	**144.0**	**116.0**	**0.68**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.1**	**7.57**	**4.6**	**310**	**140**	**112**	**0.37**
Max #		**23.0**	**7.69**	**6.4**	**319**	**148**	**120**	**0.98**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID:
GLEC ID:

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Hyalella azteca*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.9	7.90	7.4	297	124	98	0.11
		22.9	8.05	8.0	293			
12-Aug-15	1	22.8		7.2				
		22.9		7.6				
13-Aug-15	2	22.6		7.0				
		22.6		7.1				
14-Aug-15	3	22.6		6.9				
		22.6		7.0				
15-Aug-15	4	22.7		7.4				
		22.7		7.4				
16-Aug-15	5	23.1		7.5				
		23.2		7.8				
17-Aug-15	6	22.8		8.1				
		22.8		8.2				
18-Aug-15	7	22.8		7.1				
		23.0		7.2				
19-Aug-15	8	22.2		7.3				
		22.5		7.4				
20-Aug-15	9	22.6		7.3				
		22.7		7.4				
21-Aug-15	10	22.7	8.02	7.7	306	128	100	0.68
		22.7	8.04	7.5	306			
MEAN		**22.7**	**8.00**	**7.4**	**300.5**	**126.0**	**99.0**	**0.40**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.2**	**7.90**	**6.9**	**293**	**124**	**98**	**0.11**
Max #		**23.2**	**8.05**	**8.2**	**306**	**128**	**100**	**0.68**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-25**
GLEC ID: **10579**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Hyalella azteca*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.9	7.78	6.5	349	136	108	0.37
		22.9	7.77	6.5	347			
12-Aug-15	1	22.8		6.3				
		22.8		6.0				
13-Aug-15	2	22.6		6.5				
		22.6		6.1				
14-Aug-15	3	22.7		5.8				
		22.7		5.9				
15-Aug-15	4	22.7		6.0				
		22.6		5.8				
16-Aug-15	5	23.2		6.2				
		23.1		5.9				
17-Aug-15	6	22.8		6.5				
		22.9		6.1				
18-Aug-15	7	22.4		5.3				
		22.7		5.3				
19-Aug-15	8	22.5		5.8				
		22.7		5.5				
20-Aug-15	9	22.7		6.3				
		22.7		6.4				
21-Aug-15	10	22.3	8.29	5.7	342	156	114	0.46
		22.4	8.38	5.6	339			
MEAN		**22.7**	**8.06**	**6.0**	**344.3**	**146.0**	**111.0**	**0.42**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.3**	**7.77**	**5.3**	**339**	**136**	**108**	**0.37**
Max #		**23.2**	**8.38**	**6.5**	**349**	**156**	**114**	**0.46**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-30**
GLEC ID: **10580**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Hyalella azteca*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.9	7.62	6.1	372	136	116	3.10
		22.9	7.63	6.0	379			
12-Aug-15	1	22.7		6.2				
		22.7		6.3				
13-Aug-15	2	22.6		6.2				
		22.5		6.1				
14-Aug-15	3	22.7		5.2				
		22.6		5.4				
15-Aug-15	4	22.5		5.9				
		22.5		5.6				
16-Aug-15	5	23.1		5.6				
		23.1		5.8				
17-Aug-15	6	23.0		6.4				
		23.0		5.9				
18-Aug-15	7	22.6		5.6				
		22.7		5.3				
19-Aug-15	8	22.3		5.4				
		22.6		5.4				
20-Aug-15	9	22.6		5.4				
		22.7		5.6				
21-Aug-15	10	22.3	7.57	5.8	307	128	96	0.44
		22.3	7.59	6.1	303			
MEAN		**22.7**	**7.60**	**5.8**	**340.3**	**132.0**	**106.0**	**1.77**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.3**	**7.57**	**5.2**	**303**	**128**	**96**	**0.44**
Max #		**23.1**	**7.63**	**6.4**	**379**	**136**	**116**	**3.10**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-32**
GLEC ID: **10581**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Hyalella azteca*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.8	7.64	6.0	394	140	126	3.37
		22.7	7.51	6.2	401			
12-Aug-15	1	22.6		6.2				
		22.7		6.0				
13-Aug-15	2	22.5		6.0				
		22.5		6.1				
14-Aug-15	3	22.7		5.3				
		22.7		5.2				
15-Aug-15	4	22.5		6.0				
		22.6		5.4				
16-Aug-15	5	22.9		5.7				
		22.9		5.9				
17-Aug-15	6	22.8		6.3				
		22.9		6.2				
18-Aug-15	7	22.3		5.6				
		22.6		5.5				
19-Aug-15	8	22.5		5.6				
		22.6		5.2				
20-Aug-15	9	22.6		5.3				
		22.7		4.9				
21-Aug-15	10	22.3	8.33	5.1	330	140	106	0.56
		22.3	8.33	5.3	328		104	
MEAN		**22.6**	**7.95**	**5.7**	**363.3**	**140.0**	**112.0**	**1.97**
N=		**22**	**4**	**22**	**4**	**2**	**3**	**2**
Min #		**22.3**	**7.51**	**4.9**	**328**	**140**	**104**	**0.56**
Max #		**22.9**	**8.33**	**6.3**	**401**	**140**	**126**	**3.37**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-39**
GLEC ID: **10582**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Hyalella azteca*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.8	7.60	5.9	379	136	126	3.62
		22.8	7.58	5.8	383			
12-Aug-15	1	22.7		6.0				
		22.7		6.1				
13-Aug-15	2	22.5		6.1				
		22.5		6.1				
14-Aug-15	3	22.5		5.3				
		22.5		5.2				
15-Aug-15	4	22.5		6.0				
		22.5		5.4				
16-Aug-15	5	22.9		6.2				
		22.8		5.5				
17-Aug-15	6	23.0		6.3				
		22.9		6.2				
18-Aug-15	7	22.8		5.4				
		22.9		5.1				
19-Aug-15	8	22.5		5.4				
		22.6		4.8				
20-Aug-15	9	22.6		5.8				
		22.7		5.6				
21-Aug-15	10	22.2	8.58	6.0	345	148	116	1.07
		22.2	8.49	4.8	343	148		
MEAN		**22.6**	**8.06**	**5.7**	**362.5**	**144.0**	**121.0**	**2.35**
N=		**22**	**4**	**22**	**4**	**3**	**2**	**2**
Min #		**22.2**	**7.58**	**4.8**	**343**	**136**	**116**	**1.07**
Max #		**23.0**	**8.58**	**6.3**	**383**	**148**	**126**	**3.62**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-40**
GLEC ID: **10583**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Hyalella azteca*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.8	7.58	5.9	402	148	126	3.52
		22.8	7.59	5.9	398			
12-Aug-15	1	22.7		6.2				
		22.7		6.2				
13-Aug-15	2	22.5		5.8				
		22.5		6.0				
14-Aug-15	3	22.7		5.1				
		22.7		5.2				
15-Aug-15	4	22.5		5.5				
		22.5		5.2				
16-Aug-15	5	22.8		6.3				
		22.8		5.7				
17-Aug-15	6	22.8		6.4				
		22.8		5.6				
18-Aug-15	7	22.6		5.3				
		22.8		5.3				
19-Aug-15	8	22.6		5.5				
		22.7		5.4				
20-Aug-15	9	22.5		5.2				
		22.6		5.4				
21-Aug-15	10	22.2	8.24	5.4	329	148	110	0.71
		22.1	8.26	5.3	328			0.69
MEAN		**22.6**	**7.92**	**5.6**	**364.3**	**148.0**	**118.0**	**1.64**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**3**
Min #		**22.1**	**7.58**	**5.1**	**328**	**148**	**110**	**0.69**
Max #		**22.8**	**8.26**	**6.4**	**402**	**148**	**126**	**3.52**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-50**
GLEC ID: **10584**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Hyalella azteca*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.6	7.59	6.3	375	140	122	3.12
		22.7	7.62	6.2	381			3.16
12-Aug-15	1	22.6		6.2				
		22.6		6.2				
13-Aug-15	2	22.6		6.1				
		22.5		6.0				
14-Aug-15	3	22.7		5.1				
		22.7		5.1				
15-Aug-15	4	22.4		5.9				
		22.4		5.3				
16-Aug-15	5	22.7		6.1				
		22.8		5.5				
17-Aug-15	6	22.9		6.3				
		22.9		6.3				
18-Aug-15	7	22.7		5.8				
		22.8		5.6				
19-Aug-15	8	22.7		5.6				
		22.8		5.5				
20-Aug-15	9	22.5		5.2				
		22.6		5.3				
21-Aug-15	10	22.1	8.68	5.3	343	144	114	0.63
		22.1	8.75	5.4	333			
MEAN		**22.6**	**8.16**	**5.7**	**358.0**	**142.0**	**118.0**	**2.30**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**3**
Min #		**22.1**	**7.59**	**5.1**	**333**	**140**	**114**	**0.63**
Max #		**22.9**	**8.75**	**6.3**	**381**	**144**	**122**	**3.16**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-54**
GLEC ID: **10585**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Hyalella azteca*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.8	7.58	6.6	379	140	126	3.12
		22.7	7.59	6.4	379			
12-Aug-15	1	22.7		6.2				
		22.6		6.2				
13-Aug-15	2	22.5		6.1				
		22.5		6.0				
14-Aug-15	3	22.6		5.7				
		22.8		5.0				
15-Aug-15	4	22.5		5.6				
		22.6		5.7				
16-Aug-15	5	22.9		5.3				
		22.9		5.3				
17-Aug-15	6	23.0		6.1				
		22.9		6.0				
18-Aug-15	7	22.8		5.6				
		22.9		5.4				
19-Aug-15	8	22.6		5.2				
		22.7		5.2				
20-Aug-15	9	22.6		4.6				
		22.6		4.7				
21-Aug-15	10	22.2	8.56	5.7	340	156	116	0.55
		22.1	8.58	5.2	330			
MEAN		**22.7**	**8.08**	**5.6**	**357.0**	**148.0**	**121.0**	**1.84**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.1**	**7.58**	**4.6**	**330**	**140**	**116**	**0.55**
Max #		**23.0**	**8.58**	**6.6**	**379**	**156**	**126**	**3.12**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-55**
GLEC ID: **10586**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Hyalella azteca*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.8	7.55	6.3	395	148	130	3.46
		22.8	7.59	6.4	387			
12-Aug-15	1	22.6		6.1				
		22.6		5.9				
13-Aug-15	2	22.4		5.9				
		22.4		5.9				
14-Aug-15	3	22.7		5.2				
		22.7		5.4				
15-Aug-15	4	22.5		5.6				
		22.4		5.4				
16-Aug-15	5	22.8		5.5				
		22.8		5.4				
17-Aug-15	6	22.9		5.9				
		23.0		5.7				
18-Aug-15	7	22.8		5.6				
		23.0		5.1				
19-Aug-15	8	22.6		4.2				
		22.7		4.6				
20-Aug-15	9	22.5		5.7				
		22.6		5.1				
21-Aug-15	10	22.5	8.52	5.1	341	152	124	0.54
		22.1	8.63	5.3	342			
MEAN		**22.6**	**8.07**	**5.5**	**366.3**	**150.0**	**127.0**	**2.00**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.1**	**7.55**	**4.2**	**341**	**148**	**124**	**0.54**
Max #		**23.0**	**8.63**	**6.4**	**395**	**152**	**130**	**3.46**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-58**
GLEC ID: **10587**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Hyalella azteca*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	22.8	7.60	6.4	375	144	122	2.55
		22.8	7.63	6.3	383			
12-Aug-15	1	22.6		6.3				
		22.6		6.2				
13-Aug-15	2	22.5		6.3				
		22.4		6.0				
14-Aug-15	3	22.6		5.3				
		22.7		5.3				
15-Aug-15	4	22.5		6.1				
		22.5		5.5				
16-Aug-15	5	22.6		5.6				
		22.5		6.0				
17-Aug-15	6	22.7		6.2				
		22.8		6.1				
18-Aug-15	7	22.8		5.5				
		22.8		5.3				
19-Aug-15	8	22.5		4.6				
		22.5		5.4				
20-Aug-15	9	22.4		5.4				
		22.3		5.4				
21-Aug-15	10	22.0	8.86	6.2	334	144	116	0.80
		22.0	8.82	5.7	334			
MEAN		**22.5**	**8.23**	**5.8**	**356.5**	**144.0**	**119.0**	**1.68**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.0**	**7.60**	**4.6**	**334**	**144**	**116**	**0.80**
Max #		**22.8**	**8.86**	**6.4**	**383**	**144**	**122**	**2.55**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-59**
GLEC ID: **10588**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Hyalella azteca*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	23.0	7.53	6.8	383	144	136	2.72
		23.0	7.56	6.3	381			
12-Aug-15	1	23.5		6.1				
		23.5		6.2				
13-Aug-15	2	23.0		6.3				
		23.0		6.0				
14-Aug-15	3	22.9		5.1				
		23.0		5.1				
15-Aug-15	4	23.0		4.9				
		23.0		5.0				
16-Aug-15	5	22.9		6.6				
		22.9		6.1				
17-Aug-15	6	23.2		5.6				
		23.3		5.4				
18-Aug-15	7	22.4		5.8				
		22.5		5.3				
19-Aug-15	8	22.8		5.2				
		23.0		5.2				
20-Aug-15	9	22.7		5.0				
		22.7		5.1				
21-Aug-15	10	22.6	8.38	6.1	334	152	116	0.58
		22.5	8.42	5.8	334			
MEAN		**22.9**	**7.97**	**5.7**	**358.0**	**148.0**	**126.0**	**1.65**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.4**	**7.53**	**4.9**	**334**	**144**	**116**	**0.58**
Max #		**23.5**	**8.42**	**6.8**	**383**	**152**	**136**	**2.72**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-45**
GLEC ID: **10589**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Hyalella azteca*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	23.0	7.66	6.5	433	152	134	2.24
		23.0	7.67	6.4	409			
12-Aug-15	1	23.7		5.5				
		23.6		5.9				
13-Aug-15	2	22.9		6.2				
		23.1		6.1				
14-Aug-15	3	22.9		5.5				
		23.0		5.5				
15-Aug-15	4	23.0		6.4				
		22.9		6.6				
16-Aug-15	5	22.9		5.6				
		22.9		5.6				
17-Aug-15	6	23.3		6.3				
		23.3		6.2				
18-Aug-15	7	22.7		5.7				
		22.9		5.7				
19-Aug-15	8	22.9		5.7				
		23.0		5.7				
20-Aug-15	9	22.7		5.8				
		22.8		6.0				
21-Aug-15	10	22.6	8.23	5.1	324	164	118	0.42
		22.6	8.08	5.5	323			
MEAN		**23.0**	**7.91**	**5.9**	**372.3**	**158.0**	**126.0**	**1.33**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.6**	**7.66**	**5.1**	**323**	**152**	**118**	**0.42**
Max #		**23.7**	**8.23**	**6.6**	**433**	**164**	**134**	**2.24**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **SD-46**
GLEC ID: **10590**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Hyalella azteca*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	23.0	7.74	6.8	328	136	110	0.51
		23.1	7.77	6.5	328			
12-Aug-15	1	23.7		6.5				
		23.7		6.5				
13-Aug-15	2	23.2		6.1				
		23.2		6.1				
14-Aug-15	3	22.9		6.2				
		23.0		6.0				
15-Aug-15	4	22.9		6.5				
		22.9		6.7				
16-Aug-15	5	23.0		6.4				
		22.9		6.5				
17-Aug-15	6	23.3		6.7				
		23.3		6.7				
18-Aug-15	7	22.8		6.7				
		23.0		6.5				
19-Aug-15	8	22.9		6.5				
		23.1		6.5				
20-Aug-15	9	22.7		6.5				
		22.8		6.7				
21-Aug-15	10	22.6	8.09	7.0	314	148	104	0.28
		22.6	8.08	6.2	316			
MEAN		**23.0**	**7.92**	**6.5**	**321.5**	**142.0**	**107.0**	**0.40**
N=		**22**	**4**	**22**	**4**	**2**	**2**	**2**
Min #		**22.6**	**7.74**	**6.0**	**314**	**136**	**104**	**0.28**
Max #		**23.7**	**8.09**	**7.0**	**328**	**148**	**110**	**0.51**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Project Name: AECOM Macatawa
Project Number: 2264-00
Sample ID: **LM-08-13**
GLEC ID: **10591**

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Hyalella azteca*

Date	Test Day	Temperature (°C)	pH (s.u.)	D.O. (mg/L)	Conductivity (µmos)	Hardness (mg/L)	Alkalinity (mg/L)	Ammonia (mg/L)
11-Aug-15	0	23.0	7.67	6.9	352	132	112	0.80
		23.1	7.70	5.9	361	132	110	0.82
12-Aug-15	1	23.6		6.2				
		23.7		5.9				
13-Aug-15	2	23.2		6.2				
		23.2		6.2				
14-Aug-15	3	22.5		6.0				
		22.9		5.6				
15-Aug-15	4	22.9		6.4				
		22.8		6.3				
16-Aug-15	5	22.8		6.9				
		22.8		6.9				
17-Aug-15	6	23.0		6.4				
		23.1		5.7				
18-Aug-15	7	22.8		5.5				
		22.9		5.2				
19-Aug-15	8	23.1		5.4				
		23.2		5.4				
20-Aug-15	9	22.6		6.3				
		22.6		6.0				
21-Aug-15	10	22.7	8.55	5.6	343	172	126	0.32
		22.7	8.66	5.1	344	160	126	0.34
MEAN		**23.0**	**8.15**	**6.0**	**350.0**	**149.0**	**118.5**	**0.57**
N=		**22**	**4**	**22**	**4**	**4**	**4**	**4**
Min #		**22.5**	**7.67**	**5.1**	**343**	**132**	**110**	**0.32**
Max #		**23.7**	**8.66**	**6.9**	**361**	**172**	**126**	**0.82**

Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L)
U = Below MDL
J = ≥MDL and <RL

Appendix C1
Chironomus dilutus
10-Day Bench Sheets
10-Day Statistical Data
Laboratory Control

- Survival
- Weight

Project Name: AECOM Macatawa
Project Number: 2264-00

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Chironomus dilutus*

100% Data Entry

Date	Initials	Data Entered
8/25/2015	MWG	ALL DATA

100% Data Quality Check

Date	Initials	Data QC'ed
9/1/2015	MP	ALL-error corrected & highlighted

100% Error Corrected Quality Check

Date	Initials	Data QC'ed
9/14/2015	MWG	Control rep 3

Data QC 10%

Date	Initials	Data QC'ed
9/14/2015	mwg	all

2264-00
AECOM-Lake Macatawa
Chironomus dilutus 10-Day Survival and Growth Whole Sediment Toxicity Test

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QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	Laboratory Control	Test Photoperiod:	16:8
Sample ID:	CS# 129	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Chironomus dilutus*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 10 days
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
~~NOSO~~ KS chemistries time/Initial

Number Daily Renewals: — Air: ☐ yes ☒ no
☐ — renewal time/Initials ~~☐ renewal~~
~~☐ renewal time/Initials ☐ renewal~~
Food: ~~TFS# (4g/L)~~ ~~☐ Feed 1.5 ml/replicate~~
Screens Cleaned: ☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$) 8/20/15 KS	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A 8/20/15 KS	203	4	Init: ES
1					156	108	DS	Larvae: 10 Pupae: -- Midge: - 10/10 mur FM ES 8/22/15
2					end: 3.9	end: 44.8	5/24/15	Larvae: 8 Pupae: (9) ~~8~~ /10 Midge: 1 mur 1 midge on Day 9
3	22.6	7.53	4.2	318	start: 0.0	start: 39.4	1.19	Larvae: T.E. Pupae: no pupa added 0 /10 Midge: - mur 3 small discolored worms Not chiros. QC-mur 8/21/15
4	22.6	7.43	4.1	322	Titrant used (mL): 3.9	Titrant used (mL): 5.4		Larvae: 10 Pupae: - Midge: - 10 /10
5					Sample volume (mL): 8/20/15 KS 39.25	Sample volume (mL): 50		Larvae: 10 Pupae: - Midge: - 10 /10
6								Larvae: 10 Pupae: - Midge: - 10 /10
7								Larvae: 9 Pupae: - Midge: - 9/10
8								Larvae: 9 Pupae: Midge: 1 (10) ~~9~~ /10 mur 1 midge on Day 9 FM ES 8/22/15

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

KEY:
AV: Animals Visible
NAV: No Animals Visible
FOV: Foreign Organism Visible
BHV: Bore Holes Visible

revised: June 2012

2264-00
AECOM-Lake Macatawa
Chironomus dilutus 10-Day Survival and Growth Whole Sediment Toxicity Test

Page 7 of 7
QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	Secondary Control	Test Photoperiod:	16:8
Sample ID:	Water Only	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Chironomus dilutus*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 10 days
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
1650 KS chemistries time/Initial

Number Daily Renewals: — Air: ☐ yes ☒ no
☐ — renewal time/Initials ~~☐ renewal~~
~~☐ renewal time/Initials ☐ renewal~~
Food: ~~TFS# (4g/L)~~ ~~☐ Feed 1.5 ml/replicate~~
Screens Cleaned: ☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$) 8/20/15 KS	Alkalinity (mg/L $CaCO_3$) 8/20/15 KS	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	~~203~~ 175 ~~8/21/15~~ KS	203	175	175	N/A	203	4	Init: NA.
1					112	100	DS	Larvae: 8 Pupae: – Midge: – 8/10
2					end: 6.7	end: 5.0	8/21/15	Larvae: 8 Pupae: – Midge: – 8/10
3	22.6	7.68	5.5	307	start: 39	start: 8/20/15 KS ~~6.45~~ 0.0	0.72	Larvae: 10 Pupae: – Midge: – 10/10
4	22.7	7.70	6.0	306	Titrant used (mL): 2.8	Titrant used (mL): 5.0		Larvae: 9 Pupae: – Midge: – 9/10
5					Sample volume (mL): 25	Sample volume (mL): 50		Larvae: 10 Pupae: – Midge: – 10/10
6								Larvae: 10 Pupae: – Midge: – 10/10
7								Larvae: 10 Pupae: – Midge: – 10/10
8								Larvae: 9 Pupae: – Midge: – 9/10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

KEY:
AV: Animals Visible
NAV: No Animals Visible
FOV: Foreign Organism Visible
BHV: Bore Holes Visible

revised: June 2012

2264-00
AECOM-Lake Macatawa
Chironomus dilutus 10-Day Survival and Growth Whole Sediment Toxicity Test

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QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10579	Test Photoperiod:	16:8
Sample ID:	SD-25	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Chironomus dilutus*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 10 days
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
1650 KS chemistries time/Initial

Number Daily Renewals: — Air: ☐ yes ☒ no
☐ — renewal time/Initials ~~☐ renewal~~
~~☐ renewal time/Initials ☐ renewal~~
Food: ~~TFS# (4g/L)~~ ~~☐ Feed 1.5 ml/replicate~~
Screens Cleaned: ☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$) 8/20/15 KS	Alkalinity (mg/L $CaCO_3$) 8/20/15 KS	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175.	175	N/A	203	4	Init: MP.
1					140	104	0.57	Larvae: 10 Pupae: – Midge: – 10/10
2					end: 10.2	end: 10.2	DS	Larvae: 10 Pupae: – Midge: – 10/10
3	22.6	7.58	4.0	331	start: 6.7	start: 5.0	8/24/15	Larvae: 9 Pupae: – Midge: – 9/10
4	22.6	7.65	4.3	331	Titrant used (mL): 3.5	Titrant used (mL): 5.2		Larvae: 10 Pupae: – Midge: – 10/10
5					Sample volume (mL): 25	Sample volume (mL): 50		Larvae: 10 Pupae: – Midge: – 10/10
6								Larvae: 9 Pupae: – Midge: – 9/10
7								Larvae: 9 Pupae: – Midge: – 9/10
8								Larvae: 9 Pupae: 1 Midge: – 10/10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

KEY:
AV: Animals Visible
NAV: No Animals Visible
FOV: Foreign Organism Visible
BHV: Bore Holes Visible

revised: June 2012

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QC'd by: DS

2264-00
AECOM-Lake Macatawa
Chironomus dilutus 10-Day Survival and Growth Whole Sediment Toxicity Test

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10580	Test Photoperiod:	16:8
Sample ID:	SD-30	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Chironomus dilutus*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 10 days
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10

Date: 8/21/2015

Overlying Water: Dechlor

Overlying Water Batch ID (GLC Number): NA

~~1650~~ KS chemistries time/Initial

Number Daily Renewals: —— Air: ☐ yes ☒ no

☐ —— renewal time/Initials ~~☐ renewal~~

~~☐ renewal time/Initials ☐ renewal~~

Food: ~~TFS# (4g/L)~~ ~~☐ Feed 1.5 ml/replicate~~

Screens Cleaned: ☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$) 8/20/15 KS	Alkalinity (mg/L $CaCO_3$) 8/20/15 KS	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A	203	4	Init: KS
1					136	104	1.33	Larvae: 1 Pupae: 0 Midge: 0 — 1/10
2					end: 13.6	end: 15.4	DS	Larvae: 1 Pupae: 0 Midge: 0 — 1/10
3	22.5	7.54	5.7	310	start: 10.2	start: 10.2	8/24/15	Larvae: 3 Pupae: 0 Midge: 0 — 3/10
4	22.5	7.53	5.3	308	Titrant used (mL): 3.4	Titrant used (mL): 5.2		Larvae: 3 Pupae: 0 Midge: 0 — 3/10
5					Sample volume (mL): 25	Sample volume (mL): 50		Larvae: 3 Pupae: 0 Midge: 0 — 3/10
6								Larvae: 2 Pupae: 0 Midge: 0 — 2/10
7								Larvae: 2 Pupae: 0 Midge: 0 — 2/0
8								Larvae: 3 Pupae: 0 Midge: 0 — 3/10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.

*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.

Ammonia Reporting Limits:

RL = Reporting Limit (0.20 mg/L).

MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.

U = Below MDL. *J* = ≥ MDL and < RL.

KEY:

AV: Animals Visible

NAV: No Animals Visible

FOV: Foreign Organism Visible

BHV: Bore Holes Visible

revised: June 2012

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QC'd by: DS

2264-00
AECOM-Lake Macatawa
Chironomus dilutus 10-Day Survival and Growth Whole Sediment Toxicity Test

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10581	Test Photoperiod:	16:8
Sample ID:	SD-32	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Chironomus dilutus*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 10 days
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
~~1650~~ KS chemistries time/Initial

Number Daily Renewals: — Air: ☐ yes ☒ no
☐ — renewal time/Initials ☐ ~~renewal~~
☐ ~~renewal time/Initials~~ ☐ ~~renewal~~
Food: ~~TFS# (4g/L)~~ ☐ ~~Feed 1.5 ml/replicate~~
Screens Cleaned: ☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$) 8/20/15 KS	Alkalinity (mg/L $CaCO_3$) 8/20/15 KS	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A	203	4	Init: MP
1					136	102	0.94	Larvae: 10 Pupae: – Midge: – 10/10
2					end: 17.0	end: 20.5	DS	Larvae: 10 Pupae: – Midge: – 10/10
3	22.9	753	5.3	324	start: 13.6	start: 15.4	8/24/15	Larvae: 10 Pupae: – Midge: – 10/10
4	22.4	753	3.9	323	Titrant used (mL): 3.4	Titrant used (mL): 5.1		Larvae: 10 Pupae: – Midge: – 10/10
5					Sample volume (mL): 25	Sample volume (mL): 50		Larvae: 9 Pupae: – Midge: – 9/10
6								Larvae: 10 Pupae: – Midge: – 10/10
7								Larvae: 10 Pupae: – Midge: – 10/10
8								Larvae: 9 Pupae: – Midge: – 9/10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

KEY:
AV: Animals Visible
NAV: No Animals Visible
FOV: Foreign Organism Visible
BHV: Bore Holes Visible

revised: June 2012

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QC'd by: DS

2264-00
AECOM-Lake Macatawa
Chironomus dilutus 10-Day Survival and Growth Whole Sediment Toxicity Test

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10582	Test Photoperiod:	16:8
Sample ID:	SD-39	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Chironomus dilutus*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 10 days
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10

Date: 8/21/2015

Overlying Water: Dechlor

Overlying Water Batch ID (GLC Number): NA

☒ 650 KS chemistries time/Initial

Number Daily Renewals: — Air: □ yes ☒ no

□ — renewal time/Initials ~~□ renewal~~

~~□ renewal time/Initials □ renewal~~

Food: ~~TFS# (4g/L)~~ ~~□ Feed 1.5 ml/replicate~~

Screens Cleaned: □ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	12.5	20.3	17.5	175	8/20/15 KS N/A	8/20/15 KS 20.3	4	Init: MGM
1					140	112	1.59	Larvae: 8 Pupae: — Midge: — 8 /10
2					end: 20.5	end: 26.3	DS	Larvae: 9 Pupae: — Midge: — 9 /10
3	22.2	7.61	3.7	343	start: 17.0	start: 20.7	8/24/15	Larvae: 9 Pupae: — Midge: — 9 /10
4	22.3	7.79	3.8	338	Titrant used (mL): 3.5	Titrant used (mL): 5.6		Larvae: 7 Pupae: 1 Midge: — 8 7 /10
5					Sample volume (mL): 25	Sample volume (mL): 50		Larvae: 10 Pupae: — Midge: — 10 /10
6								Larvae: 9 Pupae: — Midge: — 9 /10
7								Larvae: 8 Pupae: — Midge: — 8 0
8								Larvae: ~~10~~ 9 Pupae: — Midge: — 9 /10

8/21/15 MGM

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.

*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.

Ammonia Reporting Limits:

RL = Reporting Limit (0.20 mg/L).

MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.

U = Below MDL. *J* = ≥ MDL and < RL.

KEY:

AV: Animals Visible

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BHV: Bore Holes Visible

revised: June 2012

2264-00
AECOM-Lake Macatawa
Chironomus dilutus 10-Day Survival and Growth Whole Sediment Toxicity Test

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QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10583	Test Photoperiod:	16:8
Sample ID:	SD-40	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Chironomus dilutus*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 10 days
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
~~1650~~ KS chemistries time/Initial

Number Daily Renewals: — Air: ☐ yes ☒ no
☐ — renewal time/Initials ~~☐ renewal~~
~~☐ renewal time/Initials~~ ~~☐ renewal~~
Food: ~~TFS# (4g/L)~~ ~~☐ Feed 1.5 ml/replicate~~
Screens Cleaned: ☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$) 8/20/15 KS	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A 8/20/15 KS	203	4	Init: KS
1	\	\	\	\	132	104	1.14	Larvae 10 Pupae 0 Midge 0 — 10/10
2	\	\	\	\	end: 23.8	end: 32.6	1.18 Dup	Larvae 9 Pupae 0 Midge 0 — 9/10
3	22.3	7.61	5.6	328	start: 20.5	start: 8/20/15 KS ~~26.3~~ 27.4	D.S 8/24/15	Larvae 9 Pupae 0 Midge 0 — 9/10
4	22.3	7.48	4.4	325	Titrant used (mL): 3.3	Titrant used (mL): 5.2		Larvae 8 Pupae 1 Midge 0 — 9/10
5	\	\	\	\	Sample volume (mL): 25	Sample volume (mL): 50	\	Larvae 7 Pupae 0 Midge 0 — 7/10
6	\	\	\	\	Dup Start 23.8 End 27.2 3.4	\	\	Larvae 8 Pupae 0 Midge 0 — 8/10
7	\	\	\	\		\	\	Larvae 10 Pupae 0 Midge 0 — 10/10
8	\	\	\	\	136	\	\	Larvae 0 Pupae 0 Midge 0 — 10/10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

KEY:
AV: Animals Visible
NAV: No Animals Visible
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BHV: Bore Holes Visible

revised: June 2012

2264-00
AECOM-Lake Macatawa
Chironomus dilutus 10-Day Survival and Growth Whole Sediment Toxicity Test

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QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10584	Test Photoperiod:	16:8
Sample ID:	SD-50	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Chironomus dilutus*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 10 days
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
~~A 650~~ KS chemistries time/Initial

Number Daily Renewals: — Air: □ yes ☑ no
□ — renewal time/Initials ~~□ renewal~~
~~□ renewal time/Initials □ renewal~~
Food: ~~TFS# (4g/L)~~ ~~□ Feed 1.5 ml/replicate~~
Screens Cleaned: □ yes ☑ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$) 8/20/15 KS	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A 8/20/15 KS	203	4	Init: NA
1	~~22.2~~ 8/21/15 KS				140	106	0.77	Larvae: 9 Pupae: 1 Midge: 10/10
2	—				end: 30.7	end: 37.9	DS	Larvae: 10 Pupae: — Midge: — 10/10
3	22.2	7.69	3.7	331	start: 27.2	start: 32.6	8/24/15	Larvae: 10 Pupae: — Midge: — 10/10
4	22.1	7.75	3.8	338	Titrant used (mL): 35	Titrant used (mL): 5.3		Larvae: 9 Pupae: — Midge: — 9/10
5					Sample volume (mL): 25	Sample volume (mL): 50		Larvae: 10 Pupae: — Midge: — 10/10
6								Larvae: 10 Pupae: — Midge: — 10/10
7								Larvae: 8 Pupae: — Midge: 1 9/10 Day 9 8/25/15
8								Larvae: 10 Pupae: — Midge: — 10/10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

KEY:
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revised: June 2012

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2264-00
AECOM-Lake Macatawa
Chironomus dilutus 10-Day Survival and Growth Whole Sediment Toxicity Test

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QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10585	Test Photoperiod:	16:8
Sample ID:	SD-54	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Chironomus dilutus*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 10 days
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
1650 KS chemistries time/Initial

Number Daily Renewals: — Air: ☐ yes ☒ no
☐ — renewal time/Initials ~~☐ renewal~~
~~☐ renewal time/Initials ☐ renewal~~
Food: ~~TFS# (4g/L)~~ ~~☐ Feed 1.5 ml/replicate~~
Screens Cleaned: ☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$) 8/20/15 KS	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A KS 8/20/15	203	4	Init: MGM/MWS
1					140	108	1.03	Larvae: 10 Pupae: – Midge: – 10/10
2					end: 34.2	end: 43.3	DS	Larvae: 10 Pupae: – Midge: – 10/10
3	22.2	7.58	4.2	326	start: 30.7	start: 37.9	8/24/15	Larvae: 10 Pupae: – Midge: – 10/10
4	22.1	7.57	3.2	318	Titrant used (mL): 3.5	Titrant used (mL): 5.4		Larvae: 10 Pupae: – Midge: – 10/10
5					Sample volume (mL): 25	Sample volume (mL): 50		Larvae: 10 Pupae: – Midge: – 10/10
6								Larvae: 9 Pupae: – Midge: – 9/10
7								Larvae: 9 Pupae: 1 Midge: 0 10 0
8								Larvae: 9 Pupae: 1 Midge: 0 10/10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

KEY:
AV: Animals Visible
NAV: No Animals Visible
FOV: Foreign Organism Visible
BHV: Bore Holes Visible

revised: June 2012

2264-00
AECOM-Lake Macatawa
Chironomus dilutus 10-Day Survival and Growth Whole Sediment Toxicity Test

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QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10586	Test Photoperiod:	16:8
Sample ID:	SD-55	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Chironomus dilutus*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 10 days
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
~~1650 KS~~ chemistries time/Initial

Number Daily Renewals: —— Air: □ yes ☒ no
□ —— renewal time/Initials ~~□ renewal~~
~~□ renewal time/Initials □ renewal~~
Food: ~~TFS# (4g/L)~~ ~~□ Feed 1.5 ml/replicate~~
Screens Cleaned: □ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$) 8/20/15	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	8/20/15 KS N/A	203	4	Init: KS
1					136	106	1.00	Larvae 10 Pupae 0 Midge 0 — 10/10
2					end: 37.6	end: 48.6	DS	Larvae 10 Pupae 0 Midge 0 — 10/10
3	22.1	7.66	3.9	339	start: 34.2	start: 43.3	8/24/15	Larvae 10 Pupae 0 Midge 0 — 10/10
4	22.1	7.70	4.1	339	Titrant used (mL): 3.4	Titrant used (mL): 5.3		Larvae 9 Pupae 1 Midge 0 — 10/10
5					Sample volume (mL): 25	Sample volume (mL): 50		Larvae 8 Pupae 0 Midge 0 — 8/10
6						Dup end 5.4		Larvae 9 Pupae 0 Midge 0 — 9/10 ~~Pan mix 08/18~~ moved to ashed pan mw 8/31/15
7						Start 0.0		Larvae 10 Pupae 0 Midge 0 — 10/10
8						108		Larvae 10 Pupae 0 Midge 0 — 10/10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

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Revised: June 2012

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2264-00
AECOM-Lake Macatawa
Chironomus dilutus 10-Day Survival and Growth Whole Sediment Toxicity Test

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QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10587	Test Photoperiod:	16:8
Sample ID:	SD-58	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Chironomus dilutus*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 10 days
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
~~0650~~ KS chemistries time/Initial

Number Daily Renewals: 1 Air: ☐ yes ☒ no
~~☒ 730 KS~~ renewal time/Initials ~~☐ renewal~~
~~☐ renewal time/Initials ☐ renewal~~
Food: ~~TFS# (4g/L)~~ ~~☐ Feed 1.5 ml/replicate~~
Screens Cleaned: ☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$) 8/20/15	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A 8/20/15 KS	203	4	Init: KS
1					144	102	1.21	Larvae 10 Pupae 0 Midge 0 — 10/10
2					end: 412	end: 10.5	D.S.	Larvae 8 Pupae 0 Midge 0 — 8/10
3	22.1	7.52	3.0	323	start: 37.6	start: 8/20/15 KS ~~37.6~~ 5.4	8/24/15	Larvae 8 Pupae 0 Midge 0 — 8/10
4	22.3	7.55	2.7	319	Titrant used (mL): 3.6	Titrant used (mL): 5.1		Larvae 8 Pupae 0 Midge 0 — 8/10
5					Sample volume (mL): 25	Sample volume (mL): 50		Larvae 10 Pupae 0 Midge 0 — 10/10
6								Larvae 8 Pupae 0 Midge 0 — 8/10
7								Larvae 9 Pupae 0 Midge 0 — 9/0
8								Larvae 9 Pupae 0 Midge 0 — 9/10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
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Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
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U = Below MDL. *J* = ≥ MDL and < RL.

KEY:
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revised: June 2012

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2264-00
AECOM-Lake Macatawa
Chironomus dilutus 10-Day Survival and Growth Whole Sediment Toxicity Test

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QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10588	Test Photoperiod:	16:8
Sample ID:	SD-59	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Chironomus dilutus*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 10 days
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
☒ 650 KJ chemistries time/Initial

Number Daily Renewals: 1 Air: ☐ yes ☒ no
☒ 730 KS renewal time/Initials ~~☐ renewal~~
~~☐ renewal time/Initials ☐ renewal~~
Food: ~~TFS# (4g/L)~~ ~~☐ Feed 1.5 ml/replicate~~
Screens Cleaned: ☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$) 8/20/15	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A KS 8/20/15	203	4	Init: MR.
1	\	\	\	\	140	106	1.15	Larvae: 10 Pupae: – Midge: – 10/10
2	\	\	\	\	end: 44.7	end: 15.8	DS	Larvae: 8 Pupae: – Midge: – 8/10
3	22.1	7.55	3.0	317	start: 41.2	start: 10.5	8/24/15	Larvae: 10 Pupae: – Midge: – 10/10
4	22.9	7.58	2.8	329	Titrant used (mL): 3.5	Titrant used (mL): 5.3	/	Larvae: 10 Pupae: – Midge: – 10/10
5	\	\	\	\	Sample volume (mL): 25	Sample volume (mL): 50	/	Larvae: 8 Pupae: – Midge: – 8/10
6	\	\	\	\	/	/	/	Larvae: 8 Pupae: – Midge: – 8/10
7	\	\	\	\	/	/	/	Larvae: 10 Pupae: – Midge: – 10/10
8	\	\	\	\	/	/	/	Larvae: 10 Pupae: – Midge: – 10/10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

revised: June 2012

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
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BHV: Bore Holes Visible

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QC'd by: DS

2264-00
AECOM-Lake Macatawa
Chironomus dilutus 10-Day Survival and Growth Whole Sediment Toxicity Test

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10589	Test Photoperiod:	16:8
Sample ID:	SD-45	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Chironomus dilutus*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 10 days
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day:	Day 10	Number Daily Renewals:	1 Air: □ yes ☒ no
Date:	8/21/2015	~~1730~~ KS renewal time/Initials	~~□ renewal~~
Overlying Water:	Dechlor	~~□ renewal time/Initials~~	~~□ renewal~~
Overlying Water Batch ID (GLC Number):	NA	Food: ~~TFS# (4g/L)~~	~~□ Feed 1.5 ml/replicate~~
~~1650~~ KS chemistries time/Initial		Screens Cleaned:	□ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$) 8/20/15 KS	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A KS 8/20/15	203	4	Init: MW
1					164	104	0.46	Larvae: 9 Pupae: 1 Midge: – 10/10
2					end: 48.2	end: 21.0	DS	Larvae: 9 Pupae: – Midge: – 9/10
3	23.0	7.61	3.9	324	start: 44.7	start: 15.8	8/24/15	Larvae: 9 Pupae: – Midge: – 9/10
4	23.0	7.50	3.8	326	Titrant used (mL): 4.1	Titrant used (mL): 5.2		Larvae: 9 Pupae: 1 Midge: – 10/10
5					Sample volume (mL): 25	Sample volume (mL): 50		Larvae: 7 Pupae: – Midge: – 7/10
6								Larvae: 10 Pupae: – Midge: – 10/10
7								Larvae: 9 Pupae: – Midge: – 9 0
8								Larvae: 10 Pupae: – Midge: – 10/10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

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FOV: Foreign Organism Visible
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revised: June 2012

2264-00
AECOM-Lake Macatawa
Chironomus dilutus 10-Day Survival and Growth Whole Sediment Toxicity Test

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QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10590	Test Photoperiod:	16:8
Sample ID:	SD-46	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Chironomus dilutus*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 10 days
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
~~1650~~ KS chemistries time/Initial

Number Daily Renewals: 1 Air: ☐ yes ☒ no
~~1730~~ KS renewal time/Initials ~~☐ renewal~~
~~☐ renewal time/Initials ☐ renewal~~
Food: ~~TFS# (4g/L)~~ ~~☐ Feed 1.5 ml/replicate~~
Screens Cleaned: ☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$) 8/20/15 20	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A KS 8/20/15	203	4	Init: MW
1					136	104	0.42	Larvae: 10 Pupae: – Midge: – 10 /10
2					end: 3.4	end: 26.2	DS	Larvae: 10 Pupae: – Midge: – 10/10
3	23.0	7.62	4.9	318	start: 0.0	start: 21.0	8.24	Larvae: 9 Pupae: – Midge: – 9 /10
4	23.0	7.67	4.9	317	Titrant used (mL): 3.4	Titrant used (mL): 5.2		Larvae: 8 Pupae: – Midge: – 8 /10
5					Sample volume (mL): 25	Sample volume (mL): 50		Larvae: 8 Pupae: – Midge: – 8 /10
6								Larvae: 10 Pupae: – Midge: – 10 /10
7								Larvae: 9 Pupae: – Midge: – 9/10
8								Larvae: 9 Pupae: – Midge: – 9 /10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

KEY:
AV: Animals Visible
NAV: No Animals Visible
FOV: Foreign Organism Visible
BHV: Bore Holes Visible.

revised: June 2012

2264-00
AECOM-Lake Macatawa
Chironomus dilutus 10-Day Survival and Growth Whole Sediment Toxicity Test

Page 7 of 7
QC'd by: DS

Project Number: **2264-00** Project Name: **AECOM-Lake Macatawa**
GLC#: **10591**
Sample ID: **LM-08-13**
Test Species: ***Chironomus dilutus***
Date Addition of Sediment: **8/10/2015**
Test Initiation Date: **8/11/2015**

Test Photoperiod: **16:8**
Test System: **Sediment-100 mL and Overlying Water-175mL Manual Delivery**
Test Temperature: **23± 1°C**
Test Organism Source/Age: **ABS: 10 days**
Test Termination Date: **8/21/2015**

Test Day: **Day 10**
Date: **8/21/2015**
Overlying Water: **Dechlor**
Overlying Water Batch ID (GLC Number): **NA**
~~1650~~ KS chemistries time/Initial

Number Daily Renewals: 1 Air: ☐ yes ☒ no
~~1750~~ KS renewal time/Initials ☐ ~~renewal~~
☐ ~~renewal time/Initials~~ ☐ ~~renewal~~
Food: ~~TFS# (4g/L)~~ ☐ ~~Feed 1.5 ml/replicate~~
Screens Cleaned: ☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$) 8/20/15 KS	Alkalinity (mg/L $CaCO_3$) 8/20/15	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A	203	4	Init: KS ~~Now~~ *
1					140	106	0.44	Larvae: ~~7~~ 7 Pupae: ~~*~~ * Midge: – ~~10~~ 7 /10
2					end: 6.9	end: 31.5	Dup 0.46	Larvae: ~~10~~ Pupae: ~~*~~ * Midge: – ~~10~~ 8 /10
3	23.0	7.51	2.7	324	start: 3.4	start: 26.2	DS	Larvae: ~~6~~ 6 Pupae: 0 Midge: 0 6 /10
4	22.9	7.66	3.5	324	Titrant used (mL): 3.5	Titrant used (mL): 5.3	8/24/15	Larvae: 8 Pupae: 0 Midge: 0 8 /10
5					Sample volume (mL): 25	Sample volume (mL) 50		Larvae: 5 Pupae: 1 Midge: 1 7 ~~8~~ /10
6					Dup end 10.4	Dup end 36.9		Larvae: 6 Pupae: 2 Midge: 0 8 ~~8~~ /10
7					start 6.9 / 3.5	start 31.5 / 5.0		Larvae: 7 Pupae: 0 Midge: 0 7/10
8					140	108		Larvae: 8 Pupae: 0 Midge: 0 8 /10

wrong sheet * mat 8/24/15
8/21/15 KS
8/21/15 KS
8/21/15 KS
8/25/15 KS
9/28/15 mat not legible

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

KEY:
AV: Animals Visible
NAV: No Animals Visible
FOV: Foreign Organism Visible
BHV: Bore Holes Visible

revised: June 2012

Page 1 of 2
QC'd by: KS
1009. QC MD. 9/1/15

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	Type/Model of Muffle Furnace: F6020 Thermolyne MOD.
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	Muffle Furnace Temperature: 550 °C
GLC#:	Laboratory Control	Drying Duration (Hours): ~ 24 hrs	Drying Duration (Hours): 2 hrs
Sample ID:	CS# 129	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1615
Test Species:	*Chironomus dilutus*	Dessicator: # 128	Dessicator: # 128
Test Date:	8/11/2015	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230 KS
		Dry Weigh Date / Technician's Initials: 8/24/15 MR	Ashed Weigh Date / Technician's Initials: 8/25/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	1	10	0.84609	0.83192	0.00000	10	#DIV/0!	0	0.00000
CS# 129	2	10	0.84454	0.83344	0.00000	8	#DIV/0!	1	0.00000
GLC Number:	3	~~10~~ 0	T.E.	T.E.	0.00000	0	#DIV/0!	0	0.00000
Laboratory Control	4	10	0.83746	0.82529	0.00000	10	#DIV/0!	0	0.00000
	5	10	0.82913	0.81480	0.00000	10	#DIV/0!	0	0.00000
	6	10	0.82798	0.81457	0.00000	10	#DIV/0!	0	0.00000
	7	10	0.84001	0.82781	0.00000	9	#DIV/0!	0	0.00000
	8	10	0.83795	0.82567	0.00000	9	#DIV/0!	1	0.00000
						AVERAGE:	#DIV/0!		0.00000

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	0.84284	0.82872	0	80	Average at Day 0 (mg) 0.17650		0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

Page __2__of __2__

QC'd by:____KS____

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**	Type/Model of Muffle Furnace: **F6020 Thermolyne MOD**.
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	Muffle Furnace Temperature: **550 °C**
GLC#:	**Laboratory Control**	Drying Duration (Hours): **~ 24 hrs**	Drying Duration (Hours): **2 hrs**
Sample ID:	**CS# 129**	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15/ 1715	Date/Time out: 8/24/15 1615
Test Species:	***Chironomus dilutus***	Dessicator: **# 128**	Dessicator: **# 128**
Test Date:	**8/11/2015**	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MP	Ashed Weigh Date / Technician's Initials: 8/25/15

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	**1**	10	0.84609	0.83192	0.01417	10	1.41700	0	1.41700
CS# 129	**2**	10	0.84454	0.83344	0.01110	8	1.38750	1	1.23333
GLC Number:	**3**	0	T.E.	T.E.	#VALUE!	T.E.			
Laboratory Control	**4**	10	0.83746	0.82529	0.01217	10	1.21700	0	1.21700
	5	10	0.82913	0.81480	0.01433	10	1.43300	0	1.43300
	6	10	0.82798	0.81457	0.01341	10	1.34100	0	1.34100
	7	10	0.84001	0.82787	0.01214	9	1.34889	0	1.21400
	8	10	0.83795	0.82567	0.01228	9	1.36444	1	1.36444
						AVERAGE:	1.35840		1.31711

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	0.84284	0.82872	0.01412	80	Average at Day 0 (mg)		0.17650

See Attached sheet for calculated weights.

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QC'd by: KS

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	Type/Model of Muffle Furnace: F6020 Thermolyne MOD.
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	Muffle Furnace Temperature: 550 °C
GLC#:	Secondary Control	Drying Duration (Hours): ~24 hrs	Drying Duration (Hours): 2 hrs
Sample ID:	Water Only	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1615
Test Species:	*Chironomus dilutus*	Dessicator: # 128	Dessicator: # 128
Test Date:	8/11/2015	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1220
		Dry Weigh Date / Technician's Initials: 8/24/15 MR	Ashed Weigh Date / Technician's Initials: 8/25/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	1	10	0.83727	0.83695	0.00000	8	#DIV/0!	0	0.00000
Water Only	2	10	0.83999	0.83373	0.00000	8	#DIV/0!	0	0.00000
GLC Number:	3	10	0.84542	0.83858	0.00000	10	#DIV/0!	0	0.00000
Secondary Control	4	10	0.85165	0.84600	0.00000	9	#DIV/0!	0	0.00000
	5	10	0.85307	0.84565	0.00000	10	#DIV/0!	0	0.00000
	6	10	0.82373	0.81652	0.00000	10	#DIV/0!	0	0.00000
	7	10	0.84573	0.83817	0.00000	10	#DIV/0!	0	0.00000
	8	10	0.83327	0.82644	0.00000	9	#DIV/0!	0	0.00000
						AVERAGE:	#DIV/0!		0.00000

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	See control page	-mus	0	80	Average at Day 0 (mg)		0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

Page __2__of __2__

QC'd by:____KS____

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**	Type/Model of Muffle Furnace: **F6020 Thermolyne MOD**.
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	Muffle Furnace Temperature: **550 °C**
GLC#:	**Water Only**	Drying Duration (Hours): **~ 24 hrs**	Drying Duration (Hours): **2 hrs**
Sample ID:	**Secondary Control**	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15/ 1715	Date/Time out: 8/24/15 1615
Test Species:	***Chironomus dilutus***	Dessicator: **# 128**	Dessicator: **# 128**
Test Date:	**8/11/2015**	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MP	Ashed Weigh Date / Technician's Initials: 8/25/15

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	**1**	10	0.83727	0.83095	0.00632	8	0.79000	0	0.63200
Secondary Control	**2**	10	0.83999	0.83373	0.00626	8	0.78250	0	0.62600
GLC Number:	**3**	10	0.84542	0.83858	0.00684	10	0.68400	0	0.68400
Water Only	**4**	10	0.85165	0.84600	0.00565	9	0.62778	0	0.56500
	5	10	0.85307	0.84565	0.00742	10	0.74200	0	0.74200
	6	10	0.82373	0.81652	0.00721	10	0.72100	0	0.72100
	7	10	0.84573	0.83817	0.00756	10	0.75600	0	0.75600
	8	10	0.83327	0.82644	0.00683	9	0.75889	0	0.68300
						AVERAGE:	0.73277		0.67613

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	0.84284	0.82872	0.01412	80	Average at Day 0 (mg)		0.17650

See Attached sheet for calculated weights.

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QC'd by: KS

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	Type/Model of Muffle Furnace: F6020 Thermolyne MOD.
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	Muffle Furnace Temperature: 550 °C
GLC#:	10579	Drying Duration (Hours): ~ 24 hrs	Drying Duration (Hours): 2 hrs
Sample ID:	SD-25	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1615
Test Species:	*Chironomus dilutus*	Dessicator: # 128	Dessicator: # 128
Test Date:	8/11/2015	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MP.	Ashed Weigh Date / Technician's Initials: 8/25/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	1	10	0.84381	0.83264	0.00000	10	#DIV/0!	0	0.00000
SD-25	2	10	0.84151	0.82971	0.00000	10	#DIV/0!	0	0.00000
GLC Number:	3	10	0.83793	0.82489	0.00000	9	#DIV/0!	0	0.00000
10579	4	10	0.84178	0.83171	0.00000	10	#DIV/0!	0	0.00000
	5	10	0.84913	0.83574	0.00000	10	#DIV/0!	0	0.00000
	6	10	0.84650	0.83499	0.00000	9	#DIV/0!	0	0.00000
	7	10	0.85301	0.84121	0.00000	9	#DIV/0!	0	0.00000
	8	10	0.85375	0.84275	0.00000	9 ~~10~~ MP. 8/25/15 KS	#DIV/0!	1	0.00000
						AVERAGE:	#DIV/0!		0.00000

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	See control page - Mean	0	80	Average at Day 0 (mg)		0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

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QC'd by:____KS____

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**	Type/Model of Muffle Furnace: **F6020 Thermolyne MOD**.
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	Muffle Furnace Temperature: **550 °C**
GLC#:	**10579**	Drying Duration (Hours): **~ 24 hrs**	Drying Duration (Hours): **2 hrs**
Sample ID:	**SD-25**	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15/ 1715	Date/Time out: 8/24/15 1615
Test Species:	***Chironomus dilutus***	Dessicator: **# 128**	Dessicator: **# 128**
Test Date:	**8/11/2015**	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MP	Ashed Weigh Date / Technician's Initials: 8/25/15

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	**1**	10	0.84381	0.83264	0.01117	10	1.11700	0	1.11700
SD-25	**2**	10	0.84151	0.82971	0.01180	10	1.18000	0	1.18000
GLC Number:	**3**	10	0.83793	0.82489	0.01304	9	1.44889	0	1.30400
10579	**4**	10	0.84178	0.83171	0.01007	10	1.00700	0	1.00700
	5	10	0.84913	0.83574	0.01339	10	1.33900	0	1.33900
	6	10	0.84650	0.83499	0.01151	9	1.27889	0	1.15100
	7	10	0.85301	0.84121	0.01180	9	1.31111	0	1.18000
	8	10	0.85375	0.84275	0.01100	9	1.22222	1	1.22222
						AVERAGE:	1.23801		1.18753

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	0.84284	0.82872	0.01412	80	Average at Day 0 (mg)		0.17650

See Attached sheet for calculated weights.

Page 1 of 2
QC'd by: KS

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	Type/Model of Muffle Furnace: F6020 Thermolyne MOD.
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	Muffle Furnace Temperature: 550 °C
GLC#:	10580	Drying Duration (Hours): ~ 24 hrs	Drying Duration (Hours): 2 hrs
Sample ID:	SD-30	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1615
Test Species:	*Chironomus dilutus*	Dessicator: # 128	Dessicator: # 128
Test Date:	8/11/2015	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 [illegible]	Ashed Weigh Date / Technician's Initials: 8/25/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	1	10	0.82843	0.82783	0.00000	1	#DIV/0!	0	0.00000
SD-30	2	10	0.81119	0.81100	0.00000	1	#DIV/0!	0	0.00000
GLC Number:	3	10	no Bitk 0.83741 ~~0.83444~~	0.83684	0.00000	3	#DIV/0!	0	0.00000
10580	4	10	0.82745	0.82381	0.00000	3	#DIV/0!	0	0.00000
	5	10	0.82151	0.81957	0.00000	3	#DIV/0!	0	0.00000
	6	10	0.83083	0.83034	0.00000	2	#DIV/0!	0	0.00000
	7	10	0.82557	0.82353	0.00000	2	#DIV/0!	0	0.00000
	8	10	0.82387	~~0.82359~~ 0.82326 8/25/15 KS	0.00000	3	#DIV/0!	0	0.00000
						AVERAGE:	#DIV/0!		0.00000

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	See control page - MWC		0	80	Average at Day 0 (mg)		0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

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QC'd by:____KS____

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**	Type/Model of Muffle Furnace: **F6020 Thermolyne MOD**.
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	Muffle Furnace Temperature: **550 °C**
GLC#:	**10580**	Drying Duration (Hours): **~ 24 hrs**	Drying Duration (Hours): **2 hrs**
Sample ID:	**SD-30**	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15/ 1715	Date/Time out: 8/24/15 1615
Test Species:	***Chironomus dilutus***	Dessicator: **# 128**	Dessicator: **# 128**
Test Date:	**8/11/2015**	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MP	Ashed Weigh Date / Technician's Initials: 8/25/15

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	**1**	10	0.82843	0.82783	0.00060	1	0.60000	0	0.06000
SD-30	**2**	10	0.81119	0.81100	0.00019	1	0.19000	0	0.01900
GLC Number:	**3**	10	0.83741	0.83684	0.00057	3	0.19000	0	0.05700
10580	**4**	10	0.82745	0.82381	0.00364	3	1.21333	0	0.36400
	5	10	0.82151	0.81957	0.00194	3	0.64667	0	0.19400
	6	10	0.83083	0.83034	0.00049	2	0.24500	0	0.04900
	7	10	0.82557	0.82353	0.00204	2	1.02000	0	0.20400
	8	10	0.82387	0.82326	0.00061	3	0.20333	0	0.06100
						AVERAGE:	0.53854		0.12600

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	0.84284	0.82872	0.01412	80	Average at Day 0 (mg)		0.17650

See Attached sheet for calculated weights.

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QC'd by: KS

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	Type/Model of Muffle Furnace: F6020 Thermolyne MOD.
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	Muffle Furnace Temperature: 550 °C
GLC#:	10581	Drying Duration (Hours): ~ 24 hrs	Drying Duration (Hours): 2 hrs
Sample ID:	SD-32	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1615
Test Species:	*Chironomus dilutus*	Dessicator: # 128	Dessicator: # 128
Test Date:	8/11/2015	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MP.	Ashed Weigh Date / Technician's Initials: 8/25/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	1	10	0.84123	0.83356	0.00000	10	#DIV/0!	0	0.00000
SD-32	2	10	0.84217	0.83336	0.00000	10	#DIV/0!	0	0.00000
GLC Number:	3	10	0.84484	0.83579	0.00000	10	#DIV/0!	0	0.00000
10581	4	10	0.84339	0.83395	0.00000	10	#DIV/0!	0	0.00000
	5	10	0.84496	0.83430	0.00000	9	#DIV/0!	0	0.00000
	6	10	0.84254	0.83255	0.00000	10	#DIV/0!	0	0.00000
	7	10	0.84341	0.83516	0.00000	10	#DIV/0!	0	0.00000
	8	10	0.83329	0.82421	0.00000	9	#DIV/0!	0	0.00000
						AVERAGE:	#DIV/0!		0.00000

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	See control page number		0	80	Average at Day 0 (mg)		0

See Attached sheet for calculated weights.

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QC'd by:____KS____

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**	Type/Model of Muffle Furnace: **F6020 Thermolyne MOD**.
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	Muffle Furnace Temperature: **550 °C**
GLC#:	**10581**	Drying Duration (Hours): **~ 24 hrs**	Drying Duration (Hours): **2 hrs**
Sample ID:	**SD-32**	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15/ 1715	Date/Time out: 8/24/15 1615
Test Species:	***Chironomus dilutus***	Dessicator: **# 128**	Dessicator: **# 128**
Test Date:	**8/11/2015**	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MP	Ashed Weigh Date / Technician's Initials: 8/25/15

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	**1**	10	0.84123	0.83356	0.00767	10	0.76700	0	0.76700
SD-32	**2**	10	0.84217	0.83336	0.00881	10	0.88100	0	0.88100
GLC Number:	**3**	10	0.84484	0.83579	0.00905	10	0.90500	0	0.90500
10581	**4**	10	0.84339	0.83395	0.00944	10	0.94400	0	0.94400
	5	10	0.84496	0.83430	0.01066	9	1.18444	0	1.06600
	6	10	0.84254	0.83255	0.00999	10	0.99900	0	0.99900
	7	10	0.84341	0.83516	0.00825	10	0.82500	0	0.82500
	8	10	0.83329	0.82421	0.00908	9	1.00889	0	0.90800
						AVERAGE:	0.93929		0.91188

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	0.84284	0.82872	0.01412	80	Average at Day 0 (mg)		0.17650

See Attached sheet for calculated weights.

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2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	Type/Model of Muffle Furnace: F6020 Thermolyne MOD.
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	Muffle Furnace Temperature: 550 °C
GLC#:	10582	Drying Duration (Hours): ~24 hrs	Drying Duration (Hours): 2 hrs
Sample ID:	SD-39	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1615
Test Species:	*Chironomus dilutus*	Dessicator: # 128	Dessicator: # 128
Test Date:	8/11/2015	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MC	Ashed Weigh Date / Technician's Initials: 8/25/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	1	10	0.84621	0.83585	0.00000	8	#DIV/0!	0	0.00000
SD-39	2	10	0.84207	0.83317	0.00000	9	#DIV/0!	0	0.00000
GLC Number:	3	10	0.84414	0.83363	0.00000	9	#DIV/0!	0	0.00000
10582	4	10	0.84627	0.83835	0.00000	7	#DIV/0!	1	0.00000
	5	10	0.84643	0.83827	0.00000	10	#DIV/0!	0	0.00000
	6	10	0.85526	0.84436 ~~0.83686~~	0.00000	9	#DIV/0!	0	0.00000
	7	10	0.85476	0.84527 ~~0.84436~~	0.00000	8	#DIV/0!	0	0.00000
	8	10	0.86445	0.85344	0.00000	9	#DIV/0!	0	0.00000
						AVERAGE:	#DIV/0!		0.00000

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	See control page - Mean	0	80	Average at Day 0 (mg)		0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

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QC'd by:____KS____

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**	Type/Model of Muffle Furnace: **F6020 Thermolyne MOD**.
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	Muffle Furnace Temperature: **550 °C**
GLC#:	**10582**	Drying Duration (Hours): **~ 24 hrs**	Drying Duration (Hours): **2 hrs**
Sample ID:	**SD-39**	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15/ 1715	Date/Time out: 8/24/15 1615
Test Species:	***Chironomus dilutus***	Dessicator: **# 128**	Dessicator: **# 128**
Test Date:	**8/11/2015**	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MP	Ashed Weigh Date / Technician's Initials: 8/25/15

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	**1**	10	0.84621	0.83585	0.01036	8	1.29500	0	1.03600
SD-39	**2**	10	0.84207	0.83317	0.00890	9	0.98889	0	0.89000
GLC Number:	**3**	10	0.84414	0.83363	0.01051	9	1.16778	0	1.05100
10582	**4**	10	0.84627	0.83835	0.00792	7	1.13143	1	0.88000
	5	10	0.84643	0.83827	0.00816	10	0.81600	0	0.81600
	6	10	0.85526	0.84436	0.01090	9	1.21111	0	1.09000
	7	10	0.85476	0.84527	0.00949	8	1.18625	0	0.94900
	8	10	0.86445	0.85344	0.01101	9	1.22333	0	1.10100
						AVERAGE:	1.12747		0.97663

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	0.84284	0.82872	0.01412	80	Average at Day 0 (mg)		0.17650

See Attached sheet for calculated weights.

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2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	Type/Model of Muffle Furnace: F6020 Thermolyne MOD.
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	Muffle Furnace Temperature: 550 °C
GLC#:	10583	Drying Duration (Hours): ~24 hrs	Drying Duration (Hours): 2 hrs
Sample ID:	SD-40	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1615
Test Species:	*Chironomus dilutus*	Dessicator: # 128	Dessicator: # 128
Test Date:	8/11/2015	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MR	Ashed Weigh Date / Technician's Initials: 8/25/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	1	10	0.84463	0.83426	0.00000	10	#DIV/0!	0	0.00000
SD-40	2	10	0.83324	0.82401	0.00000	9	#DIV/0!	0	0.00000
GLC Number:	3	10	0.84341	0.83319	0.00000	9	#DIV/0!	0	0.00000
10583	4	10	0.84714	0.83612	0.00000	8	#DIV/0!	1	0.00000
	5	10	0.83262	0.82537	0.00000	7	#DIV/0!	0	0.00000
	6	10	0.82799	0.81861 (82.5154)	0.00000	8	#DIV/0!	0	0.00000
	7	10	0.84065	0.83126	0.00000	10	#DIV/0!	0	0.00000
	8	10	0.84455	0.83147	0.00000	10	#DIV/0!	0	0.00000
						AVERAGE:	#DIV/0!		0.00000

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	See control page		0	80	Average at Day 0 (mg)	0

See Attached sheet for calculated weights.

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2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**	Type/Model of Muffle Furnace: **F6020 Thermolyne MOD**.
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	Muffle Furnace Temperature: **550 °C**
GLC#:	**10583**	Drying Duration (Hours): **~ 24 hrs**	Drying Duration (Hours): **2 hrs**
Sample ID:	**SD-40**	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15/ 1715	Date/Time out: 8/24/15 1615
Test Species:	***Chironomus dilutus***	Dessicator: **# 128**	Dessicator: **# 128**
Test Date:	**8/11/2015**	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MP	Ashed Weigh Date / Technician's Initials: 8/25/15

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	**1**	10	0.84463	0.83426	0.01037	10	1.03700	0	1.03700
SD-40	**2**	10	0.83324	0.82401	0.00923	9	1.02556	0	0.92300
GLC Number:	**3**	10	0.84341	0.83319	0.01022	9	1.13556	0	1.02200
10583	**4**	10	0.84714	0.83612	0.01102	8	1.37750	1	1.22444
	5	10	0.83262	0.82537	0.00725	7	1.03571	0	0.72500
	6	10	0.82799	0.81861	0.00938	8	1.17250	0	0.93800
	7	10	0.84065	0.83126	0.00939	10	0.93900	0	0.93900
	8	10	0.84455	0.83447	0.01008	10	1.00800	0	1.00800
						AVERAGE:	1.09135		0.97706

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	0.84284	0.82872	0.01412	80	Average at Day 0 (mg)		0.17650

See Attached sheet for calculated weights.

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2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	Type/Model of Muffle Furnace: F6020 Thermolyne MOD.
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	Muffle Furnace Temperature: 550 °C
GLC#:	10584	Drying Duration (Hours): ~24 hrs	Drying Duration (Hours): 2 hrs
Sample ID:	SD-50	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1615
Test Species:	*Chironomus dilutus*	Dessicator: # 128	Dessicator: # 128
Test Date:	8/11/2015	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 RR.	Ashed Weigh Date / Technician's Initials: 8/25/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	1	10	0.83944	0.83149	0.00000	9	#DIV/0!	1	0.00000
SD-50	2	10	0.84468	0.83612	0.00000	10	#DIV/0!	0	0.00000
GLC Number:	3	10	0.84605	0.83519	0.00000	10	#DIV/0!	0	0.00000
10584	4	10	0.84591	0.83657	0.00000	9	#DIV/0!	0	0.00000
	5	10	0.83248	0.82304	0.00000	10	#DIV/0!	0	0.00000
	6	10	0.85040	0.84161	0.00000	10	#DIV/0!	0	0.00000
	7	10	0.83542	0.82726	0.00000	8	#DIV/0!	1	0.00000
	8	10	0.84885	0.83866	0.00000	10	#DIV/0!	0	0.00000
						AVERAGE:	#DIV/0!		0.00000

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	See control page		new	0	80	Average at Day 0 (mg)	0

See Attached sheet for calculated weights.

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2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**	Type/Model of Muffle Furnace: **F6020 Thermolyne MOD**.
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	Muffle Furnace Temperature: **550 °C**
GLC#:	**10584**	Drying Duration (Hours): **~ 24 hrs**	Drying Duration (Hours): **2 hrs**
Sample ID:	**SD-50**	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15/ 1715	Date/Time out: 8/24/15 1615
Test Species:	***Chironomus dilutus***	Dessicator: **# 128**	Dessicator: **# 128**
Test Date:	**8/11/2015**	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MP	Ashed Weigh Date / Technician's Initials: 8/25/15

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	**1**	10	0.83944	0.83149	0.00795	9	0.88333	1	0.88333
SD-50	**2**	10	0.84468	0.83612	0.00856	10	0.85600	0	0.85600
GLC Number:	**3**	10	0.84605	0.83519	0.01086	10	1.08600	0	1.08600
10584	**4**	10	0.84591	0.83657	0.00934	9	1.03778	0	0.93400
	5	10	0.83248	0.82304	0.00944	10	0.94400	0	0.94400
	6	10	0.85040	0.84161	0.00879	10	0.87900	0	0.87900
	7	10	0.83542	0.82726	0.00816	8	1.02000	1	0.90667
	8	10	0.84885	0.83866	0.01019	10	1.01900	0	1.01900
						AVERAGE:	0.96564		0.93850

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	0.84284	0.82872	0.01412	80	Average at Day 0 (mg)		0.17650

See Attached sheet for calculated weights.

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2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	Type/Model of Muffle Furnace: F6020 Thermolyne MOD.
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	Muffle Furnace Temperature: 550 °C
GLC#:	10585	Drying Duration (Hours): ~ 24 hrs	Drying Duration (Hours): 2 hrs
Sample ID:	SD-54	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1615
Test Species:	*Chironomus dilutus*	Dessicator: # 128	Dessicator: # 128
Test Date:	8/11/2015	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 KS
		Dry Weigh Date / Technician's Initials: 8/24/15 RP	Ashed Weigh Date / Technician's Initials: 8/25/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	1	10	0.85412	0.84351	0.00000	10	#DIV/0!	0	0.00000
SD-54	2	10	0.83703	0.82663	0.00000	10	#DIV/0!	0	0.00000
GLC Number:	3	10	0.84452	0.83358	0.00000	10	#DIV/0!	0	0.00000
10585	4	10	0.84724	0.83124	0.00000	10	#DIV/0!	0	0.00000
	5	10	0.85779	0.84499	0.00000	10	#DIV/0!	0	0.00000
	6	10	0.84617	0.83369	0.00000	9	#DIV/0!	0	0.00000
	7	10	0.86225	0.85085	0.00000	9	#DIV/0!	1	0.00000
	8	10	0.86518	0.85402	0.00000	9	#DIV/0!	1	0.00000
						AVERAGE:	#DIV/0!		0.00000

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	See Control page - mean		0	80	Average at Day 0 (mg)		0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

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QC'd by:____KS____

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**	Type/Model of Muffle Furnace: **F6020 Thermolyne MOD**.
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	Muffle Furnace Temperature: **550 °C**
GLC#:	**10585**	Drying Duration (Hours): **~ 24 hrs**	Drying Duration (Hours): **2 hrs**
Sample ID:	**SD-54**	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15/ 1715	Date/Time out: 8/24/15 1615
Test Species:	***Chironomus dilutus***	Dessicator: **# 128**	Dessicator: **# 128**
Test Date:	**8/11/2015**	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MP	Ashed Weigh Date / Technician's Initials: 8/25/15

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	**1**	10	0.85412	0.84351	0.01061	10	1.06100	0	1.06100
SD-54	**2**	10	0.83703	0.82663	0.01040	10	1.04000	0	1.04000
GLC Number:	**3**	10	0.84452	0.83358	0.01094	10	1.09400	0	1.09400
10585	**4**	10	0.84724	0.83124	0.01600	10	1.60000	0	1.60000
	5	10	0.85779	0.84499	0.01280	10	1.28000	0	1.28000
	6	10	0.84617	0.83369	0.01248	9	1.38667	0	1.24800
	7	10	0.86225	0.85085	0.01140	9	1.26667	1	1.26667
	8	10	0.86518	0.85402	0.01116	9	1.24000	1	1.24000
						AVERAGE:	1.24604		1.22871

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	0.84284	0.82872	0.01412	80	Average at Day 0 (mg)		0.17650

See Attached sheet for calculated weights.

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2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	Type/Model of Muffle Furnace: F6020 Thermolyne MOD.
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	Muffle Furnace Temperature: 550 °C
GLC#:	10586	Drying Duration (Hours): ~24 hrs	Drying Duration (Hours): 2 hrs
Sample ID:	SD-55	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1615
Test Species:	*Chironomus dilutus*	Dessicator: # 128	Dessicator: # 128
Test Date:	8/11/2015	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 830
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/26/15 KS 1234
		Dry Weigh Date / Technician's Initials: 8/24/15 NL	Ashed Weigh Date / Technician's Initials: 8/26/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	1	10	0.85428	0.84240	0.00000	10	#DIV/0!	0	0.00000
SD-55	2	10	0.85533	0.841360	0.00000	10	#DIV/0!	0	0.00000
GLC Number:	3	10	0.83704	0.82471	0.00000	10	#DIV/0!	0	0.00000
10586	4	10	0.84955	0.83936	0.00000	~~10~~ 9	8/26/15 #DIV/0!	1	0.00000
	5	10	0.83807	8/26/15 0.82738	0.00000	8	#DIV/0!	0	0.00000
	6	10	pan not ashed. 0.86259	0.85623	0.00000	9	#DIV/0!	0	0.00000
	7	10	0.84459	0.83004	0.00000	10	#DIV/0!	0	0.00000
	8	10	0.83433	0.82170	0.00000	10	#DIV/0!	0	0.00000
						AVERAGE:	#DIV/0!		0.00000

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	See control page		0	80	Average at Day 0 (mg)		0

See Attached sheet for calculated weights.

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QC'd by:____KS____

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**	Type/Model of Muffle Furnace: **F6020 Thermolyne MOD**.
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	Muffle Furnace Temperature: **550 °C**
GLC#:	**10586**	Drying Duration (Hours): **~ 24 hrs**	Drying Duration (Hours): **2 hrs**
Sample ID:	**SD-55**	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15/ 1715	Date/Time out: 8/24/15 1615
Test Species:	***Chironomus dilutus***	Dessicator: **# 128**	Dessicator: **# 128**
Test Date:	**8/11/2015**	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MP	Ashed Weigh Date / Technician's Initials: 8/25/15

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	**1**	10	0.85428	0.84240	0.01188	10	1.18800	0	1.18800
SD-55	**2**	10	0.85533	0.84360	0.01173	10	1.17300	0	1.17300
GLC Number:	**3**	10	0.83704	0.82471	0.01233	10	1.23300	0	1.23300
10586	**4**	10	0.84955	0.83936	0.01019	9	1.13222	1	1.13222
	5	10	0.83802	0.82738	0.01064	8	1.33000	0	1.06400
	6	10	0.86259	0.85023	0.01236	9	1.37333	0	1.23600
	7	10	0.84459	0.83004	0.01455	10	1.45500	0	1.45500
	8	10	0.83433	0.82170	0.01263	10	1.26300	0	1.26300
						AVERAGE:	1.26844		1.21803

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	0.84284	0.82872	0.01412	80	Average at Day 0 (mg)		0.17650

See Attached sheet for calculated weights.

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2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	Type/Model of Muffle Furnace: F6020 Thermolyne MOD.
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	Muffle Furnace Temperature: 550 °C
GLC#:	10587	Drying Duration (Hours): ~ 24 hrs	Drying Duration (Hours): 2 hrs
Sample ID:	SD-58	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1615
Test Species:	*Chironomus dilutus*	Dessicator: # 128	Dessicator: # 128
Test Date:	8/11/2015	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/26/15 1234
		Dry Weigh Date / Technician's Initials: 8/24/15 NR	Ashed Weigh Date / Technician's Initials: 8/26/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	1	10	0.84973	0.83958	0.00000	10	#DIV/0!	0	0.00000
SD-58	2	10	0.84612	0.83565	0.00000	8	#DIV/0!	0	0.00000
GLC Number:	3	10	0.86024	0.84955	0.00000	8	#DIV/0!	0	0.00000
10587	4	10	0.84852	0.83963	0.00000	8	#DIV/0!	0	0.00000
	5	10	0.85634	0.84439	0.00000	10	#DIV/0!	0	0.00000
	6	10	0.83235	0.82126	0.00000	10	#DIV/0!	0	0.00000
	7	10	0.84000	0.82863	0.00000	9	#DIV/0!	0	0.00000
	8	10	0.83289	0.82068	0.00000	9	#DIV/0!	0	0.00000
						AVERAGE:	#DIV/0!		0.00000

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	See control page - mult		0	80	Average at Day 0 (mg)		0

See Attached sheet for calculated weights.

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QC'd by:____KS____

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**	Type/Model of Muffle Furnace: **F6020 Thermolyne MOD**.
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	Muffle Furnace Temperature: **550 °C**
GLC#:	**10587**	Drying Duration (Hours): **~ 24 hrs**	Drying Duration (Hours): **2 hrs**
Sample ID:	**SD-58**	Date/Time in: 8/21/15 1646	Date/Time in:8/24/15 1415
		Date/Time out: 8/22/15/ 1715	Date/Time out:8/24/15 1615
Test Species:	***Chironomus dilutus***	Dessicator: **# 128**	Dessicator: **# 128**
Test Date:	**8/11/2015**	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MP	Ashed Weigh Date / Technician's Initials: 8/25/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	**1**	10	0.84973	0.83958	0.01015	10	1.01500	0	1.01500
SD-58	**2**	10	0.84612	0.83565	0.01047	8	1.30875	0	1.04700
GLC Number:	**3**	10	0.86024	0.84955	0.01069	8	1.33625	0	1.06900
10587	**4**	10	0.84852	0.83963	0.00889	8	1.11125	0	0.88900
	5	10	0.85634	0.84439	0.01195	10	1.19500	0	1.19500
	6	10	0.83235	0.82126	0.01109	10	1.10900	0	1.10900
	7	10	0.84000	0.82863	0.01137	9	1.26333	0	1.13700
	8	10	0.83289	0.82068	0.01221	9	1.35667	0	1.22100
						AVERAGE:	1.21191		1.08525

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	0.84284	0.82872	0.01412	80	Average at Day 0 (mg)		0.17650

See Attached sheet for calculated weights.

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2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	Type/Model of Muffle Furnace: F6020 Thermolyne MOD.
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	Muffle Furnace Temperature: 550 °C
GLC#:	10588	Drying Duration (Hours): ~24 hrs	Drying Duration (Hours): 2 hrs
Sample ID:	SD-59	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1615
Test Species:	*Chironomus dilutus*	Dessicator: # 128	Dessicator: # 128
Test Date:	8/11/2015	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/26/15 KS 1234
		Dry Weigh Date / Technician's Initials: 8/24/15 MP	Ashed Weigh Date / Technician's Initials: 8/26/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	1	10	0.84672	0.83639	0.00000	10	#DIV/0!	0	0.00000
SD-59	2	10	0.86242	0.85143	0.00000	8	#DIV/0!	0	0.00000
GLC Number:	3	10	0.85733	0.84387	0.00000	10	#DIV/0!	0	0.00000
10588	4	10	0.85245	0.84107	0.00000	10	#DIV/0!	0	0.00000
	5	10	0.84845	0.83684	0.00000	8	#DIV/0!	0	0.00000
	6	10	0.84314	0.83231	0.00000	8	#DIV/0!	0	0.00000
	7	10	0.84648	0.83646	0.00000	10	#DIV/0!	0	0.00000
	8	10	0.85642	0.84196	0.00000	10	#DIV/0!	0	0.00000
						AVERAGE:	#DIV/0!		0.00000

*Biomass weight (mg): defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	See control page - Nur		0	80	Average at Day 0 (mg)		0

See Attached sheet for calculated weights.

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QC'd by:____KS____

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**	Type/Model of Muffle Furnace: **F6020 Thermolyne MOD**.
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	Muffle Furnace Temperature: **550 °C**
GLC#:	**10588**	Drying Duration (Hours): **~ 24 hrs**	Drying Duration (Hours): **2 hrs**
Sample ID:	**SD-59**	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15/ 1715	Date/Time out: 8/24/15 1615
Test Species:	***Chironomus dilutus***	Dessicator: **# 128**	Dessicator: **# 128**
Test Date:	**8/11/2015**	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MP	Ashed Weigh Date / Technician's Initials: 8/25/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	**1**	10	0.84672	0.83639	0.01033	10	1.03300	0	1.03300
SD-59	**2**	10	0.86242	0.85143	0.01099	8	1.37375	0	1.09900
GLC Number:	**3**	10	0.85733	0.84387	0.01346	10	1.34600	0	1.34600
10588	**4**	10	0.85245	0.84107	0.01138	10	1.13800	0	1.13800
	5	10	0.84845	0.83684	0.01161	8	1.45125	0	1.16100
	6	10	0.84314	0.83231	0.01083	8	1.35375	0	1.08300
	7	10	0.84848	0.83648	0.01200	10	1.20000	0	1.20000
	8	10	0.85642	0.84196	0.01446	10	1.44600	0	1.44600
						AVERAGE:	1.29272		1.18825

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	0.84284	0.82872	0.01412	80	Average at Day 0 (mg)		0.17650

See Attached sheet for calculated weights.

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2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	Type/Model of Muffle Furnace: F6020 Thermolyne MOD.
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	Muffle Furnace Temperature: 550 °C
GLC#:	10589	Drying Duration (Hours): ~ 24 hrs	Drying Duration (Hours): 2 hrs
Sample ID:	SD-45	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1445
		Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1615
Test Species:	*Chironomus dilutus*	Dessicator: # 128	Dessicator: # 128
Test Date:	8/11/2015	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/26/15 KS 1234
		Dry Weigh Date / Technician's Initials: 8/24/15 MR	Ashed Weigh Date / Technician's Initials: 8/26/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	1	10	0.85113	0.83789	0.00000	9	#DIV/0!	1	0.00000
SD-45	2	10	0.85504	0.84323	0.00000	9	#DIV/0!	0	0.00000
GLC Number:	3	10	0.85757	0.84384	0.00000	9	#DIV/0!	0	0.00000
10589	4	10	0.83943	0.82812	0.00000	9	#DIV/0!	1	0.00000
	5	10	0.84135	0.82173	0.00000	7	#DIV/0!	0	0.00000
	6	10	0.85161	0.83413	0.00000	10	#DIV/0!	~~10~~ 2 pupae	0.00000
	7	10	0.85456	0.83990	0.00000	9	#DIV/0!	0	0.00000
	8	10	0.86558	0.85341	0.00000	10	#DIV/0!	0	0.00000
						AVERAGE:	#DIV/0!		0.00000

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	See control page - new		0	80	Average at Day 0 (mg)		0

See Attached sheet for calculated weights.

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2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**	Type/Model of Muffle Furnace: **F6020 Thermolyne MOD**.
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	Muffle Furnace Temperature: **550 °C**
GLC#:	**10589**	Drying Duration (Hours): **~ 24 hrs**	Drying Duration (Hours): **2 hrs**
Sample ID:	**SD-45**	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15/ 1715	Date/Time out: 8/24/15
Test Species:	***Chironomus dilutus***	Dessicator: **# 128**	Dessicator: **# 128**
Test Date:	**8/11/2015**	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MP	Ashed Weigh Date / Technician's Initials: 8/25/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	**1**	10	0.85113	0.83789	0.01324	9	1.47111	1	1.47111
SD-45	**2**	10	0.85504	0.84323	0.01181	9	1.31222	0	1.18100
GLC Number:	**3**	10	0.85757	0.84384	0.01373	9	1.52556	0	1.37300
10589	**4**	10	0.83943	0.82812	0.01131	9	1.25667	1	1.25667
	5	10	0.84135	0.82173	0.01962	7	2.80286	0	1.96200
	6	10	0.85161	0.83813	0.01348	10	1.34800	0	1.34800
	7	10	0.85156	0.83990	0.01166	9	1.29556	0	1.16600
	8	10	0.86558	0.85341	0.01217	10	1.21700	0	1.21700
						AVERAGE:	1.52862		1.37185

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	0.84284	0.82872	0.01412	80	Average at Day 0 (mg)		0.17650

See Attached sheet for calculated weights.

Page 1 of 2
QC'd by: KS

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	Type/Model of Muffle Furnace: F6020 Thermolyne MOD.
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	Muffle Furnace Temperature: 550 °C
GLC#:	10590	Drying Duration (Hours): ~24 hrs	Drying Duration (Hours): 2 hrs
Sample ID:	SD-46	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1615
Test Species:	*Chironomus dilutus*	Dessicator: # 128	Dessicator: # 128
Test Date:	8/11/2015	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/26/15 1274
		Dry Weigh Date / Technician's Initials: 8/24/15 RM.	Ashed Weigh Date / Technician's Initials: 8/26/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	1	10	0.85592	0.84516	0.00000	10	#DIV/0!	0	0.00000
SD-46	2	10	0.86375	0.85140	0.00000	10	#DIV/0!	0	0.00000
GLC Number:	3	10	0.84768	0.83664	0.00000	9	#DIV/0!	0	0.00000
10590	4	10	0.84387	0.83386	0.00000	8	#DIV/0!	0	0.00000
	5	10	0.84081	0.83039	0.00000	8	#DIV/0!	0	0.00000
	6	10	0.85492	0.84332	0.00000	10	#DIV/0!	0	0.00000
	7	10	0.85455	0.83947	0.00000	9	#DIV/0!	0	0.00000
	8	10	0.85170	0.84459	0.00000	9	#DIV/0!	0	0.00000
						AVERAGE:	#DIV/0!		0.00000

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	See control page number		0	80	Average at Day 0 (mg)	0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

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QC'd by:____KS____

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**	Type/Model of Muffle Furnace: **F6020 Thermolyne MOD**.
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	Muffle Furnace Temperature: **550 °C**
GLC#:	**10590**	Drying Duration (Hours): **~ 24 hrs**	Drying Duration (Hours): **2 hrs**
Sample ID:	**SD-46**	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15/ 1715	Date/Time out **8/247/15 1615**
Test Species:	***Chironomus dilutus***	Dessicator: **# 128**	Dessicator: **# 128**
Test Date:	**8/11/2015**	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MP	Ashed Weigh Date / Technician's Initials: 8/25/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	**1**	10	0.85592	0.84516	0.01076	10	1.07600	0	1.07600
SD-46	**2**	10	0.86375	0.85140	0.01235	10	1.23500	0	1.23500
GLC Number:	**3**	10	0.84768	0.83664	0.01104	9	1.22667	0	1.10400
10590	**4**	10	0.84387	0.83386	0.01001	8	1.25125	0	1.00100
	5	10	0.84081	0.83039	0.01042	8	1.30250	0	1.04200
	6	10	0.85492	0.84332	0.01160	10	1.16000	0	1.16000
	7	10	0.85455	0.83947	0.01508	9	1.67556	0	1.50800
	8	10	0.85170	0.84459	0.00711	9	0.79000	0	0.71100
						AVERAGE:	1.21462		1.10463

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	0.84284	0.82872	0.01412	80	Average at Day 0 (mg)		0.17650

See Attached sheet for calculated weights.

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QC'd by: K

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number: 2264-00	Type/Model of Drying Oven: Blue M	Type/Model of Muffle Furnace: F6020 Thermolyne MOD.
Project Name: AECOM-Lake Macatawa	Oven Temperature: 60 °C	Muffle Furnace Temperature: 550 °C
GLC#: 10591	Drying Duration (Hours): ~ 24 hrs	Drying Duration (Hours): 2 hrs
Sample ID: LM-08-13	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
	Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1615
Test Species: *Chironomus dilutus*	Dessicator: # 128	Dessicator: # 128
Test Date: 8/11/2015	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out: 8/26/15 KS 1234
	Dry Weigh Date / Technician's Initials: 8/24/15 MP.	Ashed Weigh Date / Technician's Initials: 8/26/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	1	10	0.84657	0.83496	0.00000	7	#DIV/0!	0	0.00000
LM-08-13	2	10	0.85248	0.83953	0.00000	8	#DIV/0!	0	0.00000
GLC Number:	3	10	0.84844	0.83907	0.00000	6	#DIV/0!	0	0.00000
10591	4	10	0.85086	0.83799	0.00000	8	#DIV/0!	0	0.00000
	5	10	0.85886	0.84617	0.00000	5	#DIV/0!	2	0.00000
	6	10	0.85609	0.84474	0.00000	6	#DIV/0!	2	0.00000
	7	10	0.86245	0.85212	0.00000	7	#DIV/0!	0	0.00000
	8	10	0.86232 ~~0.84844~~	0.84684	0.00000	8	#DIV/0!	0	0.00000
						AVERAGE:	#DIV/0!		0.00000

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	Rec control page number	0	80	Average at Day 0 (mg)		0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

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QC'd by:____KS____

2264-00
AECOM-Lake Macatawa
Chironomus dilutus WEIGHT DATA

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**	Type/Model of Muffle Furnace: **F6020 Thermolyne MOD**.
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	Muffle Furnace Temperature: **550 °C**
GLC#:	**10591**	Drying Duration (Hours): **~ 24 hrs**	Drying Duration (Hours): **2 hrs**
Sample ID:	**LM-08-13**	Date/Time in: 8/21/15 1646	Date/Time in: 8/24/15 1415
		Date/Time out: 8/22/15/ 1715	Date/Time out: 8/24/15 1615
Test Species:	***Chironomus dilutus***	Dessicator: **# 128**	Dessicator: **# 128**
Test Date:	**8/11/2015**	Date/Time in: 8/22/15 1715	Date/Time in: 8/25/15 930
	8/21/2015	Date/Time out: 8/24/15 1100	Date/Time out 8/25/15 1230
		Dry Weigh Date / Technician's Initials: 8/24/15 MP	Ashed Weigh Date / Technician's Initials: 8/25/15 KS

	Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Ashed Weight of Pan and Organisms (g)	B-C Total Ash-Free Dry Weight (g)	D Number of Organisms Weighed	B-C/D Average Ash-Free Dry Weight (mg)	E Number of Pupae and Midges at Day 10	(B-C) / (A-E) *Biomass weight (mg)
Sample ID:	**1**	10	0.84657	0.83496	0.01161	7	1.65857	0	1.16100
LM-08-13	**2**	10	0.85248	0.83953	0.01295	8	1.61875	0	1.29500
GLC Number:	**3**	10	0.84844	0.83907	0.00937	6	1.56167	0	0.93700
10591	**4**	10	0.85086	0.83799	0.01287	8	1.60875	0	1.28700
	5	10	0.85886	0.84617	0.01269	5	2.53800	2	1.58625
	6	10	0.85609	0.84474	0.01135	6	1.89167	2	1.41875
	7	10	0.86245	0.85212	0.01033	7	1.47571	0	1.03300
	8	10	0.86232	0.84684	0.01548	8	1.93500	0	1.54800
						AVERAGE:	1.78601		1.28325

*Biomass weight (mg) : defined as the total ash-free dry weight of surviving organisms divided by the initial number of organisms minus pupae and midges

Day 0 weights	80	0.84284	0.82872	0.01412	80	Average at Day 0 (mg)		0.17650

See Attached sheet for calculated weights.

Test: EPA 100.2-Chironomus dilutus 10d Survival and Growth Test
Species: CDIL-Chironomus dilutus
Sample ID:
Start Date: 8/11/2015 End Date: 8/21/2015

Test ID: 2264cdref
Protocol: EPA 600/R-99/064
Sample Type: -WHOLE SEDIMENT
Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0	Day 4	Day 10	Day 10	Day 20	Day 20	# pupae + M	Alive in Sedi	Remain in Se	Emerged	Weight pan/c	Weight ashed pan/orgs aft
	1	1	Lab Con	10		10	10			0				0.84609	0.83192
	2	2	Lab Con	10		8	9			1				0.84454	0.83344
	3	3	Lab Con	10		10	10			0				0.83746	0.82529
	4	4	Lab Con	10		10	10			0				0.82913	0.8148
	5	5	Lab Con	10		10	10			0				0.82798	0.81457
	6	6	Lab Con	10		9	9			0				0.84001	0.82787
	7	7	Lab Con	10		9	10			1				0.83795	0.82567
	8	1	Water Only	10		8	8			0				0.83727	0.83095
	9	2	Water Only	10		8	8			0				0.83999	0.83373
	10	3	Water Only	10		10	10			0				0.84542	0.83858
	11	4	Water Only	10		9	9			0				0.85165	0.846
	12	5	Water Only	10		10	10			0				0.85307	0.84565
	13	6	Water Only	10		10	10			0				0.82373	0.81652
	14	7	Water Only	10		10	10			0				0.84573	0.83817
	15	8	Water Only	10		9	9			0				0.83327	0.82644
	16	1	SD25; 10579	10		10	10			0				0.84381	0.83264
	17	2	SD25; 10579	10		10	10			0				0.84151	0.82971
	18	3	SD25; 10579	10		9	9			0				0.83793	0.82489
	19	4	SD25; 10579	10		10	10			0				0.84178	0.83171
	20	5	SD25; 10579	10		10	10			0				0.84913	0.83574
	21	6	SD25; 10579	10		9	9			0				0.8465	0.83499
	22	7	SD25; 10579	10		9	9			0				0.85301	0.84121
	23	8	SD25; 10579	10		9	10			1				0.85375	0.84275
	24	1	SD30; 10580	10		1	1			0				0.82843	0.82783
	25	2	SD30; 10580	10		1	1			0				0.81119	0.811
	26	3	SD30; 10580	10		3	3			0				0.83741	0.83684
	27	4	SD30; 10580	10		3	3			0				0.82745	0.82381
	28	5	SD30; 10580	10		3	3			0				0.82151	0.81957
	29	6	SD30; 10580	10		2	2			0				0.83083	0.83034
	30	7	SD30; 10580	10		2	2			0				0.82557	0.82353
	31	8	SD30; 10580	10		3	3			0				0.82387	0.82326
	32	1	SD32; 10581	10		10	10			0				0.84123	0.83356
	33	2	SD32; 10581	10		10	10			0				0.84217	0.83336
	34	3	SD32; 10581	10		10	10			0				0.84484	0.83579
	35	4	SD32; 10581	10		10	10			0				0.84339	0.83395
	36	5	SD32; 10581	10		9	9			0				0.84496	0.8343
	37	6	SD32; 10581	10		10	10			0				0.84254	0.83255
	38	7	SD32; 10581	10		10	10			0				0.84341	0.83516

ToxCalc 5.0

Reviewed by: MLV

Test: EPA 100.2-Chironomus dilutus 10d Survival and Growth Test Test ID: 2264cdref
Species: CDIL-Chironomus dilutus Protocol: EPA 600/R-99/064
Sample ID: Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015 Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0	Day 4	Day 10	Day 10	Day 20	Day 20	# pupae + Mi	Alive in Sedi	Remain in Se	Emerged	Weight pan/c	Weight ashed pan/orgs aft
	39	8	SD32; 10581	10		9	9			0				0.83329	0.82421
	40	1	SD39; 10582	10		8	8			0				0.84621	0.83585
	41	2	SD39; 10582	10		9	9			0				0.84207	0.83317
	42	3	SD39; 10582	10		9	9			0				0.84414	0.83363
	43	4	SD39; 10582	10		7	8			1				0.84627	0.83835
	44	5	SD39; 10582	10		10	10			0				0.84643	0.83827
	45	6	SD39; 10582	10		9	9			0				0.85526	0.84436
	46	7	SD39; 10582	10		8	8			0				0.85476	0.84527
	47	8	SD39; 10582	10		9	9			0				0.86445	0.85344
	48	1	SD40; 10583	10		10	10			0				0.84463	0.83426
	49	2	SD40; 10583	10		9	9			0				0.83324	0.82401
	50	3	SD40; 10583	10		9	9			0				0.84341	0.83319
	51	4	SD40; 10583	10		8	9			1				0.84714	0.83612
	52	5	SD40; 10583	10		7	7			0				0.83262	0.82537
	53	6	SD40; 10583	10		8	8			0				0.82799	0.81861
	54	7	SD40; 10583	10		10	10			0				0.84065	0.83126
	55	8	SD40; 10583	10		10	10			0				0.84455	0.83447
	56	1	SD50; 10584	10		9	10			1				0.83944	0.83149
	57	2	SD50; 10584	10		10	10			0				0.84468	0.83612
	58	3	SD50; 10584	10		10	10			0				0.84605	0.83519
	59	4	SD50; 10584	10		9	9			0				0.84591	0.83657
	60	5	SD50; 10584	10		10	10			0				0.83248	0.82304
	61	6	SD50; 10584	10		10	10			0				0.8504	0.84161
	62	7	SD50; 10584	10		8	9			1				0.83542	0.82726
	63	8	SD50; 10584	10		10	10			0				0.84885	0.83866
	64	1	SD54; 10585	10		10	10			0				0.85412	0.84351
	65	2	SD54; 10585	10		10	10			0				0.83703	0.82663
	66	3	SD54; 10585	10		10	10			0				0.84452	0.83358
	67	4	SD54; 10585	10		10	10			0				0.84724	0.83124
	68	5	SD54; 10585	10		10	10			0				0.85779	0.84499
	69	6	SD54; 10585	10		9	9			0				0.84617	0.83369
	70	7	SD54; 10585	10		9	10			1				0.86225	0.85085
	71	8	SD54; 10585	10		9	10			1				0.86518	0.85402
	72	1	SD55; 10586	10		10	10			0				0.85428	0.8424
	73	2	SD55; 10586	10		10	10			0				0.85533	0.8436
	74	3	SD55; 10586	10		10	10			0				0.83704	0.82471
	75	4	SD55; 10586	10		9	10			1				0.84955	0.83936
	76	5	SD55; 10586	10		8	8			0				0.83802	0.82738

Test: EPA 100.2-Chironomus dilutus 10d Survival and Growth Test
Species: CDIL-Chironomus dilutus
Sample ID:
Start Date: 8/11/2015 End Date: 8/21/2015

Test ID: 2264cdref
Protocol: EPA 600/R-99/064
Sample Type: -WHOLE SEDIMENT
Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0	Day 4	Day 10	Day 16	Day 20	Day 20	# pupae + Mi	Alive in Sedi	Remain in Se	Emerged	Weight pan/c	Weight ashed pan/orgs aft
	77	6	SD55; 10586	10		9	9			0				0.86259	0.85023
	78	7	SD55; 10586	10		10	10			0				0.84459	0.83004
	79	8	SD55; 10586	10		10	10			0				0.83433	0.8217
	80	1	SD58; 10587	10		10	10			0				0.84973	0.83958
	81	2	SD58; 10587	10		8	8			0				0.84612	0.83565
	82	3	SD58; 10587	10		8	8			0				0.86024	0.84955
	83	4	SD58; 10587	10		8	8			0				0.84852	0.83963
	84	5	SD58; 10587	10		10	10			0				0.85634	0.84439
	85	6	SD58; 10587	10		10	10			0				0.83235	0.82126
	86	7	SD58; 10587	10		9	9			0				0.84	0.82863
	87	8	SD58; 10587	10		9	9			0				0.83289	0.82068
	88	1	SD59; 10588	10		10	10			0				0.84672	0.83639
	89	2	SD59; 10588	10		8	8			0				0.86242	0.85143
	90	3	SD59; 10588	10		10	10			0				0.85733	0.84387
	91	4	SD59; 10588	10		10	10			0				0.85245	0.84107
	92	5	SD59; 10588	10		8	8			0				0.84845	0.83684
	93	6	SD59; 10588	10		8	8			0				0.84314	0.83231
	94	7	SD59; 10588	10		10	10			0				0.84848	0.83648
	95	8	SD59; 10588	10		10	10			0				0.85642	0.84196
	96	1	SD45; 10589	10		9	10			1				0.85113	0.83789
	97	2	SD45; 10589	10		9	9			0				0.85504	0.84323
	98	3	SD45; 10589	10		9	9			0				0.85757	0.84384
	99	4	SD45; 10589	10		9	10			1				0.83943	0.82812
	100	5	SD45; 10589	10		7	7			0				0.84135	0.82173
	101	6	SD45; 10589	10		10	10			0				0.85161	0.83813
	102	7	SD45; 10589	10		9	9			0				0.85156	0.8399
	103	8	SD45; 10589	10		10	10			0				0.86558	0.85341
	104	1	SD46; 10590	10		10	10			0				0.85592	0.84516
	105	2	SD46; 10590	10		10	10			0				0.86375	0.8514
	106	3	SD46; 10590	10		9	9			0				0.84768	0.83664
	107	4	SD46; 10590	10		8	8			0				0.84387	0.83386
	108	5	SD46; 10590	10		8	8			0				0.84081	0.83039
	109	6	SD46; 10590	10		10	10			0				0.85492	0.84332
	110	7	SD46; 10590	10		9	9			0				0.85455	0.83947
	111	8	SD46; 10590	10		9	9			0				0.8517	0.84459
	112	1	LM0813; 10591	10		7	7			0				0.84657	0.83496
	113	2	LM0813; 10591	10		8	8			0				0.85248	0.83953
	114	3	LM0813; 10591	10		6	6			0				0.84844	0.83907

Test: EPA 100.2-Chironomus dilutus 10d Survival and Growth Test
Test ID: 2264cdref
Species: CDIL-Chironomus dilutus
Protocol: EPA 600/R-99/064
Sample ID:
Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015
Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0	Day 4	Day 10	Day 10	Day 20	Day 20	# pupae + Mi	Alive in Sedi	Remain in Se	Emerged	Weight pan/c	Weight ashed pan/orgs aft
	115	4	LM0813; 10591	10		8	8			0				0.85086	0.83799
	116	5	LM0813; 10591	10		5	7			2				0.85886	0.84617
	117	6	LM0813; 10591	10		6	8			2				0.85609	0.84474
	118	7	LM0813; 10591	10		7	7			0				0.86245	0.85212
	119	8	LM0813; 10591	10		8	8			0				0.86232	0.84684

Comments: AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015

Chironomus dilutus 10d Survival and Growth Test-10-day survival

Start Date:	8/11/2015	Test ID:	2264cdref	Sample ID:	
End Date:	8/21/2015	Lab ID:	-GREAT LAKES ENVIRONM	Sample Type:	-WHOLE SEDIMENT
Sample Date:		Protocol:	EPA 600/R-99/064	Test Species:	CDIL-Chironomus dilutus
Comments:	AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015				

Conc-%	1	2	3	4	5	6	7	8
Lab Con	1.0000	0.9000	1.0000	1.0000	1.0000	0.9000	1.0000	
Water Only	0.8000	0.8000	1.0000	0.9000	1.0000	1.0000	1.0000	0.9000
SD25; 10579	1.0000	1.0000	0.9000	1.0000	1.0000	0.9000	0.9000	1.0000
SD30; 10580	0.1000	0.1000	0.3000	0.3000	0.3000	0.2000	0.2000	0.3000
SD32; 10581	1.0000	1.0000	1.0000	1.0000	0.9000	1.0000	1.0000	0.9000
SD39; 10582	0.8000	0.9000	0.9000	0.8000	1.0000	0.9000	0.8000	0.9000
SD40; 10583	1.0000	0.9000	0.9000	0.9000	0.7000	0.8000	1.0000	1.0000
SD50; 10584	1.0000	1.0000	1.0000	0.9000	1.0000	1.0000	0.9000	1.0000
SD54; 10585	1.0000	1.0000	1.0000	1.0000	1.0000	0.9000	1.0000	1.0000
SD55; 10586	1.0000	1.0000	1.0000	1.0000	0.8000	0.9000	1.0000	1.0000
SD58; 10587	1.0000	0.8000	0.8000	0.8000	1.0000	1.0000	0.9000	0.9000
SD59; 10588	1.0000	0.8000	1.0000	1.0000	0.8000	0.8000	1.0000	1.0000
SD45; 10589	1.0000	0.9000	0.9000	1.0000	0.7000	1.0000	0.9000	1.0000
SD46; 10590	1.0000	1.0000	0.9000	0.8000	0.8000	1.0000	0.9000	0.9000
LM0813; 10591	0.7000	0.8000	0.6000	0.8000	0.7000	0.8000	0.7000	0.8000

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Lab Con	0.9714	1.0502	1.3655	1.2490	1.4120	5.824	7	*		
Water Only	0.9250	1.0000	1.2951	1.1071	1.4120	10.505	8			
SD25; 10579	0.9625	1.0405	1.3509	1.2490	1.4120	6.244	8	0.342	1.771	0.0753
*SD30; 10580	0.2250	0.2432	0.4862	0.3218	0.5796	23.327	8	17.124	1.771	0.0909
SD32; 10581	0.9750	1.0541	1.3713	1.2490	1.4120	5.501	8	-0.145	1.771	0.0709
*SD39; 10582	0.8750	0.9459	1.2162	1.1071	1.4120	8.698	8	3.049	1.771	0.0867
SD40; 10583	0.9000	0.9730	1.2602	0.9912	1.4120	12.195	8	1.627	1.771	0.1146
SD50; 10584	0.9750	1.0541	1.3713	1.2490	1.4120	5.501	8	-0.145	1.771	0.0709
SD54; 10585	0.9875	1.0676	1.3916	1.2490	1.4120	4.140	8	-0.738	1.771	0.0629
SD55; 10586	0.9625	1.0405	1.3535	1.1071	1.4120	8.478	8	0.230	1.771	0.0917
*SD58; 10587	0.9000	0.9730	1.2569	1.1071	1.4120	11.234	8	1.794	1.771	0.1071
SD59; 10588	0.9250	1.0000	1.2977	1.1071	1.4120	12.159	8	1.025	1.771	0.1171
SD45; 10589	0.9250	1.0000	1.2983	0.9912	1.4120	11.400	8	1.070	1.771	0.1112
SD46; 10590	0.9125	0.9865	1.2747	1.1071	1.4120	10.042	8	1.619	1.771	0.0993
*LM0813; 10591	0.7375	0.7973	1.0360	0.8861	1.1071	8.056	8	7.794	1.771	0.0749

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.80792	1.035	-0.6356	-0.2491
Bartlett's Test indicates equal variances (p = 0.24)	16.1662	22.362		
The control means are not significantly different (p = 0.25)	1.19825	2.16037		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Homoscedastic t Test indicates significant differences Treatments vs Lab Con	0.0349	0.03641	0.44021	0.01286	1.8E-30	13, 97

Chironomus dilutus 10d Survival and Growth Test-10-Day Growth (AFDW)

Start Date:	8/11/2015	Test ID:	2264cdref	Sample ID:	
End Date:	8/21/2015	Lab ID:	-GREAT LAKES ENVIRONM	Sample Type:	-WHOLE SEDIMENT
Sample Date:		Protocol:	EPA 600/R-99/064	Test Species:	CDIL-Chironomus dilutus
Comments:	AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015				

Conc-%	1	2	3	4	5	6	7	8
Lab Con	1.4170	1.3875	1.2170	1.4330	1.3410	1.3489	1.3644	
Water Only	0.7900	0.7825	0.6840	0.6278	0.7420	0.7210	0.7560	0.7589
SD25; 10579	1.1170	1.1800	1.4489	1.0070	1.3390	1.2789	1.3111	1.2222
SD30; 10580	0.6000	0.1900	0.1900	1.2133	0.6487	0.2450	1.0200	0.2033
SD32; 10581	0.7670	0.8810	0.9050	0.9440	1.1844	0.9990	0.8250	1.0089
SD39; 10582	1.2950	0.9889	1.1678	1.1314	0.8160	1.2111	1.1863	1.2233
SD40; 10583	1.0370	1.0256	1.1356	1.3775	1.0357	1.1725	0.9390	1.0080
SD50; 10584	0.8833	0.8560	1.0860	1.0378	0.9440	0.8790	1.0200	1.0190
SD54; 10585	1.0610	1.0400	1.0940	1.6000	1.2800	1.3867	1.2667	1.2400
SD55; 10586	1.1880	1.1730	1.2330	1.1322	1.3300	1.3733	1.4550	1.2630
SD58; 10587	1.0150	1.3088	1.3363	1.1113	1.1950	1.1090	1.2633	1.3567
SD59; 10588	1.0330	1.3737	1.3460	1.1380	1.4513	1.3538	1.2000	1.4460
SD45; 10589	1.4711	1.3122	1.5256	1.2587	2.8029	1.3480	1.2956	1.2170
SD46; 10590	1.0760	1.2350	1.2267	1.2513	1.3025	1.1600	1.6756	0.7900
LM0813; 10591	1.6586	1.6188	1.5617	1.6087	2.5380	1.8917	1.4757	1.9350

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Lab Con	1.3584	1.8538	1.3584	1.2170	1.4330	5.229	7	*		
Water Only	0.7328	1.0000	0.7328	0.6278	0.7900	7.402	8			
*SD25; 10579	1.2380	1.6895	1.2380	1.0070	1.4489	11.147	8	2.162	1.812	0.1009
*SD30; 10580	0.5385	0.7349	0.5385	0.1900	1.2133	75.070	8	5.637	1.895	0.2755
*SD32; 10581	0.9393	1.2818	0.9393	0.7670	1.1844	13.696	8	7.935	1.796	0.0949
*SD39; 10582	1.1275	1.5386	1.1275	0.8160	1.2950	13.640	8	3.808	1.812	0.1099
*SD40; 10583	1.0914	1.4894	1.0914	0.9390	1.3775	12.533	8	4.828	1.812	0.1002
*SD50; 10584	0.9656	1.3178	0.9656	0.8560	1.0860	8.948	8	9.658	1.782	0.0725
SD54; 10585	1.2460	1.7005	1.2460	1.0400	1.6000	15.060	8	1.570	1.833	0.1312
*SD55; 10586	1.2684	1.7310	1.2684	1.1322	1.4550	8.688	8	1.901	1.782	0.0843
*SD58; 10587	1.2119	1.6539	1.2119	1.0150	1.3567	10.260	8	2.844	1.796	0.0925
SD59; 10588	1.2927	1.7642	1.2927	1.0330	1.4513	11.759	8	1.093	1.812	0.1089
SD45; 10589	1.5286	2.0861	1.5286	1.2170	2.8029	34.367	8	-0.907	1.895	0.3555
SD46; 10590	1.2146	1.6576	1.2146	0.7900	1.6756	20.277	8	1.578	1.860	0.1694
LM0813; 10591	1.7860	2.4373	1.7860	1.4757	2.5380	19.176	8	-3.448	1.895	0.2350

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.62262	1.035	2.17924	9.88312
Bartlett's Test indicates unequal variances (p = 2.30E-08)	61.9998	22.362		
The control means are significantly different (p = 5.85E-11)	19.3254	2.16037		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences Treatments vs Lab Con	0.23498	0.17298	0.65725	0.05723	1.5E-14	13, 97

Chironomus dilutus 10d Survival and Growth Test-10-Day Biomass (AFDW)

Start Date: 8/11/2015	Test ID: 2264cdref	Sample ID:	
End Date: 8/21/2015	Lab ID: -GREAT LAKES ENVIRONM	Sample Type:	-WHOLE SEDIMENT
Sample Da	Protocol: EPA 600/R-99/064	Test Species:	CDIL-Chironomus dilutus

Comments AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015

Conc-%	1	2	3	4	5	6	7	8
Lab Con	1.4170	1.2333	1.2170	1.4330	1.3410	1.2140	1.3644	
Water Only	0.6320	0.6260	0.6840	0.5650	0.7420	0.7210	0.7560	0.6830
SD25; 10579	1.1170	1.1800	1.3040	1.0070	1.3390	1.1510	1.1800	1.2222
SD30; 10580	0.0600	0.0190	0.0570	0.3640	0.1940	0.0490	0.2040	0.0610
SD32; 10581	0.7670	0.8610	0.9050	0.9440	1.0660	0.9990	0.8250	0.9080
SD39; 10582	1.0360	0.8900	1.0510	0.8800	0.8160	1.0900	0.9490	1.1010
SD40; 10583	1.0370	0.9230	1.0220	1.2244	0.7250	0.9380	0.9390	1.0080
SD50; 10584	0.8833	0.8560	1.0860	0.9340	0.9440	0.8790	0.9067	1.0190
SD54; 10585	1.0610	1.0400	1.0940	1.6000	1.2800	1.2480	1.2667	1.2400
SD55; 10586	1.1880	1.1730	1.2330	1.1322	1.0640	1.2360	1.4550	1.2630
SD58; 10587	1.0150	1.0470	1.0690	0.8890	1.1950	1.1090	1.1370	1.2210
SD59; 10588	1.0330	1.0990	1.3460	1.1380	1.1610	1.0830	1.2000	1.4460
SD45; 10589	1.4711	1.1810	1.3730	1.2567	1.9620	1.3480	1.1660	1.2170
SD46; 10590	1.0760	1.2350	1.1040	1.0010	1.0420	1.1600	1.5080	0.7110
LM0813; 10591	1.1610	1.2950	0.9370	1.2870	1.5863	1.4188	1.0330	1.5480

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Lab Con	1.3171	1.9480	1.3171	1.2140	1.4330	7.196	7	*		
Water Only	0.6761	1.0000	0.6761	0.5850	0.7560	9.626	8			
*SD25; 10579	1.1875	1.7564	1.1875	1.0070	1.3390	8.816	8	2.518	1.782	0.0918
*SD30; 10580	0.1260	0.1864	0.1260	0.0190	0.3640	93.941	8	21.623	1.782	0.0982
*SD32; 10581	0.9119	1.3487	0.9119	0.7670	1.0660	10.315	8	8.291	1.782	0.0871
*SD39; 10582	0.9766	1.4444	0.9766	0.8160	1.1010	11.000	8	6.522	1.782	0.0931
*SD40; 10583	0.9771	1.4451	0.9771	0.7250	1.2244	14.329	8	5.566	1.782	0.1089
*SD50; 10584	0.9385	1.3881	0.9385	0.8560	1.0860	8.321	8	8.371	1.796	0.0812
SD54; 10585	1.2287	1.8173	1.2287	1.0400	1.6000	14.569	8	1.216	1.812	0.1318
*SD55; 10586	1.2180	1.8015	1.2180	1.0640	1.4550	9.450	8	1.828	1.782	0.0966
*SD58; 10587	1.0853	1.6051	1.0853	0.8890	1.2210	9.782	8	4.469	1.782	0.0925
*SD59; 10588	1.1883	1.7574	1.1883	1.0330	1.4460	11.811	8	2.106	1.782	0.1091
SD45; 10589	1.3718	2.0290	1.3718	1.1660	1.9620	18.983	8	-0.554	1.833	0.1811
*SD46; 10590	1.1046	1.6338	1.1046	0.7110	1.5080	20.335	8	2.439	1.833	0.1597
LM0813; 10591	1.2833	1.8979	1.2833	0.9370	1.5863	18.106	8	0.378	1.833	0.1643

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates normal distribution (p > 0.01)	0.91937	1.035	0.77082	2.62673
Bartlett's Test indicates unequal variances (p = 0.02)	26.0314	22.362		
The control means are significantly different (p = 9.59E-10)	15.4495	2.16037		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences Treatments vs Lab Con	0.16427	0.12472	0.7486	0.02362	3.6E-29	13, 97

Appendix C2
Chironomus dilutus
10-Day Statistical Data
Reference Sediment SD-45

- Survival
- Weight

Test: EPA 100.2-Chironomus dilutus 10d Survival and Growth Test Test ID: 2264cdSD45
Species: CDIL-Chironomus dilutus Protocol: EPA 600/R-99/064
Sample ID: Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015 Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0	Day 4	Day 1	Day 1	Day 2	Day 2	# pupae + Mi	Alive in Sedi	Remain in Se	Emerged	Weight pan/c	Weight ashed pan/orgs aft
	1	1	SD45; 10589	10		9	10			1				0.85113	0.83789
	2	2	SD45; 10589	10		9	9			0				0.85504	0.84323
	3	3	SD45; 10589	10		9	9			0				0.85757	0.84384
	4	4	SD45; 10589	10		9	10			1				0.83943	0.82812
	5	5	SD45; 10589	10		7	7			0				0.84135	0.82173
	6	6	SD45; 10589	10		10	10			0				0.85161	0.83813
	7	7	SD45; 10589	10		9	9			0				0.85156	0.8399
	8	8	SD45; 10589	10		10	10			0				0.86558	0.85341
	9	1	SD25;10579	10		10	10			0				0.84381	0.83264
	10	2	SD25;10579	10		10	10			0				0.84151	0.82971
	11	3	SD25;10579	10		9	9			0				0.83793	0.82489
	12	4	SD25;10579	10		10	10			0				0.84178	0.83171
	13	5	SD25;10579	10		10	10			0				0.84913	0.83574
	14	6	SD25;10579	10		9	9			0				0.8465	0.83499
	15	7	SD25;10579	10		9	9			0				0.85301	0.84121
	16	8	SD25;10579	10		9	10			1				0.85375	0.84275
	17	1	SD30; 10580	10		1	1			0				0.82843	0.82783
	18	2	SD30; 10580	10		1	1			0				0.81119	0.811
	19	3	SD30; 10580	10		3	3			0				0.83741	0.83684
	20	4	SD30; 10580	10		3	3			0				0.82745	0.82381
	21	5	SD30; 10580	10		3	3			0				0.82151	0.81957
	22	6	SD30; 10580	10		2	2			0				0.83083	0.83034
	23	7	SD30; 10580	10		2	2			0				0.82557	0.82353
	24	8	SD30; 10580	10		3	3			0				0.82387	0.82326
	25	1	SD32; 10581	10		10	10			0				0.84123	0.83356
	26	2	SD32; 10581	10		10	10			0				0.84217	0.83336
	27	3	SD32; 10581	10		10	10			0				0.84484	0.83579
	28	4	SD32; 10581	10		10	10			0				0.84339	0.83395
	29	5	SD32; 10581	10		9	9			0				0.84496	0.8343
	30	6	SD32; 10581	10		10	10			0				0.84254	0.83255
	31	7	SD32; 10581	10		10	10			0				0.84341	0.83516
	32	8	SD32; 10581	10		9	9			0				0.83329	0.82421
	33	1	SD39; 10582	10		8	8			0				0.84621	0.83585
	34	2	SD39; 10582	10		9	9			0				0.84207	0.83317
	35	3	SD39; 10582	10		9	9			0				0.84414	0.83363
	36	4	SD39; 10582	10		7	8			1				0.84627	0.83835
	37	5	SD39; 10582	10		10	10			0				0.84643	0.83827
	38	6	SD39; 10582	10		9	9			0				0.85526	0.84436

Test: EPA 100.2-Chironomus dilutus 10d Survival and Growth Test Test ID: 2264cdSD45
Species: CDIL-Chironomus dilutus Protocol: EPA 600/R-99/064
Sample ID: Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015 Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0	Day 4	Day 10	Day 10	Day 20	Day 20	# pupae + Mi	Alive in Sedi	Remain in Se	Emerged	Weight pan/c	Weight ashed pan/orgs aft
	39	7	SD39; 10582	10		8	8			0				0.85476	0.84527
	40	8	SD39; 10582	10		9	9			0				0.86445	0.85344
	41	1	SD40; 10583	10		10	10			0				0.84463	0.83426
	42	2	SD40; 10583	10		9	9			0				0.83324	0.82401
	43	3	SD40; 10583	10		9	9			0				0.84341	0.83319
	44	4	SD40; 10583	10		8	9			1				0.84714	0.83612
	45	5	SD40; 10583	10		7	7			0				0.83262	0.82537
	46	6	SD40; 10583	10		8	8			0				0.82799	0.81861
	47	7	SD40; 10583	10		10	10			0				0.84065	0.83126
	48	8	SD40; 10583	10		10	10			0				0.84455	0.83447
	49	1	SD50; 10584	10		9	10			1				0.83944	0.83149
	50	2	SD50; 10584	10		10	10			0				0.84468	0.83612
	51	3	SD50; 10584	10		10	10			0				0.84605	0.83519
	52	4	SD50; 10584	10		9	9			0				0.84591	0.83657
	53	5	SD50; 10584	10		10	10			0				0.83248	0.82304
	54	6	SD50; 10584	10		10	10			0				0.8504	0.84161
	55	7	SD50; 10584	10		8	9			1				0.83542	0.82726
	56	8	SD50; 10584	10		10	10			0				0.84885	0.83866
	57	1	SD54; 10585	10		10	10			0				0.85412	0.84351
	58	2	SD54; 10585	10		10	10			0				0.83703	0.82663
	59	3	SD54; 10585	10		10	10			0				0.84452	0.83358
	60	4	SD54; 10585	10		10	10			0				0.84724	0.83124
	61	5	SD54; 10585	10		10	10			0				0.85779	0.84499
	62	6	SD54; 10585	10		9	9			0				0.84617	0.83369
	63	7	SD54; 10585	10		9	10			1				0.86225	0.85085
	64	8	SD54; 10585	10		9	10			1				0.86518	0.85402
	65	1	SD55; 10586	10		10	10			0				0.85428	0.8424
	66	2	SD55; 10586	10		10	10			0				0.85533	0.8436
	67	3	SD55; 10586	10		10	10			0				0.83704	0.82471
	68	4	SD55; 10586	10		9	10			1				0.84955	0.83936
	69	5	SD55; 10586	10		8	8			0				0.83802	0.82738
	70	6	SD55; 10586	10		9	9			0				0.86259	0.85023
	71	7	SD55; 10586	10		10	10			0				0.84459	0.83004
	72	8	SD55; 10586	10		10	10			0				0.83433	0.8217
	73	1	SD58; 10587	10		10	10			0				0.84973	0.83958
	74	2	SD58; 10587	10		8	8			0				0.84612	0.83565
	75	3	SD58; 10587	10		8	8			0				0.86024	0.84955
	76	4	SD58; 10587	10		8	8			0				0.84852	0.83963

Test: EPA 100.2-Chironomus dilutus 10d Survival and Growth Test
Test ID: 2264cdSD45
Species: CDIL-Chironomus dilutus
Protocol: EPA 600/R-99/064
Sample ID:
Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015
Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0	Day 4	Day 10	Day 10	Day 20	Day 20	# pupae + Mi	Alive in Sedi	Remain in Se	Emerged	Weight pan/c	Weight ashed pan/orgs aft
	77	5	SD58; 10587	10		10	10			0				0.85634	0.84439
	78	6	SD58; 10587	10		10	10			0				0.83235	0.82126
	79	7	SD58; 10587	10		9	9			0				0.84	0.82863
	80	8	SD58; 10587	10		9	9			0				0.83289	0.82068
	81	1	SD59; 10588	10		10	10			0				0.84672	0.83639
	82	2	SD59; 10588	10		8	8			0				0.86242	0.85143
	83	3	SD59; 10588	10		10	10			0				0.85733	0.84387
	84	4	SD59; 10588	10		10	10			0				0.85245	0.84107
	85	5	SD59; 10588	10		8	8			0				0.84845	0.83684
	86	6	SD59; 10588	10		8	8			0				0.84314	0.83231
	87	7	SD59; 10588	10		10	10			0				0.84848	0.83648
	88	8	SD59; 10588	10		10	10			0				0.85642	0.84196
	89	1	SD46; 10590	10		10	10			0				0.85592	0.84516
	90	2	SD46; 10590	10		10	10			0				0.86375	0.8514
	91	3	SD46; 10590	10		9	9			0				0.84768	0.83664
	92	4	SD46; 10590	10		8	8			0				0.84387	0.83386
	93	5	SD46; 10590	10		8	8			0				0.84081	0.83039
	94	6	SD46; 10590	10		10	10			0				0.85492	0.84332
	95	7	SD46; 10590	10		9	9			0				0.85455	0.83947
	96	8	SD46; 10590	10		9	9			0				0.8517	0.84459
	97	1	LM0813; 10591	10		7	7			0				0.84657	0.83496
	98	2	LM0813; 10591	10		8	8			0				0.85248	0.83953
	99	3	LM0813; 10591	10		6	6			0				0.84844	0.83907
	100	4	LM0813; 10591	10		8	8			0				0.85086	0.83799
	101	5	LM0813; 10591	10		5	7			2				0.85886	0.84617
	102	6	LM0813; 10591	10		6	8			2				0.85609	0.84474
	103	7	LM0813; 10591	10		7	7			0				0.86245	0.85212
	104	8	LM0813; 10591	10		8	8			0				0.86232	0.84684

Comments: AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015-SD45

Chironomus dilutus 10d Survival and Growth Test-10-day survival

Start Date: 8/11/2015	Test ID:	2264cdSD45	Sample ID:		
End Date: 8/21/2015	Lab ID:	-GREAT LAKES ENVIRONMENT	Sample Type:	-WHOLE SEDIMENT	
Sample Da	Protocol:	EPA 600/R-99/064	Test Species:	CDIL-Chironomus dilutus	

Comments AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015-SD45

Conc-%	1	2	3	4	5	6	7	8
SD45; 10589	1.0000	0.9000	0.9000	1.0000	0.7000	1.0000	0.9000	1.0000
SD25;10579	1.0000	1.0000	0.9000	1.0000	1.0000	0.9000	0.9000	1.0000
SD30; 10580	0.1000	0.1000	0.3000	0.3000	0.3000	0.2000	0.2000	0.3000
SD32; 10581	1.0000	1.0000	1.0000	1.0000	0.9000	1.0000	1.0000	0.9000
SD39; 10582	0.8000	0.9000	0.9000	0.8000	1.0000	0.9000	0.8000	0.9000
SD40; 10583	1.0000	0.9000	0.9000	0.9000	0.7000	0.8000	1.0000	1.0000
SD50; 10584	1.0000	1.0000	1.0000	0.9000	1.0000	1.0000	0.9000	1.0000
SD54; 10585	1.0000	1.0000	1.0000	1.0000	1.0000	0.9000	1.0000	1.0000
SD55; 10586	1.0000	1.0000	1.0000	1.0000	0.8000	0.9000	1.0000	1.0000
SD58; 10587	1.0000	0.8000	0.8000	0.8000	1.0000	1.0000	0.9000	0.9000
SD59; 10588	1.0000	0.8000	1.0000	1.0000	0.8000	0.8000	1.0000	1.0000
SD46; 10590	1.0000	1.0000	0.9000	0.8000	0.8000	1.0000	0.9000	0.9000
LM0813; 10591	0.7000	0.8000	0.6000	0.8000	0.7000	0.8000	0.7000	0.8000

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD45; 10589	0.9250	1.0000	1.2983	0.9912	1.4120	11.400	8			
SD25;10579	0.9625	1.0405	1.3509	1.2490	1.4120	6.244	8	-0.873	1.761	0.1061
*SD30; 10580	0.2250	0.2432	0.4862	0.3218	0.5796	23.327	8	12.319	1.761	0.1161
SD32; 10581	0.9750	1.0541	1.3713	1.2490	1.4120	5.501	8	-1.243	1.761	0.1034
SD39; 10582	0.8750	0.9459	1.2162	1.1071	1.4120	8.698	8	1.276	1.761	0.1133
SD40; 10583	0.9000	0.9730	1.2602	0.9912	1.4120	12.195	8	0.505	1.761	0.1329
SD50; 10584	0.9750	1.0541	1.3713	1.2490	1.4120	5.501	8	-1.243	1.761	0.1034
SD54; 10585	0.9875	1.0876	1.3916	1.2490	1.4120	4.140	8	-1.662	1.761	0.0989
SD55; 10586	0.9625	1.0405	1.3535	1.1071	1.4120	8.476	8	-0.834	1.761	0.1166
SD58; 10587	0.9000	0.9730	1.2569	1.1071	1.4120	11.234	8	0.572	1.761	0.1274
SD59; 10588	0.9250	1.0000	1.2977	1.1071	1.4120	12.159	8	0.008	1.761	0.1347
SD46; 10590	0.9125	0.9865	1.2747	1.1071	1.4120	10.042	8	0.341	1.761	0.1219
*LM0813; 10591	0.7375	0.7973	1.0360	0.8861	1.1071	8.056	8	4.366	1.761	0.1058

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.654777	1.035	-0.62435	-0.28485
Bartlett's Test indicates equal variances (p = 0.24)	14.97433	21.02607		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Homoscedastic t Test indicates significant differences	0.063983	0.06898	0.466573	0.013288	6.1E-29	12, 91
Treatments vs SD45; 10589						

Chironomus dilutus 10d Survival and Growth Test-10-Day Growth (AFDW)

Start Date: 8/11/2015	Test ID:	2264cdSD45	Sample ID:		
End Date: 8/21/2015	Lab ID:	-GREAT LAKES ENVIRONMENT	Sample Type:	-WHOLE SEDIMENT	
Sample Da	Protocol:	EPA 600/R-99/064	Test Species:	CDIL-Chironomus dilutus	

Comments AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015-SD45

Conc-%	1	2	3	4	5	6	7	8
SD45; 10589	1.4711	1.3122	1.5256	1.2567	2.8029	1.3480	1.2956	1.2170
SD25;10579	1.1170	1.1800	1.4489	1.0070	1.3390	1.2789	1.3111	1.2222
SD30; 10580	0.6000	0.1900	0.1900	1.2133	0.6467	0.2450	1.0200	0.2033
SD32; 10581	0.7670	0.8810	0.9050	0.9440	1.1844	0.9990	0.8250	1.0089
SD39; 10582	1.2950	0.9889	1.1678	1.1314	0.8160	1.2111	1.1863	1.2233
SD40; 10583	1.0370	1.0256	1.1356	1.3775	1.0357	1.1725	0.9390	1.0080
SD50; 10584	0.8833	0.8560	1.0860	1.0378	0.9440	0.8790	1.0200	1.0190
SD54; 10585	1.0610	1.0400	1.0940	1.6000	1.2800	1.3867	1.2667	1.2400
SD55; 10586	1.1880	1.1730	1.2330	1.1322	1.3300	1.3733	1.4550	1.2630
SD58; 10587	1.0150	1.3088	1.3363	1.1113	1.1950	1.1090	1.2633	1.3567
SD59; 10588	1.0330	1.3737	1.3460	1.1380	1.4513	1.3538	1.2000	1.4460
SD46; 10590	1.0760	1.2350	1.2267	1.2513	1.3025	1.1600	1.6756	0.7900
LM0813; 10591	1.6586	1.6188	1.5617	1.6087	2.5380	1.8917	1.4757	1.9350

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD45; 10589	1.5286	1.0000	1.5286	1.2170	2.8029	34.367	8			
SD25;10579	1.2380	0.8099	1.2380	1.0070	1.4489	11.147	8	1.513	1.895	0.3638
*SD30; 10580	0.5385	0.3523	0.5385	0.1900	1.2133	75.070	8	4.224	1.771	0.4150
*SD32; 10581	0.9393	0.6145	0.9393	0.7670	1.1844	13.696	8	3.082	1.895	0.3623
*SD39; 10582	1.1275	0.7376	1.1275	0.8160	1.2950	13.640	8	2.073	1.860	0.3599
*SD40; 10583	1.0914	0.7139	1.0914	0.9390	1.3775	12.533	8	2.278	1.895	0.3636
*SD50; 10584	0.9656	0.6317	0.9656	0.8560	1.0860	8.948	8	2.991	1.895	0.3566
SD54; 10585	1.2460	0.8151	1.2460	1.0400	1.6000	15.080	8	1.433	1.880	0.3668
SD55; 10586	1.2684	0.8298	1.2684	1.1322	1.4550	8.688	8	1.371	1.895	0.3595
SD58; 10587	1.2119	0.7928	1.2119	1.0150	1.3567	10.260	8	1.659	1.895	0.3616
SD59; 10588	1.2927	0.8457	1.2927	1.0330	1.4513	11.759	8	1.220	1.860	0.3595
SD46; 10590	1.2146	0.7946	1.2146	0.7900	1.6756	20.277	8	1.531	1.833	0.3760
LM0813; 10591	1.7860	1.1684	1.7860	1.4757	2.5380	19.176	8	-1.161	1.782	0.3952

Auxillary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.511603	1.035	2.130501	9.229664
Bartlett's Test indicates unequal variances (p = 3.78E-07)	53.21261	21.02607		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences	0.395168	0.258513	0.696221	0.060671	1.2E-13	12, 91
Treatments vs SD45; 10589						

Chironomus dilutus 10d Survival and Growth Test-10-Day Biomass (AFDW)

Start Date: 8/11/2015	Test ID:	2264cdSD45	Sample ID:		
End Date: 8/21/2015	Lab ID:	-GREAT LAKES ENVIRONMENT	Sample Type:	-WHOLE SEDIMENT	
Sample Da	Protocol:	EPA 600/R-99/064	Test Species:	CDIL-Chironomus dilutus	

Comments AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015-SD45

Conc-%	1	2	3	4	5	6	7	8
SD45; 10589	1.4711	1.1810	1.3730	1.2567	1.9620	1.3480	1.1660	1.2170
SD25;10579	1.1170	1.1800	1.3040	1.0070	1.3390	1.1510	1.1800	1.2222
SD30; 10580	0.0600	0.0190	0.0570	0.3640	0.1940	0.0490	0.2040	0.0610
SD32; 10581	0.7670	0.8810	0.9050	0.9440	1.0860	0.9990	0.8250	0.9080
SD39; 10582	1.0360	0.8900	1.0510	0.8800	0.8160	1.0900	0.9490	1.1010
SD40; 10583	1.0370	0.9230	1.0220	1.2244	0.7250	0.9380	0.9390	1.0080
SD50; 10584	0.8833	0.8560	1.0860	0.9340	0.9440	0.8790	0.9067	1.0190
SD54; 10585	1.0610	1.0400	1.0940	1.6000	1.2800	1.2480	1.2867	1.2400
SD55; 10586	1.1880	1.1730	1.2330	1.1322	1.0640	1.2360	1.4550	1.2630
SD58; 10587	1.0150	1.0470	1.0690	0.8890	1.1950	1.1090	1.1370	1.2210
SD59; 10588	1.0330	1.0990	1.3460	1.1380	1.1610	1.0830	1.2000	1.4460
SD46; 10590	1.0760	1.2350	1.1040	1.0010	1.0420	1.1600	1.5080	0.7110
LM0813; 10591	1.1610	1.2950	0.9370	1.2870	1.5863	1.4188	1.0330	1.5480

			Transform: Untransformed						1-Talled	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD45; 10589	1.3718	1.0000	1.3718	1.1660	1.9620	18.983	8			
*SD25;10579	1.1875	0.8656	1.1875	1.0070	1.3390	8.816	8	1.857	1.833	0.1819
*SD30; 10580	0.1260	0.0918	0.1260	0.0190	0.3640	93.941	8	12.318	1.833	0.1854
*SD32; 10581	0.9119	0.6647	0.9119	0.7670	1.0680	10.315	8	4.699	1.860	0.1820
*SD39; 10582	0.9766	0.7119	0.9766	0.8180	1.1010	11.000	8	3.968	1.833	0.1826
*SD40; 10583	0.9771	0.7122	0.9771	0.7250	1.2244	14.329	8	3.777	1.812	0.1895
*SD50; 10584	0.9385	0.6641	0.9385	0.8560	1.0860	8.321	8	4.508	1.860	0.1787
SD54; 10585	1.2287	0.8957	1.2287	1.0400	1.6000	14.569	8	1.281	1.782	0.1991
SD55; 10586	1.2180	0.8879	1.2180	1.0640	1.4550	9.450	8	1.528	1.833	0.1845
*SD58; 10587	1.0853	0.7911	1.0853	0.8890	1.2210	9.782	8	2.882	1.833	0.1823
SD59; 10588	1.1883	0.8662	1.1883	1.0330	1.4460	11.811	8	1.755	1.812	0.1896
*SD46; 10590	1.1046	0.8052	1.1046	0.7110	1.5080	20.335	8	2.198	1.771	0.2153
LM0813; 10591	1.2833	0.9354	1.2833	0.9370	1.5863	18.106	8	0.718	1.771	0.2185

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates normal distribution (p > 0.01)	0.945938	1.035	0.77401	2.527136
Bartlett's Test indicates unequal variances (p = 0.02)	23.98869	21.02607		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences Treatments vs SD45; 10589	0.218517	0.159287	0.770796	0.024583	3.6E-27	12, 91

Appendix C3
Chironomus dilutus
10-Day Statistical Data
Reference Sediment SD-46

- Survival
- Weight

Test: EPA 100.2-Chironomus dilutus 10d Survival and Growth Test Test ID: 2264cdSD46
Species: CDIL-Chironomus dilutus Protocol: EPA 600/R-99/064
Sample ID: Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015 Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0	Day 4	Day 10	Day 10	Day 20	Day 20	# pupae + M	Alive in Sedi	Remain in Se	Emerged	Weight pan/c	Weight ashed pan/orgs aft
	1	1	SD46; 10590	10		10	10			0				0.85592	0.84516
	2	2	SD46; 10590	10		10	10			0				0.86375	0.8514
	3	3	SD46; 10590	10		9	9			0				0.84768	0.83664
	4	4	SD46; 10590	10		8	8			0				0.84387	0.83386
	5	5	SD46; 10590	10		8	8			0				0.84081	0.83039
	6	6	SD46; 10590	10		10	10			0				0.85492	0.84332
	7	7	SD46; 10590	10		9	9			0				0.85455	0.83947
	8	8	SD46; 10590	10		9	9			0				0.8517	0.84459
	9	1	SD25;10579	10		10	10			0				0.84381	0.83264
	10	2	SD25;10579	10		10	10			0				0.84151	0.82971
	11	3	SD25;10579	10		9	9			0				0.83793	0.82489
	12	4	SD25;10579	10		10	10			0				0.84178	0.83171
	13	5	SD25;10579	10		10	10			0				0.84913	0.83574
	14	6	SD25;10579	10		9	9			0				0.8465	0.83499
	15	7	SD25;10579	10		9	9			0				0.85301	0.84121
	16	8	SD25;10579	10		9	10			1				0.85375	0.84275
	17	1	SD30; 10580	10		1	1			0				0.82843	0.82783
	18	2	SD30; 10580	10		1	1			0				0.81119	0.811
	19	3	SD30; 10580	10		3	3			0				0.83741	0.83684
	20	4	SD30; 10580	10		3	3			0				0.82745	0.82381
	21	5	SD30; 10580	10		3	3			0				0.82151	0.81957
	22	6	SD30; 10580	10		2	2			0				0.83083	0.83034
	23	7	SD30; 10580	10		2	2			0				0.82557	0.82353
	24	8	SD30; 10580	10		3	3			0				0.82387	0.82326
	25	1	SD32; 10581	10		10	10			0				0.84123	0.83356
	26	2	SD32; 10581	10		10	10			0				0.84217	0.83336
	27	3	SD32; 10581	10		10	10			0				0.84484	0.83579
	28	4	SD32; 10581	10		10	10			0				0.84339	0.83395
	29	5	SD32; 10581	10		9	9			0				0.84496	0.8343
	30	6	SD32; 10581	10		10	10			0				0.84254	0.83255
	31	7	SD32; 10581	10		10	10			0				0.84341	0.83516
	32	8	SD32; 10581	10		9	9			0				0.83329	0.82421
	33	1	SD39; 10582	10		8	8			0				0.84621	0.83585
	34	2	SD39; 10582	10		9	9			0				0.84207	0.83317
	35	3	SD39; 10582	10		9	9			0				0.84414	0.83363
	36	4	SD39; 10582	10		7	8			1				0.84627	0.83835
	37	5	SD39; 10582	10		10	10			0				0.84643	0.83827
	38	6	SD39; 10582	10		9	9			0				0.85526	0.84436

Test: EPA 100.2-Chironomus dilutus 10d Survival and Growth Test Test ID: 2264cdSD46
Species: CDIL-Chironomus dilutus Protocol: EPA 600/R-99/064
Sample ID: Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015 Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0	Day 4	Day 1(	Day 1(	Day 2(	Day 2(	# pupae + M	Alive in Sedi	Remain in Se	Emerged	Weight pan/c	Weight ashed pan/orgs aft
	39	7	SD39; 10582	10		8	8			0				0.85476	0.84527
	40	8	SD39; 10582	10		9	9			0				0.86445	0.85344
	41	1	SD40; 10583	10		10	10			0				0.84463	0.83426
	42	2	SD40; 10583	10		9	9			0				0.83324	0.82401
	43	3	SD40; 10583	10		9	9			0				0.84341	0.83319
	44	4	SD40; 10583	10		8	9			1				0.84714	0.83612
	45	5	SD40; 10583	10		7	7			0				0.83262	0.82537
	46	6	SD40; 10583	10		8	8			0				0.82799	0.81861
	47	7	SD40; 10583	10		10	10			0				0.84065	0.83126
	48	8	SD40; 10583	10		10	10			0				0.84455	0.83447
	49	1	SD50; 10584	10		9	10			1				0.83944	0.83149
	50	2	SD50; 10584	10		10	10			0				0.84468	0.83612
	51	3	SD50; 10584	10		10	10			0				0.84605	0.83519
	52	4	SD50; 10584	10		9	9			0				0.84591	0.83657
	53	5	SD50; 10584	10		10	10			0				0.83248	0.82304
	54	6	SD50; 10584	10		10	10			0				0.8504	0.84161
	55	7	SD50; 10584	10		8	9			1				0.83542	0.82726
	56	8	SD50; 10584	10		10	10			0				0.84885	0.83866
	57	1	SD54; 10585	10		10	10			0				0.85412	0.84351
	58	2	SD54; 10585	10		10	10			0				0.83703	0.82663
	59	3	SD54; 10585	10		10	10			0				0.84452	0.83358
	60	4	SD54; 10585	10		10	10			0				0.84724	0.83124
	61	5	SD54; 10585	10		10	10			0				0.85779	0.84499
	62	6	SD54; 10585	10		9	9			0				0.84617	0.83369
	63	7	SD54; 10585	10		9	10			1				0.86225	0.85085
	64	8	SD54; 10585	10		9	10			1				0.86518	0.85402
	65	1	SD55; 10586	10		10	10			0				0.85428	0.8424
	66	2	SD55; 10586	10		10	10			0				0.85533	0.8436
	67	3	SD55; 10586	10		10	10			0				0.83704	0.82471
	68	4	SD55; 10586	10		9	10			1				0.84955	0.83936
	69	5	SD55; 10586	10		8	8			0				0.83802	0.82738
	70	6	SD55; 10586	10		9	9			0				0.86259	0.85023
	71	7	SD55; 10586	10		10	10			0				0.84459	0.83004
	72	8	SD55; 10586	10		10	10			0				0.83433	0.8217
	73	1	SD58; 10587	10		10	10			0				0.84973	0.83958
	74	2	SD58; 10587	10		8	8			0				0.84612	0.83565
	75	3	SD58; 10587	10		8	8			0				0.86024	0.84955
	76	4	SD58; 10587	10		8	8			0				0.84852	0.83963

Test: EPA 100.2-Chironomus dilutus 10d Survival and Growth Test Test ID: 2264cdSD46
Species: CDIL-Chironomus dilutus Protocol: EPA 600/R-99/064
Sample ID: Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015 Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0	Day 4	Day 1(	Day 1(	Day 2(	Day 2(	# pupae + M	Alive in Sedi	Remain in Se	Emerged	Weight pan/c	Weight ashed pan/orgs aft
	77	5	SD58; 10587	10		10	10			0				0.85634	0.84439
	78	6	SD58; 10587	10		10	10			0				0.83235	0.82126
	79	7	SD58; 10587	10		9	9			0				0.84	0.82863
	80	8	SD58; 10587	10		9	9			0				0.83289	0.82068
	81	1	SD59; 10588	10		10	10			0				0.84672	0.83639
	82	2	SD59; 10588	10		8	8			0				0.86242	0.85143
	83	3	SD59; 10588	10		10	10			0				0.85733	0.84387
	84	4	SD59; 10588	10		10	10			0				0.85245	0.84107
	85	5	SD59; 10588	10		8	8			0				0.84845	0.83684
	86	6	SD59; 10588	10		8	8			0				0.84314	0.83231
	87	7	SD59; 10588	10		10	10			0				0.84848	0.83648
	88	8	SD59; 10588	10		10	10			0				0.85642	0.84196
	89	1	SD45; 10589	10		9	10			1				0.85113	0.83789
	90	2	SD45; 10589	10		9	9			0				0.85504	0.84323
	91	3	SD45; 10589	10		9	9			0				0.85757	0.84384
	92	4	SD45; 10589	10		9	10			1				0.83943	0.82812
	93	5	SD45; 10589	10		7	7			0				0.84135	0.82173
	94	6	SD45; 10589	10		10	10			0				0.85161	0.83813
	95	7	SD45; 10589	10		9	9			0				0.85156	0.8399
	96	8	SD45; 10589	10		10	10			0				0.86558	0.85341
	97	1	LM0813; 10591	10		7	7			0				0.84657	0.83496
	98	2	LM0813; 10591	10		8	8			0				0.85248	0.83953
	99	3	LM0813; 10591	10		6	6			0				0.84844	0.83907
	100	4	LM0813; 10591	10		8	8			0				0.85086	0.83799
	101	5	LM0813; 10591	10		5	7			2				0.85886	0.84617
	102	6	LM0813; 10591	10		6	8			2				0.85609	0.84474
	103	7	LM0813; 10591	10		7	7			0				0.86245	0.85212
	104	8	LM0813; 10591	10		8	8			0				0.86232	0.84684

Comments: AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015-SD46

Chironomus dilutus 10d Survival and Growth Test-10-day survival

Start Date: 8/11/2015	Test ID:	2264cdSD46	Sample ID:		
End Date: 8/21/2015	Lab ID:	-GREAT LAKES ENVIRONMENT	Sample Type:	-WHOLE SEDIMENT	
Sample Da	Protocol:	EPA 600/R-99/064	Test Species:	CDIL-Chironomus dilutus	

Comments AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015-SD46

Conc-%	1	2	3	4	5	6	7	8
SD46; 10590	1.0000	1.0000	0.9000	0.8000	0.8000	1.0000	0.9000	0.9000
SD25;10579	1.0000	1.0000	0.9000	1.0000	1.0000	0.9000	0.9000	1.0000
SD30; 10580	0.1000	0.1000	0.3000	0.3000	0.3000	0.2000	0.2000	0.3000
SD32; 10581	1.0000	1.0000	1.0000	1.0000	0.9000	1.0000	1.0000	0.9000
SD39; 10582	0.8000	0.9000	0.9000	0.8000	1.0000	0.9000	0.8000	0.9000
SD40; 10583	1.0000	0.9000	0.9000	0.9000	0.7000	0.8000	1.0000	1.0000
SD50; 10584	1.0000	1.0000	1.0000	0.9000	1.0000	1.0000	0.9000	1.0000
SD54; 10585	1.0000	1.0000	1.0000	1.0000	1.0000	0.9000	1.0000	1.0000
SD55; 10586	1.0000	1.0000	1.0000	1.0000	0.8000	0.9000	1.0000	1.0000
SD58; 10587	1.0000	0.8000	0.8000	0.8000	1.0000	1.0000	0.9000	0.9000
SD59; 10588	1.0000	0.8000	1.0000	1.0000	0.8000	0.8000	1.0000	1.0000
SD45; 10589	1.0000	0.9000	0.9000	1.0000	0.7000	1.0000	0.9000	1.0000
LM0813; 10591	0.7000	0.8000	0.6000	0.8000	0.7000	0.8000	0.7000	0.8000

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD46; 10590	0.9125	1.0000	1.2747	1.1071	1.4120	10.042	8			
SD25;10579	0.9625	1.0548	1.3509	1.2490	1.4120	6.244	8	-1.406	1.761	0.0955
*SD30; 10580	0.2250	0.2466	0.4862	0.3218	0.5796	23.327	8	13.042	1.761	0.1065
SD32; 10581	0.9750	1.0685	1.3713	1.2490	1.4120	5.501	8	-1.839	1.761	0.0925
SD39; 10582	0.8750	0.9589	1.2162	1.1071	1.4120	8.698	8	0.998	1.761	0.1034
SD40; 10583	0.9000	0.9863	1.2602	0.9912	1.4120	12.195	8	0.205	1.761	0.1245
SD50; 10584	0.9750	1.0685	1.3713	1.2490	1.4120	5.501	8	-1.839	1.761	0.0925
SD54; 10585	0.9875	1.0822	1.3916	1.2490	1.4120	4.140	8	-2.357	1.761	0.0874
SD55; 10586	0.9625	1.0548	1.3535	1.1071	1.4120	8.476	8	-1.297	1.761	0.1070
SD58; 10587	0.9000	0.9863	1.2569	1.1071	1.4120	11.234	8	0.263	1.761	0.1187
SD59; 10588	0.9250	1.0137	1.2977	1.1071	1.4120	12.159	8	-0.320	1.761	0.1265
SD45; 10589	0.9250	1.0137	1.2983	0.9912	1.4120	11.400	8	-0.341	1.761	0.1219
*LM0813; 10591	0.7375	0.8082	1.0360	0.8861	1.1071	8.056	8	4.418	1.761	0.0952

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.654777	1.035	-0.62435	-0.28485
Bartlett's Test indicates equal variances (p = 0.24)	14.97433	21.02607		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Homoscedastic t Test indicates significant differences	0.060286	0.065897	0.466573	0.013288	6.1E-29	12, 91
Treatments vs SD46; 10590						

Chironomus dilutus 10d Survival and Growth Test-10-Day Growth (AFDW)

Start Date: 8/11/2015	Test ID:	2264cdSD46	Sample ID:		
End Date: 8/21/2015	Lab ID:	-GREAT LAKES ENVIRONMENT	Sample Type:	-WHOLE SEDIMENT	
Sample Da	Protocol:	EPA 600/R-99/064	Test Species:	CDIL-Chironomus dilutus	

Comments AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015-SD46

Conc-%	1	2	3	4	5	6	7	8
SD46; 10590	1.0760	1.2350	1.2267	1.2513	1.3025	1.1600	1.6756	0.7900
SD25;10579	1.1170	1.1800	1.4489	1.0070	1.3390	1.2789	1.3111	1.2222
SD30; 10580	0.6000	0.1900	0.1900	1.2133	0.6467	0.2450	1.0200	0.2033
SD32; 10581	0.7670	0.8810	0.9050	0.9440	1.1844	0.9990	0.8250	1.0089
SD39; 10582	1.2950	0.9889	1.1678	1.1314	0.8160	1.2111	1.1863	1.2233
SD40; 10583	1.0370	1.0256	1.1356	1.3775	1.0357	1.1725	0.9390	1.0080
SD50; 10584	0.8833	0.8560	1.0860	1.0378	0.9440	0.8790	1.0200	1.0190
SD54; 10585	1.0610	1.0400	1.0940	1.6000	1.2800	1.3867	1.2667	1.2400
SD55; 10586	1.1880	1.1730	1.2330	1.1322	1.3300	1.3733	1.4550	1.2630
SD58; 10587	1.0150	1.3088	1.3363	1.1113	1.1950	1.1090	1.2633	1.3567
SD59; 10588	1.0330	1.3737	1.3460	1.1380	1.4513	1.3538	1.2000	1.4460
SD45; 10589	1.4711	1.3122	1.5256	1.2567	2.8029	1.3480	1.2956	1.2170
LM0813; 10591	1.6586	1.6188	1.5617	1.6087	2.5380	1.8917	1.4757	1.9350

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD46; 10590	1.2146	1.0000	1.2146	0.7900	1.6756	20.277	8			
SD25;10579	1.2380	1.0193	1.2380	1.0070	1.4489	11.147	8	-0.234	1.796	0.1793
*SD30; 10580	0.5385	0.4434	0.5385	0.1900	1.2133	75.070	8	4.039	1.796	0.3006
*SD32; 10581	0.9393	0.7733	0.9393	0.7670	1.1844	13.696	8	2.803	1.812	0.1781
SD39; 10582	1.1275	0.9283	1.1275	0.8160	1.2950	13.640	8	0.849	1.796	0.1844
SD40; 10583	1.0914	0.8985	1.0914	0.9390	1.3775	12.533	8	1.238	1.812	0.1805
*SD50; 10584	0.9656	0.7950	0.9656	0.8560	1.0860	8.948	8	2.698	1.860	0.1716
SD54; 10585	1.2460	1.0259	1.2460	1.0400	1.8000	15.060	8	-0.287	1.771	0.1939
SD55; 10586	1.2684	1.0443	1.2684	1.1322	1.4550	8.688	8	-0.584	1.833	0.1749
SD58; 10587	1.2119	0.9978	1.2119	1.0150	1.3587	10.260	8	0.028	1.812	0.1768
SD59; 10588	1.2927	1.0643	1.2927	1.0330	1.4513	11.759	8	-0.763	1.796	0.1838
SD45; 10589	1.5286	1.2585	1.5286	1.2170	2.8029	34.367	8	-1.531	1.833	0.3780
LM0813; 10591	1.7860	1.4704	1.7860	1.4757	2.5380	19.176	8	-3.831	1.782	0.2658

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.511603	1.035	2.130501	9.229664
Bartlett's Test indicates unequal variances (p = 3.78E-07)	53.21261	21.02607		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences	0.265821	0.218851	0.696221	0.060671	1.2E-13	12, 91
Treatments vs SD46; 10590						

Chironomus dilutus 10d Survival and Growth Test-10-Day Biomass (AFDW)

Start Date: 8/11/2015	Test ID: 2264cdSD46	Sample ID:	
End Date: 8/21/2015	Lab ID: -GREAT LAKES ENVIRONMENT	Sample Type:	-WHOLE SEDIMENT
Sample Da	Protocol: EPA 600/R-99/064	Test Species:	CDIL-Chironomus dilutus

Comments AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015-SD46

Conc-%	1	2	3	4	5	6	7	8
SD46; 10590	1.0760	1.2350	1.1040	1.0010	1.0420	1.1600	1.5080	0.7110
SD25;10579	1.1170	1.1800	1.3040	1.0070	1.3390	1.1510	1.1600	1.2222
SD30; 10580	0.0600	0.0190	0.0570	0.3640	0.1940	0.0490	0.2040	0.0610
SD32; 10581	0.7670	0.8810	0.9050	0.9440	1.0660	0.9990	0.8250	0.9060
SD39; 10582	1.0360	0.8900	1.0510	0.8800	0.8160	1.0900	0.9490	1.1010
SD40; 10583	1.0370	0.9230	1.0220	1.2244	0.7250	0.9380	0.9390	1.0080
SD50; 10584	0.8833	0.8560	1.0860	0.9340	0.9440	0.8790	0.9067	1.0190
SD54; 10585	1.0610	1.0400	1.0940	1.6000	1.2800	1.2480	1.2667	1.2400
SD55; 10586	1.1880	1.1730	1.2330	1.1322	1.0640	1.2360	1.4550	1.2630
SD58; 10587	1.0150	1.0470	1.0690	0.8890	1.1950	1.1090	1.1370	1.2210
SD59; 10588	1.0330	1.0990	1.3460	1.1380	1.1610	1.0830	1.2000	1.4460
SD45; 10589	1.4711	1.1810	1.3730	1.2567	1.9620	1.3480	1.1660	1.2170
LM0813; 10591	1.1610	1.2950	0.9370	1.2870	1.5863	1.4188	1.0330	1.5480

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD46; 10590	1.1046	1.0000	1.1046	0.7110	1.5080	20.335	8			
SD25;10579	1.1875	1.0751	1.1875	1.0070	1.3390	8.816	8	-0.946	1.833	0.1606
*SD30; 10580	0.1260	0.1141	0.1260	0.0190	0.3640	93.941	8	10.902	1.812	0.1627
*SD32; 10581	0.9119	0.8255	0.9119	0.7670	1.0660	10.315	8	2.239	1.833	0.1578
SD39; 10582	0.9766	0.8841	0.9766	0.8160	1.1010	11.000	8	1.454	1.812	0.1598
SD40; 10583	0.9771	0.8845	0.9771	0.7250	1.2244	14.329	8	1.363	1.796	0.1881
*SD50; 10584	0.9385	0.8496	0.9385	0.8560	1.0860	8.321	8	1.976	1.860	0.1564
SD54; 10585	1.2287	1.1123	1.2287	1.0400	1.8000	14.569	8	-1.222	1.771	0.1798
SD55; 10586	1.2180	1.1027	1.2180	1.0640	1.4550	9.450	8	-1.271	1.812	0.1617
SD58; 10587	1.0853	0.9825	1.0853	0.8890	1.2210	9.762	8	0.221	1.833	0.1610
SD59; 10588	1.1883	1.0757	1.1883	1.0330	1.4460	11.811	8	-0.893	1.796	0.1682
SD45; 10589	1.3718	1.2419	1.3718	1.1660	1.9620	18.983	8	-2.198	1.771	0.2153
LM0813; 10591	1.2833	1.1617	1.2833	0.9370	1.5863	18.106	8	-1.563	1.771	0.2023

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates normal distribution (p > 0.01)	0.945938	1.035	0.77401	2.527136
Bartlett's Test indicates unequal variances (p = 0.02)	23.98869	21.02607		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences	0.202343	0.183178	0.770796	0.024583	3.6E-27	12, 91
Treatments vs SD46; 10590						

Appendix C4
Chironomus dilutus
10-Day Statistical Data
Reference Sediment LM-08-13

- Survival
- Weight

Test: EPA 100.2-Chironomus dilutus 10d Survival and Growth Test Test ID: 2264cdLM08
Species: CDIL-Chironomus dilutus Protocol: EPA 600/R-99/064
Sample ID: Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015 Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0	Day 4	Day 10	Day 10	Day 20	Day 20	# pupae + M	Alive in Sedi	Remain in Se	Emerged	Weight pan/c	Weight ashed pan/orgs aft
	1	1	LM0813; 10591	10		7	7			0				0.84657	0.83496
	2	2	LM0813; 10591	10		8	8			0				0.85248	0.83953
	3	3	LM0813; 10591	10		6	6			0				0.84844	0.83907
	4	4	LM0813; 10591	10		8	8			0				0.85086	0.83799
	5	5	LM0813; 10591	10		5	7			2				0.85886	0.84617
	6	6	LM0813; 10591	10		6	8			2				0.85609	0.84474
	7	7	LM0813; 10591	10		7	7			0				0.86245	0.85212
	8	8	LM0813; 10591	10		8	8			0				0.86232	0.84684
	9	1	SD25;10579	10		10	10			0				0.84381	0.83264
	10	2	SD25;10579	10		10	10			0				0.84151	0.82971
	11	3	SD25;10579	10		9	9			0				0.83793	0.82489
	12	4	SD25;10579	10		10	10			0				0.84178	0.83171
	13	5	SD25;10579	10		10	10			0				0.84913	0.83574
	14	6	SD25;10579	10		9	9			0				0.8465	0.83499
	15	7	SD25;10579	10		9	9			0				0.85301	0.84121
	16	8	SD25;10579	10		9	10			1				0.85375	0.84275
	17	1	SD30; 10580	10		1	1			0				0.82843	0.82783
	18	2	SD30; 10580	10		1	1			0				0.81119	0.811
	19	3	SD30; 10580	10		3	3			0				0.83741	0.83684
	20	4	SD30; 10580	10		3	3			0				0.82745	0.82381
	21	5	SD30; 10580	10		3	3			0				0.82151	0.81957
	22	6	SD30; 10580	10		2	2			0				0.83083	0.83034
	23	7	SD30; 10580	10		2	2			0				0.82557	0.82353
	24	8	SD30; 10580	10		3	3			0				0.82387	0.82326
	25	1	SD32; 10581	10		10	10			0				0.84123	0.83356
	26	2	SD32; 10581	10		10	10			0				0.84217	0.83336
	27	3	SD32; 10581	10		10	10			0				0.84484	0.83579
	28	4	SD32; 10581	10		10	10			0				0.84339	0.83395
	29	5	SD32; 10581	10		9	9			0				0.84496	0.8343
	30	6	SD32; 10581	10		10	10			0				0.84254	0.83255
	31	7	SD32; 10581	10		10	10			0				0.84341	0.83516
	32	8	SD32; 10581	10		9	9			0				0.83329	0.82421
	33	1	SD39; 10582	10		8	8			0				0.84621	0.83585
	34	2	SD39; 10582	10		9	9			0				0.84207	0.83317
	35	3	SD39; 10582	10		9	9			0				0.84414	0.83363
	36	4	SD39; 10582	10		7	8			1				0.84627	0.83835
	37	5	SD39; 10582	10		10	10			0				0.84643	0.83827
	38	6	SD39; 10582	10		9	9			0				0.85526	0.84436

Test: EPA 100.2-Chironomus dilutus 10d Survival and Growth Test Test ID: 2264cdLM08
Species: CDIL-Chironomus dilutus Protocol: EPA 600/R-99/064
Sample ID: Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015 Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0	Day 4	Day 10	Day 10	Day 20	Day 20	# pupae + M	Alive in Sedi	Remain in Se	Emerged	Weight pan/c	Weight ashed pan/orgs aft
	39	7	SD39; 10582	10		8	8			0				0.85476	0.84527
	40	8	SD39; 10582	10		9	9			0				0.86445	0.85344
	41	1	SD40; 10583	10		10	10			0				0.84463	0.83426
	42	2	SD40; 10583	10		9	9			0				0.83324	0.82401
	43	3	SD40; 10583	10		9	9			0				0.84341	0.83319
	44	4	SD40; 10583	10		8	9			1				0.84714	0.83612
	45	5	SD40; 10583	10		7	7			0				0.83262	0.82537
	46	6	SD40; 10583	10		8	8			0				0.82799	0.81861
	47	7	SD40; 10583	10		10	10			0				0.84065	0.83126
	48	8	SD40; 10583	10		10	10			0				0.84455	0.83447
	49	1	SD50; 10584	10		9	10			1				0.83944	0.83149
	50	2	SD50; 10584	10		10	10			0				0.84468	0.83612
	51	3	SD50; 10584	10		10	10			0				0.84605	0.83519
	52	4	SD50; 10584	10		9	9			0				0.84591	0.83657
	53	5	SD50; 10584	10		10	10			0				0.83248	0.82304
	54	6	SD50; 10584	10		10	10			0				0.8504	0.84161
	55	7	SD50; 10584	10		8	9			1				0.83542	0.82726
	56	8	SD50; 10584	10		10	10			0				0.84885	0.83866
	57	1	SD54; 10585	10		10	10			0				0.85412	0.84351
	58	2	SD54; 10585	10		10	10			0				0.83703	0.82663
	59	3	SD54; 10585	10		10	10			0				0.84452	0.83358
	60	4	SD54; 10585	10		10	10			0				0.84724	0.83124
	61	5	SD54; 10585	10		10	10			0				0.85779	0.84499
	62	6	SD54; 10585	10		9	9			0				0.84617	0.83369
	63	7	SD54; 10585	10		9	10			1				0.86225	0.85085
	64	8	SD54; 10585	10		9	10			1				0.86518	0.85402
	65	1	SD55; 10586	10		10	10			0				0.85428	0.8424
	66	2	SD55; 10586	10		10	10			0				0.85533	0.8436
	67	3	SD55; 10586	10		10	10			0				0.83704	0.82471
	68	4	SD55; 10586	10		9	10			1				0.84955	0.83936
	69	5	SD55; 10586	10		8	8			0				0.83802	0.82738
	70	6	SD55; 10586	10		9	9			0				0.86259	0.85023
	71	7	SD55; 10586	10		10	10			0				0.84459	0.83004
	72	8	SD55; 10586	10		10	10			0				0.83433	0.8217
	73	1	SD58; 10587	10		10	10			0				0.84973	0.83958
	74	2	SD58; 10587	10		8	8			0				0.84612	0.83565
	75	3	SD58; 10587	10		8	8			0				0.86024	0.84955
	76	4	SD58; 10587	10		8	8			0				0.84852	0.83963

Test: EPA 100.2-Chironomus dilutus 10d Survival and Growth Test Test ID: 2264cdLM08
Species: CDIL-Chironomus dilutus Protocol: EPA 600/R-99/064
Sample ID: Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015 Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0	Day 4	Day 10	Day 10	Day 20	Day 20	# pupae + M	Alive in Sedi	Remain in Se	Emerged	Weight pan/c	Weight ashed pan/orgs aft
	77	5	SD58; 10587	10		10	10			0				0.85634	0.84439
	78	6	SD58; 10587	10		10	10			0				0.83235	0.82126
	79	7	SD58; 10587	10		9	9			0				0.84	0.82863
	80	8	SD58; 10587	10		9	9			0				0.83289	0.82068
	81	1	SD59; 10588	10		10	10			0				0.84672	0.83639
	82	2	SD59; 10588	10		8	8			0				0.86242	0.85143
	83	3	SD59; 10588	10		10	10			0				0.85733	0.84387
	84	4	SD59; 10588	10		10	10			0				0.85245	0.84107
	85	5	SD59; 10588	10		8	8			0				0.84845	0.83684
	86	6	SD59; 10588	10		8	8			0				0.84314	0.83231
	87	7	SD59; 10588	10		10	10			0				0.84848	0.83648
	88	8	SD59; 10588	10		10	10			0				0.85642	0.84196
	89	1	SD45; 10589	10		9	10			1				0.85113	0.83789
	90	2	SD45; 10589	10		9	9			0				0.85504	0.84323
	91	3	SD45; 10589	10		9	9			0				0.85757	0.84384
	92	4	SD45; 10589	10		9	10			1				0.83943	0.82812
	93	5	SD45; 10589	10		7	7			0				0.84135	0.82173
	94	6	SD45; 10589	10		10	10			0				0.85161	0.83813
	95	7	SD45; 10589	10		9	9			0				0.85156	0.8399
	96	8	SD45; 10589	10		10	10			0				0.86558	0.85341
	97	1	SD46; 10590	10		10	10			0				0.85592	0.84516
	98	2	SD46; 10590	10		10	10			0				0.86375	0.8514
	99	3	SD46; 10590	10		9	9			0				0.84768	0.83664
	100	4	SD46; 10590	10		8	8			0				0.84387	0.83386
	101	5	SD46; 10590	10		8	8			0				0.84081	0.83039
	102	6	SD46; 10590	10		10	10			0				0.85492	0.84332
	103	7	SD46; 10590	10		9	9			0				0.85455	0.83947
	104	8	SD46; 10590	10		9	9			0				0.8517	0.84459

Comments: AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015-LM-0

Chironomus dilutus 10d Survival and Growth Test-10-day survival

Start Date: 8/11/2015	Test ID: 2264cdLM08	Sample ID:	
End Date: 8/21/2015	Lab ID: -GREAT LAKES ENVIRONMENT/	Sample Type:	-WHOLE SEDIMENT
Sample Da	Protocol: EPA 600/R-99/064	Test Species:	CDIL-Chironomus dilutus

Comments AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015-LM-0

Conc-%	1	2	3	4	5	6	7	8
LM0813; 10591	0.7000	0.8000	0.6000	0.8000	0.7000	0.8000	0.7000	0.8000
SD25;10579	1.0000	1.0000	0.9000	1.0000	1.0000	0.9000	0.9000	1.0000
SD30; 10580	0.1000	0.1000	0.3000	0.3000	0.3000	0.2000	0.2000	0.3000
SD32; 10581	1.0000	1.0000	1.0000	1.0000	0.9000	1.0000	1.0000	0.9000
SD39; 10582	0.8000	0.9000	0.9000	0.8000	1.0000	0.9000	0.8000	0.9000
SD40; 10583	1.0000	0.9000	0.9000	0.9000	0.7000	0.8000	1.0000	1.0000
SD50; 10584	1.0000	1.0000	1.0000	0.9000	1.0000	1.0000	0.9000	1.0000
SD54; 10585	1.0000	1.0000	1.0000	1.0000	1.0000	0.9000	1.0000	1.0000
SD55; 10586	1.0000	1.0000	1.0000	1.0000	0.8000	0.9000	1.0000	1.0000
SD58; 10587	1.0000	0.8000	0.8000	0.8000	1.0000	1.0000	0.9000	0.9000
SD59; 10588	1.0000	0.8000	1.0000	1.0000	0.8000	0.8000	1.0000	1.0000
SD45; 10589	1.0000	0.9000	0.9000	1.0000	0.7000	1.0000	0.9000	1.0000
SD46; 10590	1.0000	1.0000	0.9000	0.8000	0.8000	1.0000	0.9000	0.9000

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
LM0813; 10591	0.7375	1.0000	1.0360	0.8861	1.1071	8.056	8			
SD25;10579	0.9625	1.3051	1.3509	1.2490	1.4120	6.244	8	-7.506	1.761	0.0739
*SD30; 10580	0.2250	0.3051	0.4862	0.3218	0.5796	23.327	8	11.045	1.761	0.0877
SD32; 10581	0.9750	1.3220	1.3713	1.2490	1.4120	5.501	8	-8.429	1.761	0.0701
SD39; 10582	0.8750	1.1664	1.2162	1.1071	1.4120	8.698	8	-3.782	1.761	0.0839
SD40; 10583	0.9000	1.2203	1.2602	0.9912	1.4120	12.195	8	-3.626	1.761	0.1089
SD50; 10584	0.9750	1.3220	1.3713	1.2490	1.4120	5.501	8	-6.429	1.761	0.0701
SD54; 10585	0.9875	1.3390	1.3916	1.2490	1.4120	4.140	8	-9.918	1.761	0.0632
SD55; 10586	0.9825	1.3051	1.3535	1.1071	1.4120	8.476	8	-6.330	1.761	0.0883
SD58; 10587	0.9000	1.2203	1.2569	1.1071	1.4120	11.234	8	-3.810	1.761	0.1021
SD59; 10588	0.9250	1.2542	1.2977	1.1071	1.4120	12.159	8	-4.146	1.761	0.1112
SD45; 10589	0.9250	1.2542	1.2983	0.9912	1.4120	11.400	8	-4.366	1.761	0.1058
SD46; 10590	0.9125	1.2373	1.2747	1.1071	1.4120	10.042	8	-4.418	1.761	0.0952

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.654777	1.035	-0.62435	-0.28485
Bartlett's Test indicates equal variances (p = 0.24)	14.97433	21.02607		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Homoscedastic t Test indicates significant differences	0.087284	0.117911	0.466573	0.013288	6.1E-29	12, 91
Treatments vs LM0813; 10591						

Chironomus dilutus 10d Survival and Growth Test-10-Day Growth (AFDW)

Start Date: 8/11/2015	Test ID:	2264cdLM08	Sample ID:		
End Date: 8/21/2015	Lab ID:	-GREAT LAKES ENVIRONMENT	Sample Type:	-WHOLE SEDIMENT	
Sample Da	Protocol:	EPA 600/R-99/064	Test Species:	CDIL-Chironomus dilutus	

Comments AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015-LM-0

Conc-%	1	2	3	4	5	6	7	8
LM0813; 10591	1.6586	1.6188	1.5617	1.6087	2.5380	1.8917	1.4757	1.9350
SD25;10579	1.1170	1.1800	1.4489	1.0070	1.3390	1.2789	1.3111	1.2222
SD30; 10580	0.8000	0.1900	0.1900	1.2133	0.6467	0.2450	1.0200	0.2033
SD32; 10581	0.7670	0.8810	0.9050	0.9440	1.1844	0.9990	0.8250	1.0089
SD39; 10582	1.2950	0.9889	1.1678	1.1314	0.8180	1.2111	1.1863	1.2233
SD40; 10583	1.0370	1.0256	1.1356	1.3775	1.0357	1.1725	0.9390	1.0080
SD50; 10584	0.8833	0.8560	1.0880	1.0378	0.9440	0.8790	1.0200	1.0190
SD54; 10585	1.0610	1.0400	1.0940	1.6000	1.2800	1.3867	1.2667	1.2400
SD55; 10586	1.1880	1.1730	1.2330	1.1322	1.3300	1.3733	1.4550	1.2630
SD58; 10587	1.0150	1.3088	1.3363	1.1113	1.1950	1.1090	1.2633	1.3567
SD59; 10588	1.0330	1.3737	1.3460	1.1380	1.4513	1.3538	1.2000	1.4460
SD45; 10589	1.4711	1.3122	1.5256	1.2567	2.8029	1.3480	1.2956	1.2170
SD46; 10590	1.0760	1.2350	1.2267	1.2513	1.3025	1.1600	1.6756	0.7900

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
LM0813; 10591	1.7860	1.0000	1.7860	1.4757	2.5380	19.176	8			
*SD25;10579	1.2380	0.6932	1.2380	1.0070	1.4489	11.147	8	4.198	1.833	0.2393
*SD30; 10580	0.5385	0.3015	0.5385	0.1900	1.2133	75.070	8	6.659	1.771	0.3318
*SD32; 10581	0.9393	0.5259	0.9393	0.7670	1.1844	13.698	8	6.546	1.860	0.2405
*SD39; 10582	1.1275	0.6313	1.1275	0.8160	1.2950	13.640	8	4.961	1.833	0.2433
*SD40; 10583	1.0914	0.6111	1.0914	0.9390	1.3775	12.533	8	5.328	1.833	0.2390
*SD50; 10584	0.9656	0.5407	0.9656	0.8560	1.0860	8.948	8	6.569	1.895	0.2388
*SD54; 10585	1.2460	0.8977	1.2460	1.0400	1.6000	15.080	8	3.911	1.812	0.2503
*SD55; 10586	1.2684	0.7102	1.2684	1.1322	1.4550	8.888	8	4.069	1.860	0.2365
*SD58; 10587	1.2119	0.6786	1.2119	1.0150	1.3587	10.260	8	4.457	1.860	0.2396
*SD59; 10588	1.2927	0.7238	1.2927	1.0330	1.4513	11.759	8	3.724	1.833	0.2429
SD45; 10589	1.5286	0.8559	1.5286	1.2170	2.8029	34.367	8	1.161	1.782	0.3952
*SD46; 10590	1.2146	0.6801	1.2146	0.7900	1.6756	20.277	8	3.831	1.782	0.2658

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.511603	1.035	2.130501	9.229664
Bartlett's Test indicates unequal variances (p = 3.78E-07)	53.21261	21.02607		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences	0.265821	0.148834	0.696221	0.060671	1.2E-13	12, 91
Treatments vs LM0813; 10591						

Chironomus dilutus 10d Survival and Growth Test-10-Day Biomass (AFDW)

Start Date: 8/11/2015	Test ID: 2264cdLM08	Sample ID:	
End Date: 8/21/2015	Lab ID: -GREAT LAKES ENVIRONMENT	Sample Type:	-WHOLE SEDIMENT
Sample Da	Protocol: EPA 600/R-99/064	Test Species:	CDIL-Chironomus dilutus

Comments AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015-LM-0

Conc-%	1	2	3	4	5	6	7	8
LM0813; 10591	1.1610	1.2950	0.9370	1.2870	1.5863	1.4188	1.0330	1.5480
SD25;10579	1.1170	1.1800	1.3040	1.0070	1.3390	1.1510	1.1800	1.2222
SD30; 10580	0.0600	0.0190	0.0570	0.3640	0.1940	0.0490	0.2040	0.0610
SD32; 10581	0.7670	0.8810	0.9050	0.9440	1.0860	0.9990	0.8250	0.9080
SD39; 10582	1.0360	0.8900	1.0510	0.8800	0.8160	1.0900	0.9490	1.1010
SD40; 10583	1.0370	0.9230	1.0220	1.2244	0.7250	0.9380	0.9390	1.0080
SD50; 10584	0.8833	0.8560	1.0860	0.9340	0.9440	0.8790	0.9067	1.0190
SD54; 10585	1.0610	1.0400	1.0940	1.6000	1.2800	1.2480	1.2667	1.2400
SD55; 10586	1.1880	1.1730	1.2330	1.1322	1.0640	1.2380	1.4550	1.2630
SD58; 10587	1.0150	1.0470	1.0690	0.8890	1.1950	1.1090	1.1370	1.2210
SD59; 10588	1.0330	1.0990	1.3480	1.1380	1.1610	1.0830	1.2000	1.4460
SD45; 10589	1.4711	1.1810	1.3730	1.2567	1.9820	1.3480	1.1660	1.2170
SD46; 10590	1.0760	1.2350	1.1040	1.0010	1.0420	1.1600	1.5080	0.7110

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
LM0813; 10591	1.2833	1.0000	1.2833	0.9370	1.5863	18.106	8			
SD25;10579	1.1875	0.9254	1.1875	1.0070	1.3390	8.816	8	1.082	1.833	0.1652
*SD30; 10580	0.1280	0.0982	0.1260	0.0190	0.3640	93.941	8	12.553	1.812	0.1671
*SD32; 10581	0.9119	0.7106	0.9119	0.7670	1.0660	10.315	8	4.191	1.833	0.1625
*SD39; 10582	0.9766	0.7611	0.9766	0.8160	1.1010	11.000	8	3.388	1.833	0.1659
*SD40; 10583	0.9771	0.7614	0.9771	0.7250	1.2244	14.329	8	3.193	1.796	0.1722
*SD50; 10584	0.9385	0.7313	0.9385	0.8560	1.0860	8.321	8	3.978	1.860	0.1611
SD54; 10585	1.2287	0.9575	1.2287	1.0400	1.8000	14.569	8	0.526	1.771	0.1836
SD55; 10586	1.2180	0.9492	1.2180	1.0840	1.4550	9.450	8	0.711	1.812	0.1662
*SD58; 10587	1.0853	0.8457	1.0853	0.8890	1.2210	9.782	8	2.192	1.833	0.1656
SD59; 10588	1.1883	0.9260	1.1883	1.0330	1.4460	11.811	8	0.990	1.796	0.1723
SD45; 10589	1.3718	1.0690	1.3718	1.1660	1.9620	18.983	8	-0.718	1.771	0.2185
SD46; 10590	1.1046	0.8608	1.1046	0.7110	1.5080	20.335	8	1.563	1.771	0.2023

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates normal distribution (p > 0.01)	0.945938	1.035	0.77401	2.527136
Bartlett's Test indicates unequal variances (p = 0.02)	23.98869	21.02607		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences	0.202343	0.15768	0.770796	0.024583	3.6E-27	12, 91
Treatments vs LM0813; 10591						

Appendix C5
Chironomus dilutus
10-Day Statistical Data
Pooled Reference Sediments;
SD-45, SD-46, LM-08-13

- Survival
- Weight

Test: EPA 100.2-Chironomus dilutus 10d Survival and Growth Test
Species: CDIL-Chironomus dilutus
Sample ID:
Start Date: 8/11/2015 End Date: 8/21/2015

Test ID: 2264cdCSIT
Protocol: EPA 600/R-99/064
Sample Type: -WHOLE SEDIMENT
Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0	Day 4	Day 1	Day 1	Day 2	Day 2	# pupae + M	Alive in Sedi	Remain in Se	Emerged	Weight pan/	Weight ashed pan/orgs aft
	1	1	SD45, SD46, L	10		9	10			1				0.85113	0.83789
	2	2	SD45, SD46, L	10		9	9			0				0.85504	0.84323
	3	3	SD45, SD46, L	10		9	9			0				0.85757	0.84384
	4	4	SD45, SD46, L	10		9	10			1				0.83943	0.82812
	5	5	SD45, SD46, L	10		7	7			0				0.84135	0.82173
	6	6	SD45, SD46, L	10		10	10			0				0.85161	0.83813
	7	7	SD45, SD46, L	10		9	9			0				0.85156	0.8399
	8	8	SD45, SD46, L	10		10	10			0				0.86558	0.85341
	9	9	SD45, SD46, L	10		10	10			0				0.85592	0.84516
	10	10	SD45, SD46, L	10		10	10			0				0.86375	0.8514
	11	11	SD45, SD46, L	10		9	9			0				0.84768	0.83664
	12	12	SD45, SD46, L	10		8	8			0				0.84387	0.83386
	13	13	SD45, SD46, L	10		8	8			0				0.84081	0.83039
	14	14	SD45, SD46, L	10		10	10			0				0.85492	0.84332
	15	15	SD45, SD46, L	10		9	9			0				0.85455	0.83947
	16	16	SD45, SD46, L	10		9	9			0				0.8517	0.84459
	17	17	SD45, SD46, L	10		7	7			0				0.84657	0.83496
	18	18	SD45, SD46, L	10		8	8			0				0.85248	0.83953
	19	19	SD45, SD46, L	10		6	6			0				0.84844	0.83907
	20	20	SD45, SD46, L	10		8	8			0				0.85086	0.83799
	21	21	SD45, SD46, L	10		5	7			2				0.85886	0.84617
	22	22	SD45, SD46, L	10		6	8			2				0.85609	0.84474
	23	23	SD45, SD46, L	10		7	7			0				0.86245	0.85212
	24	24	SD45, SD46, L	10		8	8			0				0.86232	0.84684
	25	1	SD25;10579	10		10	10			0				0.84381	0.83264
	26	2	SD25;10579	10		10	10			0				0.84151	0.82971
	27	3	SD25;10579	10		9	9			0				0.83793	0.82489
	28	4	SD25;10579	10		10	10			0				0.84178	0.83171
	29	5	SD25;10579	10		10	10			0				0.84913	0.83574
	30	6	SD25;10579	10		9	9			0				0.8465	0.83499
	31	7	SD25;10579	10		9	9			0				0.85301	0.84121
	32	8	SD25;10579	10		9	10			1				0.85375	0.84275
	33	1	SD30; 10580	10		1	1			0				0.82843	0.82783
	34	2	SD30; 10580	10		1	1			0				0.81119	0.811
	35	3	SD30; 10580	10		3	3			0				0.83741	0.83684
	36	4	SD30; 10580	10		3	3			0				0.82745	0.82381
	37	5	SD30; 10580	10		3	3			0				0.82151	0.81957
	38	6	SD30; 10580	10		2	2			0				0.83083	0.83034

ToxCalc 5.0

Reviewed by: MLV

Test: EPA 100.2-Chironomus dilutus 10d Survival and Growth Test Test ID: 2264cdCSIT
Species: CDIL-Chironomus dilutus Protocol: EPA 600/R-99/064
Sample ID: Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015 Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0	Day 4	Day 1(	Day 1(	Day 2(	Day 2(	# pupae + Mi	Alive in Sedi	Remain in Se	Emerged	Weight pan/c	Weight ashed pan/orgs aft
	39	7	SD30; 10580	10		2	2			0				0.82557	0.82353
	40	8	SD30; 10580	10		3	3			0				0.82387	0.82326
	41	1	SD32; 10581	10		10	10			0				0.84123	0.83356
	42	2	SD32; 10581	10		10	10			0				0.84217	0.83336
	43	3	SD32; 10581	10		10	10			0				0.84484	0.83579
	44	4	SD32; 10581	10		10	10			0				0.84339	0.83395
	45	5	SD32; 10581	10		9	9			0				0.84496	0.8343
	46	6	SD32; 10581	10		10	10			0				0.84254	0.83255
	47	7	SD32; 10581	10		10	10			0				0.84341	0.83516
	48	8	SD32; 10581	10		9	9			0				0.83329	0.82421
	49	1	SD39; 10582	10		8	8			0				0.84621	0.83585
	50	2	SD39; 10582	10		9	9			0				0.84207	0.83317
	51	3	SD39; 10582	10		9	9			0				0.84414	0.83363
	52	4	SD39; 10582	10		7	8			1				0.84627	0.83835
	53	5	SD39; 10582	10		10	10			0				0.84643	0.83827
	54	6	SD39; 10582	10		9	9			0				0.85526	0.84436
	55	7	SD39; 10582	10		8	8			0				0.85476	0.84527
	56	8	SD39; 10582	10		9	9			0				0.86445	0.85344
	57	1	SD40; 10583	10		10	10			0				0.84463	0.83426
	58	2	SD40; 10583	10		9	9			0				0.83324	0.82401
	59	3	SD40; 10583	10		9	9			0				0.84341	0.83319
	60	4	SD40; 10583	10		8	9			1				0.84714	0.83612
	61	5	SD40; 10583	10		7	7			0				0.83262	0.82537
	62	6	SD40; 10583	10		8	8			0				0.82799	0.81861
	63	7	SD40; 10583	10		10	10			0				0.84065	0.83126
	64	8	SD40; 10583	10		10	10			0				0.84455	0.83447
	65	1	SD50; 10584	10		9	10			1				0.83944	0.83149
	66	2	SD50; 10584	10		10	10			0				0.84468	0.83612
	67	3	SD50; 10584	10		10	10			0				0.84605	0.83519
	68	4	SD50; 10584	10		9	9			0				0.84591	0.83657
	69	5	SD50; 10584	10		10	10			0				0.83248	0.82304
	70	6	SD50; 10584	10		10	10			0				0.8504	0.84161
	71	7	SD50; 10584	10		8	9			1				0.83542	0.82726
	72	8	SD50; 10584	10		10	10			0				0.84885	0.83866
	73	1	SD54; 10585	10		10	10			0				0.85412	0.84351
	74	2	SD54; 10585	10		10	10			0				0.83703	0.82663
	75	3	SD54; 10585	10		10	10			0				0.84452	0.83358
	76	4	SD54; 10585	10		10	10			0				0.84724	0.83124

Test: EPA 100.2-Chironomus dilutus 10d Survival and Growth Test Test ID: 2264cdCSIT
Species: CDIL-Chironomus dilutus Protocol: EPA 600/R-99/064
Sample ID: Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015 Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0	Day 4	Day 10	Day 10	Day 20	Day 20	# pupae + Mi	Alive in Sedi	Remain in Se	Emerged	Weight pan/c	Weight ashed pan/orgs aft
	77	5	SD54; 10585	10		10	10			0				0.85779	0.84499
	78	6	SD54; 10585	10		9	9			0				0.84617	0.83369
	79	7	SD54; 10585	10		9	10			1				0.86225	0.85085
	80	8	SD54; 10585	10		9	10			1				0.86518	0.85402
	81	1	SD55; 10586	10		10	10			0				0.85428	0.8424
	82	2	SD55; 10586	10		10	10			0				0.85533	0.8436
	83	3	SD55; 10586	10		10	10			0				0.83704	0.82471
	84	4	SD55; 10586	10		9	10			1				0.84955	0.83936
	85	5	SD55; 10586	10		8	8			0				0.83802	0.82738
	86	6	SD55; 10586	10		9	9			0				0.86259	0.85023
	87	7	SD55; 10586	10		10	10			0				0.84459	0.83004
	88	8	SD55; 10586	10		10	10			0				0.83433	0.8217
	89	1	SD58; 10587	10		10	10			0				0.84973	0.83958
	90	2	SD58; 10587	10		8	8			0				0.84612	0.83565
	91	3	SD58; 10587	10		8	8			0				0.86024	0.84955
	92	4	SD58; 10587	10		8	8			0				0.84852	0.83963
	93	5	SD58; 10587	10		10	10			0				0.85634	0.84439
	94	6	SD58; 10587	10		10	10			0				0.83235	0.82126
	95	7	SD58; 10587	10		9	9			0				0.84	0.82863
	96	8	SD58; 10587	10		9	9			0				0.83289	0.82068
	97	1	SD59; 10588	10		10	10			0				0.84672	0.83639
	98	2	SD59; 10588	10		8	8			0				0.86242	0.85143
	99	3	SD59; 10588	10		10	10			0				0.85733	0.84387
	100	4	SD59; 10588	10		10	10			0				0.85245	0.84107
	101	5	SD59; 10588	10		8	8			0				0.84845	0.83684
	102	6	SD59; 10588	10		8	8			0				0.84314	0.83231
	103	7	SD59; 10588	10		10	10			0				0.84848	0.83648
	104	8	SD59; 10588	10		10	10			0				0.85642	0.84196

Comments: AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015-COMB

Chironomus dilutus 10d Survival and Growth Test-10-day survival

Start Date: 8/11/2015	Test ID: 2264cdCSIT	Sample ID:	
End Date: 8/21/2015	Lab ID: -GREAT LAKES ENVIRONMENT/	Sample Type:	-WHOLE SEDIMENT
Sample Da	Protocol: EPA 600/R-99/064	Test Species:	CDIL-Chironomus dilutus

Comments AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015-COMB

Conc-%	1	2	3	4	5	6	7	8	9	10
SD45, SD46, LM0813	1.0000	0.9000	0.9000	1.0000	0.7000	1.0000	0.9000	1.0000	1.0000	1.0000
SD45, SD46, LM0813	0.9000	0.8000	0.8000	1.0000	0.9000	0.9000	0.7000	0.8000	0.8000	0.8000
SD45, SD46, LM0813	0.7000	0.8000	0.7000	0.8000						
SD25;10579	1.0000	1.0000	0.9000	1.0000	1.0000	0.9000	0.9000	1.0000		
SD30; 10580	0.1000	0.1000	0.3000	0.3000	0.3000	0.2000	0.2000	0.3000		
SD32; 10581	1.0000	1.0000	1.0000	1.0000	0.9000	1.0000	1.0000	0.9000		
SD39; 10582	0.8000	0.9000	0.9000	0.8000	1.0000	0.9000	0.8000	0.9000		
SD40; 10583	1.0000	0.9000	0.9000	0.9000	0.7000	0.8000	1.0000	1.0000		
SD50; 10584	1.0000	1.0000	1.0000	0.9000	1.0000	1.0000	0.9000	1.0000		
SD54; 10585	1.0000	1.0000	1.0000	1.0000	1.0000	0.9000	1.0000	1.0000		
SD55; 10586	1.0000	1.0000	1.0000	1.0000	0.8000	0.9000	1.0000	1.0000		
SD58; 10587	1.0000	0.8000	0.8000	0.8000	1.0000	1.0000	0.9000	0.9000		
SD59; 10588	1.0000	0.8000	1.0000	1.0000	0.8000	0.8000	1.0000	1.0000		

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD45, SD46, LM0813	0.8583	1.0000	1.2030	0.8861	1.4120	14.013	24			
SD25;10579	0.9625	1.1214	1.3509	1.2490	1.4120	6.244	8	-3.248	1.711	0.0779
*SD30; 10580	0.2250	0.2621	0.4862	0.3218	0.5796	23.327	8	13.567	1.734	0.0916
SD32; 10581	0.9750	1.1359	1.3713	1.2490	1.4120	5.501	8	-3.865	1.706	0.0743
SD39; 10582	0.8750	1.0194	1.2182	1.1071	1.4120	8.698	8	-0.260	1.729	0.0879
SD40; 10583	0.9000	1.0485	1.2802	0.9912	1.4120	12.195	8	-0.889	1.771	0.1139
SD50; 10584	0.9750	1.1359	1.3713	1.2490	1.4120	5.501	8	-3.865	1.706	0.0743
SD54; 10585	0.9875	1.1505	1.3916	1.2490	1.4120	4.140	8	-4.718	1.699	0.0679
SD55; 10586	0.9625	1.1214	1.3535	1.1071	1.4120	8.476	8	-2.830	1.740	0.0925
SD58; 10587	0.9000	1.0485	1.2569	1.1071	1.4120	11.234	8	-0.890	1.761	0.1068
SD59; 10588	0.9250	1.0777	1.2977	1.1071	1.4120	12.159	8	-1.445	1.782	0.1168

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.764619	1.035	-0.34197	-0.49727
Bartlett's Test indicates unequal variances (p = 0.05)	18.62636	18.30704		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences	0.087749	0.100778	0.526205	0.016624	1.0E-25	10, 93
Treatments vs SD45, SD46, LM0813						

Chironomus dilutus 10d Survival and Growth Test-10-Day Growth (AFDW)

Start Date: 8/11/2015	Test ID: 2264cdCSIT	Sample ID:	
End Date: 8/21/2015	Lab ID: -GREAT LAKES ENVIRONMENT	Sample Type:	-WHOLE SEDIMENT
Sample Da	Protocol: EPA 600/R-99/064	Test Species:	CDIL-Chironomus dilutus

Comments AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015-COMB

Conc-%	1	2	3	4	5	6	7	8	9	10
SD45, SD46, LM0813	1.4711	1.3122	1.5256	1.2567	2.8029	1.3480	1.2956	1.2170	1.0760	1.2350
SD45, SD46, LM0813	1.2267	1.2513	1.3025	1.1600	1.6756	0.7900	1.6586	1.6188	1.5617	1.6087
SD45, SD46, LM0813	2.5360	1.8917	1.4757	1.9350						
SD25;10579	1.1170	1.1800	1.4489	1.0070	1.3390	1.2789	1.3111	1.2222		
SD30; 10580	0.6000	0.1900	0.1900	1.2133	0.6467	0.2450	1.0200	0.2033		
SD32; 10581	0.7670	0.8810	0.9050	0.9440	1.1644	0.9990	0.8250	1.0089		
SD39; 10582	1.2950	0.9889	1.1678	1.1314	0.8160	1.2111	1.1863	1.2233		
SD40; 10583	1.0370	1.0256	1.1356	1.3775	1.0357	1.1725	0.9390	1.0080		
SD50; 10584	0.8833	0.8560	1.0860	1.0378	0.9440	0.8790	1.0200	1.0190		
SD54; 10585	1.0610	1.0400	1.0940	1.6000	1.2800	1.3867	1.2667	1.2400		
SD55; 10586	1.1880	1.1730	1.2330	1.1322	1.3300	1.3733	1.4550	1.2630		
SD58; 10587	1.0150	1.3088	1.3363	1.1113	1.1950	1.1090	1.2633	1.3567		
SD59; 10588	1.0330	1.3737	1.3460	1.1380	1.4513	1.3538	1.2000	1.4460		

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD45, SD46, LM0813	1.5098	1.0000	1.5098	0.7900	2.8029	29.258	24			
*SD25;10579	1.2380	0.8200	1.2380	1.0070	1.4489	11.147	8	2.651	1.699	0.1742
*SD30; 10580	0.5385	0.3567	0.5385	0.1900	1.2133	75.070	8	5.747	1.771	0.2993
*SD32; 10581	0.9393	0.6221	0.9393	0.7870	1.1844	13.696	8	5.649	1.699	0.1716
*SD39; 10582	1.1275	0.7468	1.1275	0.8160	1.2950	13.640	8	3.631	1.699	0.1789
*SD40; 10583	1.0914	0.7229	1.0914	0.9390	1.3775	12.533	8	4.089	1.899	0.1738
*SD50; 10584	0.9658	0.6396	0.9656	0.8560	1.0880	8.948	8	5.715	1.703	0.1622
*SD54; 10585	1.2460	0.8253	1.2460	1.0400	1.6000	15.060	8	2.356	1.703	0.1907
*SD55; 10586	1.2684	0.8402	1.2684	1.1322	1.4550	8.688	8	2.457	1.699	0.1669
*SD58; 10587	1.2119	0.8027	1.2119	1.0150	1.3567	10.260	8	2.969	1.699	0.1704
*SD59; 10588	1.2927	0.8562	1.2927	1.0330	1.4513	11.759	8	2.068	1.699	0.1784

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.560365	1.035	1.76647	7.887531
Bartlett's Test indicates unequal variances (p = 5.16E-09)	59.18999	18.30704		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences	0.178354	0.118135	0.704441	0.073455	8.5E-11	10, 93
Treatments vs SD45, SD46, LM0813						

Chironomus dilutus 10d Survival and Growth Test-10-Day Biomass (AFDW)

Start Date: 8/11/2015	Test ID: 2264cdCSIT	Sample ID:	
End Date: 8/21/2015	Lab ID: -GREAT LAKES ENVIRONMENT/	Sample Type:	-WHOLE SEDIMENT
Sample Da	Protocol: EPA 600/R-99/064	Test Species:	CDIL-Chironomus dilutus

Comments AECOM Lake Macatawa 10 day C dilutus survival and growth Aug 2015-COMB

Conc-%	1	2	3	4	5	6	7	8	9	10
SD45, SD46, LM0813	1.4711	1.1810	1.3730	1.2567	1.9620	1.3480	1.1660	1.2170	1.0760	1.2350
SD45, SD46, LM0813	1.1040	1.0010	1.0420	1.1600	1.5080	0.7110	1.1610	1.2950	0.9370	1.2870
SD45, SD46, LM0813	1.5663	1.4188	1.0330	1.5480						
SD25;10579	1.1170	1.1600	1.3040	1.0070	1.3390	1.1510	1.1800	1.2222		
SD30; 10580	0.0800	0.0190	0.0570	0.3640	0.1940	0.0490	0.2040	0.0610		
SD32; 10581	0.7670	0.8810	0.9050	0.9440	1.0660	0.9990	0.8250	0.9080		
SD39; 10582	1.0360	0.8900	1.0510	0.8800	0.8160	1.0900	0.9490	1.1010		
SD40; 10583	1.0370	0.9230	1.0220	1.2244	0.7250	0.9380	0.9390	1.0080		
SD50; 10584	0.8833	0.8560	1.0860	0.9340	0.9440	0.8790	0.9067	1.0190		
SD54; 10585	1.0610	1.0400	1.0940	1.6000	1.2800	1.2480	1.2667	1.2400		
SD55; 10586	1.1880	1.1730	1.2330	1.1322	1.0640	1.2360	1.4550	1.2630		
SD58; 10587	1.0150	1.0470	1.0690	0.8890	1.1950	1.1090	1.1370	1.2210		
SD59; 10588	1.0330	1.0990	1.3460	1.1380	1.1610	1.0830	1.2000	1.4460		

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD45, SD46, LM0813	1.2532	1.0000	1.2532	0.7110	1.9620	20.393	24			
SD25;10579	1.1875	0.9476	1.1875	1.0070	1.3390	8.816	8	1.027	1.701	0.1088
*SD30; 10580	0.1280	0.1005	0.1280	0.0190	0.3640	93.941	8	16.855	1.706	0.1141
*SD32; 10581	0.9119	0.7276	0.9119	0.7670	1.0660	10.315	8	5.518	1.699	0.1051
*SD39; 10582	0.9766	0.7793	0.9768	0.8160	1.1010	11.000	8	4.287	1.703	0.1099
*SD40; 10583	0.9771	0.7796	0.9771	0.7250	1.2244	14.329	8	3.841	1.717	0.1235
*SD50; 10584	0.9385	0.7489	0.9385	0.8560	1.0860	8.321	8	5.332	1.899	0.1003
SD54; 10585	1.2287	0.9804	1.2287	1.0400	1.6000	14.569	8	0.299	1.740	0.1427
SD55; 10586	1.2180	0.9719	1.2180	1.0640	1.4550	9.450	8	0.532	1.706	0.1128
*SD58; 10587	1.0853	0.8660	1.0853	0.8890	1.2210	9.782	8	2.614	1.701	0.1093
SD59; 10588	1.1883	0.9481	1.1883	1.0330	1.4460	11.811	8	0.903	1.717	0.1236

Auxillary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates normal distribution (p > 0.01)	0.943593	1.035	0.726322	4.315464
Bartlett's Test indicates unequal variances (p = 1.47E-03)	28.5477	18.30704		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences Treatments vs SD45, SD46, LM0813	0.123628	0.098647	0.895312	0.027242	2.7E-26	10, 93

Appendix D1
Hyalella azteca
10-Day Bench sheets
10-Day Statistical Data
Laboratory Control

- Survival
- Weight

Project Name: AECOM Macatawa
Project Number: 2264-00

Test Dates: 08/11-21/2015
Test Type: 10 Day Whole Sediment Toxicity Survival and Growth
Test Species: *Hyalella azteca* QC'd by:___ks_

100% Data Entry

Date	Initials	Data Entered
8/25/2015	MWG	ALL DATA

100% Data Quality Check

Date	Initials	Data QC'ed
9/1/2015	MP	ALL: Errors - 10590 - Corrected & Highlighted

100% Error Corrected Quality Check

Date	Initials	Data QC'ed
9/14/2015	meg	10590; rep 4 and rep 5

Data QC 10%

Date	Initials	Data QC'ed
9/14/2015	mwg	all

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day Survival and Growth Whole Sediment Toxicity Test

Page 7 of 7
QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	Laboratory Control	Test Photoperiod:	16:8
Sample ID:	CS # 129	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Hyalella azteca*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 9/10 day
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day:	Day 10	Number Daily Renewals:	1 Air: ☐ yes ☒ no
Date:	8/21/2015	renewal time/Initials	~~☐ renewal~~
Overlying Water:	Dechlor	renewal time/Initials	~~☐ renewal~~
Overlying Water Batch ID (GLC Number):	NA	Food: ~~YTC#~~	~~☐ Feed 1.0 ml/replicate~~
1660 ES chemistries time/Initial		Screens Cleaned:	☐ yes ☒ no

8/20/15 ES

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	* Hardness (mg/L $CaCO_3$) 8/20/15	* Alkalinity (mg/L $CaCO_3$) 8/20/15	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A ES	203 ES	4	Init: ES
1					148	ES 8/20/15 ~~132~~ 120	0.98	10 /10
2					end: 5.1	end: 7.6	DS	10 /10
3	22.3	7.64	5.5	319	start: 1.4	start: 1.6	8/24/15	10 /10
4	22.4	7.69	5.4	319	Titrant used (mL): 3.7	Titrant used (mL): 6.0		10 /10
5					Sample volume (mL): 25	Sample volume (mL): 50		9 /10
6								8 /10
7								10 /10
8								8 /10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 - s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

*All hardness and alkalinity reanalyzed on 8/20/15. -ES

KEY:
AV: Animals Visible
NAV: No Animals Visible
FOV: Foreign Organism Visible

revised: June 2012

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day Survival and Growth Whole Sediment Toxicity Test

Page 7 of 7
QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	Secondary Control	Test Photoperiod:	16:8
Sample ID:	Water only	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Hyalella azteca*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 9/10 day
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day:	Day 10	Number Daily Renewals:	1 Air: ☐ yes ☑ no
Date:	8/21/2015	~~0820~~ KS renewal time/Initials	~~☐ renewal~~
Overlying Water:	Dechlor	~~☐ renewal time/Initials~~	~~☐ renewal~~
Overlying Water Batch ID (GLC Number):	NA	Food: ~~YTC#~~	~~☐ Feed 1.0 ml/replicate~~
~~1750~~ KS chemistries time/Initial		Screens Cleaned:	☐ yes ☑ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A ES	203 ES	4	Init: ES
1					128	100	0.68	10 /10
2					end: 8.3	end: 12.6	DS	10 /10
3	22.7	8.02	7.7	306	start: 5.1	start: 7.6	8/24/15	10 /10
4	22.7	8.04	7.5	306	Titrant used (mL): 3.2	Titrant used (mL): 5.0		10 /10
5					Sample volume (mL): 25	Sample volume (mL): 50		10 /10
6								10 /10
7								10 /10
8								10 /10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 - s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

KEY:
AV: Animals Visible
NAV: No Animals Visible
FOV: Foreign Organism Visible

revised: June 2012

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day Survival and Growth Whole Sediment Toxicity Test

Page 7 of 7
QC'd by: DS

Project Number: 2264-00	Project Name: AECOM-Lake Macatawa		
GLC#: 10579		Test Photoperiod: 16:8	
Sample ID: SD-25		Test System: Sediment-100 mL and Overlying Water-175mL Manual Delivery	
Test Species: *Hyalella azteca*		Test Temperature: 23± 1°C	
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 9/10 day
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day:	Day 10	Number Daily Renewals: 1	Air: ☐ yes ☒ no
Date:	8/21/2015	~~X 830 KJ~~ renewal time/Initials ~~☐ renewal~~	
Overlying Water: Dechlor		~~☐ renewal time/Initials ☐ renewal~~	
Overlying Water Batch ID (GLC Number): NA		Food: ~~YTC#~~	~~☐ Feed 1.0 ml/replicate~~
~~X 750 KJ~~ chemistries time/Initial		Screens Cleaned: ☐ yes ☒ no	

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A ES	203 ES	4	Init: ES
1					156	114	0.46	9 /10
2					end: 12.2	end: 18.3	DS	9 /10
3	22.3	8.29	5.7	342	start: 8.3	start: 12.6	8/24/15	10 /10
4	22.4	8.38	5.6	339	Titrant used (mL): 3.9	Titrant used (mL): 5.7		10 /10
5					Sample volume (mL): 25	Sample volume (mL): 50		10 /10
6								9 /10
7								10 /10
8								9 /10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

KEY:
AV: Animals Visible
NAV: No Animals Visible
FOV: Foreign Organism Visible

revised: June 2012

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day Survival and Growth Whole Sediment Toxicity Test

Page 7 of 7
QC'd by: D.S

Project Number:	2264-00	Project Name: AECOM-Lake Macatawa	
GLC#:	10580	Test Photoperiod: 16:8	
Sample ID:	SD-30	Test System: Sediment-100 mL and Overlying Water-175mL Manual Delivery	
Test Species:	*Hyalella azteca*	Test Temperature: 23± 1°C	
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 9/10 day
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
~~1750 KJ~~ chemistries time/Initial

Number Daily Renewals: Air: ☐ yes ☒ no
~~1820 KJ~~ renewal time/Initials ~~☐ renewal~~
~~☐ renewal time/Initials ☐ renewal~~
Food: ~~YTC#~~ ~~☐ Feed 1.0 ml/replicate~~
Screens Cleaned: ☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A ES	203 ES	4	Init: ES
1	/	/	/	/	128	96	0.44	10 /10
2	/	/	/	/	end: 15.4	end: 23.1	DS	8 /10
3	22.3	7.57	5.8	307	start: 12.2	start: 18.3	8/24/15	9 /10
4	22.3	7.59	6.1	303	Titrant used (mL): 3.2	Titrant used (mL): 4.8	/	10 /10
5	/	/	/	/	Sample volume (mL): 25	Sample volume (mL): 50	/	9 /10
6	/	/	/	/	/	/	/	9 /10
7	/	/	/	/	/	/	/	9 /10
8	/	/	/	/	/	/	/	10 /10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

KEY:
AV: Animals Visible
NAV: No Animals Visible
FOV: Foreign Organism Visible

revised: June 2012

GLR

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day Survival and Growth Whole Sediment Toxicity Test

Page 7 of 7
QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10581	Test Photoperiod:	16:8
Sample ID:	SD-32	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Hyalella azteca*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 9/10 day
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
~~1750~~ ES chemistries time/Initial

Number Daily Renewals: 1 Air: ☐ yes ☒ no
~~1820~~ KS renewal time/Initials ~~☐ renewal~~
~~☐ renewal time/Initials ☐ renewal~~
Food: ~~YTC#~~ ~~☐ Feed 1.0 ml/replicate~~
Screens Cleaned: ☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A ES	203 ES	4	Init: ES
1					140	104/104 dup	0.56	10 /10
2					end: 18.9	28.4/33.6 end:	DS	8 /10
3	22.3	8.33	5.1	330	start: 15.4	start: 23.1/28.4	8/24/15	10 /10
4	22.3	8.33	5.3	328	Titrant used (mL): 3.5	Titrant used (mL): 5.3/5.2		10 /10
5					Sample volume (mL): 25	Sample volume (mL): 50		10 /10
6								9 /10
7								8 /10
8								8 /10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

KEY:
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revised: June 2012

GLEC

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day Survival and Growth Whole Sediment Toxicity Test

Page 7 of 7
QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10582	Test Photoperiod:	16:8
Sample ID:	SD-39	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Hyalella azteca*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 9/10 day
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
~~ADD KS~~ chemistries time/Initial

Number Daily Renewals: 1 Air: ☐ yes ☒ no
~~820 KS~~ renewal time/Initials ~~☐~~ ~~renewal~~
~~☐ renewal time/Initials ☐ renewal~~
Food: ~~YTC#~~ ~~☐ Feed 1.0 ml/replicate~~
Screens Cleaned: ☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	200	175	175	N/A ES	203 ES	4	Init: ES
1					148 / 148 dup	116	1.07	10 /10
2					22.6 / 26.3 end:	39.4 end:	DS	9 /10
3	22.2	8.58	6.0	345	18.9 / 22.6 start:	33.6 start:	8/24/15	9 /10
4	22.1	8.49	4.8	343	Titrant used (mL): 3.7/3.7	Titrant used (mL): 5.8		9 /10
5					Sample volume (mL): 25	Sample volume (mL): 50		9 /10
6								10 /10
7								10 /10
8								9 /10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

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revised June 2012

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day Survival and Growth Whole Sediment Toxicity Test

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QC'd by: DS

Project Number:	2264-00	* Project Name:	AECOM-Lake Macatawa
GLC#:	10583	Test Photoperiod:	16:8
Sample ID:	SD-40	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Hyalella azteca*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 9/10 day
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day:	Day 10	Number Daily Renewals:	1 Air: ☐ yes ☒ no
Date:	8/21/2015	~~8/20 KS~~ renewal time/Initials	~~☐ renewal~~
Overlying Water:	Dechlor	~~☐ renewal time/Initials~~	~~☐ renewal~~
Overlying Water Batch ID (GLC Number):	NA	Food: ~~YTC#~~	~~☐ Feed 1.0 ml/replicate~~
~~N 9:30~~ 8/21 KS chemistries time/Initial		Screens Cleaned:	☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	17.5	203	17.5	17.5	N/A es	203 es	4	Init: ES
1					148	110	0.71	9 /10
2					end: 30.0	end: 44.9	0.69 DOP	10 /10
3	22.2	8.24	5.4	329	start: 26.3	start: 39.4	DS	10 /10
4	22.1	8.26	5.3	328	Titrant used (mL): 3.7	Titrant used (mL): 5.5	8/24/15	9 /10
5					Sample volume (mL): 25	Sample volume (mL): 50		9 /10
6								10 /10
7								10 /10
8								10 /10

8/21 KS KS

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

KEY:
AV: Animals Visible
NAV: No Animals Visible
FOV: Foreign Organism Visible

revised: June 2012

10'/.

GLEC

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day Survival and Growth Whole Sediment Toxicity Test

Page 7 of 7
QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10584	Test Photoperiod:	16:8
Sample ID:	SD-50	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Hyalella azteca*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 9/10 day
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
~~X~~ 750 KS chemistries time/Initial

Number Daily Renewals: 1 Air: ☐ yes ☒ no
~~X~~ 820 KS renewal time/Initials ~~☐ renewal~~
~~☐ renewal time/Initials ☐ renewal~~
Food: ~~YTC#~~ ~~☐ Feed 1.0 ml/replicate~~
Screens Cleaned: ☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A ES	203 ES	DS 4	Init: MM
1					144	114	0.63	10 /10
2					end: 33.6	end: 7.9	DS	8 /10
3	22.1	8.68	5.3	343	start: 30.0	start: 2.2	8/24/15	10 /10
4	22.1	8.75	5.4	333	Titrant used (mL): 3.6	Titrant used (mL): 5.7		10 /10
5					Sample volume (mL): 25	Sample volume (mL): 50		10 /10
6								10 /10
7								10 /10
8								10 /10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

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AV: Animals Visible
NAV: No Animals Visible
FOV: Foreign Organism Visible

revised. June 2012

GLER

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day Survival and Growth Whole Sediment Toxicity Test

Page 7 of 7
QC'd by: DS

Project Number: 2264-00	Project Name: AECOM-Lake Macatawa		
GLC#: 10585		Test Photoperiod: 16:8	
Sample ID: SD-54		Test System: Sediment-100 mL and Overlying Water-175mL Manual Delivery	
Test Species: *Hyalella azteca*		Test Temperature: 23± 1°C	
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 9/10 day
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10		Number Daily Renewals: 1	Air: ☐ yes ☒ no
Date: 8/21/2015		1020 ES renewal time/Initials ☐ ~~renewal~~	
Overlying Water: Dechlor		☐ ~~renewal time/Initials~~ ☐ ~~renewal~~	
Overlying Water Batch ID (GLC Number): NA		Food: ~~YTC#~~	☐ ~~Feed 1.0 ml/replicate~~
1750 ES chemistries time/Initial		Screens Cleaned: ☐ yes ☒ no	

Replicate	Temperature (23 ± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	125	N/A	203 ES*	4	Init: ES
1					156	116	0.55	9 /10
2					end: 37.5	end: 13.7	DS	8 /10
3	22.2	8.56	5.7	340	start: 33.6	start: 7.9	8/24/15	9 /10
4	22.1	8.58	5.2	330	Titrant used (mL): 3.9	Titrant used (mL): 5.8		10 /10
5					Sample volume (mL): 25	Sample volume (mL): 50		10 /10
6								10 /10
7								9 /10
8								10 /10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 - s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L)
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

KEY:
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revised: June 2012

GLEC

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day Survival and Growth Whole Sediment Toxicity Test

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QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10586	Test Photoperiod:	16:8
Sample ID:	SD-55	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Hyalella azteca*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 9/10 day
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
~~1750 KS~~ chemistries time/Initial

Number Daily Renewals: 1 Air: □ yes ☒ no
~~1820 KS~~ renewal time/Initials ~~□ renewal~~
~~□ renewal time/Initials □ renewal~~
Food: ~~YTC#~~ ~~□ Feed 1.0 ml/replicate~~
Screens Cleaned: □ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A ES	203 ES	4	Init: MW
1					152	124	0.54	8 /10
2					end: 41.3	end: 19.9	DS	10 /10
3	22.5	8.52	5.1	341	start: 37.5	start: 13.7	8/24/15	10 /10
4	22.1	8.63	5.3	342	Titrant used (mL): 3.8	Titrant used (mL): 6.2		10 /10
5					Sample volume (mL): 25	Sample volume (mL): 50		10 /10
6								10 /10
7								8 /10
8								10 /10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

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revised: June 2012

GLEC

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day Survival and Growth Whole Sediment Toxicity Test

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QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10587	Test Photoperiod:	16:8
Sample ID:	SD-58	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Hyalella azteca*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 9/10 day
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day:	Day 10	Number Daily Renewals:	1 Air: ☐ yes ☒ no
Date:	8/21/2015	☒ 820 KS renewal time/Initials	~~renewal~~
Overlying Water:	Dechlor	~~renewal time/Initials~~	~~renewal~~
Overlying Water Batch ID (GLC Number):	NA	Food: ~~YTC#~~	~~Feed 1.0 ml/replicate~~
☒ 750 KS chemistries time/Initial		Screens Cleaned:	☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A ES	203 ES	4	Init: MWJ
1					144	116	0.80	10 /10
2					end: 44.9	end: 25.7	DS	9 /10
3	22.0	886	6.2	334	start: 41.3 ES 8/20 ~~19.9~~ 14	start: 19.9	8/24/15	10/10
4	22.0	882	5.7	334	Titrant used (mL): 3.6	Titrant used (mL): 5.8		10/10
5					Sample volume (mL): 25	Sample volume (mL): 50		8 /10
6								10 /10
7								10 /10
8								10 /10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

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revised: June 2012

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day Survival and Growth Whole Sediment Toxicity Test

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QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10588	Test Photoperiod:	16:8
Sample ID:	SD-59	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Hyalella azteca*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 9/10 day
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day:	Day 10	Number Daily Renewals:	1 Air: ☐ yes ☒ no
Date:	8/21/2015	1730 KS renewal time/Initials	~~☐ renewal~~
Overlying Water:	Dechlor	~~☐ renewal time/Initials~~	~~☐ renewal~~
Overlying Water Batch ID (GLC Number):	NA	Food: ~~YTC#~~	~~☐ Feed 1.0 ml/replicate~~
1650 KS chemistries time/Initial		Screens Cleaned:	☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A eS	203 eS	4	Init: MGG/MGM
1					152	116	0.58	9 /10
2					end: 5.6	end: 31.5	DS	9 /10
3	22.6	8.38	6.1	334	start: 1.8	start: 25.7	8/24/15	8 /10
4	22.5	8.42	5.8	334	Titrant used (mL): 3.8	Titrant used (mL): 5.8		9 /10
5					Sample volume (mL): 25	Sample volume (mL): 50		9 /10
6								10 /10
7								10 /10
8								10 /10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
U = Below MDL. *J* = ≥ MDL and < RL.

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10%

GLEC

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day Survival and Growth Whole Sediment Toxicity Test

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QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10589	Test Photoperiod:	16:8
Sample ID:	SD-45	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Hyalella azteca*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 9/10 day
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
1650 KS chemistries time/Initial

Number Daily Renewals: 1 Air: ☐ yes ☒ no
~~1830 KS renewal time/Initials ☐ renewal~~
~~☐ renewal time/Initials ☐ renewal~~
Food: ~~YTC#~~ ~~☐ Feed 1.0 ml/replicate~~
Screens Cleaned: ☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A ES	203 ES	4	Init: KS
1					164	118	0.42	8 /10
2					end: 26.5	end: 21.4	DS	10 /10
3	22.6	8.23	6.1	324	ES 8/20/15 start: ~~5.6~~ 22.4	ES 8/20/15 start: ~~5.5~~ 15.5	8/24/15	10 /10
4	22.6	8.08	5.5	323	Titrant used (mL): 4.1	Titrant used (mL): 5.9		9 /10
5					Sample volume (mL): 25	Sample volume (mL): 50		10 /10
6								9 /10
7								9 /10
8								9 /10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
RL = Reporting Limit (0.20 mg/L).
MDL = Minimum Detection Limit (0.02 mg/L) - last updated 12/2014.
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revised: June 2012

GLFC

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day Survival and Growth Whole Sediment Toxicity Test

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QC'd by: MWR

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10590	Test Photoperiod:	16:8
Sample ID:	SD-46	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Hyalella azteca*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 9/10 day
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day: Day 10
Date: 8/21/2015
Overlying Water: Dechlor
Overlying Water Batch ID (GLC Number): NA
0650 KS chemistries time/Initial

Number Daily Renewals: 1 Air: ☐ yes ☒ no
0720 KS renewal time/Initials ~~☐ renewal~~
~~☐ renewal time/Initials ☐ renewal~~
Food: ~~YTC#~~ ~~☐ Feed 1.0 ml/replicate~~
Screens Cleaned: ☐ yes ☒ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A es	203 es	4	Init: ES
1					148	104	0.28	10 /10
2					end: 30.2	end: 26.6	DS	10 /10
3	22.6	8.09	8/21/15 KS 7.80	314	start: 26.5	start: 21.4	8/24/15	10 /10
4	22.6	8.08	6.2	316	Titrant used (mL): 3.7	Titrant used (mL): 5.2		10 /10
5					Sample volume (mL): 25	Sample volume (mL): 50		T.E. no eyes added 0 /10
6								mw 8/25/15 10 /10
7								10 /10
8								10 /10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 + s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
*Alkalinity, hardness and ammonia analyzed from a composite sample of all 8 replicates.
Ammonia Reporting Limits:
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revised. June 2012

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day Survival and Growth Whole Sediment Toxicity Test

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QC'd by: DS

Project Number:	2264-00	Project Name:	AECOM-Lake Macatawa
GLC#:	10591	Test Photoperiod:	16:8
Sample ID:	LM-08-13	Test System:	Sediment-100 mL and Overlying Water-175mL Manual Delivery
Test Species:	*Hyalella azteca*	Test Temperature:	23± 1°C
Date Addition of Sediment:	8/10/2015	Test Organism Source/Age:	ABS: 9/10 day
Test Initiation Date:	8/11/2015	Test Termination Date:	8/21/2015

Test Day:	Day 10	Number Daily Renewals:	Air: ☐ yes ☐ no
Date:	8/21/2015	~~1720 KS~~ renewal time/Initials	~~☐ renewal~~
Overlying Water:	Dechlor	~~☐ renewal time/Initials~~	~~☐ renewal~~
Overlying Water Batch ID (GLC Number):	NA	Food: ~~YTC#~~	~~☐ Feed 1.0 ml/replicate~~
1650 KS	chemistries time/Initial	Screens Cleaned:	☐ yes ☐ no

Replicate	Temperature (23± 1°C)*	pH	Dissolved Oxygen (mg/L)*	Specific Conductance (µmhos/cm)	Hardness (mg/L $CaCO_3$)	Alkalinity (mg/L $CaCO_3$)	Ammonia (as N)	Observations/ # Surviving Organisms
Record Meter ID	175	203	175	175	N/A ES	203 ES	4	Init: MC
1					172/160 dup	126/126 dup	0.32 Dup 0.34	10 /10
2					end: 34.5/38.5	end: 32.9/39.2	DS	10 /10
3	22.7	8.55	5.6	343	start: 30.2/34.5	start: 26.6/~~32.9~~ 8/25 8/26/15	8/24/15	10 /10
4	22.7	8.66	5.1	344	Titrant used (mL): 4.3/4.0	Titrant used (mL): 6.3/6.3		10 /10
5					Sample volume (mL): 25	Sample volume (mL): 50		10 /10
6								10 /10
7								9 /10
8								10 /10

Relative % Difference: RPD ≤15%

$$RPD = \left| \frac{(s_1 - s_2)}{(s_1 - s_2)/2} \right| \times 100 =$$

* Contact Laboratory Coordinator if Dissolved Oxygen level is < 2.5 mg/L or if Temperature is out of range.
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revised: June 2012

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2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

QC'd by: KS

Project Number:	2264-00	Type/Model of Drying Oven: **Blue M**	
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	
GLC#:	**Laboratory Control**	Drying Duration (Hours): **~24 hrs**	Dessicator: **# 128**
Sample ID:	**CS # 129**	Date/Time in: 8/21/15 1735	Date/Time in: 8/22/15 1715
Test Species:	***Hyalella azteca***	Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1350
Test Date:	**8/11/2015**	Technician's Initials: MP.	Weigh Date / Initials: 8/24/15 MP.
	8/21/2015		

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.83412	0.83284	[redacted]	10	#DIV/0!	[redacted]
2	10	0.83339	0.83209	[redacted]	10	#DIV/0!	[redacted]
3	10	0.83010	0.82884	[redacted]	10	#DIV/0!	[redacted]
4	10	0.80645	0.80526	[redacted]	10	#DIV/0!	[redacted]
5	10	0.81308	0.81196	[redacted]	9	#DIV/0!	[redacted]
6	10	0.82817	0.82721	[redacted]	8	#DIV/0!	[redacted]
7	10	0.82755	0.82685	[redacted]	10	#DIV/0!	[redacted]
8	10	0.80997	0.80890	[redacted]	8	#DIV/0!	[redacted]
						AVERAGE:	

Day 0 weights	80	0.82719	0.82450	0	80	Average at Day 0 (mg)	0.03363

See Attached sheet for calculated weights.

MWS 8/27/15

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

Page __2__ of __2__

QC'd by:___ks_____

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**			
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**			
GLC#:	**Laboratory Control**	Drying Duration (Hours): **~ 24 hrs**		Dessicator: **# 128**	
Sample ID:	**CS # 129**	Date/Time in:	**8/21/2015 17:35**	Date/Time in:	**8/22/2015 17:15**
Test Species:	***Hyalella azteca***	Date/Time out:	**8/22/2015 17:15**	Date/Time out:	**8/24/2015 13:50**
Test Date:	**8/11/2015**	Technician's Initia	**MP**	Weigh Date / Initials:	**8/24/2015 MP**
	8/21/2015				

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.83412	0.83284	0.00128	10	0.12800	0.12800
2	10	0.83339	0.83209	0.00130	10	0.13000	0.13000
3	10	0.83010	0.82884	0.00126	10	0.12600	0.12600
4	10	0.80645	0.80526	0.00119	10	0.11900	0.11900
5	10	0.81308	0.81196	0.00112	9	0.12444	0.11200
6	10	0.82817	0.82721	0.00096	8	0.12000	0.09600
7	10	0.82755	0.82685	0.00070	10	0.07000	0.07000
8	10	0.80997	0.80890	0.00107	8	0.13375	0.10700
					AVERAGE:	0.11890	0.11100

Day 0 weights	80	0.82719	0.8245	0.00269	80	Average at Day 0 (mg)	0.033625

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2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

QC'd by: KS

Project Number:	2264-00	Type/Model of Drying Oven: **Blue M**	
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	
GLC#:	**Secondary Control**	Drying Duration (Hours): **~24 hrs**	Dessicator: **# 128**
Sample ID:	**Water only**	Date/Time in: 8/21/15 1735	Date/Time in: 8/22/15 1715
Test Species:	***Hyalella azteca***	Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1356
Test Date:	**8/11/2015**	Technician's Initials: MR.	Weigh Date / Initials: 8/24/15 MR.
	8/21/2015		

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.829760	0.828164		10	#DIV/0!	
2	10	0.835114	0.834401		10	#DIV/0!	
3	10	0.826012	0.824490		10	#DIV/0!	
4	10	0.831165	0.830058		10	#DIV/0!	
5	10	0.826665	0.825580		10	#DIV/0!	
6	10	0.840027	0.839335		10	#DIV/0!	
7	10	0.829168	0.828447		10	#DIV/0!	
8	10	0.842251	0.841149		10	#DIV/0!	
						AVERAGE:	

Day 0 weights	80	See control	pg-mult	0	80	Average at Day 0 (mg)	0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

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QC'd by:___ks_____

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**			
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**			
GLC#:	**Water Only**	Drying Duration (Hours): **~ 24 hrs**		Dessicator: **# 128**	
Sample ID:	**Secondary Control**	Date/Time in:	**8/21/2015 17:35**	Date/Time in:	**8/22/2015 17:15**
Test Species:	***Hyalella azteca***	Date/Time out:	**8/22/2015 17:15**	Date/Time out:	**8/24/2015 13:50**
Test Date:	**8/11/2015**	Technician's Initia	**MP**	Weigh Date / Initials:	**8/24/2015 MP**
	8/21/2015				

Replicate Number	**A** Number of Organisms at Test Initiation	**B** Dry Weight of Pan and Organisms (g)	**C** Dry Weight of Pan (g)	**B-C** Total Dry Weight of Organisms (g)	**D** Number of Organisms Weighed	**B-C/D** Average Weight (mg)	**B-C/A** Biomass Weight (mg)
1	10	0.82976	0.82864	0.00112	10	0.11200	0.11200
2	10	0.83514	0.83401	0.00113	10	0.11300	0.11300
3	10	0.82612	0.82490	0.00122	10	0.12200	0.12200
4	10	0.83165	0.83058	0.00107	10	0.10700	0.10700
5	10	0.82665	0.82580	0.00085	10	0.08500	0.08500
6	10	0.84027	0.83935	0.00092	10	0.09200	0.09200
7	10	0.82968	0.82847	0.00121	10	0.12100	0.12100
8	10	0.84251	0.84149	0.00102	10	0.10200	0.10200
					AVERAGE:	0.10675	0.10675

Day 0 weights	80	0.82719	0.8245	0.00269	80	Average at Day 0 (mg)	0.033625

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2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

QC'd by: KS

Project Number:	2264-00	Type/Model of Drying Oven: **Blue M**	
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	
GLC#:	10579	Drying Duration (Hours): ~24 hrs	Dessicator: # 128
Sample ID:	SD-25	Date/Time in: 8/21/15 1736	Date/Time in: 8/22/15 1715
Test Species:	*Hyalella azteca*	Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1350
Test Date:	8/11/2015	Technician's Initials: MA.	Weigh Date / Initials: MA. 8/24/15
	8/21/2015		

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.83070	0.82973		9	#DIV/0!	
2	10	0.83465	0.83409		9	#DIV/0!	
3	10	0.82237	0.82126		10	#DIV/0!	
4	10	0.82741	0.82630		10	#DIV/0!	
5	10	0.82851	0.82737		10	#DIV/0!	
6	10	0.82794	0.82701		9	#DIV/0!	
7	10	0.82668	0.82555		10	#DIV/0!	
8	10	0.84030	0.83915		9	#DIV/0!	
						AVERAGE:	

Day 0 weights	80	See control pg-mwr		0	80	Average at Day 0 (mg)	0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

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QC'd by:___ks_____

Project Number:	**2264-00**	Type/Model of Drying Oven:	**Blue M**		
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature:	**60 °C**		
GLC#:	**10579**	Drying Duration (Hours):	**~ 24 hrs**	Dessicator:	**# 128**
Sample ID:	**SD-25**	Date/Time in:	**8/21/2015 17:35**	Date/Time in:	**8/22/2015 17:15**
Test Species:	***Hyalella azteca***	Date/Time out:	**8/22/2015 17:15**	Date/Time out:	**8/24/2015 13:50**
Test Date:	**8/11/2015**	Technician's Initia	**MP**	Weigh Date / Initials:	**8/24/2015 MP**
	8/21/2015				

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.83070	0.82973	0.00097	9	0.10778	0.09700
2	10	0.83465	0.83409	0.00056	9	0.06222	0.05600
3	10	0.82237	0.82126	0.00111	10	0.11100	0.11100
4	10	0.82741	0.82630	0.00111	10	0.11100	0.11100
5	10	0.82851	0.82737	0.00114	10	0.11400	0.11400
6	10	0.82794	0.82701	0.00093	9	0.10333	0.09300
7	10	0.82668	0.82555	0.00113	10	0.11300	0.11300
8	10	0.84030	0.83915	0.00115	9	0.12778	0.11500
					AVERAGE:	0.10626	0.10125

Day 0 weights	80	0.82719	0.8245	0.00269	80	Average at Day 0 (mg)	0.033625

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

Page 1 of 2

QC'd by: KS

Project Number:	2264-00	Type/Model of Drying Oven: **Blue M**	
Project Name:	AECOM-Lake Macatawa	Oven Temperature: **60 °C**	
GLC#:	10580	Drying Duration (Hours): **~24 hrs**	Dessicator: **# 128**
Sample ID:	SD-30	Date/Time in: 8/21/15 1735	Date/Time in: 8/22/15 1715
Test Species:	*Hyalella azteca*	Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1350
Test Date:	8/11/2015	Technician's Initials: MR.	Weigh Date / Initials: 8/24/15 MR.
	8/21/2015		

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.81859	0.81784		10	#DIV/0!	
2	10	0.82176	0.82112		8	#DIV/0!	
3	10	0.83030	0.82952		9	#DIV/0!	
4	10	0.80814	0.80742		10	#DIV/0!	
5	10	0.83529	0.83461		9	#DIV/0!	
6	10	0.82054	MR 8/24/15 0.821995		9	#DIV/0!	
7	10	0.83443	0.83352		9	#DIV/0!	
8	10	0.81191	0.81111		10	#DIV/0!	
						AVERAGE:	

Day 0 weights	80	See control	py-mulr	0	80	Average at Day 0 (mg)	0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

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QC'd by:___ks_____

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**			
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**			
GLC#:	**10580**	Drying Duration (Hours): **~ 24 hrs**		Dessicator: **# 128**	
Sample ID:	**SD-30**	Date/Time in:	**8/21/2015 17:35**	Date/Time in:	**8/22/2015 17:15**
Test Species:	***Hyalella azteca***	Date/Time out:	**8/22/2015 17:15**	Date/Time out:	**8/24/2015 13:50**
Test Date:	**8/11/2015**	Technician's Initia	**MP**	Weigh Date / Initials:	**8/24/2015 MP**
	8/21/2015				

Replicate Number	**A** Number of Organisms at Test Initiation	**B** Dry Weight of Pan and Organisms (g)	**C** Dry Weight of Pan (g)	**B-C** Total Dry Weight of Organisms (g)	**D** Number of Organisms Weighed	**B-C/D** Average Weight (mg)	**B-C/A** Biomass Weight (mg)
1	10	0.81859	0.81784	0.00075	10	0.07500	0.07500
2	10	0.82176	0.82112	0.00064	8	0.08000	0.06400
3	10	0.83030	0.82952	0.00078	9	0.08667	0.07800
4	10	0.80814	0.80742	0.00072	10	0.07200	0.07200
5	10	0.83529	0.83461	0.00068	9	0.07556	0.06800
6	10	0.82054	0.81995	0.00059	9	0.06556	0.05900
7	10	0.83443	0.83352	0.00091	9	0.10111	0.09100
8	10	0.81191	0.81111	0.00080	10	0.08000	0.08000
					AVERAGE:	0.07949	0.07338

Day 0 weights	80	0.82719	0.8245	0.00269	80	Average at Day 0 (mg)	0.033625

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

Page 1 of 2

QC'd by: KS

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	
GLC#:	10581	Drying Duration (Hours): ~ 24 hrs	Dessicator: # 128
Sample ID:	SD-32	Date/Time in: 8/21/15 1735	Date/Time in: 8/22/15 1715
Test Species:	*Hyalella azteca*	Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1350
Test Date:	8/11/2015	Technician's Initials: MW	Weigh Date / Initials: MP 8/24/15
	8/21/2015		

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.83640	0.83521	[redacted]	10	#DIV/0!	[redacted]
2	10	0.83762	0.83683	[redacted]	8	#DIV/0!	[redacted]
3	10	0.83618	0.83533	[redacted]	10	#DIV/0!	[redacted]
4	10	0.83085	0.82973	[redacted]	10	#DIV/0!	[redacted]
5	10	0.81702	0.81527	[redacted]	10	#DIV/0!	[redacted]
6	10	0.82743	0.82652	[redacted]	9	#DIV/0!	[redacted]
7	10	0.82350	0.82247	[redacted]	8	#DIV/0!	[redacted]
8	10	0.82312	0.82214	[redacted]	8	#DIV/0!	[redacted]
						AVERAGE:	

Day 0 weights	80	See control pg-mw		0	80	Average at Day 0 (mg)	0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

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QC'd by:___ks_____

Project Number:	**2264-00**	Type/Model of Drying Oven:	**Blue M**		
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature:	**60 °C**		
GLC#:	**10581**	Drying Duration (Hours):	**~ 24 hrs**	Dessicator:	**# 128**
Sample ID:	**SD-32**	Date/Time in:	**8/21/2015 17:35**	Date/Time in:	**8/22/2015 17:15**
Test Species:	***Hyalella azteca***	Date/Time out:	**8/22/2015 17:15**	Date/Time out:	**8/24/2015 13:50**
Test Date:	**8/11/2015**	Technician's Initia	**MP**	Weigh Date / Initials:	**8/24/2015 MP**
	8/21/2015				

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.83640	0.83521	0.00119	10	0.11900	0.11900
2	10	0.83762	0.83683	0.00079	8	0.09875	0.07900
3	10	0.83618	0.83533	0.00085	10	0.08500	0.08500
4	10	0.83085	0.82973	0.00112	10	0.11200	0.11200
5	10	0.81702	0.81527	0.00175	10	0.17500	0.17500
6	10	0.82743	0.82652	0.00091	9	0.10111	0.09100
7	10	0.82350	0.82247	0.00103	8	0.12875	0.10300
8	10	0.82312	0.82214	0.00098	8	0.12250	0.09800
					AVERAGE:	0.11776	0.10775

Day 0 weights	80	0.82719	0.8245	0.00269	80	Average at Day 0 (mg)	0.033625

GLEC

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

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QC'd by: K

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	
GLC#:	10582	Drying Duration (Hours): ~ 24 hrs	Dessicator: # 128
Sample ID:	SD-39	Date/Time in: 8/21/15 1735	Date/Time in: 8/22/15 1715
Test Species:	*Hyalella azteca*	Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1350
Test Date:	8/11/2015	Technician's Initials: MR.	Weigh Date / Initials: 8/24/15 MR.
	8/21/2015		

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.81508	0.81408		10	#DIV/0!	
2	10	0.81331	0.81244		9	#DIV/0!	
3	10	0.82236	0.82146		9	#DIV/0!	
4	10	0.82768	0.82661		9	#DIV/0!	
5	10	0.82983	0.82875		9	#DIV/0!	
6	10	0.81221	0.81130		10	#DIV/0!	
7	10	0.82195	0.82110		10	#DIV/0!	
8	10	0.82549	0.82447		9	#DIV/0!	
						AVERAGE:	

Day 0 weights	80	See control pg- mean		0	80	Average at Day 0 (mg)	0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

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QC'd by:___ks_____

Project Number:	**2264-00**	Type/Model of Drying Oven:	**Blue M**		
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature:	**60 °C**		
GLC#:	**10582**	Drying Duration (Hours):	**~ 24 hrs**	Dessicator:	**# 128**
Sample ID:	**SD-39**	Date/Time in:	**8/21/2015 17:35**	Date/Time in:	**8/22/2015 17:15**
Test Species:	***Hyalella azteca***	Date/Time out:	**8/22/2015 17:15**	Date/Time out:	**8/24/2015 13:50**
Test Date:	**8/11/2015**	Technician's Initia	**MP**	Weigh Date / Initials:	**8/24/2015 MP**
	8/21/2015				

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.81508	0.81408	0.00100	10	0.10000	0.10000
2	10	0.81331	0.81244	0.00087	9	0.09667	0.08700
3	10	0.82236	0.82146	0.00090	9	0.10000	0.09000
4	10	0.82768	0.82661	0.00107	9	0.11889	0.10700
5	10	0.82983	0.82875	0.00108	9	0.12000	0.10800
6	10	0.81221	0.81130	0.00091	10	0.09100	0.09100
7	10	0.82195	0.82110	0.00085	10	0.08500	0.08500
8	10	0.82549	0.82447	0.00102	9	0.11333	0.10200
					AVERAGE:	0.10311	0.09625

Day 0 weights	80	0.82719	0.8245	0.00269	80	Average at Day 0 (mg)	0.033625

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

Page 1 of 2

QC'd by: KS

Project Number:	2264-00	Type/Model of Drying Oven: **Blue M**	
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	
GLC#:	**10583**	Drying Duration (Hours): **~24 hrs**	Dessicator: **# 128**
Sample ID:	**SD-40**	Date/Time in: 8/21/15 1735	Date/Time in: 8/22/15 1715
Test Species:	***Hyalella azteca***	Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1350
Test Date:	**8/11/2015**	Technician's Initials: MR.	Weigh Date / Initials: 8/24/15 MR.
	8/21/2015		

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.84191	0.84088		9	#DIV/0!	
2	10	MR. 8/24/15 0.832995	0.82895		10	#DIV/0!	
3	10	0.83651	0.83546		10	#DIV/0!	
4	10	0.82451	0.82343		9	#DIV/0!	
5	10	0.83340	0.83252		9	#DIV/0!	
6	10	0.83117	0.83040		10	#DIV/0!	
7	10	0.83398	0.83296		10	#DIV/0!	
8	10	0.82281	0.82170		10	#DIV/0!	
						AVERAGE:	

Day 0 weights	80	See control pg-mur		0	80	Average at Day 0 (mg)	0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

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QC'd by:___ks_____

Project Number:	**2264-00**	Type/Model of Drying Oven:	**Blue M**		
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature:	**60 °C**		
GLC#:	**10583**	Drying Duration (Hours):	**~ 24 hrs**	Dessicator:	**# 128**
Sample ID:	**SD-40**	Date/Time in:	**8/21/2015 17:35**	Date/Time in:	**8/22/2015 17:15**
Test Species:	***Hyalella azteca***	Date/Time out:	**8/22/2015 17:15**	Date/Time out:	**8/24/2015 13:50**
Test Date:	**8/11/2015**	Technician's Initia	**MP**	Weigh Date / Initials:	**8/24/2015 MP**
	8/21/2015				

Replicate Number	**A** Number of Organisms at Test Initiation	**B** Dry Weight of Pan and Organisms (g)	**C** Dry Weight of Pan (g)	**B-C** Total Dry Weight of Organisms (g)	**D** Number of Organisms Weighed	**B-C/D** Average Weight (mg)	**B-C/A** Biomass Weight (mg)
1	10	0.84191	0.84088	0.00103	9	0.11444	0.10300
2	10	0.82995	0.82895	0.00100	10	0.10000	0.10000
3	10	0.83651	0.83546	0.00105	10	0.10500	0.10500
4	10	0.82451	0.82343	0.00108	9	0.12000	0.10800
5	10	0.83340	0.83252	0.00088	9	0.09778	0.08800
6	10	0.83117	0.83040	0.00077	10	0.07700	0.07700
7	10	0.83398	0.83296	0.00102	10	0.10200	0.10200
8	10	0.82281	0.82170	0.00111	10	0.11100	0.11100
					AVERAGE:	0.10340	0.09925

Day 0 weights	80	0.82719	0.8245	0.00269	80	Average at Day 0 (mg)	0.033625

GLEC

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

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QC'd by: KS

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	
GLC#:	10584	Drying Duration (Hours): ~ 24 hrs	Dessicator: # 128
Sample ID:	SD-50	Date/Time in: 8/21/15 1735	Date/Time in: 8/22/15 1715
Test Species:	*Hyalella azteca*	Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1350
Test Date:	8/11/2015	Technician's Initials: MR	Weigh Date / Initials: 8/24/15 MR
	8/21/2015		

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.82704	0.82606		10	#DIV/0!	
2	10	0.82500	0.82413		8	#DIV/0!	
3	10	0.83498	0.83393		10	#DIV/0!	
4	10	0.84429	0.84322		10	#DIV/0!	
5	10	0.83388	0.83291		10	#DIV/0!	
6	10	0.82169	0.82070		10	#DIV/0!	
7	10	0.84531	0.84426		10	#DIV/0!	
8	10	0.81734	0.81653		10	#DIV/0!	
						AVERAGE:	

Day 0 weights	80	See control pg-mw		0	80	Average at Day 0 (mg)	0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

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QC'd by:___ks_____

Project Number:	**2264-00**	Type/Model of Drying Oven:	**Blue M**		
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature:	**60 °C**		
GLC#:	**10584**	Drying Duration (Hours):	**~ 24 hrs**	Dessicator:	**# 128**
Sample ID:	**SD-50**	Date/Time in:	**8/21/2015 17:35**	Date/Time in:	**8/22/2015 17:15**
Test Species:	***Hyalella azteca***	Date/Time out:	**8/22/2015 17:15**	Date/Time out:	**8/24/2015 13:50**
Test Date:	**8/11/2015**	Technician's Initia	**MP**	Weigh Date / Initials:	**8/24/2015 MP**
	8/21/2015				

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.82704	0.82606	0.00098	10	0.09800	0.09800
2	10	0.82500	0.82413	0.00087	8	0.10875	0.08700
3	10	0.83498	0.83393	0.00105	10	0.10500	0.10500
4	10	0.84429	0.84322	0.00107	10	0.10700	0.10700
5	10	0.83388	0.83291	0.00097	10	0.09700	0.09700
6	10	0.82169	0.82070	0.00099	10	0.09900	0.09900
7	10	0.84531	0.84426	0.00105	10	0.10500	0.10500
8	10	0.81734	0.81653	0.00081	10	0.08100	0.08100
					AVERAGE:	0.10009	0.09737

Day 0 weights	80	0.82719	0.8245	0.00269	80	Average at Day 0 (mg)	0.033625

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

Page 1 of 2

QC'd by: JS

Project Number:	2264-00	Type/Model of Drying Oven: **Blue M**	
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	
GLC#:	**10585**	Drying Duration (Hours): **~24 hrs**	Dessicator: **# 128**
Sample ID:	**SD-54**	Date/Time in: 8/22/15 1735 mr. 8/24/15	Date/Time in: 8/22/15 1715
Test Species:	***Hyalella azteca***	Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1350
Test Date:	**8/11/2015**	Technician's Initials: mr.	Weigh Date / Initials: 8/24/15 mr.
	8/21/2015		

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.82752	0.82641		9	#DIV/0!	
2	10	0.82375	0.82287		8	#DIV/0!	
3	10	0.83037	0.82927		9	#DIV/0!	
4	10	0.83613	0.83493		10	#DIV/0!	
5	10	0.81521	0.81399		10	#DIV/0!	
6	10	0.82558	0.82427		10	#DIV/0!	
7	10 mr 8/24/15	0.81412 ~~0.81412~~	0.81307		9	#DIV/0!	
8	10	0.81287	0.81176		10	#DIV/0!	
						AVERAGE:	

Day 0 weights	80	See control pg		0	80	Average at Day 0 (mg)	0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

Page __2__ of __2__

QC'd by:___ks_____

Project Number:	**2264-00**	Type/Model of Drying Oven:	**Blue M**		
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature:	**60 °C**		
GLC#:	**10585**	Drying Duration (Hours):	**~ 24 hrs**	Dessicator:	**# 128**
Sample ID:	**SD-54**	Date/Time in:	**8/21/2015 17:35**	Date/Time in:	**8/22/2015 17:15**
Test Species:	***Hyalella azteca***	Date/Time out:	**8/22/2015 17:15**	Date/Time out:	**8/24/2015 13:50**
Test Date:	**8/11/2015**	Technician's Initia	**MP**	Weigh Date / Initials:	**8/24/2015 MP**
	8/21/2015				

Replicate Number	**A** Number of Organisms at Test Initiation	**B** Dry Weight of Pan and Organisms (g)	**C** Dry Weight of Pan (g)	**B-C** Total Dry Weight of Organisms (g)	**D** Number of Organisms Weighed	**B-C/D** Average Weight (mg)	**B-C/A** Biomass Weight (mg)
1	10	0.82752	0.82641	0.00111	9	0.12333	0.11100
2	10	0.82375	0.82287	0.00088	8	0.11000	0.08800
3	10	0.83037	0.82927	0.00110	9	0.12222	0.11000
4	10	0.83613	0.83493	0.00120	10	0.12000	0.12000
5	10	0.81521	0.81399	0.00122	10	0.12200	0.12200
6	10	0.82558	0.82427	0.00131	10	0.13100	0.13100
7	10	0.81412	0.81307	0.00105	9	0.11667	0.10500
8	10	0.81287	0.81176	0.00111	10	0.11100	0.11100
					AVERAGE:	0.11953	0.11225

Day 0 weights	80	0.82719	0.8245	0.00269	80	Average at Day 0 (mg)	0.033625

GLEC

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

Page 1 of 2

QC'd by: KS

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	
GLC#:	10586	Drying Duration (Hours): ~24 hrs	Dessicator: # 128
Sample ID:	SD-55	Date/Time in: 8/21/15 1735	Date/Time in: 8/22/15 1715
Test Species:	*Hyalella azteca*	Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1350
Test Date:	8/11/2015	Technician's Initials: MM.	Weigh Date / Initials: 8/24/15 MM
	8/21/2015		

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.83814	0.83740		8	#DIV/0!	
2	10	0.82171	0.82069		10	#DIV/0!	
3	10	0.82466	0.82362		10	#DIV/0!	
4	10	0.83323	0.83215		10	#DIV/0!	
5	10	0.83699	0.83576		10	#DIV/0!	
6	10	0.84461	0.84350		10	#DIV/0!	
7	10	0.83853	0.83750		8	#DIV/0!	
8	10	0.82359	0.82215		10	#DIV/0!	
						AVERAGE:	

Day 0 weights	80	See control pg-	MW	0	80	Average at Day 0 (mg)	0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

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QC'd by:___ks_____

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**			
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**			
GLC#:	**10586**	Drying Duration (Hours):	**~ 24 hrs**	Dessicator: **# 128**	
Sample ID:	**SD-55**	Date/Time in:	**8/21/2015 17:35**	Date/Time in:	**8/22/2015 17:15**
Test Species:	***Hyalella azteca***	Date/Time out:	**8/22/2015 17:15**	Date/Time out:	**8/24/2015 13:50**
Test Date:	**8/11/2015**	Technician's Initia	**MP**	Weigh Date / Initials:	**8/24/2015 MP**
	8/21/2015				

Replicate Number	**A** Number of Organisms at Test Initiation	**B** Dry Weight of Pan and Organisms (g)	**C** Dry Weight of Pan (g)	**B-C** Total Dry Weight of Organisms (g)	**D** Number of Organisms Weighed	**B-C/D** Average Weight (mg)	**B-C/A** Biomass Weight (mg)
1	10	0.83814	0.83740	0.00074	8	0.09250	0.07400
2	10	0.82171	0.82069	0.00102	10	0.10200	0.10200
3	10	0.82466	0.82362	0.00104	10	0.10400	0.10400
4	10	0.83323	0.83215	0.00108	10	0.10800	0.10800
5	10	0.83699	0.83576	0.00123	10	0.12300	0.12300
6	10	0.84461	0.84350	0.00111	10	0.11100	0.11100
7	10	0.83853	0.83750	0.00103	8	0.12875	0.10300
8	10	0.82359	0.82215	0.00144	10	0.14400	0.14400
					AVERAGE:	0.11416	0.10863

Day 0 weights	80	0.82719	0.8245	0.00269	80	Average at Day 0 (mg)	0.033625

GLEC

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

Page 1 of 2

QC'd by: LS

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	
GLC#:	10587	Drying Duration (Hours): ~ 24 hrs	Dessicator: # 128
Sample ID:	SD-58	Date/Time in: 8/21/15 1135	Date/Time in: 8/22/15 1115
Test Species:	*Hyalella azteca*	Date/Time out: 8/22/15 1115	Date/Time out: 8/24/15 1350
Test Date:	8/11/2015	Technician's Initials: MA	Weigh Date / Initials: 8/24/15 MA.
	8/21/2015		

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.82453	0.82361		10	#DIV/0!	
2	10	0.83294	0.83204		9	#DIV/0!	
3	10	0.84146	0.84015		10	#DIV/0!	
4	10	0.82783	0.82654		10	#DIV/0!	
5	10	0.82883	0.82786		8	#DIV/0!	
6	10	0.83693	0.83576		10	#DIV/0!	
7	10	0.82890	0.82777		10	#DIV/0!	
8	10	0.83511	0.83413		10	#DIV/0!	
						AVERAGE:	

Day 0 weights	80	See control pg mw		0	80	Average at Day 0 (mg)	0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

Page __2__ of __2__

QC'd by:___ks_____

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**			
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**			
GLC#:	**10587**	Drying Duration (Hours):	**~ 24 hrs**	Dessicator: **# 128**	
Sample ID:	**SD-58**	Date/Time in:	**8/21/2015 17:35**	Date/Time in:	**8/22/2015 17:15**
Test Species:	***Hyalella azteca***	Date/Time out:	**8/22/2015 17:15**	Date/Time out:	**8/24/2015 13:50**
Test Date:	**8/11/2015**	Technician's Initia	**MP**	Weigh Date / Initials:	**8/24/2015 MP**
	8/21/2015				

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.82453	0.82361	0.00092	10	0.09200	0.09200
2	10	0.83294	0.83204	0.00090	9	0.10000	0.09000
3	10	0.84146	0.84015	0.00131	10	0.13100	0.13100
4	10	0.82783	0.82654	0.00129	10	0.12900	0.12900
5	10	0.82883	0.82786	0.00097	8	0.12125	0.09700
6	10	0.83693	0.83576	0.00117	10	0.11700	0.11700
7	10	0.82890	0.82777	0.00113	10	0.11300	0.11300
8	10	0.83511	0.83413	0.00098	10	0.09800	0.09800
					AVERAGE:	0.11266	0.10837

Day 0 weights	80	0.82719	0.8245	0.00269	80	Average at Day 0 (mg)	0.033625

GLEC

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

Page 1 of 2

QC'd by: VS

Project Number:	2264-00	Type/Model of Drying Oven: **Blue M**	
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	
GLC#:	**10588**	Drying Duration (Hours): **~24 hrs**	Dessicator: **# 128**
Sample ID:	**SD-59**	Date/Time in: 8/21/15 1735	Date/Time in: 8/22/15 1715
Test Species:	***Hyalella azteca***	Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1350
Test Date:	**8/11/2015**	Technician's Initials: MP.	Weigh Date / Initials: 8/24/15 MP.
	8/21/2015		

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.83102	0.82997		9	#DIV/0!	
2	10	0.83435	0.83334		9	#DIV/0!	
3	10	0.83452	0.83361		8	#DIV/0!	
4	10	0.82820	0.82718		9	#DIV/0!	
5	10	0.82058	0.81952		9	#DIV/0!	
6	10	0.82427	0.82295		10	#DIV/0!	
7	10	0.82079	0.81953		10	#DIV/0!	
8	10	0.82889	0.82769		10	#DIV/0!	
						AVERAGE:	

Day 0 weights	80	See control pg-nwr	0		80	Average at Day 0 (mg)	0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

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QC'd by:___ks_____

Project Number:	**2264-00**	Type/Model of Drying Oven:	**Blue M**		
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature:	**60 °C**		
GLC#:	**10588**	Drying Duration (Hours):	**~ 24 hrs**	Dessicator:	**# 128**
Sample ID:	**SD-59**	Date/Time in:	**8/21/2015 17:35**	Date/Time in:	**8/22/2015 17:15**
Test Species:	***Hyalella azteca***	Date/Time out:	**8/22/2015 17:15**	Date/Time out:	**8/24/2015 13:50**
Test Date:	**8/11/2015**	Technician's Initia	**MP**	Weigh Date / Initials:	**8/24/2015 MP**
	8/21/2015				

Replicate Number	**A** Number of Organisms at Test Initiation	**B** Dry Weight of Pan and Organisms (g)	**C** Dry Weight of Pan (g)	**B-C** Total Dry Weight of Organisms (g)	**D** Number of Organisms Weighed	**B-C/D** Average Weight (mg)	**B-C/A** Biomass Weight (mg)
1	10	0.83102	0.82997	0.00105	9	0.11667	0.10500
2	10	0.83435	0.83334	0.00101	9	0.11222	0.10100
3	10	0.83452	0.83361	0.00091	8	0.11375	0.09100
4	10	0.82820	0.82718	0.00102	9	0.11333	0.10200
5	10	0.82058	0.81952	0.00106	9	0.11778	0.10600
6	10	0.82427	0.82295	0.00132	10	0.13200	0.13200
7	10	0.82079	0.81953	0.00126	10	0.12600	0.12600
8	10	0.82889	0.82769	0.00120	10	0.12000	0.12000
					AVERAGE:	0.11897	0.11038

Day 0 weights	80	0.82719	0.8245	0.00269	80	Average at Day 0 (mg)	0.033625

GLEC

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

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QC'd by: K

Project Number:	2264-00	Type/Model of Drying Oven: **Blue M**	
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**	
GLC#:	**10589**	Drying Duration (Hours): **~24 hrs**	Dessicator: **# 128**
Sample ID:	**SD-45**	Date/Time in: 8/21/15 1735	Date/Time in: 8/22/15 1715
Test Species:	***Hyalella azteca***	Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1350
Test Date:	**8/11/2015**	Technician's Initials: mp.	Weigh Date / Initials: 8/24/15 mp.
	8/21/2015		

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.82921	0.82732		8	#DIV/0!	
2	10	0.82143	0.82046		10	#DIV/0!	
3	10	0.83217	0.83108		10	#DIV/0!	
4	10	0.82685	0.82586		9	#DIV/0!	
5	10	0.82087	mp 8/24/15 0.81988		10	#DIV/0!	
6	10	0.81490	0.81383		9	#DIV/0!	
7	10	0.82095	0.82010		9	#DIV/0!	
8	10	0.82020	0.81911		9	#DIV/0!	
						AVERAGE:	

Day 0 weights	80	See control pg-	mw	0	80	Average at Day 0 (mg)	0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

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QC'd by:___ks_____

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**			
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**			
GLC#:	**10589**	Drying Duration (Hours):	**~ 24 hrs**	Dessicator: **# 128**	
Sample ID:	**SD-45**	Date/Time in:	**8/21/2015 17:35**	Date/Time in:	**8/22/2015 17:15**
Test Species:	***Hyalella azteca***	Date/Time out:	**8/22/2015 17:15**	Date/Time out:	**8/24/2015 13:50**
Test Date:	**8/11/2015**	Technician's Initia	**MP**	Weigh Date / Initials:	**8/24/2015 MP**
	8/21/2015				

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.82921	0.82732	0.00189	8	0.23625	0.18900
2	10	0.82143	0.82046	0.00097	10	0.09700	0.09700
3	10	0.83217	0.83108	0.00109	10	0.10900	0.10900
4	10	0.82685	0.82586	0.00099	9	0.11000	0.09900
5	10	0.82087	0.81988	0.00099	10	0.09900	0.09900
6	10	0.81490	0.81383	0.00107	9	0.11889	0.10700
7	10	0.82095	0.82010	0.00085	9	0.09444	0.08500
8	10	0.82020	0.81911	0.00109	9	0.12111	0.10900
					AVERAGE:	0.12321	0.11175

Day 0 weights	80	0.82719	0.8245	0.00269	80	Average at Day 0 (mg)	0.033625

GLEC

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

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QC'd by: MW

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	
GLC#:	10590	Drying Duration (Hours): ~24 hrs	Dessicator: # 128
Sample ID:	SD-46	Date/Time in: 8/21/15 1735	Date/Time in: 8/22/15 1715
Test Species:	*Hyalella azteca*	Date/Time out: 8/22/15 1715	Date/Time out: 8/24/15 1350
Test Date:	8/11/2015	Technician's Initials: MP.	Weigh Date / Initials: 8/24/15 MP.
	8/21/2015		

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.82752	0.82724		10	#DIV/0!	
2	10	0.83639	0.83524		10	#DIV/0!	
3	10	0.83867	0.83681		10	#DIV/0!	
4	10	0.83511	0.83438		10	#DIV/0!	
5	~~10~~ 0 MP 9/11/15	T.E.	T.E.		T.E.	#DIV/0!	
6	10	0.82743	0.82641		10	#DIV/0!	
7	10	0.82121	0.82016		10	#DIV/0!	
8	10	0.82815	0.82~~7~~695 MP 8/24/15		10	#DIV/0!	
						AVERAGE:	

Day 0 weights	80	See control pg	mw	0	80	Average at Day 0 (mg)	0

See Attached sheet for calculated weights.

T. E: Technician Error - MW 9/9/15

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

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QC'd by:___mwg_____

Project Number:	**2264-00**	Type/Model of Drying Oven:	**Blue M**		
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature:	**60 °C**		
GLC#:	**10590**	Drying Duration (Hours):	**~ 24 hrs**	Dessicator:	**# 128**
Sample ID:	**SD-46**	Date/Time in:	**8/21/2015 17:35**	Date/Time in:	**8/22/2015 17:15**
Test Species:	***Hyalella azteca***	Date/Time out:	**8/22/2015 17:15**	Date/Time out:	**8/24/2015 13:50**
Test Date:	**8/11/2015**	Technician's Initia	**MP**	Weigh Date / Initials:	**8/24/2015 MP**
	8/21/2015				

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.82252	0.82124	0.00128	10	0.12800	0.12800
2	10	0.83639	0.83524	0.00115	10	0.11500	0.11500
3	10	0.83807	0.83681	0.00126	10	0.12600	0.12600
4	10	0.83511	0.83438	0.00073	10	0.07300	0.07300
5	0	T.E.	T.E.	#VALUE!	0	#VALUE!	#VALUE!
6	10	0.82743	0.82641	0.00102	10	0.10200	0.10200
7	10	0.82121	0.82016	0.00105	10	0.10500	0.10500
8	10	0.82815	0.82695	0.00120	10	0.12000	0.12000
					AVERAGE:	#VALUE!	#VALUE!

Day 0 weights	80	0.82719	0.8245	0.00269	80	Average at Day 0 (mg)	0.033625

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2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

QC'd by: Mu

Project Number:	2264-00	Type/Model of Drying Oven: Blue M	
Project Name:	AECOM-Lake Macatawa	Oven Temperature: 60 °C	
GLC#:	10591	Drying Duration (Hours): ~24 hrs	Dessicator: # 128
Sample ID:	LM-08-13	Date/Time in: 8/21/15 1235	Date/Time in:
Test Species:	*Hyalella azteca*	Date/Time out: 8/22/15 1715	Date/Time out:
Test Date:	8/11/2015	Technician's Initials:	Weigh Date / Initials:
	8/21/2015		

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.82618	0.82497	[redacted]	10	#DIV/0!	[redacted]
2	10	0.83671	0.83530	[redacted]	10	#DIV/0!	[redacted]
3	10	0.82463	0.82313	[redacted]	10	#DIV/0!	[redacted]
4	10	0.81833	0.81715	[redacted]	10	#DIV/0!	[redacted]
5	10	0.83001	0.82867	[redacted]	10	#DIV/0!	[redacted]
6	10	0.82087	0.81959	[redacted]	10	#DIV/0!	[redacted]
7	10	0.83967	0.83838	[redacted]	9	#DIV/0!	[redacted]
8	10	0.83183	0.83040	[redacted]	10	#DIV/0!	[redacted]
						AVERAGE:	

Day 0 weights	80	See control pg - Mu		0	80	Average at Day 0 (mg)	0

See Attached sheet for calculated weights.

Great Lakes Environmental Center

2264-00
AECOM-Lake Macatawa
Hyalella azteca 10-Day WEIGHT DATA

Page __2__ of __2__

QC'd by:___mwg_____

Project Number:	**2264-00**	Type/Model of Drying Oven: **Blue M**			
Project Name:	**AECOM-Lake Macatawa**	Oven Temperature: **60 °C**			
GLC#:	**10591**	Drying Duration (Hours): **~ 24 hrs**		Dessicator: **# 128**	
Sample ID:	**LM-08-13**	Date/Time in:	**8/21/2015 17:35**	Date/Time in:	**8/22/2015 17:15**
Test Species:	***Hyalella azteca***	Date/Time out:	**8/22/2015 17:15**	Date/Time out:	**8/24/2015 13:50**
Test Date:	**8/11/2015**	Technician's Initia	**MP**	Weigh Date / Initials:	**8/24/2015 MP**
	8/21/2015				

Replicate Number	A Number of Organisms at Test Initiation	B Dry Weight of Pan and Organisms (g)	C Dry Weight of Pan (g)	B-C Total Dry Weight of Organisms (g)	D Number of Organisms Weighed	B-C/D Average Weight (mg)	B-C/A Biomass Weight (mg)
1	10	0.82618	0.82497	0.00121	10	0.12100	0.12100
2	10	0.83671	0.83530	0.00141	10	0.14100	0.14100
3	10	0.82463	0.82313	0.00150	10	0.15000	0.15000
4	10	0.81833	0.81715	0.00118	10	0.11800	0.11800
5	10	0.83001	0.82867	0.00134	10	0.13400	0.13400
6	10	0.82087	0.81959	0.00128	10	0.12800	0.12800
7	10	0.83967	0.83838	0.00129	9	0.14333	0.12900
8	10	0.83183	0.83040	0.00143	10	0.14300	0.14300
					AVERAGE:	0.13479	0.13300

Day 0 weights	80	0.82719	0.8245	0.00269	80	Average at Day 0 (mg)	0.033625

Test: EPA.1-Hyalella azteca 10d Survival and Growth Test
Species: HA-Hyalella azteca
Sample ID:
Start Date: 8/11/2015 End Date: 8/21/2015

Test ID: 2264haref
Protocol: EPA 600/R-99/064
Sample Type: -WHOLE SEDIMENT
Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0-	Day 4	Day 10	Day 28	Total Weight	Pan weight	Weigh	Weight Ct 28	Notes
	1	1	Lab Con	10		10		0.83412	0.83284	10		
	2	2	Lab Con	10		10		0.83339	0.83209	10		
	3	3	Lab Con	10		10		0.8301	0.82884	10		
	4	4	Lab Con	10		10		0.80645	0.80526	10		
	5	5	Lab Con	10		9		0.81308	0.81196	9		
	6	6	Lab Con	10		8		0.82817	0.82721	8		
	7	7	Lab Con	10		10		0.82755	0.82685	10		
	8	8	Lab Con	10		8		0.80997	0.8089	8		
	9	1	Water Only	10		10		0.82976	0.82864	10		
	10	2	Water Only	10		10		0.83514	0.83401	10		
	11	3	Water Only	10		10		0.82612	0.8249	10		
	12	4	Water Only	10		10		0.83165	0.83058	10		
	13	5	Water Only	10		10		0.82665	0.8258	10		
	14	6	Water Only	10		10		0.84027	0.83935	10		
	15	7	Water Only	10		10		0.82968	0.82847	10		
	16	8	Water Only	10		10		0.84251	0.84149	10		
	17	1	SD25; 10579	10		9		0.8307	0.82973	9		
	18	2	SD25; 10579	10		9		0.83465	0.83409	9		
	19	3	SD25; 10579	10		10		0.82237	0.82126	10		
	20	4	SD25; 10579	10		10		0.82741	0.8263	10		
	21	5	SD25; 10579	10		10		0.82851	0.82737	10		
	22	6	SD25; 10579	10		9		0.82794	0.82701	9		
	23	7	SD25; 10579	10		10		0.82668	0.82555	10		
	24	8	SD25; 10579	10		9		0.8403	0.83915	9		
	25	1	SD30; 10580	10		10		0.81859	0.81784	10		
	26	2	SD30; 10580	10		8		0.82176	0.82112	8		
	27	3	SD30; 10580	10		9		0.8303	0.82952	9		
	28	4	SD30; 10580	10		10		0.80814	0.80742	10		
	29	5	SD30; 10580	10		9		0.83529	0.83461	9		
	30	6	SD30; 10580	10		9		0.82054	0.81995	9		
	31	7	SD30; 10580	10		9		0.83443	0.83352	9		
	32	8	SD30; 10580	10		10		0.81191	0.81111	10		
	33	1	SD32; 10581	10		10		0.8364	0.83521	10		
	34	2	SD32; 10581	10		8		0.83762	0.83683	8		
	35	3	SD32; 10581	10		10		0.83618	0.83533	10		
	36	4	SD32; 10581	10		10		0.83085	0.82973	10		
	37	5	SD32; 10581	10		10		0.81702	0.81527	10		
	38	6	SD32; 10581	10		9		0.82743	0.82652	9		
	39	7	SD32; 10581	10		8		0.8235	0.82247	8		
	40	8	SD32; 10581	10		8		0.82312	0.82214	8		
	41	1	SD39; 10582	10		10		0.81508	0.81408	10		
	42	2	SD39; 10582	10		9		0.81331	0.81244	9		
	43	3	SD39; 10582	10		9		0.82236	0.82146	9		
	44	4	SD39; 10582	10		9		0.82768	0.82661	9		
	45	5	SD39; 10582	10		9		0.82983	0.82875	9		
	46	6	SD39; 10582	10		10		0.81221	0.8113	10		
	47	7	SD39; 10582	10		10		0.82195	0.8211	10		
	48	8	SD39; 10582	10		9		0.82549	0.82447	9		
	49	1	SD40; 10583	10		9		0.84191	0.84088	9		
	50	2	SD40; 10583	10		10		0.82995	0.82895	10		
	51	3	SD40; 10583	10		10		0.83651	0.83546	10		
	52	4	SD40; 10583	10		9		0.82451	0.82343	9		
	53	5	SD40; 10583	10		9		0.8334	0.83252	9		

ToxCalc 5.0

Reviewed by: MLV

Test: EPA.1-Hyalella azteca 10d Survival and Growth Test
Test ID: 2264haref
Species: HA-Hyalella azteca
Protocol: EPA 600/R-99/064
Sample ID:
Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015
Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0-	Day 4	Day 10	Day 28	Total Weight	Pan weight	Weigh	Weight Ct 28	Notes
	54	6	SD40; 10583	10		10		0.83117	0.8304	10		
	55	7	SD40; 10583	10		10		0.83398	0.83296	10		
	56	8	SD40; 10583	10		10		0.82281	0.8217	10		
	57	1	SD50; 10584	10		10		0.82704	0.82606	10		
	58	2	SD50; 10584	10		8		0.825	0.82413	8		
	59	3	SD50; 10584	10		10		0.83498	0.83393	10		
	60	4	SD50; 10584	10		10		0.84429	0.84322	10		
	61	5	SD50; 10584	10		10		0.83388	0.83291	10		
	62	6	SD50; 10584	10		10		0.82169	0.8207	10		
	63	7	SD50; 10584	10		10		0.84531	0.84426	10		
	64	8	SD50; 10584	10		10		0.81734	0.81653	10		
	65	1	SD54; 10585	10		9		0.82752	0.82641	9		
	66	2	SD54; 10585	10		8		0.82375	0.82287	8		
	67	3	SD54; 10585	10		9		0.83037	0.82927	9		
	68	4	SD54; 10585	10		10		0.83613	0.83493	10		
	69	5	SD54; 10585	10		10		0.81521	0.81399	10		
	70	6	SD54; 10585	10		10		0.82558	0.82427	10		
	71	7	SD54; 10585	10		9		0.81412	0.81307	9		
	72	8	SD54; 10585	10		10		0.81287	0.81176	10		
	73	1	SD55; 10586	10		8		0.83814	0.8374	8		
	74	2	SD55; 10586	10		10		0.82171	0.82069	10		
	75	3	SD55; 10586	10		10		0.82466	0.82362	10		
	76	4	SD55; 10586	10		10		0.83323	0.83215	10		
	77	5	SD55; 10586	10		10		0.83699	0.83576	10		
	78	6	SD55; 10586	10		10		0.84461	0.8435	10		
	79	7	SD55; 10586	10		8		0.83853	0.8375	8		
	80	8	SD55; 10586	10		10		0.82359	0.82215	10		
	81	1	SD58; 10587	10		10		0.82453	0.82361	10		
	82	2	SD58; 10587	10		9		0.83294	0.83204	9		
	83	3	SD58; 10587	10		10		0.84146	0.84015	10		
	84	4	SD58; 10587	10		10		0.82783	0.82654	10		
	85	5	SD58; 10587	10		8		0.82883	0.82786	8		
	86	6	SD58; 10587	10		10		0.83693	0.83576	10		
	87	7	SD58; 10587	10		10		0.8289	0.82777	10		
	88	8	SD58; 10587	10		10		0.83511	0.83413	10		
	89	1	SD59; 10588	10		9		0.83102	0.82997	9		
	90	2	SD59; 10588	10		9		0.83435	0.83334	9		
	91	3	SD59; 10588	10		8		0.83452	0.83361	8		
	92	4	SD59; 10588	10		9		0.8282	0.82718	9		
	93	5	SD59; 10588	10		9		0.82058	0.81952	9		
	94	6	SD59; 10588	10		10		0.82427	0.82295	10		
	95	7	SD59; 10588	10		10		0.82079	0.81953	10		
	96	8	SD59; 10588	10		10		0.82889	0.82769	10		
	97	1	SD45; 10589	10		8		0.82921	0.82732	8		
	98	2	SD45; 10589	10		10		0.82143	0.82046	10		
	99	3	SD45; 10589	10		10		0.83217	0.83108	10		
	100	4	SD45; 10589	10		9		0.82685	0.82586	9		
	101	5	SD45; 10589	10		10		0.82087	0.81988	10		
	102	6	SD45; 10589	10		9		0.8149	0.81383	9		
	103	7	SD45; 10589	10		9		0.82095	0.8201	9		
	104	8	SD45; 10589	10		9		0.8202	0.81911	9		
	105	1	SD46; 10590	10		10		0.82252	0.82124	10		
	106	2	SD46; 10590	10		10		0.83639	0.83524	10		

ToxCalc 5.0
Reviewed by: MLV

Test: EPA.1-Hyalella azteca 10d Survival and Growth Test
Test ID: 2264haref
Species: HA-Hyalella azteca
Protocol: EPA 600/R-99/064
Sample ID:
Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015
Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0-	Day 4	Day 10	Day 28	Total Weight	Pan weight	Weigh	Weight Ct 28	Notes
	107	3	SD46; 10590	10		10		0.83807	0.83681	10		
	108	4	SD46; 10590	10		10		0.83511	0.83438	10		
	109	5	SD46; 10590	10		10		0.82743	0.82641	10		
	110	6	SD46; 10590	10		10		0.82121	0.82016	10		
	111	7	SD46; 10590	10		10		0.82815	0.82695	10		
	112	1	LM0813; 10591	10		10		0.82618	0.82497	10		
	113	2	LM0813; 10591	10		10		0.83671	0.8353	10		
	114	3	LM0813; 10591	10		10		0.82463	0.82313	10		
	115	4	LM0813; 10591	10		10		0.81833	0.81715	10		
	116	5	LM0813; 10591	10		10		0.83001	0.82867	10		
	117	6	LM0813; 10591	10		10		0.82087	0.81959	10		
	118	7	LM0813; 10591	10		9		0.83967	0.83838	9		
	119	8	LM0813; 10591	10		10		0.83183	0.8304	10		

Comments: AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015

Hyalella azteca 10d Survival and Growth Test-10-day survival

Start Date: 8/11/2015	Test ID:	2264haref	Sample ID:		
End Date: 8/21/2015	Lab ID:	-GREAT LAKES ENVIRONMENTAL (	Sample Type:	-WHOLE SEDIMENT	
Sample Da	Protocol:	EPA 600/R-99/064	Test Species:	HA-Hyalella azteca	

Comments AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015

Conc-%	1	2	3	4	5	6	7	8
Lab Con	1.0000	1.0000	1.0000	1.0000	0.9000	0.8000	1.0000	0.8000
Water Only	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
SD25; 10579	0.9000	0.9000	1.0000	1.0000	1.0000	0.9000	1.0000	0.9000
SD30; 10580	1.0000	0.8000	0.9000	1.0000	0.9000	0.9000	0.9000	1.0000
SD32; 10581	1.0000	0.8000	1.0000	1.0000	1.0000	0.9000	0.8000	0.8000
SD39; 10582	1.0000	0.9000	0.9000	0.9000	0.9000	1.0000	1.0000	0.9000
SD40; 10583	0.9000	1.0000	1.0000	0.9000	0.9000	1.0000	1.0000	1.0000
SD50; 10584	1.0000	0.8000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
SD54; 10585	0.9000	0.8000	0.9000	1.0000	1.0000	1.0000	0.9000	1.0000
SD55; 10586	0.8000	1.0000	1.0000	1.0000	1.0000	1.0000	0.8000	1.0000
SD58; 10587	1.0000	0.9000	1.0000	1.0000	0.8000	1.0000	1.0000	1.0000
SD59; 10588	0.9000	0.9000	0.8000	0.9000	0.9000	1.0000	1.0000	1.0000
SD45; 10589	0.8000	1.0000	1.0000	0.9000	1.0000	0.9000	0.9000	0.9000
SD46; 10590	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	
LM0813; 10591	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9000	1.0000

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Lab Con	0.9375	0.9375	1.3154	1.1071	1.4120	10.667	8	*		
Water Only	1.0000	1.0000	1.4120	1.4120	1.4120	0.000	8			
SD25; 10579	0.9500	0.9500	1.3305	1.2490	1.4120	6.547	8	-0.259	1.796	0.1049
SD30; 10580	0.9250	0.9250	1.2924	1.1071	1.4120	8.514	8	0.365	1.771	0.1116
SD32; 10581	0.9125	0.9125	1.2773	1.1071	1.4120	11.845	8	0.522	1.771	0.1292
SD39; 10582	0.9375	0.9375	1.3102	1.2490	1.4120	6.438	8	0.091	1.796	0.1039
SD40; 10583	0.9625	0.9625	1.3509	1.2490	1.4120	6.244	8	-0.613	1.796	0.1039
SD50; 10584	0.9750	0.9750	1.3739	1.1071	1.4120	7.845	8	-0.935	1.771	0.1108
SD54; 10585	0.9375	0.9375	1.3128	1.1071	1.4120	8.821	8	0.041	1.771	0.1139
SD55; 10586	0.9500	0.9500	1.3358	1.1071	1.4120	10.565	8	-0.290	1.771	0.1246
SD58; 10587	0.9825	0.9625	1.3535	1.1071	1.4120	8.476	8	-0.595	1.771	0.1135
SD59; 10588	0.9250	0.9250	1.2924	1.1071	1.4120	8.514	8	0.365	1.771	0.1118
SD45; 10589	0.9250	0.9250	1.2924	1.1071	1.4120	8.514	8	0.365	1.771	0.1116
SD46; 10590	1.0000	1.0000	1.4120	1.4120	1.4120	0.000	7	-1.947	1.895	0.0940
LM0813; 10591	0.9875	0.9875	1.3916	1.2490	1.4120	4.140	8	-1.421	1.833	0.0983

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.40009	1.035	-0.7658	-0.2099
Equality of variance cannot be confirmed				
The control means are not significantly different (p = 0.07)	1.94703	2.14479		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates no significant differences	0.05615	0.05998	0.01264	0.0117	0.385	13, 97
Treatments vs Lab Con						

ToxCalc v5.0.32

Reviewed by: MLV

Hyalella azteca 10d Survival and Growth Test-10-Day Average Growth

Start Date: 8/11/2015	Test ID: 2264haref	Sample ID:	
End Date: 8/21/2015	Lab ID: -GREAT LAKES ENVIRONMENTAI	Sample Type:	-WHOLE SEDIMENT
Sample Da	Protocol: EPA 600/R-99/064	Test Species:	HA-Hyalella azteca

Comments AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015

Conc-%	1	2	3	4	5	6	7	8
Lab Con	0.1280	0.1300	0.1260	0.1190	0.1244	0.1200	0.0700	0.1338
Water Only	0.1120	0.1130	0.1220	0.1070	0.0850	0.0920	0.1210	0.1020
SD25; 10579	0.1078	0.0622	0.1110	0.1110	0.1140	0.1033	0.1130	0.1278
SD30; 10580	0.0750	0.0800	0.0867	0.0720	0.0756	0.0656	0.1011	0.0800
SD32; 10581	0.1190	0.0988	0.0850	0.1120	0.1750	0.1011	0.1287	0.1225
SD39; 10582	0.1000	0.0967	0.1000	0.1189	0.1200	0.0910	0.0650	0.1133
SD40; 10583	0.1144	0.1000	0.1050	0.1200	0.0978	0.0770	0.1020	0.1110
SD50; 10584	0.0980	0.1087	0.1050	0.1070	0.0970	0.0990	0.1050	0.0810
SD54; 10585	0.1233	0.1100	0.1222	0.1200	0.1220	0.1310	0.1167	0.1110
SD55; 10586	0.0925	0.1020	0.1040	0.1080	0.1230	0.1110	0.1287	0.1440
SD58; 10587	0.0920	0.1000	0.1310	0.1290	0.1212	0.1170	0.1130	0.0980
SD59; 10588	0.1167	0.1122	0.1138	0.1133	0.1178	0.1320	0.1260	0.1200
SD45; 10589	0.2362	0.0970	0.1090	0.1100	0.0990	0.1189	0.0944	0.1211
SD46; 10590	0.1280	0.1150	0.1260	0.0730	0.1020	0.1050	0.1200	
LM0813; 10591	0.1210	0.1410	0.1500	0.1180	0.1340	0.1280	0.1433	0.1430

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Lab Con	0.1189	1.1138	0.1189	0.0700	0.1338	17.119	8	*		
Water Only	0.1067	1.0000	0.1067	0.0850	0.1220	12.344	8			
SD25; 10579	0.1063	0.9954	0.1063	0.0622	0.1278	18.009	8	1.279	1.771	0.0175
*SD30; 10580	0.0795	0.7446	0.0795	0.0656	0.1011	13.495	8	4.845	1.812	0.0147
SD32; 10581	0.1178	1.1032	0.1178	0.0850	0.1750	23.069	8	0.095	1.782	0.0214
*SD39; 10582	0.1031	0.9659	0.1031	0.0850	0.1200	12.561	8	1.851	1.796	0.0153
*SD40; 10583	0.1034	0.9686	0.1034	0.0770	0.1200	12.662	8	1.811	1.796	0.0154
*SD50; 10584	0.1001	0.9376	0.1001	0.0810	0.1087	8.860	8	2.396	1.833	0.0144
SD54; 10585	0.1195	1.1197	0.1195	0.1100	0.1310	5.756	8	-0.083	1.860	0.0141
SD55; 10586	0.1142	1.0694	0.1142	0.0925	0.1440	14.619	8	0.510	1.771	0.0165
SD58; 10587	0.1127	1.0553	0.1127	0.0920	0.1310	12.986	8	0.704	1.782	0.0158
SD59; 10588	0.1190	1.1145	0.1190	0.1122	0.1320	5.785	8	-0.009	1.860	0.0141
SD45; 10589	0.1232	1.1542	0.1232	0.0944	0.2362	37.917	8	-0.239	1.833	0.0330
SD46; 10590	0.1099	1.0291	0.1099	0.0730	0.1280	17.283	7	0.890	1.782	0.0181
LM0813; 10591	0.1348	1.2627	0.1348	0.1180	0.1500	8.547	8	-1.922	1.796	0.0149

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.28577	1.035	1.97102	13.3349
Bartlett's Test indicates unequal variances (p = 6.92E-07)	53.6642	22.362		
The control means are not significantly different (p = 0.18)	1.41719	2.14479		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences Treatments vs Lab Con	0.01485	0.1249	0.00137	0.00038	1.2E-04	13, 97

ToxCalc v5.0.32

Reviewed by: MLV

Hyalella azteca 10d Survival and Growth Test-10-day Biomass

Start Date:	8/11/2015	Test ID:	2264haref	Sample ID:	
End Date:	8/21/2015	Lab ID:	-GREAT LAKES ENVIRONM	Sample Type:	-WHOLE SEDIMENT
Sample Date:		Protocol:	EPA 600/R-99/064	Test Species:	HA-Hyalella azteca
Comments:	AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015				

Conc-%	1	2	3	4	5	6	7	8
Lab Con	0.1280	0.1300	0.1260	0.1190	0.1120	0.0960	0.0700	0.1070
Water Only	0.1120	0.1130	0.1220	0.1070	0.0850	0.0920	0.1210	0.1020
SD25; 10579	0.0970	0.0560	0.1110	0.1110	0.1140	0.0930	0.1130	0.1150
SD30; 10580	0.0750	0.0640	0.0780	0.0720	0.0680	0.0590	0.0910	0.0800
SD32; 10581	0.1190	0.0790	0.0850	0.1120	0.1750	0.0910	0.1030	0.0980
SD39; 10582	0.1000	0.0870	0.0900	0.1070	0.1080	0.0910	0.0850	0.1020
SD40; 10583	0.1030	0.1000	0.1050	0.1080	0.0880	0.0770	0.1020	0.1110
SD50; 10584	0.0980	0.0870	0.1050	0.1070	0.0970	0.0990	0.1050	0.0810
SD54; 10585	0.1110	0.0880	0.1100	0.1200	0.1220	0.1310	0.1050	0.1110
SD55; 10586	0.0740	0.1020	0.1040	0.1080	0.1230	0.1110	0.1030	0.1440
SD58; 10587	0.0920	0.0900	0.1310	0.1290	0.0970	0.1170	0.1130	0.0980
SD59; 10588	0.1050	0.1010	0.0910	0.1020	0.1060	0.1320	0.1260	0.1200
SD45; 10589	0.1890	0.0970	0.1090	0.0990	0.0990	0.1070	0.0850	0.1090
SD46; 10590	0.1280	0.1150	0.1260	0.0730	0.1020	0.1050	0.1200	
M0813; 10591	0.1210	0.1410	0.1500	0.1180	0.1340	0.1280	0.1290	0.1430

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
Lab Con	0.1110	1.0398	0.1110	0.0700	0.1300	18.216	8	*		
Water Only	0.1067	1.0000	0.1067	0.0850	0.1220	12.344	8			
SD25; 10579	0.1013	0.9485	0.1013	0.0560	0.1150	19.801	8	0.968	1.771	0.0178
*SD30; 10580	0.0734	0.6874	0.0734	0.0590	0.0910	13.666	8	4.715	1.812	0.0145
SD32; 10581	0.1078	1.0094	0.1078	0.0790	0.1750	28.083	8	0.253	1.782	0.0229
*SD39; 10582	0.0962	0.9016	0.0962	0.0850	0.1080	9.453	8	1.882	1.833	0.0144
SD40; 10583	0.0993	0.9297	0.0993	0.0770	0.1110	11.371	8	1.435	1.812	0.0148
SD50; 10584	0.0974	0.9122	0.0974	0.0810	0.1070	9.411	8	1.736	1.833	0.0144
SD54; 10585	0.1123	1.0515	0.1123	0.0880	0.1310	11.446	8	-0.148	1.796	0.0152
SD55; 10586	0.1086	1.0176	0.1086	0.0740	0.1440	18.280	8	0.237	1.771	0.0177
SD58; 10587	0.1084	1.0152	0.1084	0.0900	0.1310	15.105	8	0.285	1.771	0.0163
SD59; 10588	0.1104	1.0340	0.1104	0.0910	0.1320	12.748	8	0.072	1.782	0.0155
SD45; 10589	0.1117	1.0468	0.1117	0.0850	0.1890	28.825	8	-0.056	1.796	0.0241
SD46; 10590	0.1099	1.0291	0.1099	0.0730	0.1280	17.283	7	0.113	1.782	0.0181
M0813; 10591	0.1330	1.2459	0.1330	0.1180	0.1500	8.353	8	-2.697	1.812	0.0148

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates normal distribution (p > 0.01)	0.89454	1.035	0.95573	4.99457
Bartlett's Test indicates unequal variances (p = 3.94E-03)	30.5347	22.362		
The control means are not significantly different (p = 0.63)	0.49806	2.14479		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences Treatments vs Lab Con	0.01478	0.13319	0.00134	0.00033	3.0E-05	13, 97

ToxCalc v5.0.32

Reviewed by: MLV

Appendix D2
Hyalella azteca
10-Day Statistical Data
Reference Sediment SD-45

- Survival
- Weight

Test: EPA.1-Hyalella azteca 10d Survival and Growth Test
Test ID: 2264hasd45
Species: HA-Hyalella azteca
Protocol: EPA 600/R-99/064
Sample ID:
Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015
Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0-	Day 4	Day 10	Day 28	Total Weight	Pan weight	Weigh	Weight Ct 28	Notes
	1	1	SD45; 10589	10		8		0.82921	0.82732	8		
	2	2	SD45; 10589	10		10		0.82143	0.82046	10		
	3	3	SD45; 10589	10		10		0.83217	0.83108	10		
	4	4	SD45; 10589	10		9		0.82685	0.82586	9		
	5	5	SD45; 10589	10		10		0.82087	0.81988	10		
	6	6	SD45; 10589	10		9		0.8149	0.81383	9		
	7	7	SD45; 10589	10		9		0.82095	0.8201	9		
	8	8	SD45; 10589	10		9		0.8202	0.81911	9		
	9	1	SD25;10579	10		9		0.8307	0.82973	9		
	10	2	SD25;10579	10		9		0.83465	0.83409	9		
	11	3	SD25;10579	10		10		0.82237	0.82126	10		
	12	4	SD25;10579	10		10		0.82741	0.8263	10		
	13	5	SD25;10579	10		10		0.82851	0.82737	10		
	14	6	SD25;10579	10		9		0.82794	0.82701	9		
	15	7	SD25;10579	10		10		0.82668	0.82555	10		
	16	8	SD25;10579	10		9		0.8403	0.83915	9		
	17	1	SD30; 10580	10		10		0.81859	0.81784	10		
	18	2	SD30; 10580	10		8		0.82176	0.82112	8		
	19	3	SD30; 10580	10		9		0.8303	0.82952	9		
	20	4	SD30; 10580	10		10		0.80814	0.80742	10		
	21	5	SD30; 10580	10		9		0.83529	0.83461	9		
	22	6	SD30; 10580	10		9		0.82054	0.81995	9		
	23	7	SD30; 10580	10		9		0.83443	0.83352	9		
	24	8	SD30; 10580	10		10		0.81191	0.81111	10		
	25	1	SD32; 10581	10		10		0.8364	0.83521	10		
	26	2	SD32; 10581	10		8		0.83762	0.83683	8		
	27	3	SD32; 10581	10		10		0.83618	0.83533	10		
	28	4	SD32; 10581	10		10		0.83085	0.82973	10		
	29	5	SD32; 10581	10		10		0.81702	0.81527	10		
	30	6	SD32; 10581	10		9		0.82743	0.82652	9		
	31	7	SD32; 10581	10		8		0.8235	0.82247	8		
	32	8	SD32; 10581	10		8		0.82312	0.82214	8		
	33	1	SD39; 10582	10		10		0.81508	0.81408	10		
	34	2	SD39; 10582	10		9		0.81331	0.81244	9		
	35	3	SD39; 10582	10		9		0.82236	0.82146	9		
	36	4	SD39; 10582	10		9		0.82768	0.82661	9		
	37	5	SD39; 10582	10		9		0.82983	0.82875	9		
	38	6	SD39; 10582	10		10		0.81221	0.8113	10		
	39	7	SD39; 10582	10		10		0.82195	0.8211	10		
	40	8	SD39; 10582	10		9		0.82549	0.82447	9		
	41	1	SD40; 10583	10		9		0.84191	0.84088	9		
	42	2	SD40; 10583	10		10		0.82995	0.82895	10		
	43	3	SD40; 10583	10		10		0.83651	0.83546	10		
	44	4	SD40; 10583	10		9		0.82451	0.82343	9		
	45	5	SD40; 10583	10		9		0.8334	0.83252	9		
	46	6	SD40; 10583	10		10		0.83117	0.8304	10		
	47	7	SD40; 10583	10		10		0.83398	0.83296	10		
	48	8	SD40; 10583	10		10		0.82281	0.8217	10		
	49	1	SD50; 10584	10		10		0.82704	0.82606	10		
	50	2	SD50; 10584	10		8		0.825	0.82413	8		
	51	3	SD50; 10584	10		10		0.83498	0.83393	10		
	52	4	SD50; 10584	10		10		0.84429	0.84322	10		
	53	5	SD50; 10584	10		10		0.83388	0.83291	10		

ToxCalc 5.0
Reviewed by: MLW

Test: EPA.1-Hyalella azteca 10d Survival and Growth Test — Test ID: 2264hasd45
Species: HA-Hyalella azteca — Protocol: EPA 600/R-99/064
Sample ID: — Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 — End Date: 8/21/2015 — Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0-	Day 4	Day 10	Day 28	Total Weight	Pan weight	Weigh	Weight Ct 28	Notes
	54	6	SD50; 10584	10		10		0.82169	0.8207	10		
	55	7	SD50; 10584	10		10		0.84531	0.84426	10		
	56	8	SD50; 10584	10		10		0.81734	0.81653	10		
	57	1	SD54; 10585	10		9		0.82752	0.82641	9		
	58	2	SD54; 10585	10		8		0.82375	0.82287	8		
	59	3	SD54; 10585	10		9		0.83037	0.82927	9		
	60	4	SD54; 10585	10		10		0.83613	0.83493	10		
	61	5	SD54; 10585	10		10		0.81521	0.81399	10		
	62	6	SD54; 10585	10		10		0.82558	0.82427	10		
	63	7	SD54; 10585	10		9		0.81412	0.81307	9		
	64	8	SD54; 10585	10		10		0.81287	0.81176	10		
	65	1	SD55; 10586	10		8		0.83814	0.8374	8		
	66	2	SD55; 10586	10		10		0.82171	0.82069	10		
	67	3	SD55; 10586	10		10		0.82466	0.82362	10		
	68	4	SD55; 10586	10		10		0.83323	0.83215	10		
	69	5	SD55; 10586	10		10		0.83699	0.83576	10		
	70	6	SD55; 10586	10		10		0.84461	0.8435	10		
	71	7	SD55; 10586	10		8		0.83853	0.8375	8		
	72	8	SD55; 10586	10		10		0.82359	0.82215	10		
	73	1	SD58; 10587	10		10		0.82453	0.82361	10		
	74	2	SD58; 10587	10		9		0.83294	0.83204	9		
	75	3	SD58; 10587	10		10		0.84146	0.84015	10		
	76	4	SD58; 10587	10		10		0.82783	0.82654	10		
	77	5	SD58; 10587	10		8		0.82883	0.82786	8		
	78	6	SD58; 10587	10		10		0.83693	0.83576	10		
	79	7	SD58; 10587	10		10		0.8289	0.82777	10		
	80	8	SD58; 10587	10		10		0.83511	0.83413	10		
	81	1	SD59; 10588	10		9		0.83102	0.82997	9		
	82	2	SD59; 10588	10		9		0.83435	0.83334	9		
	83	3	SD59; 10588	10		8		0.83452	0.83361	8		
	84	4	SD59; 10588	10		9		0.8282	0.82718	9		
	85	5	SD59; 10588	10		9		0.82058	0.81952	9		
	86	6	SD59; 10588	10		10		0.82427	0.82295	10		
	87	7	SD59; 10588	10		10		0.82079	0.81953	10		
	88	8	SD59; 10588	10		10		0.82889	0.82769	10		
	89	1	SD46; 10590	10		10		0.82252	0.82124	10		
	90	2	SD46; 10590	10		10		0.83639	0.83524	10		
	91	3	SD46; 10590	10		10		0.83807	0.83681	10		
	92	4	SD46; 10590	10		10		0.83511	0.83438	10		
	93	5	SD46; 10590	10		10		0.82743	0.82641	10		
	94	6	SD46; 10590	10		10		0.82121	0.82016	10		
	95	7	SD46; 10590	10		10		0.82815	0.82695	10		
	96	1	LM0813; 10591	10		10		0.82618	0.82497	10		
	97	2	LM0813; 10591	10		10		0.83671	0.8353	10		
	98	3	LM0813; 10591	10		10		0.82463	0.82313	10		
	99	4	LM0813; 10591	10		10		0.81833	0.81715	10		
	100	5	LM0813; 10591	10		10		0.83001	0.82867	10		
	101	6	LM0813; 10591	10		10		0.82087	0.81959	10		
	102	7	LM0813; 10591	10		9		0.83967	0.83838	9		
	103	8	LM0813; 10591	10		10		0.83183	0.8304	10		

Comments: AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015-SD45

Hyalella azteca 10d Survival and Growth Test-10-day survival

Start Date:	8/11/2015	Test ID:	2264hasd45	Sample ID:	
End Date:	8/21/2015	Lab ID:	-GREAT LAKES ENVIRONM	Sample Type:	-WHOLE SEDIMENT
Sample Date:		Protocol:	EPA 600/R-99/064	Test Species:	HA-Hyalella azteca

Comments: AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015-SD45

Conc-%	1	2	3	4	5	6	7	8
SD45; 10589	0.8000	1.0000	1.0000	0.9000	1.0000	0.9000	0.9000	0.9000
SD25;10579	0.9000	0.9000	1.0000	1.0000	1.0000	0.9000	1.0000	0.9000
SD30; 10580	1.0000	0.8000	0.9000	1.0000	0.9000	0.9000	0.9000	1.0000
SD32; 10581	1.0000	0.8000	1.0000	1.0000	1.0000	0.9000	0.8000	0.8000
SD39; 10582	1.0000	0.9000	0.9000	0.9000	0.9000	1.0000	1.0000	0.9000
SD40; 10583	0.9000	1.0000	1.0000	0.9000	0.9000	1.0000	1.0000	1.0000
SD50; 10584	1.0000	0.8000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
SD54; 10585	0.9000	0.8000	0.9000	1.0000	1.0000	1.0000	0.9000	1.0000
SD55; 10586	0.8000	1.0000	1.0000	1.0000	1.0000	1.0000	0.8000	1.0000
SD58; 10587	1.0000	0.9000	1.0000	1.0000	0.8000	1.0000	1.0000	1.0000
SD59; 10588	0.9000	0.9000	0.8000	0.9000	0.9000	1.0000	1.0000	1.0000
SD46; 10590	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	
LM0813; 10591	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9000	1.0000

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD45; 10589	0.9250	1.0000	1.2924	1.1071	1.4120	8.514	8			
SD25;10579	0.9500	1.0270	1.3305	1.2490	1.4120	6.547	8	-0.768	1.771	0.0879
SD30; 10580	0.9250	1.0000	1.2924	1.1071	1.4120	8.514	8	0.000	1.761	0.0969
SD32; 10581	0.9125	0.9865	1.2773	1.1071	1.4120	11.845	8	0.228	1.782	0.1179
SD39; 10582	0.9375	1.0135	1.3102	1.2490	1.4120	6.438	8	-0.362	1.771	0.0868
SD40; 10583	0.9625	1.0405	1.3509	1.2490	1.4120	6.244	8	-1.193	1.771	0.0868
SD50; 10584	0.9750	1.0541	1.3739	1.1071	1.4120	7.845	8	-1.496	1.771	0.0964
SD54; 10585	0.9375	1.0135	1.3128	1.1071	1.4120	8.821	8	-0.361	1.771	0.1000
SD55; 10586	0.9500	1.0270	1.3358	1.1071	1.4120	10.565	8	-0.686	1.771	0.1120
SD58; 10587	0.9625	1.0405	1.3535	1.1071	1.4120	8.476	8	-1.087	1.771	0.0995
SD59; 10588	0.9250	1.0000	1.2924	1.1071	1.4120	8.514	8	0.000	1.761	0.0969
SD46; 10590	1.0000	1.0811	1.4120	1.4120	1.4120	0.000	7	-3.074	1.895	0.0737
LM0813; 10591	0.9875	1.0676	1.3916	1.2490	1.4120	4.140	8	-2.259	1.812	0.0796

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.23637	1.035	-0.7534	-0.0822
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates no significant differences	0.04725	0.05111	0.01353	0.01108	0.28154	12, 90
Treatments vs SD45; 10589						

ToxCalc v5.0.32

Reviewed by: MLN

Hyalella azteca 10d Survival and Growth Test-10-Day Average Growth

Start Date: 8/11/2015	Test ID: 2264hasd45	Sample ID:	
End Date: 8/21/2015	Lab ID: -GREAT LAKES ENVIRONM	Sample Type:	-WHOLE SEDIMENT
Sample Da	Protocol: EPA 600/R-99/064	Test Species:	HA-Hyalella azteca

Comments AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015-SD45

Conc-%	1	2	3	4	5	6	7	8
SD45; 10589	0.2362	0.0970	0.1090	0.1100	0.0990	0.1189	0.0944	0.1211
SD25;10579	0.1078	0.0622	0.1110	0.1110	0.1140	0.1033	0.1130	0.1278
SD30; 10580	0.0750	0.0800	0.0867	0.0720	0.0756	0.0656	0.1011	0.0800
SD32; 10581	0.1190	0.0988	0.0850	0.1120	0.1750	0.1011	0.1287	0.1225
SD39; 10582	0.1000	0.0967	0.1000	0.1189	0.1200	0.0910	0.0850	0.1133
SD40; 10583	0.1144	0.1000	0.1050	0.1200	0.0978	0.0770	0.1020	0.1110
SD50; 10584	0.0980	0.1087	0.1050	0.1070	0.0970	0.0990	0.1050	0.0810
SD54; 10585	0.1233	0.1100	0.1222	0.1200	0.1220	0.1310	0.1167	0.1110
SD55; 10586	0.0925	0.1020	0.1040	0.1080	0.1230	0.1110	0.1287	0.1440
SD58; 10587	0.0920	0.1000	0.1310	0.1290	0.1212	0.1170	0.1130	0.0980
SD59; 10588	0.1187	0.1122	0.1138	0.1133	0.1178	0.1320	0.1260	0.1200
SD46; 10590	0.1280	0.1150	0.1260	0.0730	0.1020	0.1050	0.1200	
LM0813; 10591	0.1210	0.1410	0.1500	0.1180	0.1340	0.1280	0.1433	0.1430

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD45; 10589	0.1232	1.0000	0.1232	0.0944	0.2362	37.917	8			
SD25;10579	0.1063	0.8624	0.1063	0.0622	0.1278	18.009	8	0.949	1.833	0.0327
*SD30; 10580	0.0795	0.6451	0.0795	0.0656	0.1011	13.495	8	2.580	1.895	0.0321
SD32; 10581	0.1178	0.9558	0.1178	0.0850	0.1750	23.069	8	0.265	1.796	0.0343
SD39; 10582	0.1031	0.8369	0.1031	0.0850	0.1200	12.561	8	1.173	1.860	0.0319
SD40; 10583	0.1034	0.8392	0.1034	0.0770	0.1200	12.662	8	1.155	1.860	0.0319
SD50; 10584	0.1001	0.8124	0.1001	0.0810	0.1087	8.860	8	1.375	1.895	0.0319
SD54; 10585	0.1195	0.9701	0.1195	0.1100	0.1310	5.756	8	0.221	1.895	0.0316
SD55; 10586	0.1142	0.9265	0.1142	0.0925	0.1440	14.619	8	0.516	1.860	0.0326
SD58; 10587	0.1127	0.9143	0.1127	0.0920	0.1310	12.986	8	0.610	1.860	0.0322
SD59; 10588	0.1190	0.9656	0.1190	0.1122	0.1320	5.785	8	0.254	1.895	0.0318
SD46; 10590	0.1099	0.8916	0.1099	0.0730	0.1280	17.283	7	0.742	1.833	0.0330
LM0813; 10591	0.1348	1.0940	0.1348	0.1180	0.1500	8.547	8	-0.681	1.895	0.0322

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.22394	1.035	2.33228	14.3801
Bartlett's Test indicates unequal variances (p = 3.19E-07)	53.6203	21.0261		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences	0.03223	0.26159	0.00144	0.00038	1.0E-04	12, 90
Treatments vs SD45; 10589						

ToxCalc v5.0.32

Reviewed by: MLV

Hyalella azteca 10d Survival and Growth Test-10-day Biomass

Start Date: 8/11/2015	Test ID: 2264hasd45	Sample ID:	
End Date: 8/21/2015	Lab ID: -GREAT LAKES ENVIRONM	Sample Type:	-WHOLE SEDIMENT
Sample Da	Protocol: EPA 600/R-99/064	Test Species:	HA-Hyalella azteca

Comments AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015-SD45

Conc-%	1	2	3	4	5	6	7	8
SD45; 10589	0.1890	0.0970	0.1090	0.0990	0.0990	0.1070	0.0850	0.1090
SD25;10579	0.0970	0.0560	0.1110	0.1110	0.1140	0.0930	0.1130	0.1150
SD30; 10580	0.0750	0.0640	0.0780	0.0720	0.0680	0.0590	0.0910	0.0800
SD32; 10581	0.1190	0.0790	0.0850	0.1120	0.1750	0.0910	0.1030	0.0980
SD39; 10582	0.1000	0.0870	0.0900	0.1070	0.1080	0.0910	0.0850	0.1020
SD40; 10583	0.1030	0.1000	0.1050	0.1080	0.0880	0.0770	0.1020	0.1110
SD50; 10584	0.0980	0.0870	0.1050	0.1070	0.0970	0.0990	0.1050	0.0810
SD54; 10585	0.1110	0.0880	0.1100	0.1200	0.1220	0.1310	0.1050	0.1110
SD55; 10586	0.0740	0.1020	0.1040	0.1080	0.1230	0.1110	0.1030	0.1440
SD58; 10587	0.0920	0.0900	0.1310	0.1290	0.0970	0.1170	0.1130	0.0980
SD59; 10588	0.1050	0.1010	0.0910	0.1020	0.1060	0.1320	0.1260	0.1200
SD46; 10590	0.1280	0.1150	0.1260	0.0730	0.1020	0.1050	0.1200	
LM0813; 10591	0.1210	0.1410	0.1500	0.1180	0.1340	0.1280	0.1290	0.1430

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD45; 10589	0.1117	1.0000	0.1117	0.0850	0.1890	28.825	8			
SD25;10579	0.1013	0.9060	0.1013	0.0560	0.1150	19.801	8	0.783	1.796	0.0241
*SD30; 10580	0.0734	0.6566	0.0734	0.0590	0.0910	13.666	8	3.217	1.860	0.0222
SD32; 10581	0.1078	0.9642	0.1078	0.0790	0.1750	28.083	8	0.256	1.771	0.0277
SD39; 10582	0.0962	0.8613	0.0962	0.0850	0.1080	9.453	8	1.310	1.860	0.0220
SD40; 10583	0.0993	0.8881	0.0993	0.0770	0.1110	11.371	8	1.036	1.860	0.0224
SD50; 10584	0.0974	0.8714	0.0974	0.0810	0.1070	9.411	8	1.214	1.860	0.0220
SD54; 10585	0.1123	1.0045	0.1123	0.0880	0.1310	11.446	8	-0.041	1.833	0.0225
SD55; 10586	0.1086	0.9720	0.1086	0.0740	0.1440	18.280	8	0.234	1.796	0.0240
SD58; 10587	0.1084	0.9698	0.1084	0.0900	0.1310	15.105	8	0.264	1.812	0.0232
SD59; 10588	0.1104	0.9877	0.1104	0.0910	0.1320	12.748	8	0.111	1.833	0.0228
SD46; 10590	0.1099	0.9831	0.1099	0.0730	0.1280	17.283	7	0.141	1.796	0.0242
LM0813; 10591	0.1330	1.1902	0.1330	0.1180	0.1500	8.353	8	-1.764	1.860	0.0224

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates normal distribution (p > 0.01)	1.01209	1.035	1.17472	5.57328
Bartlett's Test indicates unequal variances (p = 2.46E-03)	30.3626	21.0261		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences	0.0224	0.20047	0.00143	0.00033	1.9E-05	12, 90
Treatments vs SD45; 10589						

ToxCalc v5.0.32

Reviewed by: MLV

Appendix D3
Hyalella azteca
10-Day Statistical Data
Reference Sediment SD-46

- Survival
- Weight

Test: EPA.1-Hyalella azteca 10d Survival and Growth Test
Species: HA-Hyalella azteca
Sample ID:
Start Date: 8/11/2015 End Date: 8/21/2015

Test ID: 2264hasd46
Protocol: EPA 600/R-99/064
Sample Type: -WHOLE SEDIMENT
Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0-	Day 4	Day 10	Day 28	Total Weight	Pan weight	Weigh	Weight Ct 28-	Notes
	1	1	SD46; 10590	10		10		0.82252	0.82124	10		
	2	2	SD46; 10590	10		10		0.83639	0.83524	10		
	3	3	SD46; 10590	10		10		0.83807	0.83681	10		
	4	4	SD46; 10590	10		10		0.83511	0.83438	10		
	5	5	SD46; 10590	10		10		0.82743	0.82641	10		
	6	6	SD46; 10590	10		10		0.82121	0.82016	10		
	7	7	SD46; 10590	10		10		0.82815	0.82695	10		
	8	1	SD25;10579	10		9		0.8307	0.82973	9		
	9	2	SD25;10579	10		9		0.83465	0.83409	9		
	10	3	SD25;10579	10		10		0.82237	0.82126	10		
	11	4	SD25;10579	10		10		0.82741	0.8263	10		
	12	5	SD25;10579	10		10		0.82851	0.82737	10		
	13	6	SD25;10579	10		9		0.82794	0.82701	9		
	14	7	SD25;10579	10		10		0.82668	0.82555	10		
	15	8	SD25;10579	10		9		0.8403	0.83915	9		
	16	1	SD30; 10580	10		10		0.81859	0.81784	10		
	17	2	SD30; 10580	10		8		0.82176	0.82112	8		
	18	3	SD30; 10580	10		9		0.8303	0.82952	9		
	19	4	SD30; 10580	10		10		0.80814	0.80742	10		
	20	5	SD30; 10580	10		9		0.83529	0.83461	9		
	21	6	SD30; 10580	10		9		0.82054	0.81995	9		
	22	7	SD30; 10580	10		9		0.83443	0.83352	9		
	23	8	SD30; 10580	10		10		0.81191	0.81111	10		
	24	1	SD32; 10581	10		10		0.8364	0.83521	10		
	25	2	SD32; 10581	10		8		0.83762	0.83683	8		
	26	3	SD32; 10581	10		10		0.83618	0.83533	10		
	27	4	SD32; 10581	10		10		0.83085	0.82973	10		
	28	5	SD32; 10581	10		10		0.81702	0.81527	10		
	29	6	SD32; 10581	10		9		0.82743	0.82652	9		
	30	7	SD32; 10581	10		8		0.8235	0.82247	8		
	31	8	SD32; 10581	10		8		0.82312	0.82214	8		
	32	1	SD39; 10582	10		10		0.81508	0.81408	10		
	33	2	SD39; 10582	10		9		0.81331	0.81244	9		
	34	3	SD39; 10582	10		9		0.82236	0.82146	9		
	35	4	SD39; 10582	10		9		0.82768	0.82661	9		
	36	5	SD39; 10582	10		9		0.82983	0.82875	9		
	37	6	SD39; 10582	10		10		0.81221	0.8113	10		
	38	7	SD39; 10582	10		10		0.82195	0.8211	10		
	39	8	SD39; 10582	10		9		0.82549	0.82447	9		
	40	1	SD40; 10583	10		9		0.84191	0.84088	9		
	41	2	SD40; 10583	10		10		0.82995	0.82895	10		
	42	3	SD40; 10583	10		10		0.83651	0.83546	10		
	43	4	SD40; 10583	10		9		0.82451	0.82343	9		
	44	5	SD40; 10583	10		9		0.8334	0.83252	9		
	45	6	SD40; 10583	10		10		0.83117	0.8304	10		
	46	7	SD40; 10583	10		10		0.83398	0.83296	10		
	47	8	SD40; 10583	10		10		0.82281	0.8217	10		
	48	1	SD50; 10584	10		10		0.82704	0.82606	10		
	49	2	SD50; 10584	10		8		0.825	0.82413	8		
	50	3	SD50; 10584	10		10		0.83498	0.83393	10		
	51	4	SD50; 10584	10		10		0.84429	0.84322	10		
	52	5	SD50; 10584	10		10		0.83388	0.83291	10		
	53	6	SD50; 10584	10		10		0.82169	0.8207	10		

ToxCalc 5.0

Reviewed by: MLV

Test: EPA.1-Hyalella azteca 10d Survival and Growth Test
Test ID: 2264hasd46
Species: HA-Hyalella azteca
Protocol: EPA 600/R-99/064
Sample ID:
Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015
Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0-	Day 4	Day 10	Day 28	Total Weight	Pan weight	Weigh	Weight Ct 28-	Notes
	54	7	SD50; 10584	10		10		0.84531	0.84426	10		
	55	8	SD50; 10584	10		10		0.81734	0.81653	10		
	56	1	SD54; 10585	10		9		0.82752	0.82641	9		
	57	2	SD54; 10585	10		8		0.82375	0.82287	8		
	58	3	SD54; 10585	10		9		0.83037	0.82927	9		
	59	4	SD54; 10585	10		10		0.83613	0.83493	10		
	60	5	SD54; 10585	10		10		0.81521	0.81399	10		
	61	6	SD54; 10585	10		10		0.82558	0.82427	10		
	62	7	SD54; 10585	10		9		0.81412	0.81307	9		
	63	8	SD54; 10585	10		10		0.81287	0.81176	10		
	64	1	SD55; 10586	10		8		0.83814	0.8374	8		
	65	2	SD55; 10586	10		10		0.82171	0.82069	10		
	66	3	SD55; 10586	10		10		0.82466	0.82362	10		
	67	4	SD55; 10586	10		10		0.83323	0.83215	10		
	68	5	SD55; 10586	10		10		0.83699	0.83576	10		
	69	6	SD55; 10586	10		10		0.84461	0.8435	10		
	70	7	SD55; 10586	10		8		0.83853	0.8375	8		
	71	8	SD55; 10586	10		10		0.82359	0.82215	10		
	72	1	SD58; 10587	10		10		0.82453	0.82361	10		
	73	2	SD58; 10587	10		9		0.83294	0.83204	9		
	74	3	SD58; 10587	10		10		0.84146	0.84015	10		
	75	4	SD58; 10587	10		10		0.82783	0.82654	10		
	76	5	SD58; 10587	10		8		0.82883	0.82786	8		
	77	6	SD58; 10587	10		10		0.83693	0.83576	10		
	78	7	SD58; 10587	10		10		0.8289	0.82777	10		
	79	8	SD58; 10587	10		10		0.83511	0.83413	10		
	80	1	SD59; 10588	10		9		0.83102	0.82997	9		
	81	2	SD59; 10588	10		9		0.83435	0.83334	9		
	82	3	SD59; 10588	10		8		0.83452	0.83361	8		
	83	4	SD59; 10588	10		9		0.8282	0.82718	9		
	84	5	SD59; 10588	10		9		0.82058	0.81952	9		
	85	6	SD59; 10588	10		10		0.82427	0.82295	10		
	86	7	SD59; 10588	10		10		0.82079	0.81953	10		
	87	8	SD59; 10588	10		10		0.82889	0.82769	10		
	88	1	SD45; 10589	10		8		0.82921	0.82732	8		
	89	2	SD45; 10589	10		10		0.82143	0.82046	10		
	90	3	SD45; 10589	10		10		0.83217	0.83108	10		
	91	4	SD45; 10589	10		9		0.82685	0.82586	9		
	92	5	SD45; 10589	10		10		0.82087	0.81988	10		
	93	6	SD45; 10589	10		9		0.8149	0.81383	9		
	94	7	SD45; 10589	10		9		0.82095	0.8201	9		
	95	8	SD45; 10589	10		9		0.8202	0.81911	9		
	96	1	LM0813; 10591	10		10		0.82618	0.82497	10		
	97	2	LM0813; 10591	10		10		0.83671	0.8353	10		
	98	3	LM0813; 10591	10		10		0.82463	0.82313	10		
	99	4	LM0813; 10591	10		10		0.81833	0.81715	10		
	100	5	LM0813; 10591	10		10		0.83001	0.82867	10		
	101	6	LM0813; 10591	10		10		0.82087	0.81959	10		
	102	7	LM0813; 10591	10		9		0.83967	0.83838	9		
	103	8	LM0813; 10591	10		10		0.83183	0.8304	10		

Comments: AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015-SD45

Hyalella azteca 10d Survival and Growth Test-10-day survival

Start Date: 8/11/2015	Test ID:	2264hasd46	Sample ID:		
End Date: 8/21/2015	Lab ID:	-GREAT LAKES ENVIRONMENT/	Sample Type:	-WHOLE SEDIMENT	
Sample Da	Protocol:	EPA 600/R-99/064	Test Species:	HA-Hyalella azteca	

Comments AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015-SD46

Conc-%	1	2	3	4	5	6	7	8
SD46; 10590	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	
SD25;10579	0.9000	0.9000	1.0000	1.0000	1.0000	0.9000	1.0000	0.9000
SD30; 10580	1.0000	0.8000	0.9000	1.0000	0.9000	0.9000	0.9000	1.0000
SD32; 10581	1.0000	0.8000	1.0000	1.0000	1.0000	0.9000	0.8000	0.8000
SD39; 10582	1.0000	0.9000	0.9000	0.9000	0.9000	1.0000	1.0000	0.9000
SD40; 10583	0.9000	1.0000	1.0000	0.9000	0.9000	1.0000	1.0000	1.0000
SD50; 10584	1.0000	0.8000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
SD54; 10585	0.9000	0.8000	0.9000	1.0000	1.0000	1.0000	0.9000	1.0000
SD55; 10586	0.8000	1.0000	1.0000	1.0000	1.0000	1.0000	0.8000	1.0000
SD58; 10587	1.0000	0.9000	1.0000	1.0000	0.8000	1.0000	1.0000	1.0000
SD59; 10588	0.9000	0.9000	0.8000	0.9000	0.9000	1.0000	1.0000	1.0000
SD45; 10589	0.8000	1.0000	1.0000	0.9000	1.0000	0.9000	0.9000	0.9000
LM0813; 10591	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9000	1.0000

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD46; 10590	1.0000	1.0000	1.4120	1.4120	1.4120	0.000	7			
*SD25;10579	0.9500	0.9500	1.3305	1.2490	1.4120	6.547	8	2.646	1.895	0.0584
*SD30; 10580	0.9250	0.9250	1.2924	1.1071	1.4120	8.514	8	3.074	1.895	0.0737
*SD32; 10581	0.9125	0.9125	1.2773	1.1071	1.4120	11.845	8	2.518	1.895	0.1013
*SD39; 10582	0.9375	0.9375	1.3102	1.2490	1.4120	6.438	8	3.416	1.895	0.0565
*SD40; 10583	0.9625	0.9625	1.3509	1.2490	1.4120	6.244	8	2.049	1.895	0.0565
SD50; 10584	0.9750	0.9750	1.3739	1.1071	1.4120	7.845	8	1.000	1.895	0.0722
*SD54; 10585	0.9375	0.9375	1.3128	1.1071	1.4120	8.821	8	2.424	1.895	0.0776
SD55; 10586	0.9500	0.9500	1.3358	1.1071	1.4120	10.565	8	1.528	1.895	0.0945
SD58; 10587	0.9625	0.9625	1.3535	1.1071	1.4120	8.476	8	1.442	1.895	0.0769
*SD59; 10588	0.9250	0.9250	1.2924	1.1071	1.4120	8.514	8	3.074	1.895	0.0737
*SD45; 10589	0.9250	0.9250	1.2924	1.1071	1.4120	8.514	8	3.074	1.895	0.0737
LM0813; 10591	0.9875	0.9875	1.3916	1.2490	1.4120	4.140	8	1.000	1.895	0.0386

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.236367	1.035	-0.75341679	-0.0822
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences	0.013454	0.013799	0.013526	0.01108	0.281539291	12, 90
Treatments vs SD46; 10590						

ToxCalc v5.0.32

Reviewed by: MLV

Hyalella azteca 10d Survival and Growth Test-10-Day Average Growth

Start Date: 8/11/2015	Test ID:	2264hasd46	Sample ID:		
End Date: 8/21/2015	Lab ID:	-GREAT LAKES ENVIRONMENT	Sample Type:	-WHOLE SEDIMENT	
Sample Da	Protocol:	EPA 600/R-99/064	Test Species:	HA-Hyalella azteca	

Comments AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015-SD46

Conc-%	1	2	3	4	5	6	7	8
SD46; 10590	0.1280	0.1150	0.1260	0.0730	0.1020	0.1050	0.1200	
SD25;10579	0.1078	0.0622	0.1110	0.1110	0.1140	0.1033	0.1130	0.1278
SD30; 10580	0.0750	0.0800	0.0867	0.0720	0.0756	0.0656	0.1011	0.0800
SD32; 10581	0.1190	0.0988	0.0850	0.1120	0.1750	0.1011	0.1287	0.1225
SD39; 10582	0.1000	0.0967	0.1000	0.1189	0.1200	0.0910	0.0850	0.1133
SD40; 10583	0.1144	0.1000	0.1050	0.1200	0.0978	0.0770	0.1020	0.1110
SD50; 10584	0.0980	0.1087	0.1050	0.1070	0.0970	0.0990	0.1050	0.0810
SD54; 10585	0.1233	0.1100	0.1222	0.1200	0.1220	0.1310	0.1167	0.1110
SD55; 10586	0.0925	0.1020	0.1040	0.1080	0.1230	0.1110	0.1287	0.1440
SD58; 10587	0.0920	0.1000	0.1310	0.1290	0.1212	0.1170	0.1130	0.0980
SD59; 10588	0.1187	0.1122	0.1138	0.1133	0.1178	0.1320	0.1260	0.1200
SD45; 10589	0.2362	0.0970	0.1090	0.1100	0.0990	0.1189	0.0944	0.1211
LM0813; 10591	0.1210	0.1410	0.1500	0.1180	0.1340	0.1280	0.1433	0.1430

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD46; 10590	0.1099	1.0000	0.1099	0.0730	0.1280	17.283	7			
SD25;10579	0.1063	0.9673	0.1063	0.0622	0.1278	18.009	8	0.364	1.782	0.0176
*SD30; 10580	0.0795	0.7235	0.0795	0.0656	0.1011	13.495	8	3.742	1.833	0.0149
SD32; 10581	0.1178	1.0720	0.1178	0.0850	0.1750	23.069	8	-0.659	1.782	0.0214
SD39; 10582	0.1031	0.9386	0.1031	0.0850	0.1200	12.561	8	0.792	1.812	0.0154
SD40; 10583	0.1034	0.9412	0.1034	0.0770	0.1200	12.662	8	0.756	1.812	0.0155
SD50; 10584	0.1001	0.9111	0.1001	0.0810	0.1087	8.660	8	1.247	1.660	0.0146
SD54; 10585	0.1195	1.0880	0.1195	0.1100	0.1310	5.756	8	-1.276	1.895	0.0144
SD55; 10586	0.1142	1.0391	0.1142	0.0925	0.1440	14.619	8	-0.463	1.782	0.0166
SD58; 10587	0.1127	1.0255	0.1127	0.0920	0.1310	12.986	8	-0.316	1.796	0.0159
SD59; 10588	0.1190	1.0829	0.1190	0.1122	0.1320	5.785	8	-1.202	1.895	0.0144
SD45; 10589	0.1232	1.1216	0.1232	0.0944	0.2362	37.917	8	-0.742	1.833	0.0330
LM0813; 10591	0.1348	1.2270	0.1348	0.1180	0.1500	8.547	8	-3.022	1.833	0.0151

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.22394	1.035	2.33228	14.3801
Bartlett's Test indicates unequal variances (p = 3.19E-07)	53.62027	21.02607		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences	0.015126	0.137688	0.001444	0.000377116	1.0E-04	12, 90
Treatments vs SD46; 10590						

ToxCalc v5.0.32

Reviewed by: MLV

Hyalella azteca 10d Survival and Growth Test-10-day Biomass

Start Date: 8/11/2015	Test ID:	2264hasd46	Sample ID:		
End Date: 8/21/2015	Lab ID:	-GREAT LAKES ENVIRONMENT.	Sample Type:	-WHOLE SEDIMENT	
Sample Da	Protocol:	EPA 600/R-99/064	Test Species:	HA-Hyalella azteca	

Comments AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015-SD46

Conc-%	1	2	3	4	5	6	7	8
SD46; 10590	0.1280	0.1150	0.1260	0.0730	0.1020	0.1050	0.1200	
SD25;10579	0.0970	0.0560	0.1110	0.1110	0.1140	0.0930	0.1130	0.1150
SD30; 10580	0.0750	0.0840	0.0780	0.0720	0.0680	0.0590	0.0910	0.0800
SD32; 10581	0.1190	0.0790	0.0850	0.1120	0.1750	0.0910	0.1030	0.0980
SD39; 10582	0.1000	0.0870	0.0900	0.1070	0.1080	0.0910	0.0850	0.1020
SD40; 10583	0.1030	0.1000	0.1050	0.1080	0.0880	0.0770	0.1020	0.1110
SD50; 10584	0.0980	0.0870	0.1050	0.1070	0.0970	0.0990	0.1050	0.0810
SD54; 10585	0.1110	0.0880	0.1100	0.1200	0.1220	0.1310	0.1050	0.1110
SD55; 10588	0.0740	0.1020	0.1040	0.1080	0.1230	0.1110	0.1030	0.1440
SD58; 10587	0.0920	0.0900	0.1310	0.1290	0.0970	0.1170	0.1130	0.0980
SD59; 10588	0.1050	0.1010	0.0910	0.1020	0.1060	0.1320	0.1260	0.1200
SD45; 10589	0.1890	0.0970	0.1090	0.0990	0.0990	0.1070	0.0850	0.1090
LM0813; 10591	0.1210	0.1410	0.1500	0.1180	0.1340	0.1280	0.1290	0.1430

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD46; 10590	0.1099	1.0000	0.1099	0.0730	0.1280	17.283	7			
SD25;10579	0.1013	0.9217	0.1013	0.0560	0.1150	19.801	8	0.853	1.782	0.0180
*SD30; 10580	0.0734	0.6679	0.0734	0.0590	0.0910	13.668	8	4.558	1.860	0.0149
SD32; 10581	0.1078	0.9808	0.1078	0.0790	0.1750	28.083	8	0.164	1.796	0.0231
SD39; 10582	0.0962	0.8761	0.0962	0.0850	0.1080	9.453	8	1.730	1.860	0.0146
SD40; 10583	0.0993	0.9034	0.0993	0.0770	0.1110	11.371	8	1.292	1.833	0.0151
SD50; 10584	0.0974	0.8864	0.0974	0.0810	0.1070	9.411	8	1.585	1.860	0.0146
SD54; 10585	0.1123	1.0218	0.1123	0.0880	0.1310	11.446	8	-0.282	1.812	0.0154
SD55; 10586	0.1086	0.9888	0.1086	0.0740	0.1440	18.280	8	0.123	1.782	0.0179
SD58; 10587	0.1084	0.9865	0.1084	0.0900	0.1310	15.105	8	0.181	1.796	0.0166
SD59; 10588	0.1104	1.0047	0.1104	0.0910	0.1320	12.748	8	-0.059	1.812	0.0158
SD45; 10589	0.1117	1.0172	0.1117	0.0850	0.1890	28.825	8	-0.141	1.796	0.0242
LM0813; 10591	0.1330	1.2107	0.1330	0.1180	0.1500	8.353	8	-2.829	1.833	0.0150

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates normal distribution (p > 0.01)	1.012092	1.035	1.17472	5.57328
Bartlett's Test indicates unequal variances (p = 2.46E-03)	30.36259	21.02606964		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences	0.014996	0.136507	0.001429703	0.00033	1.9E-05	12, 90
Treatments vs SD46; 10590						

ToxCalc v5.0.32

Reviewed by: MLV

Appendix D4
Hyalella azteca
10-Day Statistical Data
Reference Sediment LM-08-13

- Survival
- Weight

Test: EPA.1-Hyalella azteca 10d Survival and Growth Test
Test ID: 2264haLM08
Species: HA-Hyalella azteca
Protocol: EPA 600/R-99/064
Sample ID:
Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015
Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0	Day 4	Day 10	Day 28	Total Weight	Pan weight	Weigh	Weight Ct 28	Notes
	1	1	LM0813; 10591	10		10		0.82618	0.82497	10		
	2	2	LM0813; 10591	10		10		0.83671	0.8353	10		
	3	3	LM0813; 10591	10		10		0.82463	0.82313	10		
	4	4	LM0813; 10591	10		10		0.81833	0.81715	10		
	5	5	LM0813; 10591	10		10		0.83001	0.82867	10		
	6	6	LM0813; 10591	10		10		0.82087	0.81959	10		
	7	7	LM0813; 10591	10		9		0.83967	0.83838	9		
	8	8	LM0813; 10591	10		10		0.83183	0.8304	10		
	9	1	SD25;10579	10		9		0.8307	0.82973	9		
	10	2	SD25;10579	10		9		0.83465	0.83409	9		
	11	3	SD25;10579	10		10		0.82237	0.82126	10		
	12	4	SD25;10579	10		10		0.82741	0.8263	10		
	13	5	SD25;10579	10		10		0.82851	0.82737	10		
	14	6	SD25;10579	10		9		0.82794	0.82701	9		
	15	7	SD25;10579	10		10		0.82668	0.82555	10		
	16	8	SD25;10579	10		9		0.8403	0.83915	9		
	17	1	SD30; 10580	10		10		0.81859	0.81784	10		
	18	2	SD30; 10580	10		8		0.82176	0.82112	8		
	19	3	SD30; 10580	10		9		0.8303	0.82952	9		
	20	4	SD30; 10580	10		10		0.80814	0.80742	10		
	21	5	SD30; 10580	10		9		0.83529	0.83461	9		
	22	6	SD30; 10580	10		9		0.82054	0.81995	9		
	23	7	SD30; 10580	10		9		0.83443	0.83352	9		
	24	8	SD30; 10580	10		10		0.81191	0.81111	10		
	25	1	SD32; 10581	10		10		0.8364	0.83521	10		
	26	2	SD32; 10581	10		8		0.83762	0.83683	8		
	27	3	SD32; 10581	10		10		0.83618	0.83533	10		
	28	4	SD32; 10581	10		10		0.83085	0.82973	10		
	29	5	SD32; 10581	10		10		0.81702	0.81527	10		
	30	6	SD32; 10581	10		9		0.82743	0.82652	9		
	31	7	SD32; 10581	10		8		0.8235	0.82247	8		
	32	8	SD32; 10581	10		8		0.82312	0.82214	8		
	33	1	SD39; 10582	10		10		0.81508	0.81408	10		
	34	2	SD39; 10582	10		9		0.81331	0.81244	9		
	35	3	SD39; 10582	10		9		0.82236	0.82146	9		
	36	4	SD39; 10582	10		9		0.82768	0.82661	9		
	37	5	SD39; 10582	10		9		0.82983	0.82875	9		
	38	6	SD39; 10582	10		10		0.81221	0.8113	10		
	39	7	SD39; 10582	10		10		0.82195	0.8211	10		
	40	8	SD39; 10582	10		9		0.82549	0.82447	9		
	41	1	SD40; 10583	10		9		0.84191	0.84088	9		
	42	2	SD40; 10583	10		10		0.82995	0.82895	10		
	43	3	SD40; 10583	10		10		0.83651	0.83546	10		
	44	4	SD40; 10583	10		9		0.82451	0.82343	9		
	45	5	SD40; 10583	10		9		0.8334	0.83252	9		
	46	6	SD40; 10583	10		10		0.83117	0.8304	10		
	47	7	SD40; 10583	10		10		0.83398	0.83296	10		
	48	8	SD40; 10583	10		10		0.82281	0.8217	10		
	49	1	SD50; 10584	10		10		0.82704	0.82606	10		
	50	2	SD50; 10584	10		8		0.825	0.82413	8		
	51	3	SD50; 10584	10		10		0.83498	0.83393	10		
	52	4	SD50; 10584	10		10		0.84429	0.84322	10		
	53	5	SD50; 10584	10		10		0.83388	0.83291	10		

ToxCalc 5.0
Reviewed by: MLV

Test: EPA.1-Hyalella azteca 10d Survival and Growth Test | Test ID: 2264haLM08
Species: HA-Hyalella azteca | Protocol: EPA 600/R-99/064
Sample ID: | Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015 | Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0-	Day 4	Day 10	Day 28	Total Weight	Pan weight	Weigh	Weight Ct 28	Notes
	54	6	SD50; 10584	10		10		0.82169	0.8207	10		
	55	7	SD50; 10584	10		10		0.84531	0.84426	10		
	56	8	SD50; 10584	10		10		0.81734	0.81653	10		
	57	1	SD54; 10585	10		9		0.82752	0.82641	9		
	58	2	SD54; 10585	10		8		0.82375	0.82287	8		
	59	3	SD54; 10585	10		9		0.83037	0.82927	9		
	60	4	SD54; 10585	10		10		0.83613	0.83493	10		
	61	5	SD54; 10585	10		10		0.81521	0.81399	10		
	62	6	SD54; 10585	10		10		0.82558	0.82427	10		
	63	7	SD54; 10585	10		9		0.81412	0.81307	9		
	64	8	SD54; 10585	10		10		0.81287	0.81176	10		
	65	1	SD55; 10586	10		8		0.83814	0.8374	8		
	66	2	SD55; 10586	10		10		0.82171	0.82069	10		
	67	3	SD55; 10586	10		10		0.82466	0.82362	10		
	68	4	SD55; 10586	10		10		0.83323	0.83215	10		
	69	5	SD55; 10586	10		10		0.83699	0.83576	10		
	70	6	SD55; 10586	10		10		0.84461	0.8435	10		
	71	7	SD55; 10586	10		8		0.83853	0.8375	8		
	72	8	SD55; 10586	10		10		0.82359	0.82215	10		
	73	1	SD58; 10587	10		10		0.82453	0.82361	10		
	74	2	SD58; 10587	10		9		0.83294	0.83204	9		
	75	3	SD58; 10587	10		10		0.84146	0.84015	10		
	76	4	SD58; 10587	10		10		0.82783	0.82654	10		
	77	5	SD58; 10587	10		8		0.82883	0.82786	8		
	78	6	SD58; 10587	10		10		0.83693	0.83576	10		
	79	7	SD58; 10587	10		10		0.8289	0.82777	10		
	80	8	SD58; 10587	10		10		0.83511	0.83413	10		
	81	1	SD59; 10588	10		9		0.83102	0.82997	9		
	82	2	SD59; 10588	10		9		0.83435	0.83334	9		
	83	3	SD59; 10588	10		8		0.83452	0.83361	8		
	84	4	SD59; 10588	10		9		0.8282	0.82718	9		
	85	5	SD59; 10588	10		9		0.82058	0.81952	9		
	86	6	SD59; 10588	10		10		0.82427	0.82295	10		
	87	7	SD59; 10588	10		10		0.82079	0.81953	10		
	88	8	SD59; 10588	10		10		0.82889	0.82769	10		
	89	1	SD45; 10589	10		8		0.82921	0.82732	8		
	90	2	SD45; 10589	10		10		0.82143	0.82046	10		
	91	3	SD45; 10589	10		10		0.83217	0.83108	10		
	92	4	SD45; 10589	10		9		0.82685	0.82586	9		
	93	5	SD45; 10589	10		10		0.82087	0.81988	10		
	94	6	SD45; 10589	10		9		0.8149	0.81383	9		
	95	7	SD45; 10589	10		9		0.82095	0.8201	9		
	96	8	SD45; 10589	10		9		0.8202	0.81911	9		
	97	1	SD46; 10590	10		10		0.82252	0.82124	10		
	98	2	SD46; 10590	10		10		0.83639	0.83524	10		
	99	3	SD46; 10590	10		10		0.83807	0.83681	10		
	100	4	SD46; 10590	10		10		0.83511	0.83438	10		
	101	5	SD46; 10590	10		10		0.82743	0.82641	10		
	102	6	SD46; 10590	10		10		0.82121	0.82016	10		
	103	7	SD46; 10590	10		10		0.82815	0.82695	10		

Comments: AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015-LM081

Hyalella azteca 10d Survival and Growth Test-10-day survival

Start Date: 8/11/2015	Test ID:	2264haLM08	Sample ID:		
End Date: 8/21/2015	Lab ID:	-GREAT LAKES ENVIRONMENTAL (	Sample Type:	-WHOLE SEDIMENT	
Sample Da	Protocol:	EPA 600/R-99/064	Test Species:	HA-Hyalella azteca	

Comments AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015-LM081

Conc-%	1	2	3	4	5	6	7	8
LM0813; 10591	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9000	1.0000
SD25;10579	0.9000	0.9000	1.0000	1.0000	1.0000	0.9000	1.0000	0.9000
SD30; 10580	1.0000	0.8000	0.9000	1.0000	0.9000	0.9000	0.9000	1.0000
SD32; 10581	1.0000	0.8000	1.0000	1.0000	1.0000	0.9000	0.8000	0.8000
SD39; 10582	1.0000	0.9000	0.9000	0.9000	0.9000	1.0000	1.0000	0.9000
SD40; 10583	0.9000	1.0000	1.0000	0.9000	0.9000	1.0000	1.0000	1.0000
SD50; 10584	1.0000	0.8000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
SD54; 10585	0.9000	0.8000	0.9000	1.0000	1.0000	1.0000	0.9000	1.0000
SD55; 10586	0.8000	1.0000	1.0000	1.0000	1.0000	1.0000	0.8000	1.0000
SD58; 10587	1.0000	0.9000	1.0000	1.0000	0.8000	1.0000	1.0000	1.0000
SD59; 10588	0.9000	0.9000	0.8000	0.9000	0.9000	1.0000	1.0000	1.0000
SD45; 10589	0.8000	1.0000	1.0000	0.9000	1.0000	0.9000	0.9000	0.9000
SD46; 10590	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
LM0813; 10591	0.9875	1.0000	1.3916	1.2490	1.4120	4.140	8			
SD25;10579	0.9500	0.9620	1.3305	1.2490	1.4120	6.547	8	1.655	1.782	0.0658
*SD30; 10580	0.9250	0.9367	1.2924	1.1071	1.4120	8.514	8	2.259	1.812	0.0798
*SD32; 10581	0.9125	0.9241	1.2773	1.1071	1.4120	11.845	8	1.997	1.860	0.1064
*SD39; 10582	0.9375	0.9494	1.3102	1.2490	1.4120	6.438	8	2.256	1.782	0.0644
SD40; 10583	0.9625	0.9747	1.3509	1.2490	1.4120	6.244	8	1.128	1.782	0.0644
SD50; 10584	0.9750	0.9873	1.3739	1.1071	1.4120	7.845	8	0.410	1.812	0.0783
SD54; 10585	0.9375	0.9494	1.3128	1.1071	1.4120	8.821	8	1.724	1.812	0.0829
SD55; 10586	0.9500	0.9620	1.3358	1.1071	1.4120	10.565	8	1.036	1.833	0.0988
SD58; 10587	0.9625	0.9747	1.3535	1.1071	1.4120	8.476	8	0.840	1.812	0.0823
*SD59; 10588	0.9250	0.9367	1.2924	1.1071	1.4120	8.514	8	2.259	1.812	0.0796
*SD45; 10589	0.9250	0.9367	1.2924	1.1071	1.4120	8.514	8	2.259	1.812	0.0796
SD46; 10590	1.0000	1.0127	1.4120	1.4120	1.4120	0.000	7	-1.000	1.895	0.0386

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.23637	1.035	-0.7534	-0.0822
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences	0.01492	0.0154	0.01353	0.01108	0.28154	12, 90
Treatments vs LM0813; 10591						

ToxCalc v5.0.32

Reviewed by: MLV

Hyalella azteca 10d Survival and Growth Test-10-Day Average Growth

Start Date: 8/11/2015	Test ID:	2264haLM08	Sample ID:		
End Date: 8/21/2015	Lab ID:	-GREAT LAKES ENVIRONMENT/	Sample Type:		-WHOLE SEDIMENT
Sample Da	Protocol:	EPA 600/R-99/064	Test Species:		HA-Hyalella azteca

Comments AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015-LM081

Conc-%	1	2	3	4	5	6	7	8
LM0813; 10591	0.1210	0.1410	0.1500	0.1180	0.1340	0.1280	0.1433	0.1430
SD25;10579	0.1078	0.0622	0.1110	0.1110	0.1140	0.1033	0.1130	0.1278
SD30; 10580	0.0750	0.0800	0.0867	0.0720	0.0756	0.0656	0.1011	0.0800
SD32; 10581	0.1190	0.0988	0.0850	0.1120	0.1750	0.1011	0.1287	0.1225
SD39; 10582	0.1000	0.0967	0.1000	0.1189	0.1200	0.0910	0.0850	0.1133
SD40; 10583	0.1144	0.1000	0.1050	0.1200	0.0978	0.0770	0.1020	0.1110
SD50; 10584	0.0980	0.1087	0.1050	0.1070	0.0970	0.0990	0.1050	0.0810
SD54; 10585	0.1233	0.1100	0.1222	0.1200	0.1220	0.1310	0.1167	0.1110
SD55; 10586	0.0925	0.1020	0.1040	0.1080	0.1230	0.1110	0.1287	0.1440
SD58; 10587	0.0920	0.1000	0.1310	0.1290	0.1212	0.1170	0.1130	0.0980
SD59; 10588	0.1167	0.1122	0.1138	0.1133	0.1178	0.1320	0.1260	0.1200
SD45; 10589	0.2362	0.0970	0.1090	0.1100	0.0990	0.1189	0.0944	0.1211
SD46; 10590	0.1280	0.1150	0.1260	0.0730	0.1020	0.1050	0.1200	

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
LM0813; 10591	0.1348	1.0000	0.1348	0.1180	0.1500	8.547	8			
*SD25;10579	0.1063	0.7884	0.1063	0.0622	0.1278	18.009	8	3.612	1.796	0.0142
*SD30; 10580	0.0795	0.5897	0.0795	0.0656	0.1011	13.495	8	9.937	1.771	0.0099
SD32; 10581	0.1178	0.8737	0.1178	0.0850	0.1750	23.069	8	1.632	1.833	0.0191
*SD39; 10582	0.1031	0.7650	0.1031	0.0850	0.1200	12.561	8	5.169	1.771	0.0109
*SD40; 10583	0.1034	0.7671	0.1034	0.0770	0.1200	12.662	8	5.091	1.771	0.0109
*SD50; 10584	0.1001	0.7426	0.1001	0.0810	0.1087	8.860	8	6.750	1.771	0.0091
*SD54; 10585	0.1195	0.8868	0.1195	0.1100	0.1310	5.756	8	3.217	1.796	0.0085
*SD55; 10586	0.1142	0.8469	0.1142	0.0925	0.1440	14.619	8	2.878	1.782	0.0128
*SD58; 10587	0.1127	0.8358	0.1127	0.0920	0.1310	12.986	8	3.362	1.771	0.0117
*SD59; 10588	0.1190	0.8826	0.1190	0.1122	0.1320	5.785	8	3.335	1.796	0.0085
SD45; 10589	0.1232	0.9141	0.1232	0.0944	0.2362	37.917	8	0.681	1.895	0.0322
*SD46; 10590	0.1099	0.8150	0.1099	0.0730	0.1280	17.283	7	3.022	1.833	0.0151

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.223940134	1.035	2.33228	14.3801
Bartlett's Test indicates unequal variances (p = 3.19E-07)	53.62026596	21.0261		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences	0.015125972	0.11222	0.00144	0.00038	1.0E-04	12, 90
Treatments vs LM0813; 10591						

ToxCalc v5.0.32

Reviewed by: MLV

Hyalella azteca 10d Survival and Growth Test-10-day Biomass

Start Date: 8/11/2015	Test ID:	2264haLM08	Sample ID:		
End Date: 8/21/2015	Lab ID:	-GREAT LAKES ENVIRONMENT.	Sample Type:		-WHOLE SEDIMENT
Sample Da	Protocol:	EPA 600/R-99/064	Test Species:		HA-Hyalella azteca

Comments AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015-LM081

Conc-%	1	2	3	4	5	6	7	8
LM0813; 10591	0.1210	0.1410	0.1500	0.1180	0.1340	0.1280	0.1290	0.1430
SD25;10579	0.0970	0.0560	0.1110	0.1110	0.1140	0.0930	0.1130	0.1150
SD30; 10580	0.0750	0.0640	0.0780	0.0720	0.0680	0.0590	0.0910	0.0800
SD32; 10581	0.1190	0.0790	0.0850	0.1120	0.1750	0.0910	0.1030	0.0980
SD39; 10582	0.1000	0.0870	0.0900	0.1070	0.1080	0.0910	0.0850	0.1020
SD40; 10583	0.1030	0.1000	0.1050	0.1080	0.0880	0.0770	0.1020	0.1110
SD50; 10584	0.0980	0.0870	0.1050	0.1070	0.0970	0.0990	0.1050	0.0810
SD54; 10585	0.1110	0.0880	0.1100	0.1200	0.1220	0.1310	0.1050	0.1110
SD55; 10586	0.0740	0.1020	0.1040	0.1080	0.1230	0.1110	0.1030	0.1440
SD58; 10587	0.0920	0.0900	0.1310	0.1290	0.0970	0.1170	0.1130	0.0980
SD59; 10588	0.1050	0.1010	0.0910	0.1020	0.1060	0.1320	0.1260	0.1200
SD45; 10589	0.1890	0.0970	0.1090	0.0990	0.0990	0.1070	0.0850	0.1090
SD46; 10590	0.1280	0.1150	0.1260	0.0730	0.1020	0.1050	0.1200	

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
LM0813; 10591	0.1330	1.0000	0.1330	0.1180	0.1500	8.353	8			
*SD25;10579	0.1013	0.7613	0.1013	0.0560	0.1150	19.801	8	3.918	1.812	0.0147
*SD30; 10580	0.0734	0.5517	0.0734	0.0590	0.0910	13.666	8	11.269	1.771	0.0094
*SD32; 10581	0.1078	0.8102	0.1078	0.0790	0.1750	28.083	8	2.216	1.860	0.0212
*SD39; 10582	0.0982	0.7237	0.0962	0.0850	0.1080	9.453	8	7.238	1.771	0.0090
*SD40; 10583	0.0993	0.7462	0.0993	0.0770	0.1110	11.371	8	6.028	1.771	0.0099
*SD50; 10584	0.0974	0.7321	0.0974	0.0810	0.1070	9.411	8	6.997	1.771	0.0090
*SD54; 10585	0.1123	0.8440	0.1123	0.0880	0.1310	11.446	8	3.455	1.771	0.0106
*SD55; 10586	0.1086	0.8167	0.1086	0.0740	0.1440	18.280	8	3.030	1.812	0.0146
*SD58; 10587	0.1084	0.8148	0.1084	0.0900	0.1310	15.105	8	3.521	1.762	0.0125
*SD59; 10588	0.1104	0.8299	0.1104	0.0910	0.1320	12.748	8	3.569	1.771	0.0112
SD45; 10589	0.1117	0.8402	0.1117	0.0850	0.1890	28.825	8	1.764	1.860	0.0224
*SD46; 10590	0.1099	0.8260	0.1099	0.0730	0.1280	17.283	7	2.829	1.833	0.0150

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates normal distribution (p > 0.01)	1.012092	1.035	1.17472	5.57328
Bartlett's Test indicates unequal variances (p = 2.46E-03)	30.36259	21.0261		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences	0.014996	0.112754096	0.00143	0.00033	1.9E-05	12, 90
Treatments vs LM0813; 10591						

ToxCalc v5.0.32

Reviewed by: MLV

Appendix D5
Hyalella azteca
10-Day Statistical Data
Pooled Reference Sediments;
SD-45, SD-46, LM-08-13

- Survival
- Weight

Test: EPA.1-Hyalella azteca 10d Survival and Growth Test
Test ID: 2264haCSIT
Species: HA-Hyalella azteca
Protocol: EPA 600/R-99/064
Sample ID:
Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 End Date: 8/21/2015
Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0-	Day 4	Day 10	Day 28	Total Weight	Pan weight	Weigh	Weight Ct 28-	Notes
	1	1	SD45, SD46, L	10		8		0.82921	0.82732	8		
	2	2	SD45, SD46, L	10		10		0.82143	0.82046	10		
	3	3	SD45, SD46, L	10		10		0.83217	0.83108	10		
	4	4	SD45, SD46, L	10		9		0.82685	0.82586	9		
	5	5	SD45, SD46, L	10		10		0.82087	0.81988	10		
	6	6	SD45, SD46, L	10		9		0.8149	0.81383	9		
	7	7	SD45, SD46, L	10		9		0.82095	0.8201	9		
	8	8	SD45, SD46, L	10		9		0.8202	0.81911	9		
	9	9	SD45, SD46, L	10		10		0.82252	0.82124	10		
	10	10	SD45, SD46, L	10		10		0.83639	0.83524	10		
	11	11	SD45, SD46, L	10		10		0.83807	0.83681	10		
	12	12	SD45, SD46, L	10		10		0.83511	0.83438	10		
	13	13	SD45, SD46, L	10		10		0.82743	0.82641	10		
	14	14	SD45, SD46, L	10		10		0.82121	0.82016	10		
	15	15	SD45, SD46, L	10		10		0.82815	0.82695	10		
	16	16	SD45, SD46, L	10		10		0.82618	0.82497	10		
	17	17	SD45, SD46, L	10		10		0.83671	0.8353	10		
	18	18	SD45, SD46, L	10		10		0.82463	0.82313	10		
	19	19	SD45, SD46, L	10		10		0.81833	0.81715	10		
	20	20	SD45, SD46, L	10		10		0.83001	0.82867	10		
	21	21	SD45, SD46, L	10		10		0.82087	0.81959	10		
	22	22	SD45, SD46, L	10		9		0.83967	0.83838	9		
	23	23	SD45, SD46, L	10		10		0.83183	0.8304	10		
	24	1	SD25;10579	10		9		0.8307	0.82973	9		
	25	2	SD25;10579	10		9		0.83465	0.83409	9		
	26	3	SD25;10579	10		10		0.82237	0.82126	10		
	27	4	SD25;10579	10		10		0.82741	0.8263	10		
	28	5	SD25;10579	10		10		0.82851	0.82737	10		
	29	6	SD25;10579	10		9		0.82794	0.82701	9		
	30	7	SD25;10579	10		10		0.82668	0.82555	10		
	31	8	SD25;10579	10		9		0.8403	0.83915	9		
	32	1	SD30; 10580	10		10		0.81859	0.81784	10		
	33	2	SD30; 10580	10		8		0.82176	0.82112	8		
	34	3	SD30; 10580	10		9		0.8303	0.82952	9		
	35	4	SD30; 10580	10		10		0.80814	0.80742	10		
	36	5	SD30; 10580	10		9		0.83529	0.83461	9		
	37	6	SD30; 10580	10		9		0.82054	0.81995	9		
	38	7	SD30; 10580	10		9		0.83443	0.83352	9		
	39	8	SD30; 10580	10		10		0.81191	0.81111	10		
	40	1	SD32; 10581	10		10		0.8364	0.83521	10		
	41	2	SD32; 10581	10		8		0.83762	0.83683	8		
	42	3	SD32; 10581	10		10		0.83618	0.83533	10		
	43	4	SD32; 10581	10		10		0.83085	0.82973	10		
	44	5	SD32; 10581	10		10		0.81702	0.81527	10		
	45	6	SD32; 10581	10		9		0.82743	0.82652	9		
	46	7	SD32; 10581	10		8		0.8235	0.82247	8		
	47	8	SD32; 10581	10		8		0.82312	0.82214	8		
	48	1	SD39; 10582	10		10		0.81508	0.81408	10		
	49	2	SD39; 10582	10		9		0.81331	0.81244	9		
	50	3	SD39; 10582	10		9		0.82236	0.82146	9		
	51	4	SD39; 10582	10		9		0.82768	0.82661	9		
	52	5	SD39; 10582	10		9		0.82983	0.82875	9		
	53	6	SD39; 10582	10		10		0.81221	0.8113	10		

Test: EPA.1-Hyalella azteca 10d Survival and Growth Test — Test ID: 2264haCSIT
Species: HA-Hyalella azteca — Protocol: EPA 600/R-99/064
Sample ID: — Sample Type: -WHOLE SEDIMENT
Start Date: 8/11/2015 — End Date: 8/21/2015 — Lab ID: -GREAT LAKES ENVIRONMENTAL CENTER

Pos	ID	Rep	Group	Day 0-	Day 4	Day 10	Day 28	Total Weight	Pan weight	Weigh	Weight Ct 28-	Notes
	54	7	SD39; 10582	10		10		0.82195	0.8211	10		
	55	8	SD39; 10582	10		9		0.82549	0.82447	9		
	56	1	SD40; 10583	10		9		0.84191	0.84088	9		
	57	2	SD40; 10583	10		10		0.82995	0.82895	10		
	58	3	SD40; 10583	10		10		0.83651	0.83546	10		
	59	4	SD40; 10583	10		9		0.82451	0.82343	9		
	60	5	SD40; 10583	10		9		0.8334	0.83252	9		
	61	6	SD40; 10583	10		10		0.83117	0.8304	10		
	62	7	SD40; 10583	10		10		0.83398	0.83296	10		
	63	8	SD40; 10583	10		10		0.82281	0.8217	10		
	64	1	SD50; 10584	10		10		0.82704	0.82606	10		
	65	2	SD50; 10584	10		8		0.825	0.82413	8		
	66	3	SD50; 10584	10		10		0.83498	0.83393	10		
	67	4	SD50; 10584	10		10		0.84429	0.84322	10		
	68	5	SD50; 10584	10		10		0.83388	0.83291	10		
	69	6	SD50; 10584	10		10		0.82169	0.8207	10		
	70	7	SD50; 10584	10		10		0.84531	0.84426	10		
	71	8	SD50; 10584	10		10		0.81734	0.81653	10		
	72	1	SD54; 10585	10		9		0.82752	0.82641	9		
	73	2	SD54; 10585	10		8		0.82375	0.82287	8		
	74	3	SD54; 10585	10		9		0.83037	0.82927	9		
	75	4	SD54; 10585	10		10		0.83613	0.83493	10		
	76	5	SD54; 10585	10		10		0.81521	0.81399	10		
	77	6	SD54; 10585	10		10		0.82558	0.82427	10		
	78	7	SD54; 10585	10		9		0.81412	0.81307	9		
	79	8	SD54; 10585	10		10		0.81287	0.81176	10		
	80	1	SD55; 10586	10		8		0.83814	0.8374	8		
	81	2	SD55; 10586	10		10		0.82171	0.82069	10		
	82	3	SD55; 10586	10		10		0.82466	0.82362	10		
	83	4	SD55; 10586	10		10		0.83323	0.83215	10		
	84	5	SD55; 10586	10		10		0.83699	0.83576	10		
	85	6	SD55; 10586	10		10		0.84461	0.8435	10		
	86	7	SD55; 10586	10		8		0.83853	0.8375	8		
	87	8	SD55; 10586	10		10		0.82359	0.82215	10		
	88	1	SD58; 10587	10		10		0.82453	0.82361	10		
	89	2	SD58; 10587	10		9		0.83294	0.83204	9		
	90	3	SD58; 10587	10		10		0.84146	0.84015	10		
	91	4	SD58; 10587	10		10		0.82783	0.82654	10		
	92	5	SD58; 10587	10		8		0.82883	0.82786	8		
	93	6	SD58; 10587	10		10		0.83693	0.83576	10		
	94	7	SD58; 10587	10		10		0.8289	0.82777	10		
	95	8	SD58; 10587	10		10		0.83511	0.83413	10		
	96	1	SD59; 10588	10		9		0.83102	0.82997	9		
	97	2	SD59; 10588	10		9		0.83435	0.83334	9		
	98	3	SD59; 10588	10		8		0.83452	0.83361	8		
	99	4	SD59; 10588	10		9		0.8282	0.82718	9		
	100	5	SD59; 10588	10		9		0.82058	0.81952	9		
	101	6	SD59; 10588	10		10		0.82427	0.82295	10		
	102	7	SD59; 10588	10		10		0.82079	0.81953	10		
	103	8	SD59; 10588	10		10		0.82889	0.82769	10		

Comments: AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015-COMBI

Hyalella azteca 10d Survival and Growth Test-10-day survival

Start Date: 8/11/2015	Test ID: 2264haCSIT	Sample ID:	
End Date: 8/21/2015	Lab ID: -GREAT LAKES ENVIRONMENT	Sample Type:	-WHOLE SEDIMENT
Sample Da	Protocol: EPA 600/R-99/064	Test Species:	HA-Hyalella azteca

Comments AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015-COMBI

Conc-%	1	2	3	4	5	6	7	8	9	10
SD45, SD46, LM0813	0.8000	1.0000	1.0000	0.9000	1.0000	0.9000	0.9000	0.9000	1.0000	1.0000
SD45, SD46, LM0813	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
SD45, SD46, LM0813	1.0000	0.9000	1.0000							
SD25;10579	0.9000	0.9000	1.0000	1.0000	1.0000	0.9000	1.0000	0.9000		
SD30; 10580	1.0000	0.8000	0.9000	1.0000	0.9000	0.9000	0.9000	1.0000		
SD32; 10581	1.0000	0.8000	1.0000	1.0000	1.0000	0.9000	0.8000	0.8000		
SD39; 10582	1.0000	0.9000	0.9000	0.9000	0.9000	1.0000	1.0000	0.9000		
SD40; 10583	0.9000	1.0000	1.0000	0.9000	0.9000	1.0000	1.0000	1.0000		
SD50; 10584	1.0000	0.8000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000		
SD54; 10585	0.9000	0.8000	0.9000	1.0000	1.0000	1.0000	0.9000	1.0000		
SD55; 10586	0.8000	1.0000	1.0000	1.0000	1.0000	1.0000	0.8000	1.0000		
SD58; 10587	1.0000	0.9000	1.0000	1.0000	0.8000	1.0000	1.0000	1.0000		
SD59; 10588	0.9000	0.9000	0.8000	0.9000	0.9000	1.0000	1.0000	1.0000		

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD45, SD46, LM0813	0.9696	1.0000	1.3633	1.1071	1.4120	6.471	23			
SD25;10579	0.9500	0.9798	1.3305	1.2490	1.4120	6.547	8	0.909	1.899	0.0613
*SD30; 10580	0.9250	0.9540	1.2924	1.1071	1.4120	8.514	8	1.839	1.699	0.0655
*SD32; 10581	0.9125	0.9411	1.2773	1.1071	1.4120	11.845	8	1.960	1.699	0.0746
SD39; 10582	0.9375	0.9669	1.3102	1.2490	1.4120	6.438	8	1.484	1.699	0.0609
SD40; 10583	0.9625	0.9927	1.3509	1.2490	1.4120	6.244	8	0.347	1.699	0.0609
SD50; 10584	0.9750	1.0056	1.3739	1.1071	1.4120	7.845	8	-0.276	1.699	0.0651
SD54; 10585	0.9375	0.9669	1.3128	1.1071	1.4120	8.821	8	1.288	1.699	0.0667
SD55; 10586	0.9500	0.9798	1.3358	1.1071	1.4120	10.565	8	0.648	1.699	0.0722
SD58; 10587	0.9625	0.9927	1.3535	1.1071	1.4120	8.476	8	0.250	1.699	0.0665
*SD59; 10588	0.9250	0.9540	1.2924	1.1071	1.4120	8.514	8	1.839	1.699	0.0655

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	2.531578	1.035	-0.85606	-0.13829
Bartlett's Test indicates equal variances (p = 0.76)	6.634758	18.30704		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Homoscedastic t Test indicates significant differences	0.030263	0.031604	0.009908	0.011527	0.573493	10, 92
Treatments vs SD45, SD46, LM0813						

ToxCalc v5.0.32

Reviewed by: MLJ

Hyalella azteca 10d Survival and Growth Test-10-Day Average Growth

Start Date: 8/11/2015	Test ID:	2264haCSIT	Sample ID:		
End Date: 8/21/2015	Lab ID:	-GREAT LAKES ENVIRONMENT	Sample Type:	-WHOLE SEDIMENT	
Sample Da	Protocol:	EPA 600/R-99/064	Test Species:	HA-Hyalella azteca	
Comments AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015-COMBI					

Conc-%	1	2	3	4	5	6	7	8	9	10
SD45, SD46, LM0813	0.2362	0.0970	0.1090	0.1100	0.0990	0.1189	0.0944	0.1211	0.1280	0.1150
SD45, SD46, LM0813	0.1260	0.0730	0.1020	0.1050	0.1200	0.1210	0.1410	0.1500	0.1180	0.1340
SD45, SD46, LM0813	0.1280	0.1433	0.1430							
SD25;10579	0.1078	0.0822	0.1110	0.1110	0.1140	0.1033	0.1130	0.1278		
SD30; 10580	0.0750	0.0800	0.0867	0.0720	0.0756	0.0656	0.1011	0.0800		
SD32; 10581	0.1190	0.0988	0.0850	0.1120	0.1750	0.1011	0.1287	0.1225		
SD39; 10582	0.1000	0.0967	0.1000	0.1189	0.1200	0.0910	0.0850	0.1133		
SD40; 10583	0.1144	0.1000	0.1050	0.1200	0.0978	0.0770	0.1020	0.1110		
SD50; 10584	0.0980	0.1087	0.1050	0.1070	0.0970	0.0990	0.1050	0.0810		
SD54; 10585	0.1233	0.1100	0.1222	0.1200	0.1220	0.1310	0.1187	0.1110		
SD55; 10586	0.0925	0.1020	0.1040	0.1080	0.1230	0.1110	0.1287	0.1440		
SD58; 10587	0.0920	0.1000	0.1310	0.1290	0.1212	0.1170	0.1130	0.0980		
SD59; 10588	0.1167	0.1122	0.1138	0.1133	0.1178	0.1320	0.1260	0.1200		

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD45, SD46, LM0813	0.1232	1.0000	0.1232	0.0730	0.2362	24.898	23			
*SD25;10579	0.1063	0.8627	0.1063	0.0822	0.1278	18.009	8	1.817	1.725	0.0181
*SD30; 10580	0.0795	0.6453	0.0795	0.0656	0.1011	13.495	8	5.876	1.701	0.0126
SD32; 10581	0.1178	0.9561	0.1178	0.0850	0.1750	23.069	8	0.469	1.771	0.0204
*SD39; 10582	0.1031	0.8371	0.1031	0.0850	0.1200	12.561	8	2.551	1.703	0.0134
*SD40; 10583	0.1034	0.8395	0.1034	0.0770	0.1200	12.662	8	2.505	1.703	0.0134
*SD50; 10584	0.1001	0.8128	0.1001	0.0810	0.1087	8.860	8	3.241	1.701	0.0121
SD54; 10585	0.1195	0.9704	0.1195	0.1100	0.1310	5.756	8	0.533	1.703	0.0117
SD55; 10586	0.1142	0.9268	0.1142	0.0925	0.1440	14.619	8	1.037	1.714	0.0149
SD58; 10587	0.1127	0.9148	0.1127	0.0920	0.1310	12.986	8	1.279	1.708	0.0140
SD59; 10588	0.1190	0.9659	0.1190	0.1122	0.1320	5.785	8	0.615	1.703	0.0117

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.1869	1.035	2.027916	12.67496
Bartlett's Test indicates unequal variances (p = 5.02E-06)	42.97749	18.30704		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences	0.011654	0.094612	0.0015	0.000394	2.5E-04	10, 92
Treatments vs SD45, SD46, LM0813						

ToxCalc v5.0.32

Reviewed by: MLV

Hyalella azteca 10d Survival and Growth Test-10-day Biomass

Start Date: 8/11/2015	Test ID: 2264haCSIT	Sample ID:	
End Date: 8/21/2015	Lab ID: -GREAT LAKES ENVIRONMENT	Sample Type:	-WHOLE SEDIMENT
Sample Da	Protocol: EPA 600/R-99/064	Test Species:	HA-Hyalella azteca

Comments AECOM Lake Macatawa 10 day H azteca survival and growth Aug 2015-COMBI

Conc-%	1	2	3	4	5	6	7	8	9	10
SD45, SD46, LM0813	0.1890	0.0970	0.1090	0.0990	0.0990	0.1070	0.0850	0.1090	0.1280	0.1150
SD45, SD46, LM0813	0.1260	0.0730	0.1020	0.1050	0.1200	0.1210	0.1410	0.1500	0.1180	0.1340
SD45, SD46, LM0813	0.1280	0.1290	0.1430							
SD25;10579	0.0970	0.0560	0.1110	0.1110	0.1140	0.0930	0.1130	0.1150		
SD30; 10580	0.0750	0.0640	0.0780	0.0720	0.0680	0.0590	0.0910	0.0800		
SD32; 10581	0.1190	0.0790	0.0850	0.1120	0.1750	0.0910	0.1030	0.0980		
SD39; 10582	0.1000	0.0870	0.0900	0.1070	0.1080	0.0910	0.0850	0.1020		
SD40; 10583	0.1030	0.1000	0.1050	0.1080	0.0880	0.0770	0.1020	0.1110		
SD50; 10584	0.0980	0.0870	0.1050	0.1070	0.0970	0.0990	0.1050	0.0810		
SD54; 10585	0.1110	0.0880	0.1100	0.1200	0.1220	0.1310	0.1050	0.1110		
SD55; 10586	0.0740	0.1020	0.1040	0.1080	0.1230	0.1110	0.1030	0.1440		
SD58; 10587	0.0920	0.0900	0.1310	0.1290	0.0970	0.1170	0.1130	0.0980		
SD59; 10588	0.1050	0.1010	0.0910	0.1020	0.1060	0.1320	0.1260	0.1200		

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
SD45, SD46, LM0813	0.1186	1.0000	0.1186	0.0730	0.1890	20.391	23			
*SD25;10579	0.1013	0.8540	0.1013	0.0560	0.1150	19.801	8	1.991	1.781	0.0153
*SD30; 10580	0.0734	0.6189	0.0734	0.0590	0.0910	13.666	8	7.332	1.703	0.0105
SD32; 10581	0.1078	0.9088	0.1078	0.0790	0.1750	28.083	8	0.914	1.812	0.0214
*SD39; 10582	0.0962	0.8118	0.0962	0.0850	0.1080	9.453	8	3.732	1.701	0.0102
*SD40; 10583	0.0993	0.8371	0.0993	0.0770	0.1110	11.371	8	3.004	1.706	0.0110
*SD50; 10584	0.0974	0.8213	0.0974	0.0810	0.1070	9.411	8	3.536	1.701	0.0102
SD54; 10585	0.1123	0.9467	0.1123	0.0880	0.1310	11.446	8	0.931	1.714	0.0116
SD55; 10586	0.1086	0.9162	0.1086	0.0740	0.1440	18.280	8	1.150	1.781	0.0152
SD58; 10587	0.1084	0.9141	0.1084	0.0900	0.1310	15.105	8	1.328	1.734	0.0133
SD59; 10588	0.1104	0.9309	0.1104	0.0910	0.1320	12.748	8	1.156	1.721	0.0122

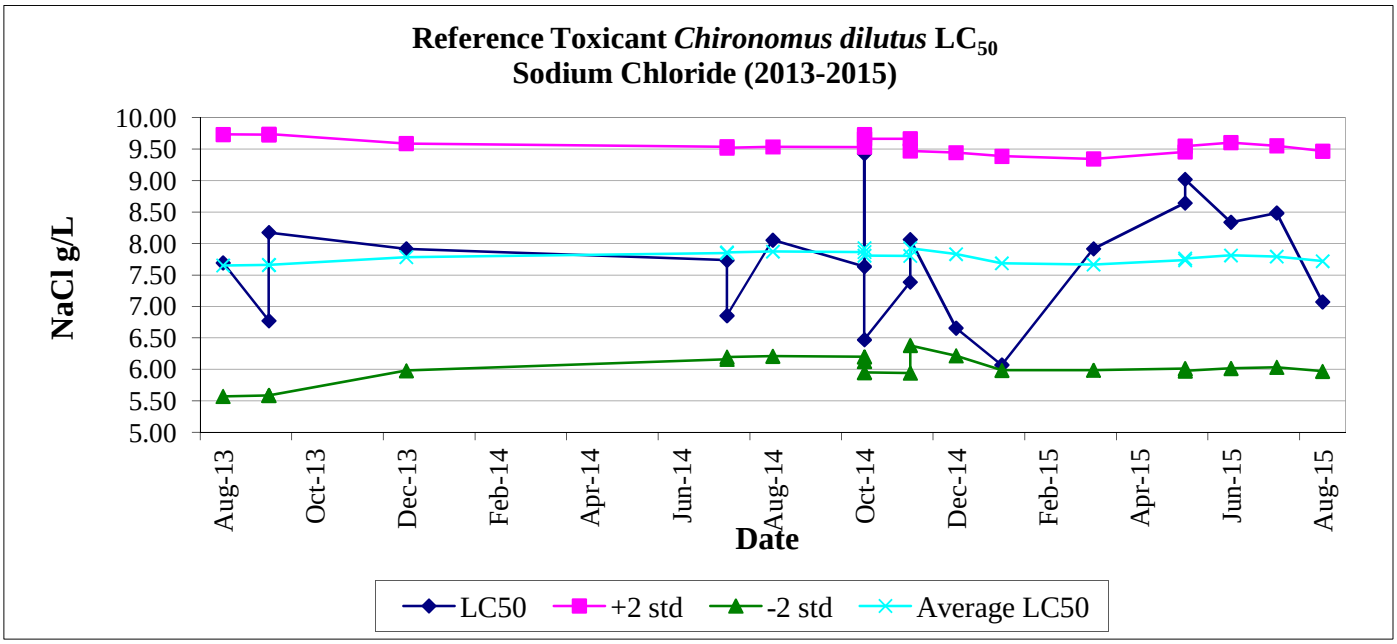
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates normal distribution (p > 0.01)	1.004663	1.035	0.765373	3.615052
Bartlett's Test indicates unequal variances (p = 4.57E-03)	25.44209	18.30704		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Heteroscedastic t Test indicates significant differences	0.012187	0.102789	0.001459	0.000348	8.5E-05	10, 92
Treatments vs SD45, SD46, LM0813						

ToxCalc v5.0.32

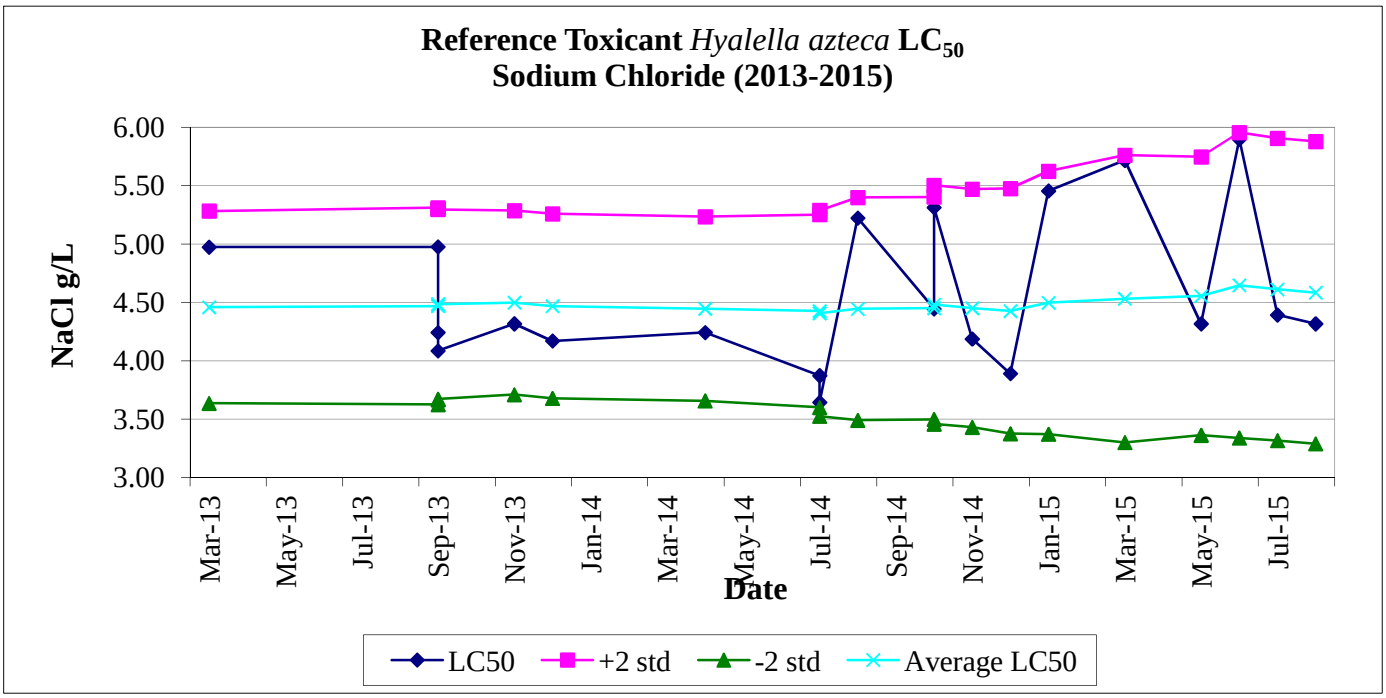
Reviewed by: MLV

Appendix E
Reference Toxicant Data



96-Hour Acute Toxicity Data for *Chironomus dilutus*

Date	Control Survival (%)	LC_{50} (g/L NaCl)	Average LC_{50} (g/L NaCl)	+2 std	-2 std
May 8, 2015	95.0	8.65	7.74	9.46	6.01
May 26, 2015	100.0	9.02	7.76	9.55	5.98
June 29, 2015	100.0	8.34	7.81	9.61	6.02
July 8, 2015	100.0	8.49	7.79	9.55	6.03
August 12, 2015	100.0	7.07	7.72	9.47	5.97



96-Hour Acute Toxicity Data for
Hyalella azteca

Date	Control Survival (%)	LC_{50} (g/L NaCl)	Average LC_{50} (g/L NaCl)	+2 std	-2 std
March 18, 2015	95.0	5.72	4.53	5.76	3.30
May 11, 2015	100.0	4.32	4.55	5.75	3.36
June 16, 2015	100.0	5.90	4.65	5.95	3.34
July 8, 2015	100.0	4.39	4.61	5.91	3.32
August 12, 2015	100.0	4.32	4.58	5.88	3.29

Appendix C

Regression Analysis

Appendix C Table 1
Regression Results : Chlorobenzene and Midge Survival
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.386574068
R Square	0.14943951
Adjusted R Square	0.072115829
Standard Error	19.58494491
Observations	13

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	741.3061841	741.3061841	1.93264868	0.19195734
Residual	11	4219.270739	383.5700672		
Total	12	4960.576923			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	90.93525306	6.251032609	14.54723703	1.57291E-08	77.17682305	104.6936831	77.17682305	104.6936831
X Variable 1	-0.002302762	0.001656428	-1.390197353	0.19195734	-0.005948535	0.001343012	-0.005948535	0.001343012

Appendix C Table 2
Regression Results : Total VOCs and Midge Survival
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.166796691
R Square	0.027821136
Adjusted R Square	-0.06939675
Standard Error	7.003712834
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	14.03735707	14.03735707	0.286173019	0.604374088
Residual	10	490.5199346	49.05199346		
Total	11	504.5572917			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	92.54726619	2.283732728	40.52456099	2.0037E-12	87.45879258	97.63573981	87.45879258	97.63573981
X Variable 1	-0.00032286	0.000603538	-0.53495142	0.604374088	-0.00166763	0.001021902	-0.00166763	0.001021902

Appendix C Table 3
Regression Results : TOC and Midge Survival
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.393652387
R Square	0.154962201
Adjusted R Square	0.070458422
Standard Error	6.529701241
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	78.18730866	78.18730866	1.833790177	0.205488707
Residual	10	426.369983	42.6369983		
Total	11	504.5572917			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	87.30373386	3.933645911	22.1941008	7.73953E-10	78.53902458	96.06844315	78.53902458	96.06844315
X Variable 1	0.000109256	8.06809E-05	1.354175091	0.205488707	-7.05122E-05	0.000289024	-7.05122E-05	0.000289024

Appendix C Table 4
Regression Results : Percent Fines and Midge Survival
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.415021277
R Square	0.17224266
Adjusted R Square	0.089466927
Standard Error	6.46259237
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	86.90629029	86.90629029	2.080835195	0.179738286
Residual	10	417.6510014	41.76510014		
Total	11	504.5572917			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	86.87252236	4.001600229	21.70944557	9.61203E-10	77.95640142	95.7886433	77.95640142	95.7886433
X Variable 1	0.084372479	0.058490047	1.442510033	0.179738286	-0.045951466	0.214696425	-0.045951466	0.214696425

Appendix C Table 5
Regression Results : Arsenic and Midge Survival
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.039339173
R Square	0.001547571
Adjusted R Square	-0.089220832
Standard Error	21.21941667
Observations	13

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	7.676842735	7.676842735	0.017049662	0.89846937
Residual	11	4952.90008	450.2636437		
Total	12	4960.576923			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	84.96773688	14.05702083	6.044505297	8.37461E-05	54.02844263	115.9070311	54.02844263	115.9070311
X Variable 1	0.264648516	2.026803206	0.130574353	0.89846937	-4.196315262	4.725612295	-4.196315262	4.725612295

Appendix C Table 6
Regression Results : Barium and Midge Survival
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.908742804
R Square	0.825813484
Adjusted R Square	0.809978346
Standard Error	8.862923854
Observations	13

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	4096.511311	4096.511311	52.15069761	1.70493E-05
Residual	11	864.0656117	78.55141924		
Total	12	4960.576923			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	95.02889582	2.719113276	34.94848731	1.26347E-12	89.04416785	101.0136238	89.04416785	101.0136238
X Variable 1	-0.004496448	0.000622644	-7.22154399	1.70493E-05	-0.005866877	-0.003126019	-0.005866877	-0.003126019

Appendix C Table 7
Regression Results : Barium and Midge Survival: SD-30 Removed
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.37125411
R Square	0.137829614
Adjusted R Square	0.051612576
Standard Error	6.595561801
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	69.54293696	69.54293696	1.598635452	0.234770572
Residual	10	435.0143547	43.50143547		
Total	11	504.5572917			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	89.64488213	2.652089586	33.80160406	1.21445E-11	83.73565829	95.55410598	83.73565829	95.55410598
X Variable 1	0.003123032	0.002470027	1.264371564	0.234770572	-0.002380532	0.008626596	-0.002380532	0.008626596

Appendix C Table 8
Regression Results : Barium and Midge Growth (AFDW)
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.744383943
R Square	0.554107455
Adjusted R Square	0.513571769
Standard Error	0.205749057
Observations	13

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.578671608	0.578671608	13.66962078	0.003518453
Residual	11	0.465659421	0.042332675		
Total	12	1.044331029			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.288128398	0.063123073	20.40661723	4.30598E-10	1.14919545	1.427061346	1.14919545	1.427061346
X Variable 1	-5.3441E-05	1.44544E-05	-3.69724503	0.003518453	-8.5255E-05	-2.1628E-05	-8.5255E-05	-2.1628E-05

Appendix C Table 9
Regression Results : Barium and Midge Biomass
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.933388418
R Square	0.871213938
Adjusted R Square	0.859506114
Standard Error	0.116346556
Observations	13

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1.007292738	1.007292738	74.41296974	3.16795E-06
Residual	11	0.148901732	0.013536521		
Total	12	1.15619447			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.177594551	0.035694706	32.99073356	2.36898E-12	1.099031032	1.25615807	1.099031032	1.25615807
X Variable 1	-7.05083E-05	8.17365E-06	-8.62629525	3.16795E-06	-8.84984E-05	-5.25182E-05	-8.84984E-05	-5.25182E-05

Appendix C Table 10
Regression Results : Barium and Midge Growth (AFDW) : SD-30 Removed
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.670513153
R Square	0.449587888
Adjusted R Square	0.394546677
Standard Error	0.179728948
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.263853393	0.263853393	8.16820484	0.017014924
Residual	10	0.323024947	0.032302495		
Total	11	0.58687834			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.386295014	0.072269396	19.1823245	3.2263E-09	1.225268764	1.547321264	1.225268764	1.547321264
X Variable 1	-0.000192367	6.73082E-05	-2.85800714	0.01701492	-0.000342339	-4.23953E-05	-0.000342339	-4.23953E-05

Appendix C Table 11
Regression Results : Barium and Midge Biomass : SD-30 Removed
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.687667392
R Square	0.472886442
Adjusted R Square	0.420175086
Standard Error	0.112318668
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.11317658	0.11317658	8.97124414	0.013453477
Residual	10	0.126154833	0.012615483		
Total	11	0.239331413			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.216796953	0.045163578	26.94199623	1.14701E-10	1.116166229	1.317427676	1.116166229	1.317427676
X Variable 1	-0.000125988	4.20632E-05	-2.995203522	0.013453477	-0.00021971	-3.22652E-05	-0.00021971	-3.22652E-05

Appendix D

Development of MATCs

Table D-1
Development of MATCs for Amphipod (*Hyalella azteca*) - Based on Laboratory Control Results
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

	Barium (mg/kg)	Mean 10 Day Survival (%)	% of Lab Control
Lab Control	--	93.8	
NONTOXIC SAMPLES			
SD-25	140	95.0	101%
SD-59	217	92.5	99%
SD-58	286	96.3	103%
SD-54	750	93.8	100%
SD-50	961	97.5	104%
SD-39	1110	93.8	100%
SD-55	1180	95.0	101%
SD-40	1500	96.3	103%
SD-32	2705	91.3	97%
SD-30	15300	92.5	99%
TOXIC SAMPLES			

	Barium (mg/kg)	Mean Ash-Free Dry Weight (mg)	% of Lab Control
Lab Control	--	0.11890	
NONTOXIC SAMPLES			
SD-25	140	0.10626	89%
SD-59	217	0.11897	100%
SD-58	286	0.11266	95%
SD-54	750	0.11953	101%
SD-50	961	0.10009	84%
SD-39	1110	0.10311	87%
SD-55	1180	0.11416	96%
SD-40	1500	0.10340	87%
SD-32	2705	0.11776	99%
TOXIC SAMPLES			
SD-30	15300	0.07949	**67%**

	Barium (mg/kg)	Biomass (mg)	% of Lab Control
Lab Control	--	0.11100	
NONTOXIC SAMPLES			
SD-25	140	0.10125	91%
SD-59	217	0.11038	99%
SD-58	286	0.10837	98%
SD-54	750	0.11225	101%
SD-50	961	0.09737	88%
SD-39	1110	0.09625	87%
SD-55	1180	0.10863	98%
SD-40	1500	0.09925	89%
SD-32	2705	0.10775	97%
TOXIC SAMPLES			
SD-30	15300	0.07338	**66%**

Endpoint which is >20% reduced from respective control or the pooled reference sample data is presented in bold face font and shaded
mg = milligram
NOEC = Yellow
LOEC = Blue

Table D-2
Development of MATCs for Amphipod (*Hyalella azteca*) - Based on Reference SD-45 Results
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

	Barium (mg/kg)	Mean 10 Day Survival (%)	% SD-45
Lab Control	--	93.8	
SD-45 - reference	87.3	92.5	
NONTOXIC SAMPLES			
SD-25	140	95.0	103%
SD-30	15300	92.5	100%
SD-32	2705	91.3	99%
SD-39	1110	93.8	101%
SD-40	1500	96.3	104%
SD-50	961	97.5	105%
SD-54	750	93.8	101%
SD-55	1180	95.0	103%
SD-58	286	96.3	104%
SD-59	217	92.5	100%
TOXIC SAMPLES			

	Barium (mg/kg)	Mean Ash-Free Dry Weight (mg)	% SD-45
Lab Control	--	0.11890	
SD-45 - reference	87.3	0.12321	
NONTOXIC SAMPLES			
SD-25	140	0.10626	86%
SD-32	2705	0.11776	96%
SD-39	1110	0.10311	84%
SD-40	1500	0.10340	84%
SD-50	961	0.10009	81%
SD-54	750	0.11953	97%
SD-55	1180	0.11416	93%
SD-58	286	0.11266	91%
SD-59	217	0.11897	97%
TOXIC SAMPLES			
SD-30	15300	0.07949	**65%**

	Barium (mg/kg)	Biomass (mg)	% SD-45
Lab Control	--	0.11100	
SD-45 - reference	87.3	0.11750	
NONTOXIC SAMPLES			
SD-25	140	0.10125	86%
SD-32	2705	0.10775	92%
SD-39	1110	0.09625	82%
SD-40	1500	0.09925	84%
SD-50	961	0.09737	83%
SD-54	750	0.11225	96%
SD-55	1180	0.10863	92%
SD-58	286	0.10837	92%
SD-59	217	0.11038	94%
TOXIC SAMPLES			
SD-30	15300	0.07338	**62%**

Endpoint which is >20% reduced from respective control or the pooled reference sample data is presented in bold face font and shaded
mg = milligram
NOEC = Yellow
LOEC = Blue

Table D-3
Development of MATCs for Midge (*Chironomus dilutus*) - Based on Laboratory Control Results
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

	Barium (mg/kg)	Mean 10 Day Survival (%)	% of Lab Control
Lab Control		97.1	
NONTOXIC SAMPLES			
SD-25	140	96.3	99%
SD-59	217	92.5	95%
SD-58	286	90.0	93%
SD-54	750	98.8	102%
SD-50	961	97.5	100%
SD-39	1110	87.5	90%
SD-55	1180	96.3	99%
SD-40	1500	90.0	93%
SD-32	2705	97.5	100%
TOXIC SAMPLES			
SD-30	15300	22.5	**23%**

	Barium (mg/kg)	Mean Ash-Free Dry Weight (mg)	% of Lab Control
Lab Control		1.3584	
NONTOXIC SAMPLES			
SD-25	140	1.23801	91%
SD-59	217	1.29272	95%
SD-58	286	1.21191	89%
SD-54	750	1.24604	92%
SD-39	1110	1.12747	83%
SD-55	1180	1.26844	93%
SD-40	1500	1.09135	80%
TOXIC SAMPLES			
SD-50	961	0.96564	**71%**
SD-32	2705	0.93929	**69%**
SD-30	15300	0.53854	**40%**

	Barium (mg/kg)	Biomass (mg)	% of Lab Control
Lab Control		1.31711	
NONTOXIC SAMPLES			
SD-25	140	1.18753	90%
SD-59	217	1.18825	90%
SD-58	286	1.08525	82%
SD-54	750	1.22871	93%
SD-55	1180	1.21803	92%
TOXIC SAMPLES			
SD-50	961	0.93850	**71%**
SD-39	1110	0.97663	**74%**
SD-40	1500	0.97706	**74%**
SD-32	2705	0.91188	**69%**
SD-30	15300	0.12600	**10%**

Endpoint which is >20% reduced from respective control or the pooled reference sample data is presented in bold face font and shaded
mg = milligram
NOEC = Yellow
LOEC = Blue

Table D-4
Development of MATCs for Midge (*Chironomus dilutus*) - Based on Reference SD-45 Results
Lake Macatawa Sediment Baseline Ecological Risk Assessment and Data Summary Report
Former BASF Corporation Howard Avenue Facility, Holland, MI

	Barium (mg/kg)	Mean 10 Day Survival (%)	% of SD-45
SD-45 - reference	87.3	92.5	
NONTOXIC SAMPLES			
SD-25	140	96.3	104%
SD-59	217	92.5	100%
SD-58	286	90.0	97%
SD-54	750	98.8	107%
SD-50	961	97.5	105%
SD-39	1110	87.5	95%
SD-55	1180	96.3	104%
SD-40	1500	90.0	97%
SD-32	2705	97.5	105%
TOXIC SAMPLES			
SD-30	15300	22.5	**24%**

	Barium (mg/kg)	Mean Ash-Free Dry Weight (mg)	% of SD-45
SD-45 - reference	87.3	1.52862	
NONTOXIC SAMPLES			
SD-25	140	1.23801	81%
SD-59	217	1.29272	85%
SD-58	286	1.21191	79%
SD-54	750	1.24604	82%
SD-55	1180	1.26844	83%
TOXIC SAMPLES			
SD-50	961	0.96564	**63%**
SD-39	1110	1.12747	**74%**
SD-40	1500	1.09135	**71%**
SD-32	2705	0.93929	**61%**
SD-30	15300	0.53854	**35%**

	Barium (mg/kg)	Biomass (mg)	% of SD-45
SD-45 - reference	87.3	1.37185	
NONTOXIC SAMPLES			
SD-25	140	1.18753	87%
SD-59	217	1.18825	87%
SD-58	286	1.08525	79%
SD-54	750	1.22871	90%
SD-55	1180	1.21803	89%
TOXIC SAMPLES			
SD-50	961	0.93850	**68%**
SD-39	1110	0.97663	**71%**
SD-40	1500	0.97706	**71%**
SD-32	2705	0.91188	**66%**
SD-30	15300	0.12600	**9%**

Endpoint which is >20% reduced from respective control or the pooled reference sample data is presented in bold face font and shaded
mg = milligram
NOEC = Yellow
LOEC = Blue

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April 29, 2016

Corrective Measures Implementation Work Plan Addendum – Lake Macatawa Sediment Removal

Former BASF Corporation
Howard Avenue Facility
Holland, Michigan

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Corrective Measures Implementation Work Plan Addendum – Lake Macatawa Sediment Removal

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Figure 2-1 Barium Concentration Distribution

Figure 2-2 Lake Macatawa Surface Dredge Area (0-2 ft) Concentrations >6,400 Removed

List of Acronyms

AECOM	AECOM Technology Services
BASF	BASF Corporation
BAZ	Bio-Active Zone
BERA	Baseline Ecological Risk Assessment
CKD	Cement Kiln Dust
CMIWP	Correct Measures Implementation Work Plan
COPCs	Constituents of Potential Concern
CY	Cubic Yard
DEQ	Department of Environmental Quality
DIP	Ductile Iron Pipe
FD/RC	Final Decision and Response to Comments
GPS	Global Positioning System
HDPE	High Density Polyethylene
mg/Kg	milligram per kilogram
ML/OL	Soft Silt and Organic Silt
NAD83	North American Datum of 1983
NPDES	National Pollutant Discharge Elimination System
RCP	Reinforced Concrete Pipe
RCRA	resource Conservation and Recovery Act
RTK	Real Time Kinematic
SF	square feet
SM	Loose Silty Sand
SP	Poorly Graded Sand
USEPA	United States Environmental Protection Agency
USC	Unified Soil Classification

1.0 Introduction

AECOM Technology Services (AECOM) has prepared this Correct Measures Implementation Work Plan (CMIWP) Addendum on behalf of BASF Corporation (BASF). The CMIWP describes the design, permitting, and construction sequence for a focused sediment removal action in Lake Macatawa adjacent to the former BASF site, in Holland, Michigan (Site).

In a January 27, 2016 communication, the U. S. Environmental Protection Agency (US EPA) Region 5 requested a Corrective Measures Work Plan for a focused sediment removal action as recommended in AECOM's November 2015 Lake Macatawa Sediment Baseline Ecological Risk Assessment (BERA). The BERA identified potential ecological risks associated with benthic receptor exposures to elevated barium concentrations in surface sediments. The sediment removal action described in this CMIWP will address these impacts through focused removal of sediments to ensure that the remaining barium concentrations in sediment are protective of benthic receptors.

1.1 Site Setting and Background

The former BASF facility is located on the northern shore of the eastern basin of Lake Macatawa within the Lake Macatawa Watershed. Figure 1-1 depicts the Site and Lake Macatawa, a five mile long freshwater body that forms at the junction of the Macatawa River with Lake Michigan. BASF operated the facility from 1979 until May 1, 1996 when it was sold to Flint Ink Corporation.

The portion of the Site that abuts Lake Macatawa is separated from the former BASF facility by Howard Avenue. The Facility's water treatment plant was formerly located in this area and has since been decommissioned. This area is currently landscaped with lawn, trees, an asphalt driveway, and a gravel parking area. The area is fenced and houses a 42 foot (ft) by 30 ft single story steel frame building located along Howard Avenue. Residential properties and condominiums are located to the east and west. The abutting properties directly on the shoreline have docks and finger piers extending into the lake.

Storm water and treated wastewater from the decommissioned plant were historically discharged to Lake Macatawa under a National Pollutant Discharge Elimination System (NPDES) permitted outfall located approximately 300 feet southeast of the shoreline. Flint Ink stopped discharging treated wastewater to the NPDES outfall in spring 2008 and currently only storm water is being conveyed via the outfall. The NPDES outfall pipe is shown on Figure 1-1.

The BASF Holland Site, including Lake Macatawa, has been under investigation as part of a Resource Conservation and Recovery Act (RCRA) Corrective Action program for much of the past decade. In August 2009, USEPA issued a Final Decision and Response to Comments (FD/RC) for the selection of Remedial Alternative for BASF Facility, Holland, Michigan (USEPA, 2009) requiring BASF to draft a work plan identifying an approach to assess sediment quality in Lake Macatawa. The USEPA Final Decision indicated that BASF should develop a scope of work "to delineate the nature and extent of sediment contamination and to conduct site specific toxicity testing to determine whether potential risks exist to aquatic habitat and biota." BASF submitted a Sediment Sampling Work Plan to USEPA Region 5 in April 2010, followed by a revised work plan in September 2010 (AECOM, 2010). The revised work plan was approved by USEPA on October 19, 2010. Subsequent to Work Plan approval, surficial and sub-surficial sediment samples were collected from Lake Macatawa adjacent to

the Site (Figure 1-2) and at nearby reference areas in July 2011. The results of this program were reported in the *Sediment Sampling* Report (AECOM, 2012) and further analyzed in the January 2013 *Proposed No Action Remedy Addendum* (AECOM, 2013) to the Sediment Sampling Report.

In March 2013 the USEPA Region 5 provided BASF with comments on both the September 2012 Sediment Sampling Report and the January 2013 *Proposed No Action Remedy* Addendum to the Sediment Sampling Report. In their March 2013 comment letter, the USEPA suggested that the *No Action Report Addendum* did not adequately address elevated concentrations of inorganic constituents (specifically barium and copper) in sediment adjacent to the BASF Site, and that additional sampling and analysis activities focused on these two inorganic COPCs is warranted. In September 2013, BASF provided USEPA Region 5 with a Work Plan Addendum, and in October 2013 BASF provided a Food Web Model to USEPA (AECOM, 2013a, b). USEPA provided comments on these documents in January 2014, and BASF responded to these comments in July 2014. USEPA submitted additional comments in October 2014 and in April 2015, BASF provided USEPA Region 5 with responses to comments on the Sediment Sampling Report, Work Plan Addendum, and Food Web Model.

Based on the above-described ecological risk assessment documents, it was determined that there are no unacceptable ecological risks to mammals, birds, or fish. However, the potential for risks to benthic organisms from exposures to surficial sediments could not be eliminated. On June 12, 2015, USEPA provided BASF with a letter approving the response to comments and the ecological evaluations. In their June 2015 approval letter, USEPA requested that BASF integrate all components of the ecological evaluation into a comprehensive Baseline Ecological Risk Assessment (BERA) report. BASF submitted the BERA report to the USEPA Region 5 on November 18, 2015. USEPA comments on the BERA were received on March 11, 2016, and the BERA report has been revised and finalized in response to these comments (and is being submitted to USEPA Region 5 concurrently with this work plan).

The BERA evaluated potential risks to the benthic community based on laboratory toxicity test results. The results of the benthic toxicity testing program indicate that there is a potential for benthic toxicity associated with exposure to barium in surficial sediments. Multiple lines of evidence were reviewed in the BERA in order to develop barium effects concentrations that are protective of benthic ecological receptors. For three of the four toxicological endpoints evaluated in the risk assessment (midge survival, amphipod survival, amphipod growth), the risk assessment determined that a barium concentration of approximately 6,400 milligrams per kilogram (mg/Kg) is protective of benthic receptors.

1.2 Remedial Action Summary

The focused sediment removal action presented in this CMIWP will include the following elements:

- Installation of temporary upland site facilities including fencing, access roads, contained stockpile and staging areas, and erosion and sediment controls
- Installation of turbidity curtains around the dredge areas
- Implementation of turbidity and ambient air monitoring
- Mechanical dredging of surficial sediments (approximately 0 to 2 feet deep) and transfer of dredge material to the upland staging area

- Sediment dewatering via gravity drainage and/or use of drying agents and treatment and discharge of any water generated
- Loading, transportation, and off-site disposal of the dewatered dredge material
- Placement of a sand cover over the dredged area
- Removal of temporary facilities and demobilization

Details for the design, permitting and construction of these elements are provided below.

1.3 CMIWP Objectives

Based on the results of the BERA, eliminating potential benthic receptor exposures to surficial sediments containing barium concentrations in excess of 6,400 mg/Kg has been established as the primary remedial action objective for this CWIWP Addendum.

This CMIWP identifies primary design considerations, establishes permit requirements, and presents a conceptual construction sequence for the focused sediment removal action. Two primary objectives of this document are (1) to gain US EPA concurrence with the scope of the response action outlined in this Work Plan, and (2) to demonstrate that the sediment removal can be implemented in a manner that is protective of the public health and the environment. The CMIWP provides a clearly established basis for preparation of the detailed design and bid documents needed to permit and implement the focused sediment removal action.

2.0 Design Considerations

This section describes the sediment removal components and presents the considerations and rationale used to design the specific elements of the remedial response action.

2.1 Design Objectives

The BERA evaluated risk to benthic receptors for four toxicological endpoints (midge survival, amphipod survival, amphipod growth, and midge growth). The results determined that a barium concentration of approximately 6,400 mg/Kg is protective of the majority of benthic receptors.

Therefore, the objective of this focused sediment removal is to ensure that barium concentrations in surficial sediments within the bioactive zone (BAZ) are below 6,400 mg/kg (the BAZ at this site has conservatively been assumed to be approximately 6 inches in depth). This objective will be achieved through a combination of sediment removal via dredging and installation of a sand cover in the dredged areas.

2.2 Dredge Limits and Volumes

The proposed dredge limits were established by evaluating barium concentrations at the samples locations shown in Figure 2-1. Sample depth intervals of 0 to 0.5 foot, 0.5 to 2 foot and 2 to 6 foot depth were evaluated separately. Barium concentrations above 6,400 mg/Kg were observed at the following sample locations:

- From 0 to 0.5 feet – sampling locations SD-25, SD-30, and SD-53
- From 0.5 to 2 feet – sampling locations SD -30, SD-31, and SD-34
- From 2 to 6 feet - no samples were characterized by barium concentrations above 6,400 mg/Kg

Thiessen Polygons of the areas with barium concentration in excess of 6,400 mg/Kg were drawn from the sample data at each depth interval. The results of this analysis are shown in Figure 2-2. The observed barium concentrations at each sample location are provided in Appendix A. This analysis indicates that, in order to achieve the remedial action objective, dredging from 0 to 2 feet depth is required over 28,760 square feet (SF); an additional 18,480 SF will need to be dredged from 0 to 0.5 feet depth. Assuming a 0.5 foot over dredge in all areas and sloughing at the dredge area perimeter, approximately 3,500 cubic yards (CY) of dredging will be required to remove the sediment with barium concentrations in excess of 6,400 mg/Kg.

2.3 Physical Setting

2.3.1 Upland Area

The upland area adjacent to the Lake will be used to offload, stage, dewater, and load out the dredged sediment. Along Howard Avenue the upland area is fairly level at elevation 603± feet above the North American Vertical Datum of 1988 (NAVD88). From the central portion of the upland area to the shoreline, grade drops approximately 23 feet (from elevation 603 to 580 feet) over roughly 200

linear feet. The topographic information is based on CDR Pigment WWTP Modifications Drawings by Rose and Westra dated December 16, 2003. These Drawings are included in Appendix B.

2.3.2 Dredge Area

The dredge areas depicted in Figure 2-2 include two distinct areas: (1) a larger area centered around sampling location SD-30 and extending approximately 50 to 300 feet off the shoreline, and (2) a smaller area centered around sampling location SD- 53 and located approximately 500 feet off the shoreline.

A bathymetric survey of the dredge areas was conducted by Hibbard Inshore in July of 2011. The results are provided in Appendix C. At the time of the survey the lake level was 578.6 feet above NAVD88. In the SD-30 dredge area the lake bottom elevation was between 570.5 to 573.5 feet. In the SD-53 area the lake bottom elevation was approximately 570.5 feet. Directly along the shoreline, the lake bottom elevation is approximately 575. Lake levels vary from elevation 576.80 to 582.50 based on information provided in the Rose and Westra Drawings. The resulting water depth would vary between 3 to 8 feet over the dredge area.

2.3.3 Outfall Pipe

The Rose and Westra Drawings (Appendix B) show the modifications to the former facilities water treatment plant and NPDES outfall. According to the Drawings:

- Stormwater and treated waste water from the plant were originally discharged through a gravity 18-inch reinforced concrete pipe (RCP) that extended to a NDPES permitted discharge location 300 from the shoreline.
- A pump chamber and an 8-inch ductile iron pipe (DIP) force main was constructed approximately 10 south of the original gravity drain. This force main also discharged 300 feet from the shoreline.
- The 8-inch DIP became the primary discharge for the treated waste water.
- A portion of the 18-inch RCP gravity drain below the lake was removed.
- The upland portion of the 18-inch RCP gravity drain was left in-place and terminated at a concrete headwall on the shoreline to discharge stormwater from the former facility.

The water treatment plant was decommissioned in 2008. Based on review of the Drawings the 8-inch DIP force main no longer discharges any water and stormwater continues to discharge through the 18-inch RCP to the headwall at the shoreline.

2.4 Sediment Properties

Logs from the sediment sample locations and results of sediment grain size results conducted during the 2012 sediment sampling are provided in Appendix D. The sediment texture across the dredge area, using Unified Soil Classification (USC) system, is predominately soft silt and organic silt (ML/OL). Closer to the shoreline the sediment is more coarse grained consisting of loose poorly graded sand (SP), to loose silty sand (SM).

Grain size varied little within individual cores. The uniform nature of the grain size down core indicates minimal changes in lake level and shoreline position in recent past, minimal storm wave impact, overall sediment stability, and relative shore stability with respect to gravity driven slope processes.

2.5 Sediment Dredging and Handling

A detailed dredge prism will be developed during the design phase. Drawings will show horizontal position of the dredge limits relative to the North American Datum of 1983 (NAD83) and the vertical position of the dredge limits relative to NAVD88. The Drawings will allow dredging equipment controlled with a Real Time Kinematic (RTK) Global Positioning System (GPS) to accurately remove the impacted sediment with maximum over-dredge of 0.5 feet.

Based on preliminary discussions with dredging contractors and given the location and quantity of the dredge material, mechanical dredging will be the preferred removal method. The design Drawings and Specifications will include provisions (e.g., use of silt curtains and best management practices) to ensure that the mechanical dredging operations are conducted in a manner that minimizes suspension of sediment in the water column. Provisions to ensure that dredged sediment is not released outside the dredge area during transfer to and off loading at the shoreline will also be established.

The dredged sediment will be dewatered prior to loading and shipment to off-site disposal facilities. The dried sediment will need to pass the Paint Filter Test (ASTM STP993) before loading. Drying may be achieved through gravity drainage or by mixing with a dry reagent (cement kiln dust [CKD], lime, Calciment®, or other proprietary reagents). Given the sediment texture, gravity drainage alone is unlikely to yield sufficient drying. Reagent mixing may take place directly on the deck of a watertight transfer barge or in a lined mixing area in an upland support area. Any water generated during dewatering will be transferred to an off-site treatment facility or managed on site with a temporary water treatment system. Treatment at the existing groundwater treatment facility on the main Site will also be evaluated in the design phase.

A temporary haul road will be constructed across the upland area from Howard Avenue to the shoreline off-loading area. If sediment dewatering takes place in the transfer barges, then dewatered sediment could be loaded directly into trucks and shipped off-site. Alternatively, sediment may be transferred, via an off-rod truck, to a staging area located on the level portion of the upland area where it will be dewatered and loaded into trucks for off-Site disposal.

Trucks carrying sediment off-site will have beds lined with plastic sheeting bed liners. The sediment will be disposed of at a Type II Solid Waste Landfill. A decontamination area and gravel construction exit will be installed to ensure that sediment, silt, or dust is not tracked onto Howard Avenue.

2.6 Monitoring and Controls

The design documents will include requirements for turbidity control and monitoring at the perimeter of the dredge area. A single line of turbidly curtain will be deployed and maintained around the active dredge and off-loading areas. Type I curtain should be sufficient given the relatively calm water currents in this area. If wakes from recreational boating are determined to be a substantive design consideration, the use of Type II curtain may be considered. The curtain will be set in a manner that limits lake access from the boat docks belonging to the adjacent residential properties and condominiums.

Buoys with real time turbidity monitors will be placed just outside the silt curtain (alternatively, turbidity will be monitored by field technicians from a small jon boat or equivalent). The design will establish turbidity action levels including warning and stop work levels. Dredging practices will be adjusted as needed to ensure that sustained exceedance of the action levels does not occur.

Any upland staging areas will be bermed and lined with 40-mil high density polyethylene (HDPE) sheeting or equivalent. Ambient dust monitoring will be conducted at the perimeter of the upland area to ensure that off-site dust emissions are not generated by the work.

2.7 Restoration and Backfill

The design Drawings will also provide the horizontal and vertical limits of backfill relative to NAD83 and NAVD88. The dredge limits will backfilled with one to three feet of sand (USC designation of SP, SW or SM). The sand backfill will be broadcast directly at the sediment surface (not dumped into the water column) in thin lifts (3 to 6 inches). This will minimize intermingling of sediment and backfill and ensure that a discrete sand cover is established over the dredge area. It is likely that the soft silt sediment will settle 0.5 to 1 foot under the load from the backfill. Post dredging and post backfill bathymetric surveys will be conducted to document the extent of the dredge area and the backfill cover.

2.8 Pre-Design Investigation

Completing the detailed design of the focused sediment removal action will require additional data and information including:

- Updated Bathymetric Survey – An updated survey will be conducted to ensure that the design dredge prism is consistent with the bathymetric surface at the time the dredging takes place.
- Disposal Facility Pre-characterization – Sediment samples in the dredge area will be collected and analyzed as needed to gain disposal facility acceptance. This will allow dewatered material to be loaded directly and minimize the need for staging in the upland area.
- Drying/Dewatering Study – Sediment samples will be collected and subject to dewatering studies, including gravity drainage studies and amendment studies (e.g., sediment will be mixed with varying percentages of drying reagents to determine the optimal drying procedures).

3.0 Permitting

Completing the focused sediment removal action will require:

- A Part 301 Inland Lakes and Streams permit from the Michigan Department of Environmental Quality (DEQ)
- A Clean Water Act Section 404 or a Nationwide 38 permit from the US Army Corps of Engineers.

There also may be some co-ordination with the U.S. Coast Guard required since this area is used by commercial and recreational boats. The time to process the permits is expected to range from three to six months.

4.0 Construction Sequence

The exact construction sequence and procedures required to implement the sediment removal action will be determined by the selected Contractor (as approved by BASF) and within the framework presented in the design documents approved by USEPA. A conceptual sequence for this project, consistent with standard practice, would include:

- Mobilization
  - Obtain all state and federal environmental permits and licenses
  - Conduct a pre-dredge bathymetric survey
  - Conduct preconditions survey of the roadway
  - Preparation of Contactor submittals
  - Obtaining any local permits, approvals, or access agreements
  - Install all required upland erosion and siltation controls.
  - Mobilizing the required equipment, materials and personnel to the Site.
- Install temporary facilities;
  - Construct a temporary site haul road.
  - Construct a lined (40 mil HDPE) sediment mixing, staging and truck loading areas
  - Install a temporary portable loading dock on the shoreline which will allow shallow water access for the floating equipment and transfer of sediment with minimal disturbance to the shoreline
  - Install temporary erosion control silt fencing
  - Provide support trailers and temporary sanitary facilities and waste service.
- Install site controls
  - Conduct any background or baseline monitoring (air and water column)
  - Install turbidity curtain
  - Install turbidity monitors
  - Install fence line dust monitors
- Dredge sediment
  - Mobilize dredge barge, dredge equipment, transfer barges, and support boats to the dredge area directly from the site or from a boat ramp at another location along the Lake
  - Arrange and spud sectional barges to create a dredging platform (roughly 50 ftx 50 ft)
  - Dredge the sediment to the limits shown on the Drawings from the dredging platform using a long reach excavator with RTK GPS controls

  - Transfer the dredge material from the dredging platform to material transfer barges using a long reach material handler equipped with a hydraulic clamshell bucket. Potentially transfer sediment to a watertight dewatering barge if it is determined in the design phase that this represents the best dewatering option).
  - Transfer and off-load the sediment at the temporary portable dock.
- Dewater and dispose of the dredge material
  - Gravity dewater sediment to the extent practicable.
  - Mix in drying reagents until material passes Paint Filter Test
  - Load material into lined trucks and transport to a Type II Solid Waste Landfill for Disposal.
- Backfill the dredge areas with clean sand
  - Transfer backfill to the dredging platform
  - Place the backfill in thin lifts directly at the sediment surface to the grades shown on the Drawings.
- Conduct post dredge and post backfill bathymetric surveys
- Demobilize all equipment, materials, and temporary facilities.

The total project implementation duration is estimated at approximately 10 weeks. This includes 2 weeks for mobilization and setup, 3 weeks for dredging, 2 weeks for backfilling, and 2 weeks for demobilization. This would require a dredging processing rate of approximately 200 CY/day which is conservative under these circumstances

5.0 Corrective Measures Schedule

Immediately following US EPA approval of the CMIWP, BASF will begin design of the sediment removal action. Primary tasks would include:

- Pre-design Investigation (3 months)
- Preparation of remedial design documents (3 months)
- Permitting (6 months)
- Contactor Procurement (2.5 months)
- Sediment Removal Implementation (2.5 months)

Assuming that there is some overlap in the design, procurement and permitting tasks, the sediment removal can be completed within approximately one year of USEPA approval of the CMIWP.

Figures

Map Location

N
W E
S

BASF - Holland, Michigan Former Facility
Corrective Measures Implementation Work Plan Addendum
Lake Macatawa Sediment Removal
Site Location

0 250 500 1,000 Feet

Outfall Pipe
BASF Property Boundary

AECOM

Project # 60217278
April 2016

Figure 1-1

\\uschl1fp001\Data\Projects\Jobs\Indl_Service\Project Files\BASF-0760\Holland 0760-044\2016 Planning\2016GIS\Figure1-1_SiteLocation.mxd

Map Location

N
W E
S

BASF - Holland, Michigan Former Facility
Corrective Measures Implementation Work Plan Addendum
Lake Macatawa Sediment Removal
Sediment Sampling Locations

0 125 250 500 Feet

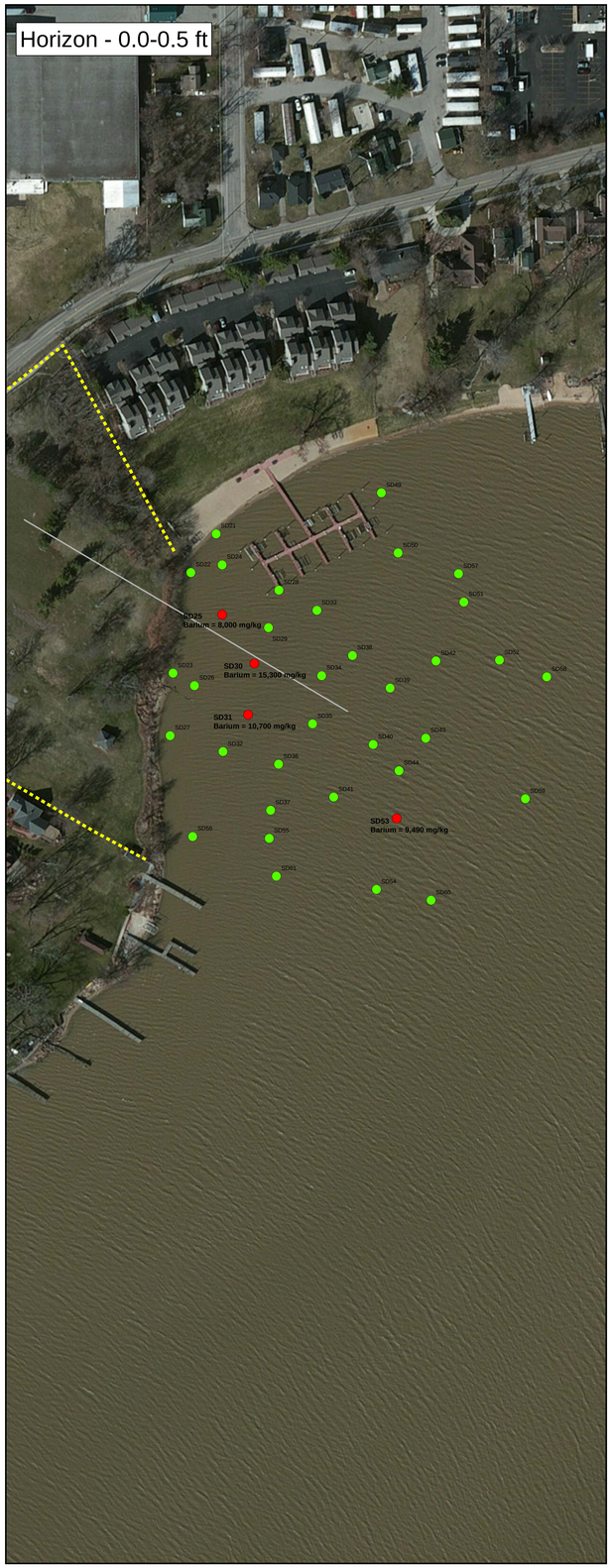
- 2011 Sediment Sampling Location
- 2015 Sediment Sampling Location
- Outfall Pipe
- BASF Property Boundary
- Adjacent Offshore Sediment
- Adjacent Nearshore Sediment

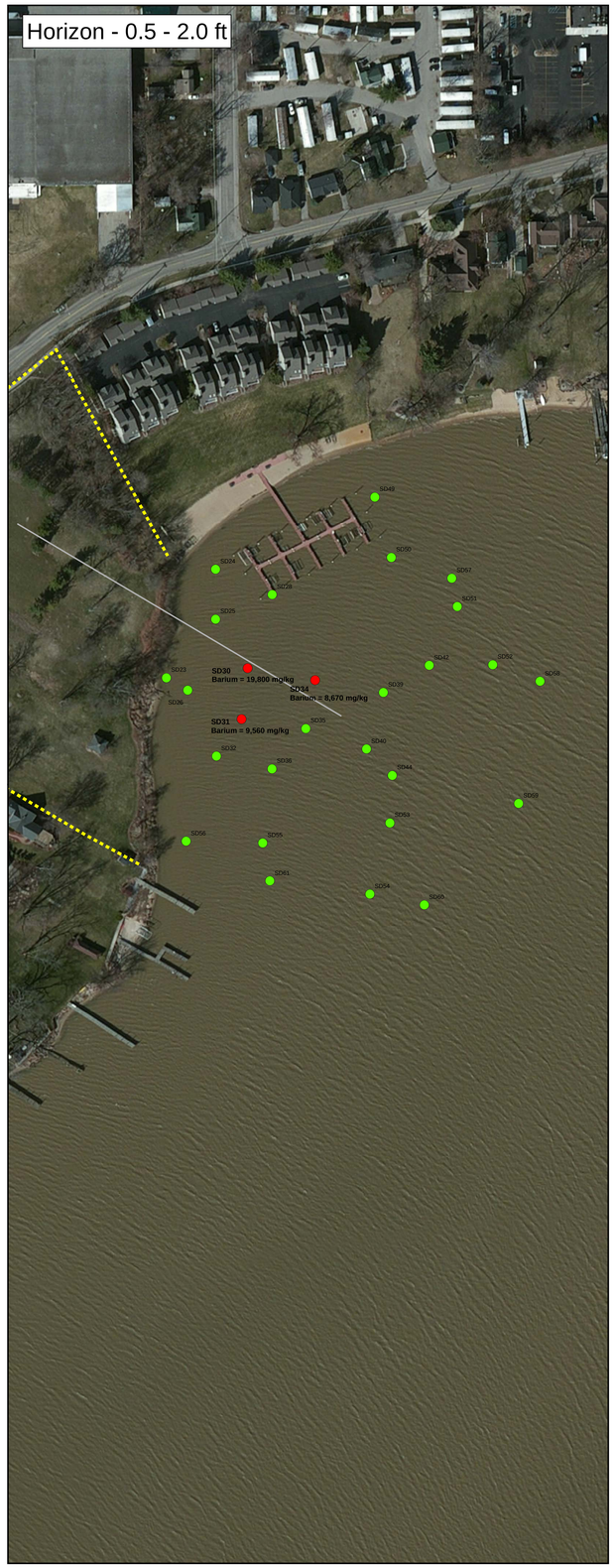
AECOM

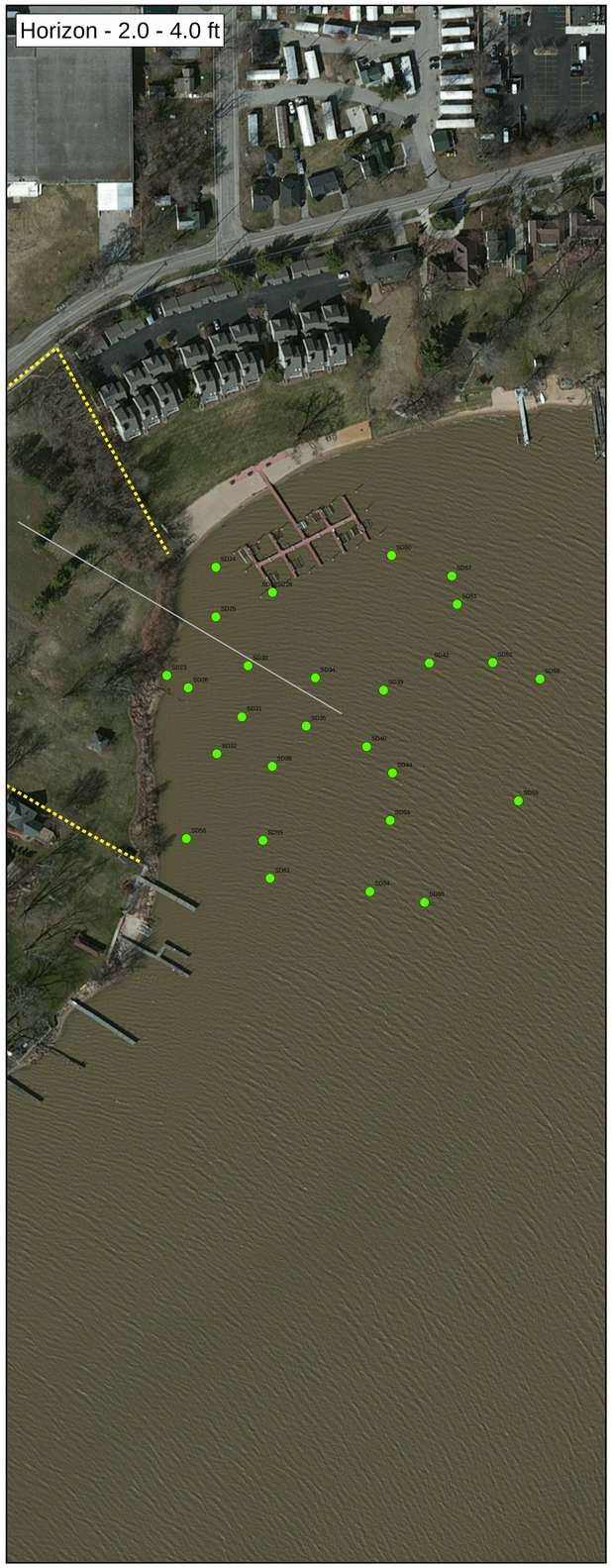
Project # 60217278
April 2016

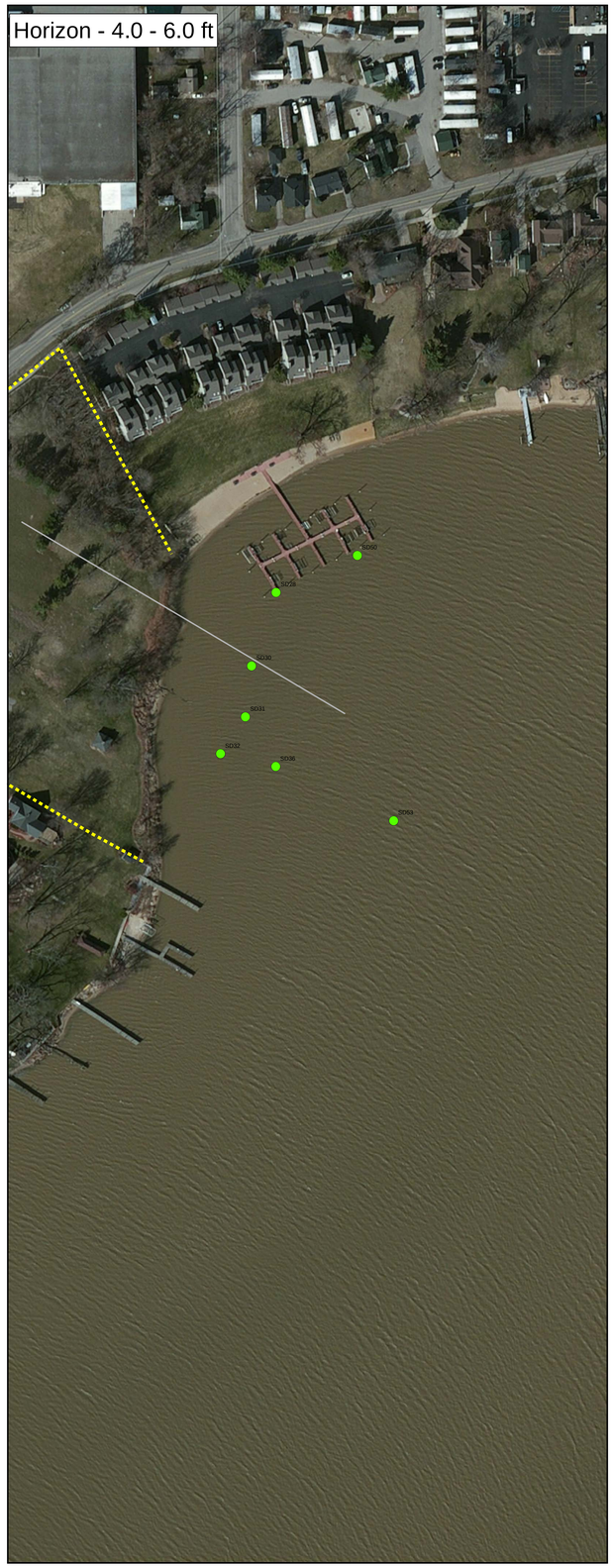
Figure 1-2

\\uschl1fp001\Data\Projects\Jobs\Indl_Service\Project Files\BASF-0760\Holland 0760-044\2016 Planning\2016GIS\SamplingLocations2011_2015_rev.mxd









Map Location

BASF - Holland, Michigan Former Facility
Corrective Measures Implementation Work Plan Addendum
Lake Macatawa Sediment Removal
Barium Concentraions (mg/Kg)

0 250 500 1,000 Feet

Outfall Pipe
BASF Property Boundary
Adjacent Offshore Sediment
Adjacent Nearshore Sediment

Barium (mg/Kg)
<6400
>6400

AECOM

Project # 60217278
April 2016

Figure 2-1

\\uschl1fp001\Data\Projects\Jobs\Indl_Service\Project Files\BASF-0760\Holland 0760-044\2016 Planning\2016GIS\Barium_Points_To6Ft_2016.mxd

Map Location

N
W E
S

BASF - Holland, Michigan Former Facility
Corrective Measures Implementation Work Plan Addendum
Lake Macatawa Surface Dredge Areas (0-2 ft)
Concentrations >6,400 Removed

0 137.5 275 550 Feet

Outfall Pipe (Approximate Location of NPDES Outfall)
BASF Property Boundary
Adjacent Offshore Sediment
Adjacent Nearshore Sediment
0.5 Foot Boundary
2.0 Foot Boundary

Barium (mg/Kg)
<6,400
6,400 - 15,299
>15,300

AECOM

Project # 60217278
April 2016

Figure 2-2

\\uschl1fp001\Data\Projects\Jobs\Indl_Service\Project Files\BASF-0760\Holland 0760-044\2016 Planning\2016GIS\BariumRemoval6400_rev.mxd

Appendix A

Barium Concentrations

UPDATED 04/15/16

Surface (0.0 - 0.5)				
Location	Depth	Barium (mg/kg)	Year	SqFt
SD21	0 - 0.5	7.80	2011	6,821.36
SD22	0 - 0.5	10.00	2011	4,481.39
SD27	0 - 0.5	14.30	2011	8,374.53
SD49	0 - 0.5	24.60	2011	18,570.00
SD23	0 - 0.5	29.80	2011	5,594.57
SD24	0 - 0.5	148.00	2011	4,913.99
SD57	0 - 0.5	232.00	2011	29,520.00
SD59	0 - 0.5	242.00	2011	27,110.00
SD56	0 - 0.5	246.00	2011	17,660.00
SD58	0 - 0.5	286.00	2015	25,280.00
SD52	0 - 0.5	395.00	2011	15,970.00
SD26	0 - 0.5	489.00	2011	6,134.18
SD61	0 - 0.5	647.00	2011	17,270.00
SD51	0 - 0.5	650.00	2011	9,165.29
SD60	0 - 0.5	700.00	2011	20,490.00
SD35	0 - 0.5	850.00	2011	7,785.14
SD50	0 - 0.5	961.00	2015	15,330.00
SD36	0 - 0.5	990.00	2011	6,472.51
SD28	0 - 0.5	1,020.00	2011	13,910.00
SD31	0 - 0.5	1,090.00	2011	6,366.48
SD34	0 - 0.5	1,120.00	2011	6,562.47
SD42	0 - 0.5	1,160.00	2011	11,130.00
SD55	0 - 0.5	1,180.00	2015	6,122.86
SD33	0 - 0.5	1,200.00	2011	11,660.00
SD41	0 - 0.5	1,220.00	2011	11,990.00
SD37	0 - 0.5	1,600.00	2011	6,087.27
SD39	0 - 0.5	1,960.00	2011	7,859.47
SD38	0 - 0.5	2,370.00	2011	8,761.20
SD43	0 - 0.5	2,550.00	2011	13,850.00
SD32	0 - 0.5	2,620.00	2015	8,755.95
SD54	0 - 0.5	3,080.00	2011	17,620.00
SD44	0 - 0.5	3,090.00	2011	5,169.83
SD40	0 - 0.5	3,470.00	2011	7,139.14
SD29	0 - 0.5	3,480.00	2011	5,047.77
SD25	0 - 0.5	8,000.00	2011	6,945.92
SD53	0 - 0.5	9,490.00	2015	11,530.00
SD30	0 - 0.5	15,300.00	2015	6253.34

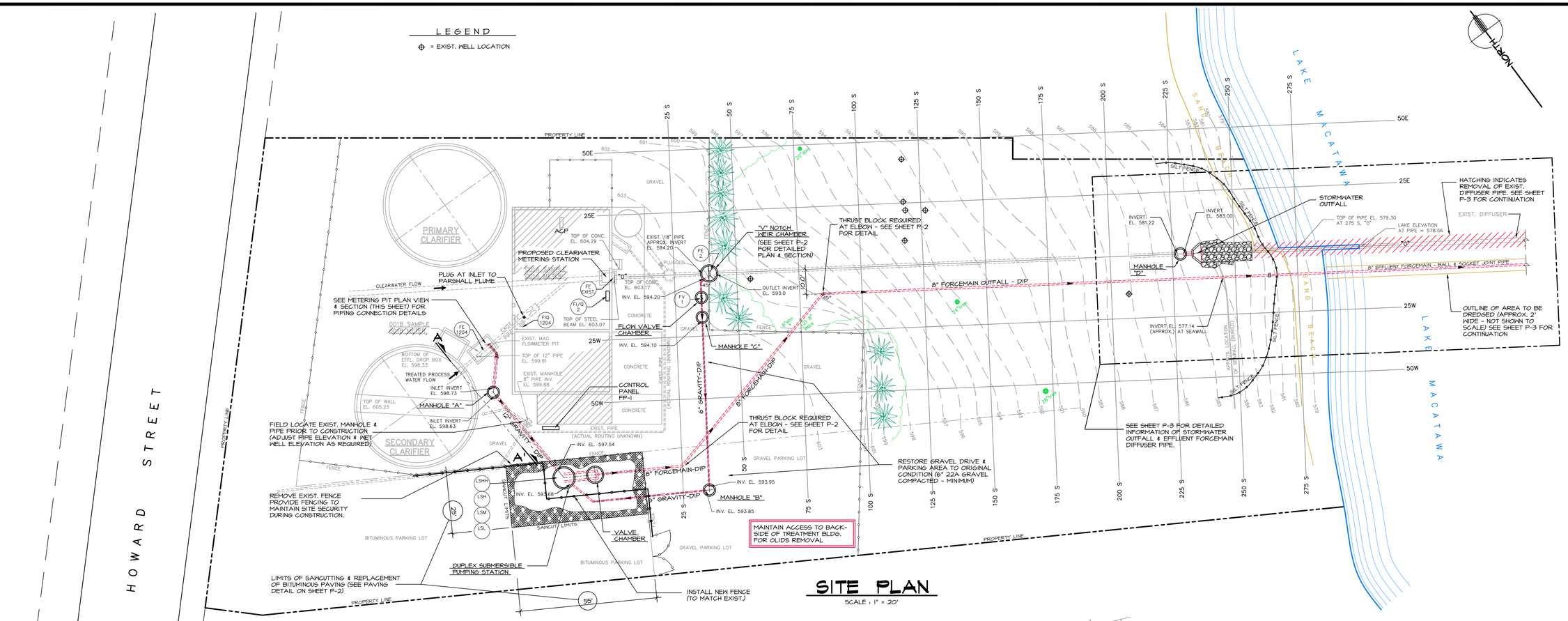
0.5 - 2.0				
Location	Depth	Barium (mg/kg)	Year	SqFt
SD49	0.5 - 2	16.80	2011	18,940.00
SD24	0.5 - 2	84.40	2011	13,510.00
SD26	0.5 - 2	105.00	2011	8,083.23
SD23	0.5 - 2	199.00	2011	8,273.98
SD39	0.5 - 2	331.00	2011	12,340.00
SD25	0.5 - 2	373.00	2011	8,874.03
SD59	0.5 - 2	394.00	2011	28,530.00
SD58	0.5 - 2	548.00	2011	25,280.00
SD52	0.5 - 2	621.00	2011	16,700.00
SD57	0.5 - 2	704.00	2011	29,520.00
SD60	0.5 - 2	707.00	2011	20,480.00
SD54	0.5 - 2	879.00	2011	19,060.00
SD50	0.5 - 2	1,110.00	2011	18,410.00
SD44	0.5 - 2	1,210.00	2011	12,460.00
SD42	0.5 - 2	1,440.00	2011	14,220.00
SD61	0.5 - 2	1,450.00	2011	17,870.00
SD51	0.5 - 2	1,520.00	2011	9,165.29
SD53	0.5 - 2	1,810.00	2015	13,940.00
SD56	0.5 - 2	2,040.00	2011	19,200.00
SD55	0.5 - 2	2,230.00	2011	11,740.00
SD35	0.5 - 2	2,430.00	2011	9,229.39
SD32	0.5 - 2	2,760.00	2015	11,650.00
SD28	0.5 - 2	3,440.00	2015	23,380.00
SD36	0.5 - 2	4,170.00	2015	10,280.00
SD40	0.5 - 2	4,720.00	2011	9,783.64
SD34	0.5 - 2	8,670.00	2011	13,930.00
SD31	0.5 - 2	9,560.00	2015	6,366.48
SD30	0.5 - 2	19,800.00	2015	8,470.59

2.0 - 4.0				
Location	Depth	Barium (mg/kg)	Year	SqFt
SD26	2 - 3	6.10	2011	8,083.23
SD24	2 - 4	10.20	2011	13,530.00
SD25	2 - 3	21.20	2011	8,874.03
SD23	2 - 4	29.50	2011	8,273.98
SD60	2 - 4	169.00	2011	20,490.00
SD56	2 - 4	188.00	2011	19,210.00
SD58	2 - 4	198.00	2011	25,280.00
SD59	2 - 4	203.00	2011	28,530.00
SD54	2 - 4	212.00	2011	19,050.00
SD52	2 - 4	241.00	2011	16,700.00
SD39	2 - 4	263.00	2011	12,340.00
SD35	2 - 4	299.00	2011	9,229.39
SD57	2 - 4	319.00	2011	29,870.00
SD42	2 - 4	331.00	2011	14,220.00
SD50	2 - 4	344.00	2015	34,460.00
SD53	2 - 4	400.00	2015	13,940.00
SD28	2 - 4	403.00	2015	25,900.00
SD44	2 - 4	649.00	2011	12,460.00
SD51	2 - 4	664.00	2011	9,165.29
SD55	2 - 4	671.00	2011	11,740.00
SD61	2 - 4	994.00	2011	17,870.00
SD40	2 - 4	1,020.00	2011	9,783.64
SD32	2 - 4	1,690.00	2015	11,650.00
SD36	2 - 4	1,810.00	2015	10,280.00
SD34	2 - 4	2,000.00	2011	13,930.00
SD31	2 - 4	3,080.00	2015	6,366.48
SD30	2 - 4	5,080.00	2015	8,470.59

Barrium > 6,400 mg/kg

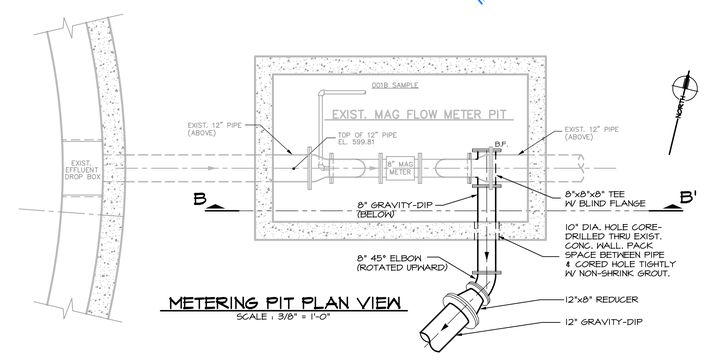
Appendix B

Outfall Drawings



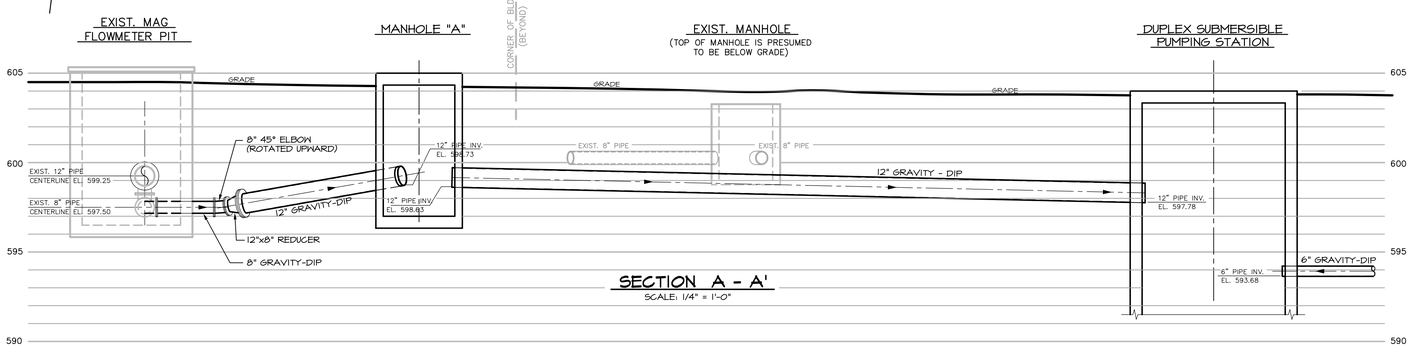
SITE PLAN

SCALE : 1" = 20'



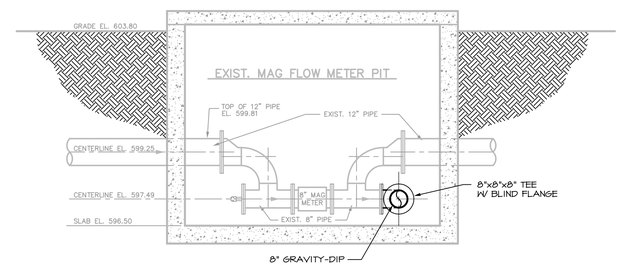
METERING PIT PLAN VIEW

SCALE : 3/8" = 1'-0"



SECTION A - A'

SCALE: 1/4" = 1'-0"



METERING PIT SECTION B-B'

SCALE : 3/8" = 1'-0"

DRAWN BY	DESIGN BY	DATE
KJB	BLR	12/16/03

FILE NO.: P1

NO.	REVISIONS	BY	DATE

REVISED IN ACCORDANCE WITH CONSTRUCTION RECORDS

CDR PIGMENTS

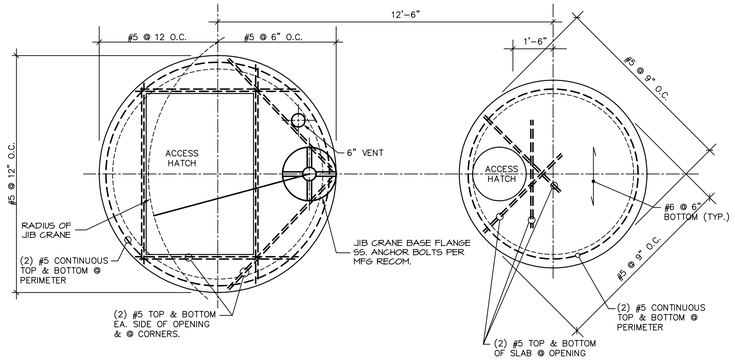
471 HOWARD AVENUE, HOLLAND, MICHIGAN

W.W.T.P. MODIFICATIONS

ROSE & WESTRA, INC.
ENVIRONMENTAL CONSULTANTS
Grand Rapids, Michigan

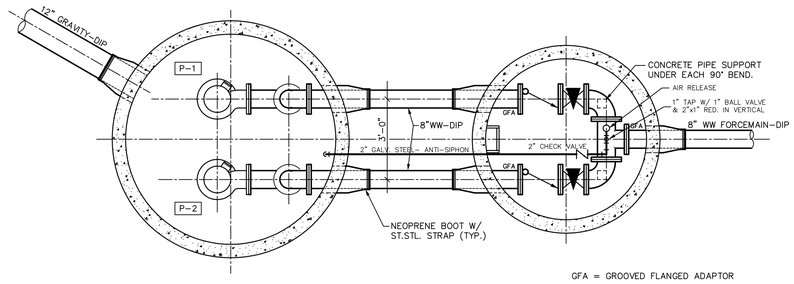
PROJECT NO. 0286.01379.3

SHEET NO. P-1



TOP SLAB PLAN - (STRUCTURAL)

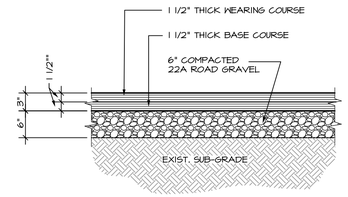
COORDINATE LAYOUT WITH PUMP MANUFACTURER



GFA = GROOVED FLANGED ADAPTOR

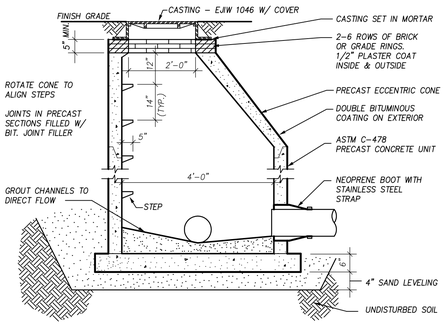
PUMP STATION PLAN VIEW

COORDINATE LAYOUT WITH PUMP MANUFACTURER



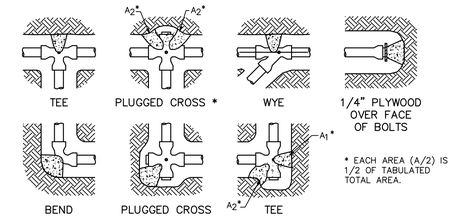
BITUMINOUS PAVING DETAIL

NO SCALE



STANDARD SANITARY MANHOLE

NO SCALE



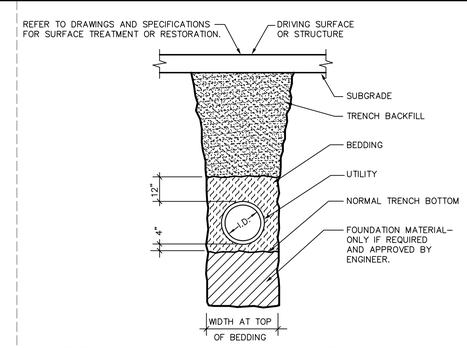
NOTES:

1. KEEP CONCRETE CLEAR OF JOINT AND JOINT ACESSORIES. PLACE BUILDING PAPER OR PLASTIC BETWEEN FITTING AND CONCREATE.
2. POUR CONCRETE THRUST BLOCK AGAINST UNDISTURBED EARTH.
3. REQUIRED VOLUMES OR BEARING AREAS AT FITTING SHALL BE AS INDICATED BELOW. ADJUSTED, IF NECESSARY, TO CONFORM TO THE TEST PRESSURE(S) AND ALLOWABLE SOIL BEARING STRESS(ES) STATED IN THE SPECIFICATIONS.
4. THRUST BLOCK VOLUMES FOR VERTICAL BENDS HAVING UPWARD RESULTANT THRUSTS ARE BASED ON TEST PRESSURE OF 150 PSIG AND THE WEIGHT OF CONCRETE = 4050 LBS./CU.YD. TO COMPUTE VOLUMES FOR DIFFERENT TEST PRESSURES, USE THE FOLLOWING EQUATION: VOLUME = (TEST PRESS./150) x (TABLE VALUE)
5. BEARING AREAS FOR HORIZONTAL BEND THRUST BLOCKS ARE BASED ON TEST PRESSURE OR 150 PSIG AND AN ALLOWABLE SOIL BEARING STRSS OF 2000 LBS./SQ.FT. TO COMPUTE BEARING AREAS FOR DIFFERENT TEST PRESSURES AND SOIL BEARING STRESSES, USE THE FOLLOWING EQUATION: BEARING AREA = (TEST PRESS./150) x (2000/SOIL BEARING STRESS) x (TABLE VALUE)
6. THRUST BLOCKS FOR VERTICAL BENDS HAVING DOWNWARD RESULTANT THRUSTS SHALL BE THE SAME AS FOR THE HORIZONTAL BENDS.
7. BEARING AREAS, VOLUMES AND SPECIAL BLOCKING DETAILS SHOWN ON DRAWINGS TAKE PRECEDENCE OVER THIS STANDARD.
8. BEARING AREA OF THRUST BLOCK SHALL NOT BE LESS THAN 1.0 SQ.FT.
9. VERTICAL BENDS THAT REQUIRE A THRUST BLOCK VOLUME EXCEEDING 5 CUBIC YARDS REQUIRE SPECIAL BLOCKING DETAILS. SEE DRAWINGS.
10. CONCRETE SHALL BE 3000 PSI.

BEARING AREA OF THRUST BLOCKS IN SQ. FT. (HORIZONTAL BENDS)												VOLUME OF THRUST BLOCK IN CUBIC YARDS (VERTICAL BENDS)			
FITTING SIZE	TEE, WYE PLUG, OR CAP	90° BEND PLUGGED CROSS	TEE PLUGGED RUN		BEND ANGLE							FITTING SIZE	BEND ANGLE		
			A1	A2	45°	22.5°	11.25°						45°	22.5°	11.25°
4" & SMALLER	1.0	1.4	1.0	1.4	1.0	1.0	1.0					4" & SMALLER	1.1	0.4	0.2
6"	2.1	3.0	2.1	3.0	1.6	1.0	1.0					6"	2.7	1.0	0.4
8"	3.8	5.3	3.8	5.3	2.9	1.5	1.0					8"	4.0	1.5	0.6
10"	5.9	8.4	5.9	8.4	4.6	2.4	1.2					10"	6.0	2.3	0.9
12"	8.5	12.0	8.5	12.0	6.6	3.4	1.7					12"	8.5	3.2	1.3

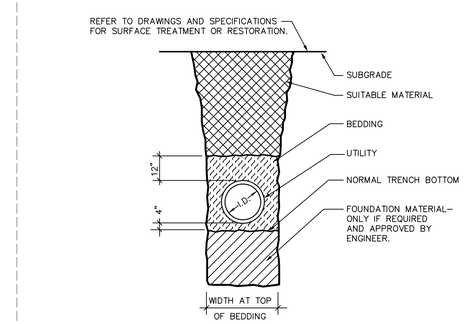
THRUST BLOCK DETAIL (C03)

NO SCALE



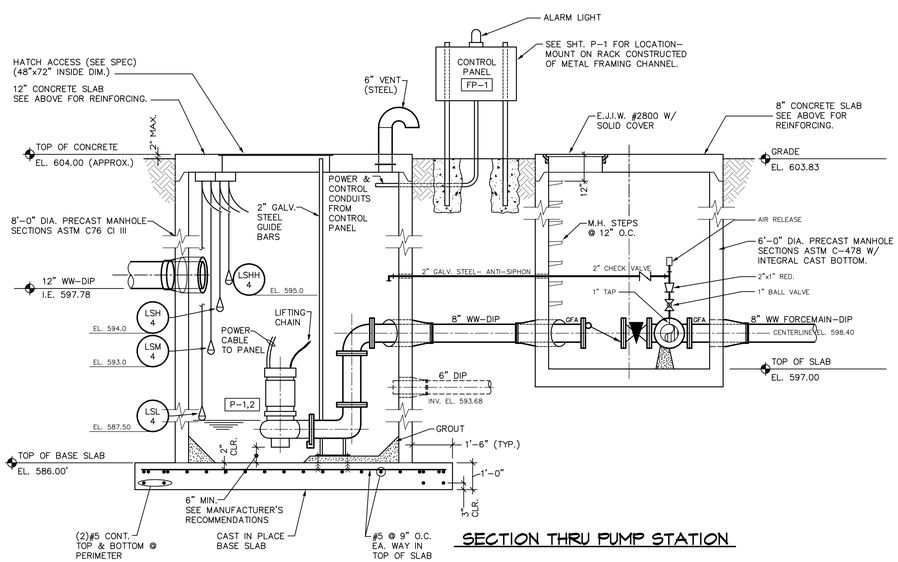
TRENCH BELOW DRIVING SURFACE OR STRUCTURE

NO SCALE



TRENCH NOT ADJACENT TO DRIVING SURFACE OR STRUCTURE

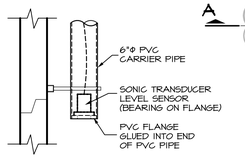
NO SCALE



SECTION THRU PUMP STATION

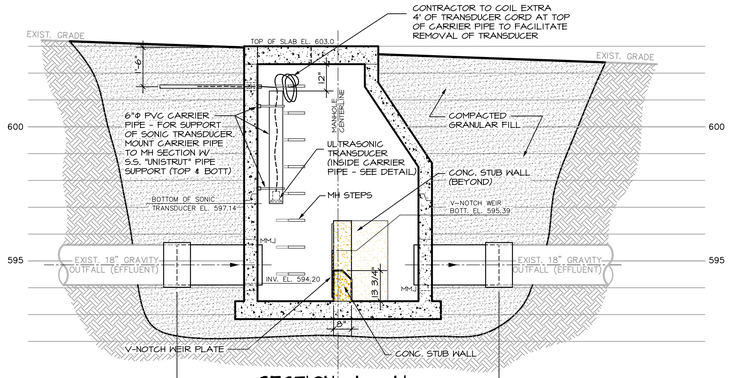
DUPLEX SUBMERSIBLE PUMPING STATION

SCALE: 3/8" = 1'-0"

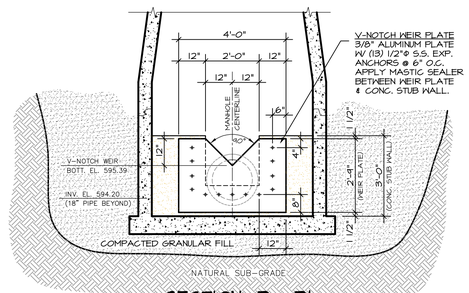


ENLARGED DETAIL OF SONIC TRANSDUCER SUPPORT

SCALE: 3/4" = 1'-0"

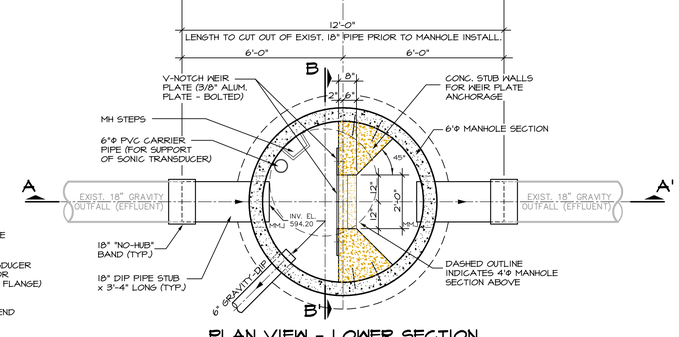


SECTION A - A'

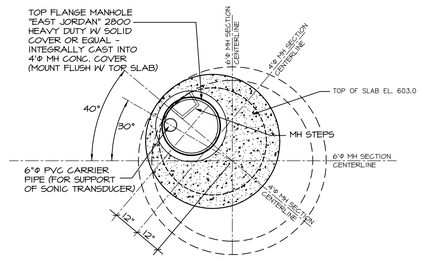


SECTION B - B'

MM.J = MODULAR MECHANICAL JOINT SEAL



PLAN VIEW - LOWER SECTION



PLAN VIEW - UPPER

"V" NOTCH WEIR CHAMBER DETAILS

SCALE: 3/8" = 1'-0"

NO.	REVISIONS	BY	DATE

REVISED IN ACCORDANCE WITH CONSTRUCTION RECORDS

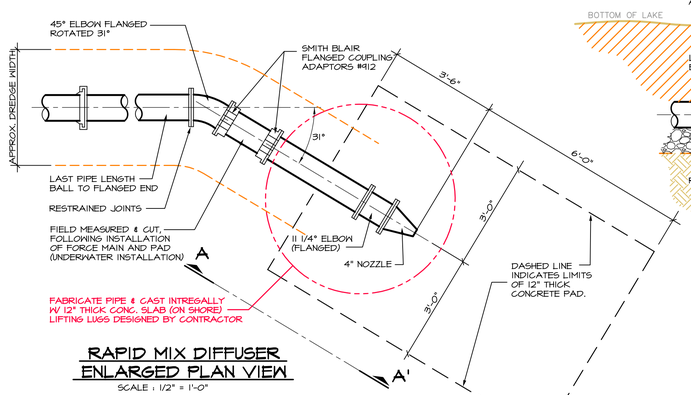
DRAWN BY: KJB
DESIGN BY: BLR
DATE: 12/12/03
FILE NO.: P2

CDR PIGMENTS
471 HOWARD AVENUE, HOLLAND, MICHIGAN
W.W.T.P. MODIFICATIONS

ROSE & WESTRA, INC.
ENVIRONMENTAL CONSULTANTS
Grand Rapids, Michigan

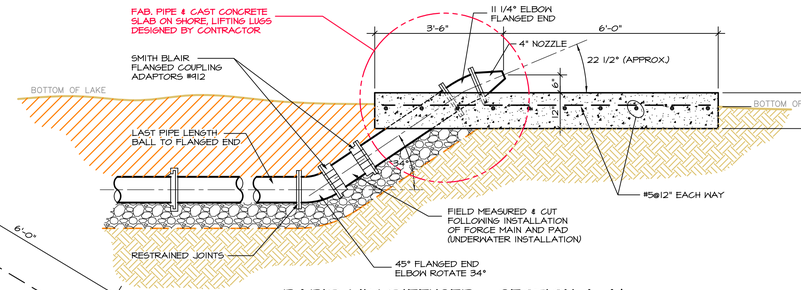
PROJECT NO. 0286.01379.3

SHEET NO. P-2



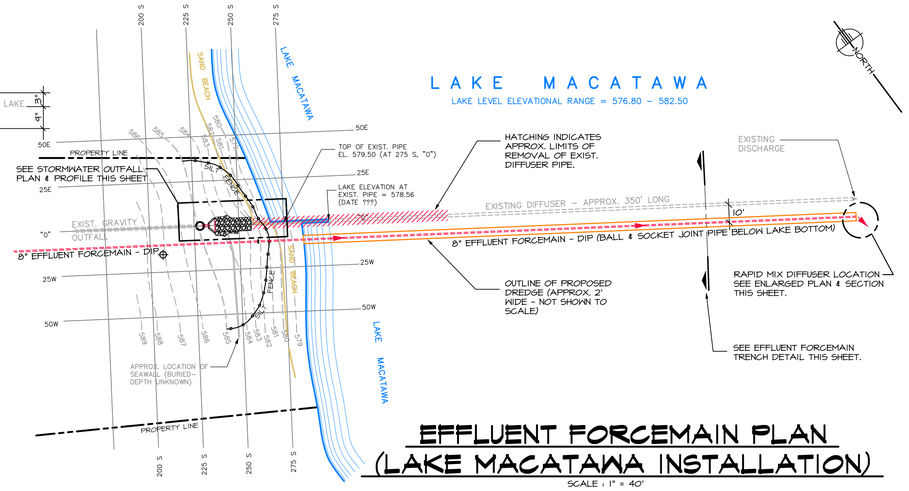
RAPID MIX DIFFUSER ENLARGED PLAN VIEW

SCALE : 1/2" = 1'-0"



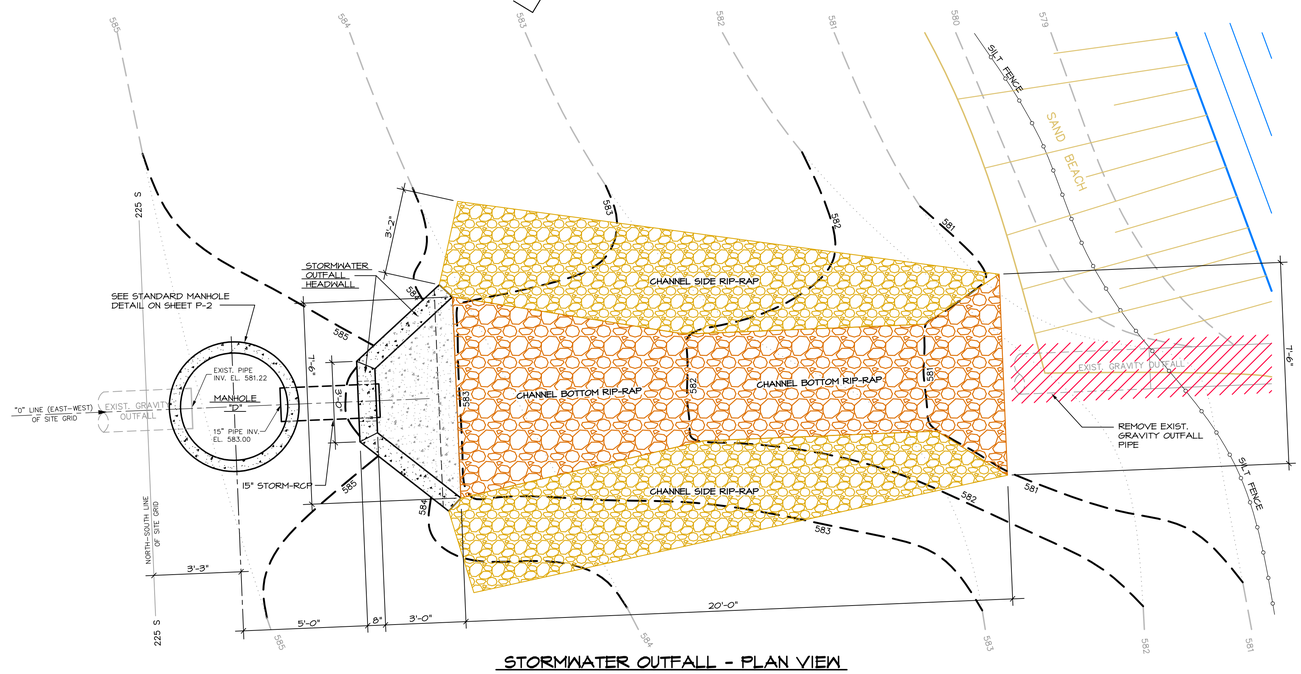
RAPID MIX DIFFUSER - SECTION A-A'

SCALE : 1/2" = 1'-0"



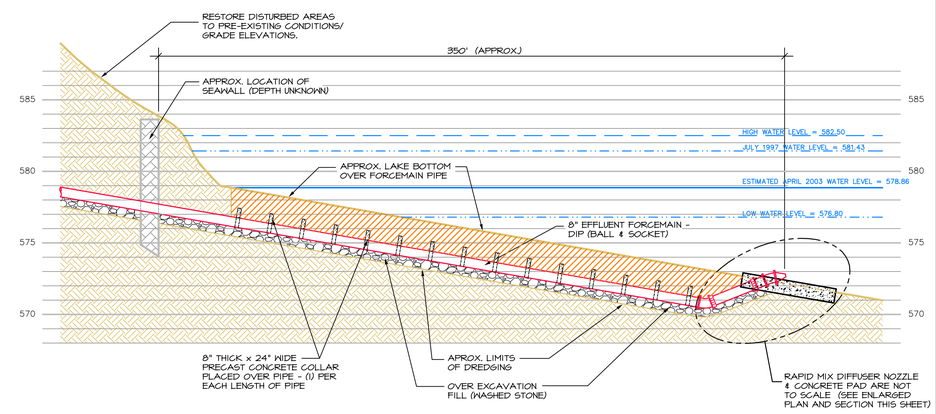
EFFLUENT FORCEMAIN PLAN (LAKE MACATAWA INSTALLATION)

SCALE : 1" = 40'



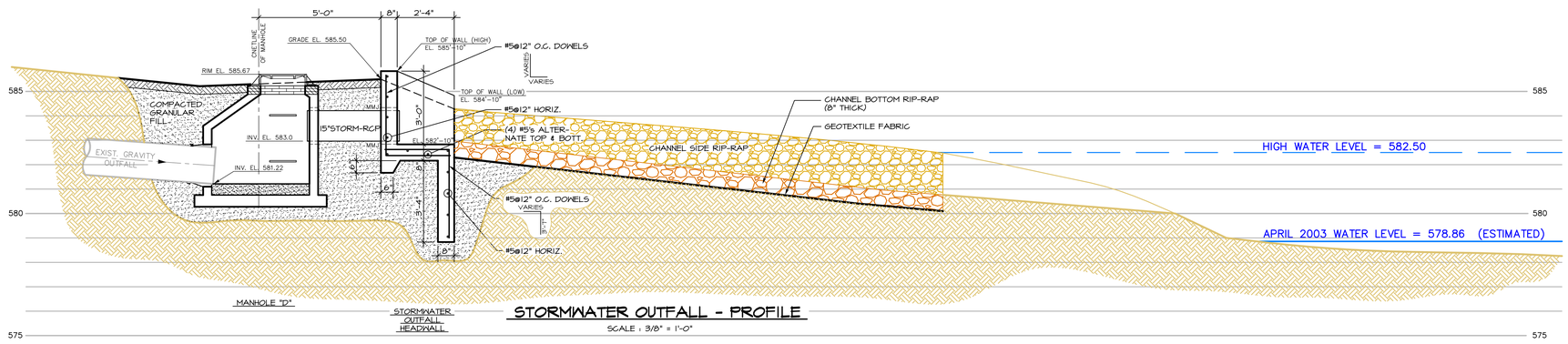
STORMWATER OUTFALL - PLAN VIEW

SCALE : 3/8" = 1'-0"



EFFLUENT FORCEMAIN PROFILE (LAKE MACATAWA INSTALLATION)

HOIZONTAL SCALE : 1" = 40', VERTICAL SCALE : 1" = 4'

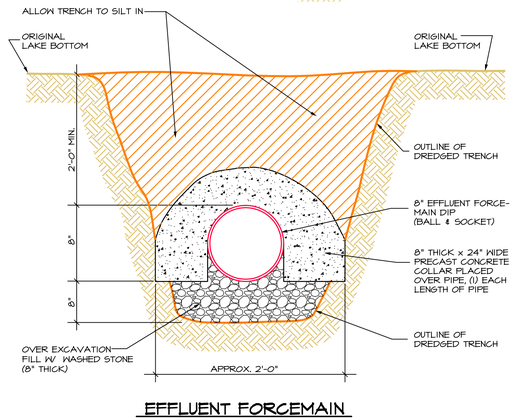


STORMWATER OUTFALL - PROFILE

SCALE : 3/8" = 1'-0"

LEGEND

- = DREDGED TRENCH ALLOWED TO SILT IN (APPROXIMATELY 16")
- = OVER EXCAVATION FILLED WITH WASHED STONE (APPROX. 8")
- = NATIVE SOIL



EFFLUENT FORCEMAIN TRENCH DETAIL

NO SCALE

DRAWN BY	DESIGN BY	DATE
KJB	BLR	12/12/03

FILE NO.: P3

NO.	REVISIONS	BY	DATE

REVISED IN ACCORDANCE WITH CONSTRUCTION RECORDS

CDR PIGMENTS
471 HOWARD AVENUE, HOLLAND, MICHIGAN
W.W.T.P. MODIFICATIONS

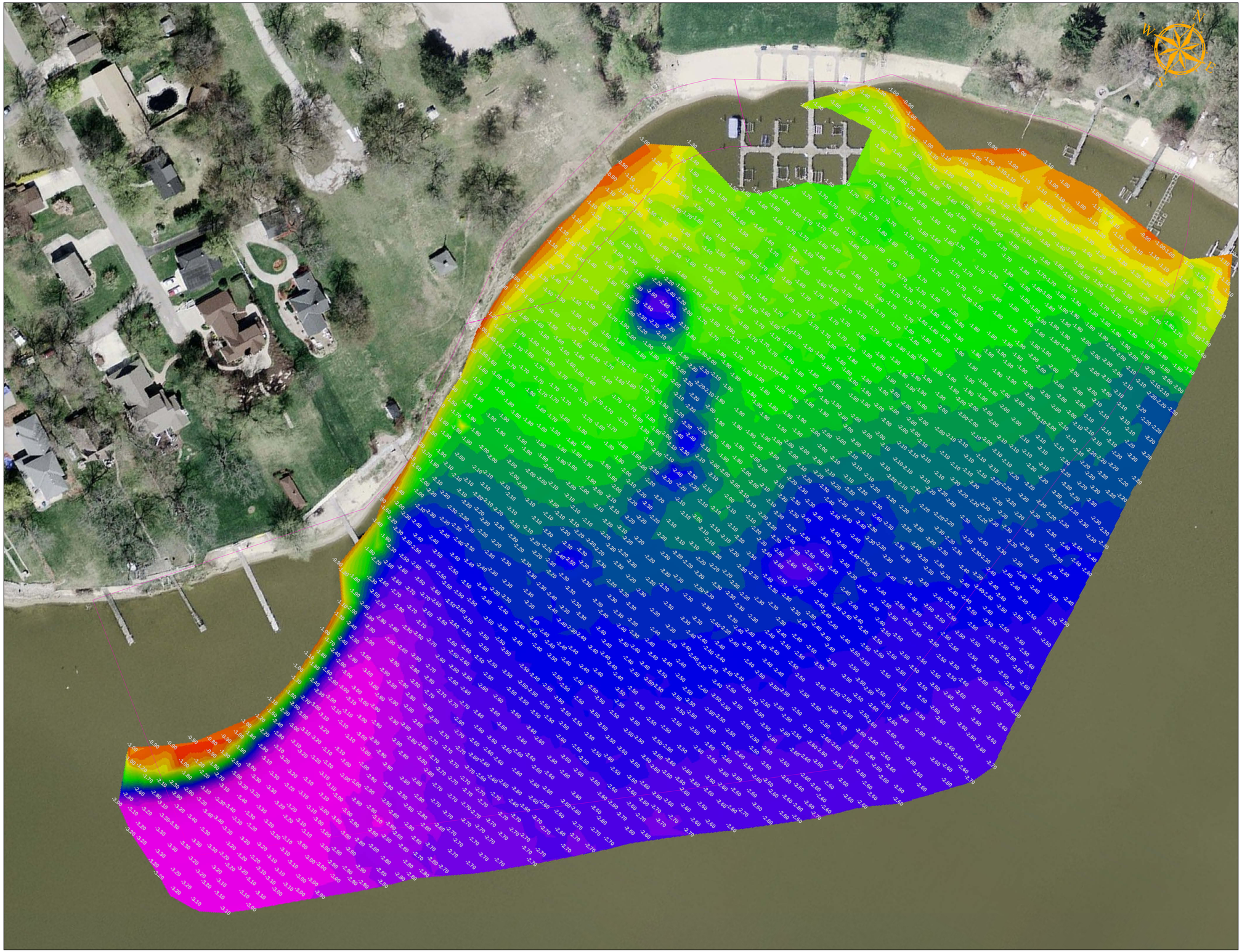
ROSE & WESTRA, INC.
ENVIRONMENTAL CONSULTANTS
Grand Rapids, Michigan

PROJECT NO. 0286.01379.3

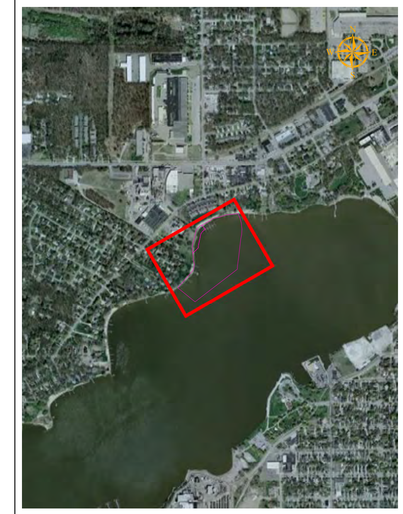
SHEET NO. P-3

Appendix C

Bathymetric Survey Report



Vicinity Map (N.T.S.)



Scale

0 15 30 60
Meters

1 centimeter = 6 meters

Notes

1. The bathymetry depicted on this drawing represents the results of a survey performed by Hibbard Inshore LLC on June 15, 2011 and can only be considered to indicate the general conditions existing at that time.

2. The singlebeam bathymetry data was collected using a Trimble DSM 232 Differential Global Positioning System with Real-Time Kinematic corrections transmitted from the Michigan DOT Virtual Reference Station Network. Hibbard utilized a Knudsen 3212 Chirp Echosounder operating at 200 kHz, and a ComNav G2 Heading Sensor to collect the data.

3. Horizontal positioning is expressed in feet and references the North American Datum of 1983, HARN Michigan GeoRef System (meters). Elevations are in meters and reference elevations below the water level of Laka Macatawa.

4. At the time of this survey, the lake water level was observed to be 176.35 meters relative to the North American Vertical Datum of 1988.

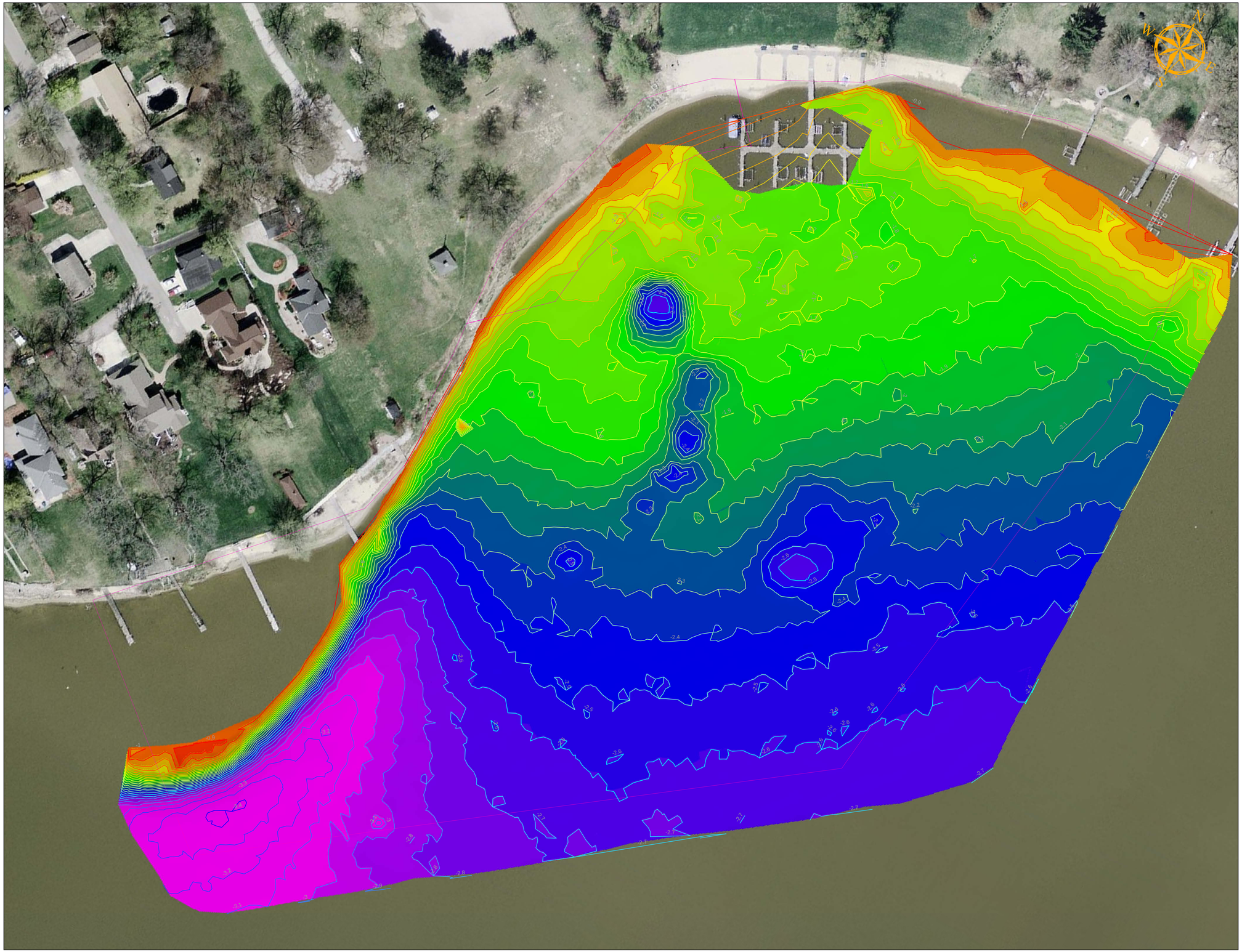
Underwater Site Characterization Survey
Lake Macatawa, Holland, MI
Singlebeam Bathymetric Survey and Sidescan Sonar Survey

Client: AECOM

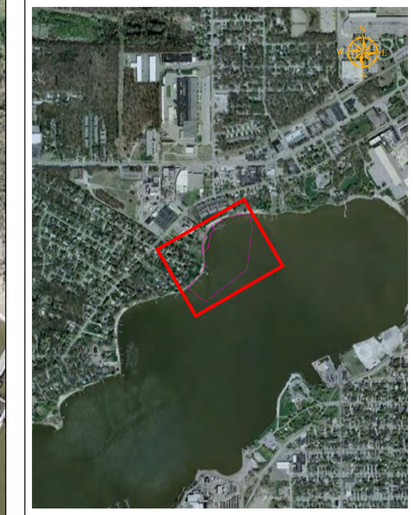
Figure 1
Lake Macatawa
Color Shaded Relief Bathymetry

Figure 11-029-01
Drawn by: J. Snyder
Date: 7/01/2011

Hibbard Inshore
361 Gallogly Road
Lake Angelus, MI 48326
Phone 248.745.8456
Fax 248.745.4958
http://www.hibbardinshore.com



Vicinity Map (N.T.S.)



Scale

0 15 30 60
Meters

1 centimeter = 6 meters

Notes

1. The bathymetry depicted on this drawing represents the results of a survey performed by Hibbard Inshore LLC on June 15, 2011 and can only be considered to indicate the general conditions existing at that time.

2. The singlebeam bathymetry data was collected using a Trimble DSM 232 Differential Global Positioning System with Real-Time Kinematic corrections transmitted from the Michigan DOT Virtual Reference Station Network. Hibbard utilized a Knudsen 3212 Chirp Echosounder operating at 200 kHz, and a ComNav G2 Heading Sensor to collect the data.

3. Horizontal positioning is expressed in feet and references the North American Datum of 1983, HARN Michigan GeoRef System (meters). Elevations are in meters and reference elevations below the water level of Laka Macatawa.

4. At the time of this survey, the lake water level was observed to be 176.35 meters relative to the North American Vertical Datum of 1988.

Underwater Site Characterization Survey
Lake Macatawa, Holland, MI
Singlebeam Bathymetric Survey and Sidescan Sonar Survey

Client: AECOM

Figure 2
Lake Macatawa
Color Shaded Relief Bathymetry
Bathymetric Contours

Figure 11-029-02
Drawn by: J. Snyder
Date: 7/01/2011

Hibbard Inshore
361 Gallogly Road
Lake Angelus, MI 48326
Phone 248.745.8456
Fax 248.745.4958
http://www.hibbardinshore.com

Appendix D

Soil Grain Size Results

Table: Sediment Grain Size Results – Surface Sediments

Sample ID	Depth Interval	< 4 µ	4-75 µ	2000-4750 µ	425-2000 µ	75- 425 µ	>4750 µ
SD21-0-SD-11A-S	0 - 0.5 ft	-0.3	2.4	0.5	24.5	72.9	0.1
SD22-0-SD-11A-S	0 - 0.5 ft	0.3	0.2	1	21.2	76.8	0.5
SD23-0-SD-11A-S	0 - 0.5 ft	3.5	1	1.8	13.6	79.5	0.5
SD24-0-SD-11A-S	0 - 0.5 ft	9.2	23.8	1.1	5.9	59.2	0.8
SD25-0-SD-11A-S	0 - 0.5 ft	24.1	38	0.5	5.9	31.5	0
SD26-0-SD-11A-S	0 - 0.5 ft	18.2	15.3	1.1	4	60.8	0.6
SD27-0-SD-11A-S	0 - 0.5 ft	1.1	1.8	1.8	15.3	78	2
SD28-0-SD-11A-S	0 - 0.5 ft	24.8	37.3	0.5	3.4	34	0
SD29-0-SD-11A-S	0 - 0.5 ft	42.4	46.2	0.4	2.4	8.6	0
SD30-0-SD-11A-S	0 - 0.5 ft	37.8	36.1	0.5	4.5	21.1	0
SD31-0-SD-11A-S	0 - 0.5 ft	36.1	53.7	0.1	0.8	9.3	0
SD32-0-SD-11A-S	0 - 0.5 ft	38.3	46.4	0.1	1.7	13.5	0
SD33-0-SD-11A-D	0 - 0.5 ft	54.7	37.7	0	1.5	6.1	0
SD33-0-SD-11A-S	0 - 0.5 ft	56.7	35.8	0.4	1	6.1	0
SD34-0-SD-11A-S	0 - 0.5 ft	42.6	43	0	2.5	11.9	0
SD35-0-SD-11A-S	0 - 0.5 ft	44.3	48.8	0	0.9	6	0
SD36-0-SD-11A-D	0 - 0.5 ft	39.8	51.7	0.1	0.4	8	0
SD36-0-SD-11A-S	0 - 0.5 ft	37	54.2	0.1	0.4	8.3	0
SD37-0-SD-11A-S	0 - 0.5 ft	42.3	48.5	0.1	0.8	8.3	0
SD38-0-SD-11A-S	0 - 0.5 ft	50.9	45.6	0.1	0.4	3	0
SD39-0-SD-11A-S	0 - 0.5 ft	46.7	39.8	0	2.3	11.2	0
SD40-0-SD-11A-S	0 - 0.5 ft	48.5	36	0.8	2.3	12.4	0
SD41-0-SD-11A-S	0 - 0.5 ft	51	41.3	0	0.8	6.9	0
SD42-0-SD-11A-S	0 - 0.5 ft	46.3	46.8	0	0.9	6	0
SD43-0-SD-11A-S	0 - 0.5 ft	27.3	67.7	0	1.6	3.4	0
SD44-0-SD-11A-S	0 - 0.5 ft	1.2	87	0.1	1.6	10.1	0
SD45-0-SD-11A-D	0 - 0.5 ft	3	6.7	0.3	14.8	75.2	0
SD45-0-SD-11A-S	0 - 0.5 ft	2.8	6.5	0.3	14.5	75.9	0
SD46-0-SD-11A-S	0 - 0.5 ft	0.9	0.7	5.5	68.4	23.9	0.6
SD47-0-SD-11A-S	0 - 0.5 ft	44.5	48.2	0	0.9	6.4	0
SD48-0-SD-11A-S	0 - 0.5 ft	49.7	49.2	0	0.2	0.9	0
SD49-0-SD-11A-S	0 - 0.5 ft	4	3.6	1.5	13.2	77.4	0.3
SD50-0-SD-11A-S	0 - 0.5 ft	42.4	47.1	0.3	2.4	7.8	0
SD51-0-SD-11A-D	0 - 0.5 ft	42.6	39.3	0	2.8	15.3	0
SD51-0-SD-11A-S	0 - 0.5 ft	42	40.8	0.2	2.5	14.5	0
SD52-0-SD-11A-S	0 - 0.5 ft	39.2	45	0.1	2.4	13.3	0
SD53-0-SD-11A-S	0 - 0.5 ft	31.7	52.6	0.2	2.6	12.9	0
SD54-0-SD-11A-S	0 - 0.5 ft	27.4	63.6	0.1	1.6	7.3	0
SD55-0-SD-11A-S	0 - 0.5 ft	33.3	44.3	0.3	2.4	19.7	0
SD56-0-SD-11A-S	0 - 0.5 ft	10.6	9.9	1.2	5.6	72.7	0

Table : Sediment Grain Size Results – Subsurface Sediments

Sample ID	Depth Interval	< 4 µ	4-75 µ	2000-4750 µ	425-2000 µ	75- 425 µ	>4750 µ
SD23-0.5-2-SD-11A-S	0.5 - 2 ft	18.8	38.8	1.3	5.7	32.3	3.1
SD24-0.5-2-SD-11A-S	0.5 - 2 ft	10	42.3	0.4	1.5	45.5	0.3
SD25-0.5-2-SD-11A-S	0.5 - 2 ft	14.8	14.7	3.1	20.9	38.7	7.8
SD26-0.5-2-SD-11A-S	0.5 - 2 ft	5.3	3.4	3.4	29.8	57.1	1
SD28-0.5-2-SD-11A-S	0.5 - 2 ft	49.3	47.2	0	0.6	2.9	0
SD31-0.5-2-SD-11A-S	0.5 - 2 ft	43.7	49.7	0.3	1.1	5.2	0
SD34-0.5-2-SD-11A-S	0.5 - 2 ft	33.2	61.4	0	1.3	4.1	0
SD35-0.5-2-SD-11A-S	0.5 - 2 ft	48.6	46.8	0.3	0.6	2.6	1.1
SD36-0.5-2-SD-11A-S	0.5 - 2 ft	40.5	43.2	0	2	14.3	0
SD39-0.5-2-SD-11A-S	0.5 - 2 ft	52	45.3	0	0.6	2.1	0
SD40-0.5-2-SD-11A-S	0.5 - 2 ft	41.3	55.6	0	0.6	2.5	0
SD42-0.5-2-SD-11A-S	0.5 - 2 ft	55.9	43.3	0	0.1	0.7	0
SD44-0.5-2-SD-11A-S	0.5 - 2 ft	42.5	55.4	0	0.6	1.5	0
SD49-0.5-2-SD-11A-S	0.5 - 2 ft	2.7	2.4	2.4	19	66.2	7.4
SD50-0.5-2-SD-11A-S	0.5 - 2 ft	57.9	41.3	0	0.2	0.6	0
SD51-0.5-2-SD-11A-S	0.5 - 2 ft	54.7	42.6	0	0.8	1.9	0
SD52-0.5-2-SD-11A-S	0.5 - 2 ft	63.9	31.9	0	1.2	3	0
SD53-0.5-2-SD-11A-S	0.5 - 2 ft	49.4	47.2	0	1	2.4	0
SD54-0.5-2-SD-11A-S	0.5 - 2 ft	40.1	55.8	0	1	3.1	0
SD56-0.5-2-SD-11A-S	0.5 - 2 ft	53.8	32.7	0.1	1.6	11.8	0
SD25-2-3-SD-11A-S	2 - 3 ft	2.6	2.5	5.9	37.3	47.3	4.4
SD26-2-3-SD-11A-S	2 - 3 ft	1.4	2.9	2.9	17.2	71.1	4.5
SD23-2-4-SD-11A-S	2 - 4 ft	21.9	70.2	0	0.7	7.2	0
SD24-2-4-SD-11A-S	2 - 4 ft	2.6	20.1	0	0.2	77.2	0
SD28-2-4-SD-11A-S	2 - 4 ft	59.5	38.9	0	0.4	1.2	0
SD31-2-4-SD-11A-S	2 - 4 ft	55.3	43	0.7	0.3	0.4	0.3
SD34-2-4-SD-11A-S	2 - 4 ft	37.7	59.5	0	0.6	2.2	0
SD35-2-4-SD-11A-S	2 - 4 ft	65.8	34.1	0	0.1	0	0
SD36-2-4-SD-11A-S	2 - 4 ft	48.2	49.4	0	0.5	1.9	0
SD39-2-4-SD-11A-S	2 - 4 ft	58.4	40.6	0	0.3	0.7	0
SD40-2-4-SD-11A-S	2 - 4 ft	57.4	42	0	0.2	0.4	0
SD42-2-4-SD-11A-S	2 - 4 ft	56.7	41.8	0	0.7	0.8	0
SD44-2-4-SD-11A-S	2 - 4 ft	61.8	37.3	0	0.5	0.4	0
SD50-2-4-SD-11A-S	2 - 4 ft	53.1	27.6	0.1	1.9	17.2	0.1
SD51-2-4-SD-11A-S	2 - 4 ft	62.9	37	0	0.1	0	0
SD52-2-4-SD-11A-S	2 - 4 ft	64.9	33.6	0	0.7	0.8	0
SD53-2-4-SD-11A-S	2 - 4 ft	60.9	37.1	0	0.7	1.3	0
SD54-2-4-SD-11A-S	2 - 4 ft	65.1	33.6	0	0.6	0.7	0
SD55-2-4-SD-11A-S	2 - 4 ft	61.4	36.6	0	0.6	1.4	0
SD56-2-4-SD-11A-S	2 - 4 ft	52.6	32.9	0	2.7	11.8	0