May 3, 2013

Mr. Weiquan Dong, PE
Bureau of Corrective Actions, Special Projects Branch
Nevada Division of Environmental Protection
2030 E. Flamingo Rd., Suite 230
Las Vegas, Nevada 89119

Re: Response to NDEP Comments on *Revised Technical Memorandum: Screening-Level Indoor Air Health Risk Assessment for the 2008 Tronox Parcels A/B Soil Gas Investigation, BMI Industrial Complex, Clark County, Nevada,* dated November 12, 2010.

Dear Mr. Dong:

On behalf of the Nevada Environmental Response Trust (the Trust), this technical memorandum has been prepared to respond to Nevada Division of Environmental Protection's (NDEP) May 23, 2011 comments (NDEP 2011) on the *Revised Technical Memorandum: Screening-Level Indoor Air Health Risk Assessment for the 2008 Tronox Parcels A/B Soil Gas Investigation* (the Indoor Air HRA) (Northgate Environmental Management, Inc. [Northgate] 2010b). This technical memorandum also addresses comments received from NDEP during a conference call on February 21, 2013 (NDEP 2013b) and in a March 6, 2013 e-mail (NDEP 2013c). As discussed with NDEP during the February 21, 2013 call, all NDEP comments are addressed in this memorandum and the November 12, 2010 Indoor Air HRA will not be revised.

To facilitate the review of information provided in this memorandum, the following related reports and information have been provided in Attachments A through C.

- Attachment A: Chronological Listing of Select Documents for Parcels A and B (lists all previous versions of the Parcels A and B vapor intrusion risk assessments, NDEP comments, and other related reports);
- Attachment B: *Phase B Source Area Investigation Soil Gas Survey Work Plan* (ENSR Corporation [ENSR] 2008); and
- Attachment C: *Revised Technical Memorandum: Screening-Level Indoor Air Health Risk Assessment for the 2008 Tronox Parcels A/B Soil Gas Investigation* (includes the November 12, 2010 Response to Comments) (Northgate 2010b).

RESPONSE TO COMMENTS

NDEP's May 23, 2011 letter included comments on the Indoor Air HRA (Comments #1 and 8 below) and comments on Northgate's responses to NDEP comments, which were included as Attachment A of the Indoor Air HRA (Comments #2 - 7, below).

1. General comment, NDEP has noted that this technical memorandum does not discuss the sampling design used for the data that were collected and presented. Please reference the appropriate document where this information can be found.

   The Phase B Source Area Investigation Soil Gas Survey Work Plan *(ENSR 2008) presents the soil gas sampling design, including collection methods, analytical testing, and reporting. This document is provided as Attachment B of this memorandum.*

2. (Northgate's) Response to Comment (RTC) 4.a.iv and Table 2, this RTC indicates that the appropriate reference for the enclosed space floor thickness parameter is EPA guidance. However, Table 2 indicates that the reference is "model default". Please revise for consistency.

   The enclosed space floor thickness parameter is a model default value as provided in U.S. Environmental Protection Agency (USEPA) guidance (2004). Table 2 of the Indoor Air HRA has been revised for consistency and is presented as Table 1 of this memorandum.

3. (Northgate's) RTC 3.d, NDEP comment 3.d requested that the data be displayed spatially as is noted in NDEP guidance for risk assessment. Spatial data plots have not been provided for any COPC other than chloroform and rationale for this has not been given. The RTC simply states that the requested spatial plots have not been submitted. NDEP understands that chloroform is one of the more pervasive compounds; however, other compounds have been shown to dominate the vapor intrusion pathway (e.g. naphthalene). The downgradient soil vapor intrusion study should be reviewed to assist in the selection of compounds other than chloroform for spatial data plots.

   ENVIRON International Corporation (ENVIRON) reviewed the results of the vapor intrusion health risk assessments (HRAs) for Parcels A and B (Northgate 2010b) and for upgradient Parcels C and D (Northgate 2010c). In addition, vapor intrusion risks estimated based on groundwater data were considered. Based on this review, soil gas and groundwater results for benzene; 1,4-dichlorobenzene; and naphthalene were considered for spatial presentation (in addition to chloroform). Chloroform (over 90 percent) and 1,4-dichlorobenzene (3 percent) were the primary contributors to the total cancer risk, and naphthalene (over 13 percent), in addition to chloroform (over 60 percent), were the primary contributors to the total noncancer hazard index (HI) for the vapor intrusion pathway based on the risk results estimated using the soil gas data. Additionally, benzene was selected because in 2008, detected groundwater concentrations exceeded its groundwater risk-based concentration (RBC). (The RBC represents the benzene concentration corresponding to a cancer risk of one in a million [1×10^{-6}]). Although initially identified for presentation, naphthalene was ultimately not presented because it was not detected in 2008 in wells located in or near Parcels A or B.

   Figure 1 presents the soil gas and groundwater concentrations for benzene, 1,4-dichlorobenzene, and chloroform for locations within or near Parcels A and B.[1] Groundwater concentrations from 2008 were selected for presentation to correspond to the year in which the soil gas samples were collected. The groundwater results are the maximum concentrations from the Phase B groundwater investigation (Northgate 2010a). In addition, results are shown for wells located on or near Parcels A and B that were sampled in 2008 by the former Montrose Chemical Corporation of California and by Stauffer Management Company LLC/Syngenta Crop Protection, Inc. facilities and current Olin Corporation (Olin) facility. These results were obtained from the NDEP regional database.[2] In addition, figures developed by Hargis & Associates (2012) depicting groundwater concentrations of chloroform, benzene, and 1,4-dichlorobenzene for upgradient and in-parcel areas are provided in Attachment D.

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[1] Additional chemicals were not identified for spatial presentation because (1) spatial distributions of the most frequently detected chemicals (i.e., other chlorobenzenes) are similar to those for benzene and 1,4-dichlorobenzene, (2) few wells in Parcels A and B have been sampled for VOCs, and (3) the detection frequencies for most VOCs were very low.

[2] The NDEP regional database is available at: http://ndep.neptuneinc.org/ndep_gisdt/home/index.xml.

Our review of soil gas and groundwater data presented on Figure 1 indicates the following:

- *Benzene was detected at elevated concentrations in three wells (MC-50, MC-62, and MC-114, at concentrations of 1,100; 2,400; and 700 micrograms per liter [µg/L], respectively), while in the remaining wells, benzene was either not detected or detected at low concentrations (from less than detection limits to 6 µg/L). In soil gas, benzene was detected at low concentrations at all locations (from 1.2 to 2.7 micrograms per cubic meter [µg/m^3]). In particular, the benzene concentration was 2.4 µg/m^3 in the soil gas sample co-located with the maximum groundwater concentration of 2,400 µg/L.*

- *The highest soil gas and groundwater chloroform concentrations were detected in the eastern parcel areas (eastern side and former portion of Parcel B, and former Parcel I). The maximum chloroform groundwater and soil gas concentrations were 390 µg/L (M-95) and 1,100 µg/m^3 (SG09), respectively. For comparison, the maximum chloroform groundwater and soil gas concentrations within Parcels A and B were 34 µg/L (M-44) and 440 µg/m^3 (SG-10), respectively.*

- *1,4-Dichlorobenzene was either not detected or detected at low concentrations at all groundwater (less than 59 µg/L) and soil gas (less than 43 µg/m^3) sampling locations.*

4. (Northgate's) RTC 4.b, this RTC includes a table of chemicals and toxicological surrogates; however, this table could not be located within the main document. Please include this table in the main document as appropriate.

   The table of chemicals and toxicological surrogates from the November 12, 2010 Response to Comments is presented in Table 2 of this memorandum.

5. (Northgate's) RTC 5, the last paragraph in the current Section 3.3.1 describes QSoil as an input to the J&E model. If it is an input, then please include it in Table 2. If not, then it should be labeled as an intermediate value. Please revise as necessary.

   The vapor flow rate into a building (Q_{soil}) is an input parameter to the Johnson and Ettinger (J&E) model for calculating the indoor air concentrations as shown in Table 3 of the Indoor Air HRA and is also an intermediate value used in the model to calculate indoor air concentrations, as shown in Table 4 of the Indoor Air HRA. Two different values for Q_{soil} were used to provide a range of estimated indoor air concentrations and corresponding risk estimates to address the uncertainty in this parameter, as described in the last paragraph of Section 3.3 of the Indoor Air HRA. Table 2 of the Indoor Air HRA has been revised to reflect this information and is presented as Table 1 of this memorandum.

6. (Northgate's) RTC 14, the redline additions to the document reference a groundwater well MW23, that seems to appear as M-23 on Figure 2. Please clarify that this is the same well as there are MW and M series wells associated with the Site. Additionally, please revise the document as necessary for consistency.

   Groundwater well MW23, referenced in Section 3.5 in the last paragraph on page 9 of the Indoor Air HRA, is the same as M-23 shown on Figure 2 of the Indoor Air HRA. The correct name of this well is M-23. This well is also presented on Figures 1 and 2 of this memorandum.[3]

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[3] Figure 2 of this memorandum presents the shallow groundwater and soil gas locations within and near Parcels A and B. In preparing this memorandum, ENVIRON reviewed the data for these locations, with results from many of the locations used in the analyses presented in this memorandum. (See for example, Figure 3 and Tables.) The specific data used for each analysis is identified in the text or on the appropriate table and/or figure.

7. (Northgate's) RTC 16, as requested in this RTC, NDEP is clarifying that cumulative risk be presented in this document.

   ENVIRON noted a few minor errors in the Indoor Air HRA when preparing the response to this comment that affect the cumulative risk calculation. The original and corrected text is provided below:

   - *Indoor Air HRA, Section 4.0: Originally stated in the first bullet on page 12, "the largest contributors to the cumulative [incremental lifetime cancer risk (ILCR)] are dioxins/furans, alpha-BHC, and polycyclic aromatic hydrocarbons (PAHs)" for non-radionuclide chemicals other than asbestos. The correct list of non-radionuclide chemicals other than asbestos that are the largest contributors to the cumulative ILCR are: dioxins/furans, beta-BHC, benzo(a)pyrene, and hexachlorobenzene.*
   - *Indoor Air HRA, Section 4.0: Originally stated in the last bullet on page 12, "for construction workers, the best estimate and upper bound concentrations of asbestos range from 1×10^{-7} (best estimate) to 8×10^{-7} (upper bound estimate) for chryostile fibers." The correct upper bound estimate for chryostile fibers is 3×10^{-7}.*

   As requested by NDEP, ENVIRON calculated the cumulative non-cancer HI and cancer risk (see Table 3 of this memorandum).[4] For commercial/industrial workers, the cumulative HI[5] for the vapor intrusion and soil-related pathways is 0.10, and the cumulative cancer risk for chemical carcinogens and radionuclides combined for these same pathways is 5.1×10^{-6}.

8. Attachment E, NDEP provides the following comments:

   a. NDEP issued guidance for blank contamination based on EPA's revision to the National Functional Guidelines in 2009. This guidance is referenced in the September 2010 revision that is included in the references in Appendix E. TRX did not follow the most recent NDEP guidance on blank contamination. Please revise the Deliverable accordingly.

      As noted in NDEP's current guidance on blank contamination (NDEP 2012) and discussed during the February 21, 2013 call (NDEP 2013b), the 2012 blank contamination guidance applies only to data collected after June 2011. Given the data presented in this report were collected prior to June 2011 (specifically, the soil gas data were collected in 2008), it was agreed that the guidance does not apply. However, NDEP's 2012 guidance states that uncertainties in the risk results associated with use of the older guidance for addressing blanks should be discussed. The following paragraph taken from the Indoor Air HRA discusses the validated 2008 soil gas results impacted by blank contamination. Additional discussion is then provided in the paragraph "Additional ENVIRON Discussion."

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[4] For cumulative risk, ENVIRON understands that NDEP is requesting that the estimated cancer risks for chemical and radiological contaminants for the soil-related and inhalation pathways be summed and that asbestos risks be presented separately. For the noncancer HI, the estimated HQs for all chemical COPCs are summed for the soil-related and inhalation pathways.

[5] The total HI of 0.27 for all soil-related pathways and COPCs reported by Basic Environmental Company (BEC) (2008) incorrectly included lead. The portion of the HI attributed to lead (0.17) has been subtracted from the HI of 0.27, resulting in an adjusted HI of 0.10. It is noted that the maximum detected concentration of lead in soils in Parcels A and B combined is 136 milligrams per kilogram (mg/kg), less than its industrial soil Basic Comparison Level of 800 mg/kg (NDEP 2013d).

Blank Contamination *(summarized from Attachments D and E in the Northgate 2010 Indoor Air HRA):*

". . . in general, laboratory and field blanks were free of contamination at significant levels. Table E-4 [in the Indoor Air HRA presented in Table 4 of this memorandum] lists the sample results [in Parcels A and B] that were qualified based on contamination in laboratory method blanks. Target compounds were not detected in the canister blanks."

ENVIRON notes that seven sample results were qualified (U) due to blank contamination based on the presence of low levels of the common laboratory contaminants methylene chloride and acetone as well as trace levels of carbon disulfide and vinyl acetate in the method blanks. The majority of these were based on the presence of acetone. Two sample results were qualified (J+) due to quantitation problems and the acetone results may be biased high. As stated in the Data Usability Evaluation in Attachment E of the Indoor Air HRA, "… in all cases, the qualified data were deemed acceptable for risk assessment purposes."

Additional ENVIRON Discussion: Comparison of Potential Differences between Blank Contamination Approaches

ENVIRON's review of the 2008 soil gas sampling results indicated that (1) only seven samples were qualified due to blank contamination and (2) all chemicals with blank contamination were also reported as detected in at least one sample for which blank contamination was not identified. Thus, no detected analyte was eliminated as a possible chemical of potential concern (COPC) simply on the basis of blank contamination; further, reported concentrations in the qualified (J+) contaminated samples were biased high. Thus, use of the former approach for addressing blanks would have had minimal to no impact on the risk assessment results.

b. Table E-2, please include footnotes that explain the reason codes and qualifiers.

Footnotes for the reason codes and qualifiers have been added to Table E-2 (included as Table 4 of this memorandum).

ADDITIONAL DATA ANALYSIS

Additional data analysis for Parcels A and B was requested by NDEP during a conference call on February 21, 2013 (NDEP 2013b) and in a March 6, 2013 e-mail (NDEP 2013c). The requested analyses and responses are provided below.

A1. Cross plots (scatter plots) should be done for the new and combined data sets.

ENVIRON understands that NDEP is requesting a cross plot similar to Table 9 of Northgate (2010c), which presented a plot of the chloroform 2008 soil gas and 2008/2009 groundwater concentrations for co-located soil gas and groundwater samples across the entire Nevada Environmental Response Trust Site (Site). (We note that only 2008 groundwater data were used for 2008 co-located soil gas samples in and near Parcels A and B, except for three locations where 2008 groundwater data were not available and 2006 and 2010 data were used instead. The most recent groundwater data [2008, 2009, and 2011] were used for 2013 co-located soil gas samples in and near Parcels A and B).

As shown on Figure 2 of this memorandum, four co-located 2008 soil gas and shallow groundwater sampling locations within Parcels A and B (SG01 and PC-40, SG04 and H-49A, SG05 and MC-62, and SG06 and PC-37) were identified with results for volatile organic compounds (VOCs); an additional 11 locations were identified near Parcels A and B (E-SG-2 and

MC-3, E-SG-3 and AA-BW-04A, E-SG-9 and M-23, SG07 and M-95, SG14 and M-48, SG16 and MC-45, SG17 and MC-97, SG19 and M-7B, SG24 and M-99, SG90 and M-98, and SG91 and M-100).[6] *These 2008 and 2013 soil gas data were plotted and a linear regression model applied, as shown on Figure 3. Pearson's correlation coefficient (r of 0.87) indicates a strong positive correlation between groundwater and soil gas concentrations in and near Parcels A and B, providing further evidence to support the conceptual site model that groundwater is the source of chloroform in soil gas.*

A second cross plot for only "new" (2013) soil gas data is not presented (as requested by NDEP) because "new" soil gas samples have not been collected in Parcels A and B since 2008, apart from the three nearby 2013 soil gas samples, which were included as nearby sample locations in Figure 3 of this memorandum.

A2. Compare groundwater VOC concentrations used for the Site-Wide Soil Gas Human Health Risk Assessment with most recent groundwater sample results for the same wells.

For clarification, ENVIRON notes that the groundwater results were not "used" for estimating risks in the Site-Wide Soil Gas Human Health Risk Assessment (Site-Wide HHRA) (Northgate 2010c). Northgate presented groundwater concentrations for chloroform, carbon tetrachloride, and trichloroethylene (TCE) in Figures 5, 6, and 7, respectively, of the Site-Wide HHRA. Northgate's selection of chemicals for presentation was based on the risk results for the entire Site, and not specifically on the risk results for Parcels A and B. As shown on Figures 6 and 7 of the Site-Wide HHRA, carbon tetrachloride and TCE concentrations in Parcels A and B groundwater were either below detection limits or detected at low concentrations only slightly exceeding detection limits. The areas of higher carbon tetrachloride and TCE concentrations are located south of Parcels A and B, along the western boundary of the Site, and for TCE, also in the central portion of the Site. Given the very low concentrations of carbon tetrachloride and TCE (and the observation that they contributed less than 1 percent of the total cancer risk in Parcels A and B), the requested comparison is presented for chloroform only. [7]

ENVIRON searched NDEP's regional database for chloroform results in shallow groundwater wells sampled within or near Parcels A and B, as presented in Table 5 of this memorandum. The 2008/2009 chloroform concentrations presented on Figure 5 of the Site-Wide HHRA (Northgate 2010c) are highlighted gray in Table 5, while the most recent groundwater results are shown in ***bold*** *font. Eight shallow wells within Parcel A, 3 wells within Parcel B, and 15 wells near Parcels A and B were identified with chloroform results. Well locations are shown on Figure 1 of this memorandum. For most wells, more recent sampling data were not available, as Tronox, and now the Trust, have not sampled for VOCs since 2008. For the 3 wells (H-49A, H-56A, and MC 53) included in the Site-Wide HHRA for which more recent data are available, chloroform concentrations remain approximately the same or show a general downward trend as compared with the 2008/2009 sampling results.*

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[6] A middle-water bearing zone well, MC-MW-32, was previously misidentified as a shallow well in the *Soil Gas Investigation and Human Health Risk Assessment Work Plan for Parcels C, D, F, G, and H* (ENVIRON 2013). Although co-located with soil gas sample, E-SG-1, this well was not included in the cross plot presented in Figure 3.

[7] In addition to chloroform, historical and recent groundwater results for benzene and 1,4-dichlorobenzene are discussed and displayed spatially in the response to comment #3 and in Attachment D. Similar to the results for chloroform, the groundwater concentrations for these chemicals generally show decreasing concentration trends from 2008 to 2012.

A3. Calculate risk for the new soil gas samples and compare with risk calculations for the earlier data set.

This requested analysis is not presented because "new" soil gas samples were not collected in Parcels A and B.[8] Specifically, the only available data set for soil gas in these two parcels was collected in 2008 (Northgate 2010b).

A4. Calculate risk using the groundwater VOC concentrations and compare with risk associated with the soil gas.

The maximum 2008 groundwater concentrations were used to estimate risks for the vapor intrusion pathway at 23 locations in and near Parcels A and B. Specifically, hazard quotients (HQs) and cancer risks were estimated for the three primary risk contributors (chloroform, benzene, and 1,4-dichlorobenzene) identified in the response to Comment #3 above. The methodology and assumptions presented in the Soil Gas Investigation and Human Health Risk Assessment Work Plan for Parcels C, D, F, G, and H *(ENVIRON 2013) were used for these calculations, using a parcel-specific depth to groundwater (for Parcels A and B) of 35 feet (ft). The results are presented in Table 6 of this memorandum.*

A comparison of the risk estimates based on 2008 groundwater results with those estimated based on 2008 soil gas results indicates the following:

- *For benzene, the cancer risks and HQs estimated using the groundwater data are approximately 3000-fold higher than cancer risks and HQs estimated using soil gas results based on one set of co-located groundwater and soil gas samples at the location of the maximum groundwater concentration. (As described in response to Comment #3 and in Attachment D, benzene was not detected in groundwater and was detected at low concentrations in soil gas in the remaining co-located samples). While the predicted risks using the detected groundwater concentrations are substantially higher than the predicted risks using the soil gas data, this finding is not unexpected given what is known about the aerobic biodegradation of petroleum hydrocarbons (including benzene) in vadose zone soils and literature studies reporting that biodegradation can significantly reduce the potential for vapor intrusion for this class of compounds. When oxygen supply from the atmosphere is sufficient, petroleum hydrocarbons (including benzene) in the vadose zone can be rapidly biodegraded by microorganisms that are naturally present in soil, resulting in substantial attenuation over relatively short distances (USEPA 2012, 2013). This biodegradation is not accounted for in the J&E model such that the predicted indoor air concentrations (and associated risks) of petroleum hydrocarbons can be substantially overestimated. For this reason, the benzene soil gas data is considered to provide the better estimate of potential risk for the vapor intrusion pathway.*

- *For chloroform, the cancer risks and HQs estimated using the groundwater data were approximately 2- to 3-fold higher than those estimated using the soil gas concentrations at the two locations with the highest soil gas and groundwater concentrations. (The two highest groundwater concentrations were 130 and 390 µg/L, at M-23 and M-95, both outside of Parcels A and B; co-located soil gas concentrations were 98 and 430 µg/m^3, respectively.) At all other locations with co-located samples, groundwater concentrations were low (less than or equal to 3 µg/L), and estimated risks based on the groundwater data were approximately 1- to 12-fold less than those estimated using the soil gas data.*

[8] NDEP confirmed that additional soil gas samples did not need to be collected in Parcels A and B in the March 7, 2013 e-mail from Weiquan Dong of NDEP to John Pekala of ENVIRON.

- *For 1,4-dichlorobenzene, the cancer risks and HQs estimated using the groundwater data were on average, 6-fold higher than those estimated using soil gas measurements (although a wide range of ratios was exhibited.*

In summary, the comparisons are consistent with expectations. Chloroform is recalcitrant to biodegradation and the risks estimated using soil gas or groundwater results are relatively consistent. For benzene, risks estimated using the groundwater data are substantially overestimated, which is not unexpected given that the J&E model does not account for biodegradation. 1,4-Dichlorobenzene is not expected to biodegrade readily (but is expected to be less recalcitrant to biodegradation than chloroform). The finding that the ratio of risks estimated based on groundwater to risks estimated based on soil gas data are highest for benzene, followed by 1,4-dichlorobenzene, and then chloroform is consistent with the expected rate of degradation of these chemicals in the vadose zone.

SUMMARY

This section summarizes the results of risk assessments conducted for Parcels A and B indoor air (Northgate 2010b, as supplemented by information presented in this memorandum) and soils (BEC 2008). The soil risk assessment was previously reported in *Technical Memorandum – Data Review for 2007 Tronox Parcels A/B Investigation* (Soil HRA). The risk estimates for soils were based on soil samples collected from 0 and 10 ft below ground surface (bgs) in 2007 and the risk estimates for indoor air were based on 5-ft bgs soil gas samples collected in 2008.

As presented in Table 3 of this memorandum, the cumulative HI for commercial/industrial workers for soil-related and indoor air pathways is 0.10, well below the health benchmark of 1, indicating little potential for adverse noncancer health effects. The estimated cumulative cancer risk for these pathways ranges from 4.4×10^{-6} to 5.1×10^{-6}, depending on the value of Q_{soil} used for estimating risks for the vapor intrusion pathway, well within USEPA's target risk range of 1×10^{-6} to 1×10^{-4}. The primary contributors to cancer risk for the soil-related pathways are dioxins/furans, beta-BHC, benzo(a)pyrene, hexachlorobenzene, uranium-233/234, uranium-235/236, and uranium-238; for indoor air, the primary contributor to cancer risk is chloroform.

The Soil HRA (BEC 2008) also included best and upperbound estimates of potential risks from asbestos exposures for construction workers, future maintenance workers, and current/future on-site trespassers. For the future maintenance worker and current/future on-site trespasser, the estimated asbestos cancer risks were well below 1×10^{-6}. For construction workers, the best estimate and upper bound risk estimates for asbestos ranged from 1.5×10^{-7} to 5.4×10^{-6} for the different asbestos fibers.

Based on the Parcel A and B soil investigation data and the results of the Soil HRA, NDEP issued a No Further Action (NFA) letter for soils in the 0 to 10 ft depth interval (NDEP 2008). This memorandum has responded to NDEP comments on the Indoor Air HRA. With NDEP approval of the Indoor Air HRA, the environmental investigation and risk assessment work for Parcels A and B will be complete. Given the high priority for completing this work, we would appreciate your prompt

review and approval of the Indoor Air HRA. Upon approval, the Trust will request that NDEP issue a NFA letter for Parcel A/B soils less than 10 ft bgs, including vapor intrusion.

Sincerely,

John M. Pekala, PG
Senior Manager
Nevada CEM #2347, expires 9/20/2014

Allan J. DeLorme, PE
Managing Principal

Attachments (see list below)

cc: BMI Compliance Coordinator, NDEP, BCA, Las Vegas
Brian Rakvica, McGinley and Associates, Las Vegas
NDEP c/o McGinley and Associates, Reno

ec: Shannon Harbour, NDEP
JD Dotchin, NDEP
Greg Lovato, NDEP
Stephen Tyahla, USEPA
Nevada Environmental Response Trust
Tanya O'Neill, Foley & Lardner LLP
Jeff Gibson, AMPAC
Mark Paris, BMI
Lee Farris, Landwell
Ranajit Sahu, BMI
Joe Kelly, Montrose
Paul Sundberg, Montrose
Curt Richards, Olin
Jay Gear, Olin
Ed Modiano, *de maximis, inc.*
Chuck Elmendorf, Stauffer
Nick Pogoncheff, Stauffer
George Crouse, Syngenta
David Hadzinski, TIMET
Kirk Stowers, Broadbent & Associates (for TIMET)
Victoria Tyson, Tyson Contracting (for TIMET)
Enoe Marcum, WAPA

Tables

Figures

Attachments

References

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Tables

TABLE 1
Johnson and Ettinger Model Input Parameters (former Table 2 of the Indoor Air HRA)

Parameter	Value	Reference/Rationale
Depth below grade to bottom of enclosed floor space (cm)	15	Model default (slab on grade) (USEPA 2004)
Soil gas sampling depth (cm)	150	Site-specific (five feet below ground surface [bgs])
Average soil temperature (°C)	17	Site-specific (Figure 8, USEPA 2004, p. 48). The average shallow groundwater temperature in the Henderson, Nevada area.
Thickness of soil stratum (cm) A	150	Site-specific (five feet bgs)
Thickness of soil stratum (cm) B	0	No stratum B; used single stratum model
Thickness of soil stratum (cm) C	0	No stratum C; used single stratum model
Soil stratum used to calculate soil vapor permeability	S	Sand
Vadose zone dry bulk density (g/cm^3)	1.83	Site-specific (Borrow Area data)
Vadose zone total porosity (unitless)	0.30	Site-specific (Borrow Area data)
Vadose zone water-filled porosity (unitless)	0.090	(Dry bulk density/water density) × soil moisture content [1]
Stratum B soil parameters	blank	No stratum B; used single stratum model
Stratum C soil parameters	blank	No stratum C; used single stratum model
Enclosed space floor thickness (cm)	10	Model default (USEPA 2004)
Soil-building pressure differential, ($g/cm\text{-}s^2$)	40	Model default (USEPA 2004)
Enclosed space floor length (cm)	2,000	MDEQ - commericial (2001)
Enclosed space floor width (cm)	2,000	MDEQ - commericial (2001)
Modeling Enclosed space height (cm)	244	Model default (USEPA 2004) [2]
Floor-wall seam crack width (cm)	0.1	Model default (USEPA 2004)
Indoor air exchange rate (1/hr)	1 or 2	Cal-EPA (2005) or MDEQ (2001)
Average vapor flow rate into building, Qsoil, (L/m) - Table 3 Results	20	Model default (Cal-EPA 2005)
Average vapor flow rate into building, Qsoil, (L/m) - Table 4 Results	Calculated	Intermediate value (Eq. 15, USEPA 2004, p. 22) [3]
Averaging time for carcinogens (yrs)	70	USEPA 2002
Averaging time for non-carcinogens (yrs)	25	USEPA 2002
Exposure duration (yrs)	25	USEPA 2002
Exposure frequency (days/yr)	250	USEPA 2002

Notes:
1 - Where soil moisture content=gravimetric moisture content per ASTM D2216; site-specific value=0.049
2 - This value is the model default for residential buildings since there is no model default for commercial buildings (USEPA 2004).
3 - This is a calculated value of 10 L/min.

TABLE 2
Toxicological Surrogates for Toxicity Values

Chemical	Surrogate
1,2-Dichlorotetrafluoroethane	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)
1,3-Dichlorobenzene	1,2-Dichlorobenzene
4-Ethyltoluene	Isopropylbenzene (Cumene)
4-Isopropyltoluene	Isopropylbenzene (Cumene)
alpha-Methylstyrene	Styrene
cis-1,2-Dichloroethene	trans-1,2-Dichloroethene
Ethanol[a]	See footnote a
N-Butylbenzene	Isopropylbenzene (Cumene)
n-Heptane	n-Hexane
n-Octane	C5 - C8 alkane and cycloalkane compounds
sec-Butylbenzene	Isopropylbenzene (Cumene)
t-Butyl alcohol	sec-Butyl Alcohol
tert-Butylbenzene	Isopropylbenzene (Cumene)

Notes:

[a] California Environmental Protection Agency derived a draft reference concentration for ethanol based on ethanol toxicity data as provided in Attachment B of NDEP (2010).

References:

Nevada Division of Environmental Protection (NDEP), 2010. NDEP Response to Revised Technical Memorandum: Screening-Level Indoor Air Health Assessment for the 2008 Tronox Parcels A/B Soil Gas Investigation, Tronox LLC, Henderson, Nevada, Dated: June 29, 2010. August 31.

TABLE 3
Cumulative Risk for Vapor Intrusion and Soil-Related Pathways

Receptor[a]	Commercial/Industrial Worker				Construction Worker	Future Maintenance Worker	Current/Future On-Site Trespasser
Media	**Soil**	**Indoor Air[b]**	**Indoor Air[c]**	**Cumulative HI and Cancer Risk[d]**	**Soil[e]**	**Soil[e]**	**Soil[e]**
Total Non-Cancer HI	0.10	0.002	0.0008	**0.10**			
Total Cancer Risk	3.9E-06	1.2E-06	4.5E-07	**5.1E-06**			
Estimated Chrysotile Risk - Best Estimate[f]					1.5E-07	2.6E-09	7.0E-11
Estimated Chrysotile Risk - Upper Bound[g]					2.6E-07	4.6E-09	1.2E-10
Estimated Amphibole Risk - Best Estimate[f]					0.0E+00	0.0E+00	0.0E+00
Estimated Amphibole Risk - Upper Bound[g]					5.4E-06	9.7E-08	2.6E-09

Notes:
BEC = Basic Environmental Company
Cal/EPA = California Environmental Protection Agency
ER = Indoor air exchange rate
HI = Hazard index
L/min = Liters per minute
Q_{soil} = Average vapor flow rate
UCL = Upper confidence limit

[a] Gray shading indicates that the pathway was not evaluated in the screening-level health risk assessment. The indoor air pathway was only evaluated for the commercial/industrial worker.
[b] The indoor air concentrations were estimated based on a scaled Q_{soil} value of 4 × 5 L/min or 20 L/min to account for the default commercial building size and an ER of 1 per hour as recommended by Cal/EPA (2011).
[c] The indoor air concentrations were estimated based on a calculated Q_{soil} value and an ER of 2 per hour as recommended by Michigan Environmental Science Board (2001).
[d] The indoor air cancer risk and HI were based on a scaled Q_{soil} value of 20 L/min and an ER of 1 per hour as described in footnote b.
[e] The estimated risks for asbestos were presented as reported in BEC (2008).
[f] The best estimate was based on the pooled analytical sensitivity multiplied by the number of asbestos fibers found.
[g] The upper bound was based on the 95% UCL of the Poisson distribution.

References:
Basic Environmental Company (BEC). 2008. Technical Memorandum – Data Review for 2007 Tronox Parcels A/B Investigation, BMI Industrial Complex, Clark County, Nevada, Revision 1. February 11.
California Environmental Protection Agency (Cal/EPA). 2011. Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance). October.
Michigan Environmental Science Board. 2001. Evaluation of the Michigan Department of Environmental Quality's Generic Groundwater and Soil Volatilization to Indoor Air Inhalation Criteria. (A Science Report to Governor John Engler). Michigan Environmental Science Board, Lansing, MI.

TABLE 4
Summary of Data Qualifiers for Parcel A/B Data (former Table E-2 of the Indoor Air HRA)

Sample ID	SDG	Method	Matrix	Analyte	Result	Qualifiers	Units	Reason	Batch ID	Method Blank Result	Dilution Factor	SQL
Qualifications based on blank contamination (b) (from Table E-4 of the soil gas DVSR)												
SG06B-05	P0801507	TO-15	GS	Methylene chloride	0.77	U	µg/m^3	b	MS16052708	0.076	1.54	0.77
SG10B-05	P0801483	TO-15	GS	Vinyl acetate	7.8	U	µg/m^3	b	MS13052708	0.40	1.55	7.8
SG10B-05	P0801483	TO-15	GS	Acetone	24	U	µg/m^3	b	MS13052708	1.8	1.55	7.8
SG11B-05	P0801483	TO-15	GS	Carbon disulfide	1.4	U	µg/m^3	b	MS13052708	0.29	1.47	0.74
SG12B-05	P0801483	TO-15	GS	Vinyl acetate	7.7	U	µg/m^3	b	MS13052708	0.40	1.54	7.7
SG12B-05	P0801483	TO-15	GS	Carbon disulfide	1.1	U	µg/m^3	b	MS13052708	0.29	1.54	0.77
SG12B-05	P0801483	TO-15	GS	Acetone	15	U	µg/m^3	b	MS13052708	1.8	1.54	7.7
Qualification based on quantitation problems (q) (from Table D-7 of the soil gas DVSR)												
SG01B-05	P0801656	TO-15	GS	Acetone	33	J+	µg/m^3	q				
SG04B-05	P0801656	TO-15	GS	Acetone	12	J+	µg/m^3	q				

Notes:
- GS = Soil gas
- SDG = Sample delivery group
- SQL = Sample quantitation limit
- µg/m^3 = micrograms per cubic meter

Reason codes:
- b = Qualified due to blank contamination
- q = Qualified due to quantitation problem

Qualifiers:
- U = The analyte was analyzed for, but was not detected above the sample reporting limit
- J+ = The result is an estimated quantity and the result may be biased high

TABLE 5

Historical and Recent Chloroform Concentrations in Shallow Groundwater[a]

Parcel	Well ID	Date Sampled[b]	Chloroform (µg/L)[b]
Parcel A	H-48	9/1/1981	900
		10/14/1981	400
		11/10/1981	300
		2/9/1982	ND
		4/13/1982	300
		6/23/1982	ND
		8/16/1982	ND
		10/19/1982	400
		12/6/1982	ND
		2/14/1983	200
		2/29/1984	1000
		6/19/2008	**<1**
	H-49A	9/16/2004	10
		11/30/2004	6.0
		2/22/2005	<5.0
		5/24/2005	<5.0
		9/23/2005	7.6
		10/25/2005	7.0
		2/2/2006	<5.0
		4/25/2006	<5.0
		7/25/2006	<5.0
		11/30/2006	<0.33
		1/18/2007	3.4
		4/17/2007	2.3
		7/11/2007	2.0
		11/14/2007	3.2
		1/30/2008	<0.33
		4/3/2008	<0.33
		4/3/2008	<0.33
		6/24/2008	3.0
		7/11/2008	<0.33
		11/5/2008	2.0
		1/19/2009	<0.33
		4/15/2009	<0.33
		4/20/2010	1.4
		4/4/2011	**0.97**
	H-56A	9/16/2004	ND
		2/22/2005	<5.0
		5/24/2005	<5.0
		9/23/2005	<5.0
		10/25/2005	<5.0
		1/31/2006	<5.0
		4/25/2006	<5.0
		7/19/2006	1.1
		7/25/2006	<5.0
		11/30/2006	<0.33J
		1/17/2007	<0.33
		4/18/2007	<0.33
		4/18/2007	<0.33
		7/11/2007	<0.33
		11/14/2007	<0.33
		1/30/2008	<0.33
		4/3/2008	<0.33
		7/11/2008	<0.33
		11/5/2008	<0.33
		1/19/2009	<0.33
		4/15/2009	<0.33
		4/19/2010	2.0

TABLE 5

Historical and Recent Chloroform Concentrations in Shallow Groundwater[a]

Parcel	Well ID	Date Sampled[b]	Chloroform (µg/L)[b]
Parcel A (Continued)	H-56A (Continued)	7/28/2010	2.0
		4/4/2011	**1.8**
	H-58A	9/16/2004	ND
		2/22/2005	<5.0
		5/24/2005	<5.0
		9/23/2005	9.6
		10/25/2005	17
		2/2/2006	7.7
		4/25/2006	4.9
		7/25/2006	16
		11/30/2006	<0.33
		1/18/2007	4.3
		4/18/2007	4.6
		7/11/2007	6.6
		11/14/2007	5.6
		1/30/2008	9.7
		1/30/2008	9.0
		4/3/2008	8.6
		7/11/2008	4.8
		11/5/2008	2.4
		1/19/2009	2.0
		4/15/2009	<0.33
		4/19/2010	2.2
		4/4/2011	**5.2**
	MC-62	1/25/2005	3.4
		4/19/2005	2.8
		10/27/2005	4.3
		2/1/2006	68
		4/27/2006	8
		7/27/2006	4.6
		6/23/2008	**2.3J**
	MC-65	**6/20/2008**	**8.3**
	MC-66	6/20/2008	5.2
		6/20/2008	**5.3**
	PC-40	12/17/1998	<5.0
		5/26/2000	<5.0
		12/1/2006	4J
		6/18/2008	**1.6**
Parcel B	M-44	**6/24/2008**	**34**
	PC-37	**6/20/2008**	**2.0**
	PC-72	**6/23/2008**	**29**
Relevant Nearby Locations for Parcels A and B	M-23	**6/25/2008**	**130**
	M-48	12/6/2006	99
		7/9/2008	**180**
	M-94	**6/23/2008**	**50**
	M-95	12/4/2006	350
		6/27/2008	**390**
	M-96	**7/9/2008**	**28**
	MC-09R	7/24/2009	7.9
		5/19/2010	4.3
		4/22/2011	6.5
		4/30/2012	**0.94J**
	MC-45	1/17/1986	ND
		2/19/1986	ND
		7/15/1986	ND
		12/6/2006	3.0J
		6/25/2008	**3.0**
	MC-47	1/25/2005	1.7
		4/19/2005	1.9

TABLE 5

Historical and Recent Chloroform Concentrations in Shallow Groundwater[a]

Parcel	Well ID	Date Sampled[b]	Chloroform (µg/L)[b]
	MC-47 (Continued)	10/26/2005	4.5
		1/31/2006	4.3
		4/26/2006	16
		7/26/2006	4.9
		11/29/2006	2
		1/17/2007	2.7
		4/18/2007	3.6
		7/13/2007	11
		12/20/2007	8
		1/29/2008	12
		1/29/2008	13
		4/9/2008	8.1
		4/9/2008	7.5
		7/10/2008	7.2
		11/7/2008	8.2
		1/20/2009	11.0
		4/13/2009	5.9
		4/20/2010	10.0
		4/5/2011	13.0
		4/11/2012	**8.4**
	MC-48	1/15/1986	ND
		2/20/1986	ND
		7/15/1986	ND
		3/31/2004	13
		6/29/2004	8.1
		9/28/2004	1.4
		1/25/2005	1
		4/19/2005	1.8
		10/26/2005	2.1
		2/1/2006	14
		4/26/2006	31
		7/26/2006	6.4
		11/29/2006	<0.33J
		1/24/2007	2.3
		4/18/2007	9.3
		7/13/2007	14
		12/20/2007	4.5
		12/20/2007	4.4
		1/29/2008	57
		4/9/2008	7.9
		7/10/2008	2.2
		11/7/2008	<0.33
		1/20/2009	<0.33
		4/13/2009	<0.33
		4/21/2010	2.7
		4/5/2011	4.2
		4/11/2012	**0.4**
	MC-49	1/16/1986	2100
		2/20/1986	1000.0
		7/15/1986	1600
		4/1/2004	<5
		6/29/2004	1
		9/28/2004	5.3
		1/26/2005	5.1
		4/19/2005	4.6
		10/27/2005	13
		10/27/2005	13

TABLE 5

Historical and Recent Chloroform Concentrations in Shallow Groundwater[a]

Parcel	Well ID	Date Sampled[b]	Chloroform (µg/L)[b]
Relevant Nearby Locations for Parcels A and B (Continued)	MC-49 (Continued)	2/2/2006	<10
		2/2/2006	<10
		4/27/2006	39
		4/27/2006	37
		7/27/2006	9.1
		7/27/2006	9.2
		12/4/2006	2.2
		12/4/2006	440J
		1/19/2007	2.2
		4/19/2007	6.7
		7/13/2007	12
		7/13/2007	13
		12/20/2007	3.5
		1/29/2008	55
		4/9/2008	5.2
		7/10/2008	<0.33
		11/6/2008	<0.33
		1/20/2009	<0.33
		4/13/2009	<0.33
		4/21/2010	1.6
		4/5/2011	2.5
		4/12/2012	**<2.0**
	MC-50	4/1/2004	55
		6/29/2004	25
		9/29/2004	9.3
		1/26/2005	4.7
		4/20/2005	3.4
		10/27/2005	<0.5
		2/1/2006	270
		4/26/2006	6.3
		7/27/2006	3.1
		11/29/2006	<0.33
		1/18/2007	4
		4/18/2007	15
		7/16/2007	6.2
		12/21/2007	<0.66
		1/29/2008	<1.3
		4/9/2008	7.6
		7/10/2008	5
		7/10/2008	4.2
		11/6/2008	3.2
		1/21/2009	3.4
		4/13/2009	2.9
		4/21/2010	3.2
		4/6/2011	15
		4/11/2012	**2.6**
	MC-53	4/1/2004	9.0
		6/29/2004	31
		9/28/2004	220
		1/26/2005	30
		4/20/2005	15
		10/26/2005	17
		2/1/2006	2.7
		4/26/2006	300
		7/26/2006	25
		12/4/2006	4.0

TABLE 5

Historical and Recent Chloroform Concentrations in Shallow Groundwater[a]

Parcel	Well ID	Date Sampled[b]	Chloroform (µg/L)[b]
Relevant Nearby Locations for Parcels A and B (Continued)	MC-53 (Continued)	1/17/2007	6.6
		4/18/2007	9.6
		7/16/2007	8.1
		12/21/2007	5.1
		1/29/2008	10
		4/9/2008	36
		6/25/2008	13
		7/10/2008	11
		11/6/2008	7.3
		1/21/2009	9.3
		4/14/2009	7.1
		4/21/2010	5.0
		4/6/2011	14.0
		4/11/2012	**1.3**
	MC-94	**10/7/2009**	**5.4**
	MC-113	11/7/2008	2.6
		1/22/2009	2
		4/14/2009	2.6
		4/22/2010	3
		4/6/2011	5.7
		4/12/2012	**0.59**
	MC-114	11/7/2008	37.0
		1/22/2009	<3.3
		4/14/2009	16.0
		4/22/2010	5.4
		4/6/2011	22.0
		4/12/2012	**3.5**

Notes:
< = sample not detected
µg/L = micrograms per liter
J = the associated value is an estimated quantity
ND = sample not detected and detection limit not available

[a] ENVIRON identified these wells using NDEP's Regional Database available at http://ndep.neptuneinc.org/ndep_gisdt/home/index.xml, the Data Validation Summary Reports for the Phase A Investigation (ENSR 2007) and the Phase B Groundwater Investigation (Northgate 2010a).

[b] Sample results highlighted gray were presented in the Site-Wide Soil Gas HRA (Northgate 2010c) and bolded sample results represent the most recent chloroform sample results.

References:

ENSR Corporation (ENSR), 2007. Phase A Source Area Investigation Results Report, Tronox LLC Facility, Henderson, Nevada, September. NDEP approved the Report November 30, 2007 and Appendix G – Data Validation Summary Report (DVSR) December 17, 2007.

Northgate Environmental Management, Inc. (Northgate), 2010a. Revised Data Validation Summary Report, Phase B Investigation Groundwater, Tronox LLC, Henderson, Nevada. April 7. NDEP approved April 14, 2010.

Northgate, 2010c. Site-Wide Soil Gas Human Health Risk Assessment, Tronox LLC, Henderson, Nevada. November 22. Not reviewed by NDEP.

TABLE 6
Cancer Risks Estimated Using Soil Gas and Groundwater Results from Co-located Samples

Chemical	Groundwater							Soil Gas						Ratio of Cancer Risk[c]	Ratio of Hazard Quotient[d]
	Well ID[a]	Sample Location Relative to Parcels A and B	Sample Date	Maximum Concentration (µg/L)[b]	RBC (µg/L)	Cancer Risk	Hazard Quotient	Soil Gas Boring	Sample Date	Maximum Concentration (µg/m^3)	RBC (µg/m^3)	Cancer Risk	Hazard Quotient		
Benzene	H-48	Within Parcel A	6/19/2008	3	420	6.0E-09	7.1E-05	--	--	--	--	--	--	--	--
	MC-49	Near Parcels A/B	1/29/2008	6	420	1.4E-08	1.7E-04	--	--	--	--	--	--	--	--
	MC-47	Near Parcels A/B	11/7/2008	4	420	8.8E-09	1.1E-04	--	--	--	--	--	--	--	--
	MC-50	Near Parcels A/B	1/29/2008	1100	420	2.6E-06	3.1E-02	--	--	--	--	--	--	--	--
	MC-62	**Within Parcel A**	**6/23/2008**	**2400**	**420**	**5.7E-06**	**6.8E-02**	**SG05**	**5/29/2008**	**2**	**6197**	**1.9E-09**	**2.2E-05**	**3.1E+03**	**3.1E+03**
	MC-114	Near Parcels A/B	11/7/2008	700	420	1.7E-06	2.0E-02	--	--	--	--	--	--	--	--
Chloroform	**H-49A**	**Within Parcel A**	**6/24/2008**	**3**	**176**	**1.7E-08**	**2.1E-05**	**SG04**	**5/29/2008**	**9**	**1861**	**2.2E-08**	**2.7E-05**	**7.8E-01**	**7.8E-01**
	H-58A	Within Parcel A	1/30/2008	10	176	5.5E-08	6.9E-05	--	--	--	--	--	--	--	--
	M-23	**Near Parcels A/B**	**6/25/2008**	**130**	**176**	**7.4E-07**	**9.2E-04**	**E-SG-9**	**3/8/2013**	**98**	**1861**	**2.5E-07**	**3.1E-04**	**3.0E+00**	**3.0E+00**
	M-44	Within Parcel B	6/24/2008	34	176	1.9E-07	2.4E-04	--	--	--	--	--	--	--	--
	M-94	Near Parcels A/B	6/23/2008	50	176	2.8E-07	3.5E-04	--	--	--	--	--	--	--	--
	M-95	**Near Parcels A/B**	**6/27/2008**	**390**	**176**	**2.2E-06**	**2.8E-03**	**SG07**	**5/17/2008**	**430**	**1861**	**1.1E-06**	**1.4E-03**	**2.0E+00**	**2.0E+00**
	M-96	Near Parcels A/B	7/9/2008	28	176	1.6E-07	2.0E-04	--	--	--	--	--	--	--	--
	MC-45	**Near Parcels A/B**	**6/24/2008**	**3**	**176**	**1.7E-08**	**2.1E-05**	**SG16**	**5/18/2008**	**84**	**1861**	**2.1E-07**	**2.7E-04**	**7.9E-02**	**7.9E-02**
	MC-47	Near Parcels A/B	1/29/2008	13	176	7.4E-08	9.2E-05	--	--	--	--	--	--	--	--
	MC-48	Near Parcels A/B	1/29/2008	57	176	3.2E-07	4.0E-04	--	--	--	--	--	--	--	--
	MC-49	Near Parcels A/B	1/29/2008	55	176	3.1E-07	3.9E-04	--	--	--	--	--	--	--	--
	MC-50	Near Parcels A/B	4/9/2008	8	176	4.3E-08	5.4E-05	--	--	--	--	--	--	--	--
	MC-53	Near Parcels A/B	4/9/2008	36	176	2.0E-07	2.5E-04	--	--	--	--	--	--	--	--
	MC-62	**Within Parcel A**	**6/23/2008**	**2**	**176**	**1.3E-08**	**1.6E-05**	**SG05**	**5/29/2008**	**62**	**1861**	**1.6E-07**	**2.0E-04**	**8.3E-02**	**8.3E-02**
	MC-65	Within Parcel A	6/20/2008	8	176	4.7E-08	5.9E-05	--	--	--	--	--	--	--	--
	MC-66	Within Parcel A	6/20/2008	5	176	3.0E-08	3.7E-05	--	--	--	--	--	--	--	--
	MC-113	Near Parcels A/B	11/7/2008	3	176	1.5E-08	1.8E-05	--	--	--	--	--	--	--	--
	MC-114	Near Parcels A/B	11/7/2008	37	176	2.1E-07	2.6E-04	--	--	--	--	--	--	--	--
	PC-37	**Within Parcel B**	**11/5/2008**	**2**	**176**	**1.1E-08**	**1.4E-05**	**SG06**	**5/20/2008**	**34**	**1861**	**8.7E-08**	**1.1E-04**	**1.3E-01**	**1.3E-01**
	PC-40	**Within Parcel A**	**6/18/2008**	**2**	**176**	**9.1E-09**	**1.1E-05**	**SG01**	**5/29/2008**	**14**	**1861**	**3.6E-08**	**4.4E-05**	**2.5E-01**	**2.5E-01**
	PC-72	Within Parcel B	6/23/2008	29	176	1.6E-07	2.0E-04	--	--	--	--	--	--	--	--

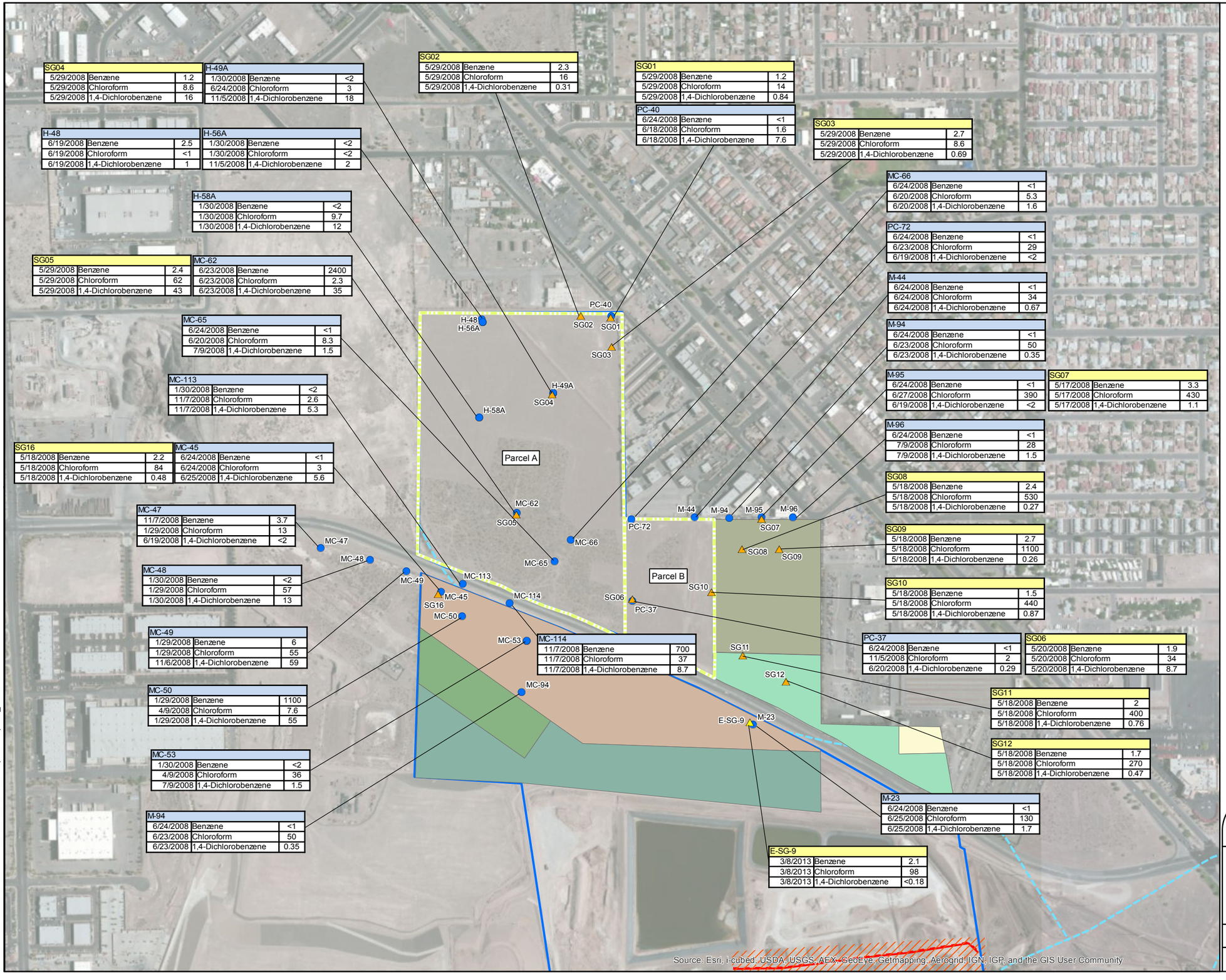
TABLE 6
Cancer Risks Estimated Using Soil Gas and Groundwater Results from Co-located Samples

Chemical	Groundwater							Soil Gas						Ratio of Cancer Risk[c]	Ratio of Hazard Quotient[d]
	Well ID[a]	Sample Location Relative to Parcels A and B	Sample Date	Maximum Concentration (µg/L)[b]	RBC (µg/L)	Cancer Risk	Hazard Quotient	Soil Gas Boring	Sample Date	Maximum Concentration (µg/m^3)	RBC (µg/m^3)	Cancer Risk	Hazard Quotient		
1,4-Dichlorobenzene	H-48	Within Parcel A	6/19/2008	1	933	1.1E-09	3.4E-07	--	--	--	--	--	--	--	--
	H-49A	**Within Parcel A**	**11/5/2008**	**18**	**933**	**1.9E-08**	**6.1E-06**	**SG04**	**5/29/2008**	**16**	**5290**	**1.5E-08**	**4.7E-06**	**1.3E+00**	**1.3E+00**
	H-56A	Within Parcel A	11/5/2008	2	933	2.1E-09	6.8E-07	--	--	--	--	--	--	--	--
	H-58A	Within Parcel A	1/30/2008	12	933	1.3E-08	4.1E-06	--	--	--	--	--	--	--	--
	M-23	**Near Parcels A/B**	**6/25/2008**	**2**	**933**	**1.8E-09**	**5.8E-07**	**E-SG-9**	**3/8/2013**	**<0.18**	**5290**	**1.7E-10**	**5.3E-08**	**1.1E+01**	**1.1E+01**
	M-44	Within Parcel B	6/24/2008	1	933	7.2E-10	2.3E-07	--	--	--	--	--	--	--	--
	M-94	Near Parcels A/B	6/23/2008	0.35	933	3.7E-10	1.2E-07	--	--	--	--	--	--	--	--
	M-96	Near Parcels A/B	7/9/2008	2	933	1.6E-09	5.1E-07	--	--	--	--	--	--	--	--
	MC-45	**Near Parcels A/B**	**6/25/2008**	**6**	**933**	**6.0E-09**	**1.9E-06**	**SG16**	**5/18/2008**	**0.5**	**5290**	**4.4E-10**	**1.4E-07**	**1.4E+01**	**1.4E+01**
	MC-48	Near Parcels A/B	1/30/2008	13	933	1.4E-08	4.4E-06	--	--	--	--	--	--	--	--
	MC-49	Near Parcels A/B	11/6/2008	59	933	6.3E-08	2.0E-05	--	--	--	--	--	--	--	--
	MC-50	Near Parcels A/B	1/29/2008	55	933	5.9E-08	1.9E-05	--	--	--	--	--	--	--	--
	MC-53	Near Parcels A/B	7/9/2008	2	933	1.6E-09	5.1E-07	--	--	--	--	--	--	--	--
	MC-62	**Within Parcel A**	**6/23/2008**	**35**	**933**	**3.7E-08**	**1.2E-05**	**SG05**	**5/29/2008**	**43**	**5290**	**4.0E-08**	**1.3E-05**	**9.4E-01**	**9.4E-01**
	MC-65	Within Parcel A	7/9/2008	2	933	1.6E-09	5.1E-07	--	--	--	--	--	--	--	--
	MC-66	Within Parcel A	6/20/2008	2	933	1.7E-09	5.5E-07	--	--	--	--	--	--	--	--
	MC-113	Near Parcels A/B	11/7/2008	5	933	5.7E-09	1.8E-06	--	--	--	--	--	--	--	--
	MC-114	Near Parcels A/B	11/7/2008	9	933	9.3E-09	3.0E-06	--	--	--	--	--	--	--	--
	PC-37	**Within Parcel B**	**6/20/2008**	**0.29**	**933**	**3.1E-10**	**9.9E-08**	**SG06**	**5/20/2008**	**9**	**5290**	**8.1E-09**	**2.6E-06**	**3.9E-02**	**3.9E-02**
	PC-40	**Within Parcel A**	**6/18/2008**	**8**	**933**	**8.1E-09**	**2.6E-06**	**SG01**	**5/29/2008**	**1**	**5290**	**7.8E-10**	**2.5E-07**	**1.0E+01**	**1.0E+01**

Notes:
-- = no value
µg/L= micrograms per liter
µg/m^3 = micrograms per cubic meter
RBC = risk-based concentration

[a] Only groundwater wells with detected concentrations are shown. Bolded sample results indicate groundwater wells are collocated with a 2008 or 2013 soil gas sample.
[b] Sample results highlighted gray indicate that the maximum concentration exceeds its risk-based concentration.
[c] This value represents the ratio of cancer risk calculated from groundwater to cancer risk calculated from soil gas.
[d] This value represents the ratio of the hazard quotient calculated from groundwater to the hazard quotient calculated from soil gas.

Figures



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Legend

- 2008 Phase B Soil Gas Location (µg/m³)
- 2013 Soil Gas Location (µg/m³)
- Shallow Groundwater Well (µg/L)
- Study Area
- Former portion of Parcel B
- Parcel C
- Parcel D
- Parcel E
- Former Parcel I
- Former Parcel J
- Ditches
- Interceptor Well Field
- Groundwater Barrier Wall

NOTE:
Data boxes highlighted blue indicate groundwater data in µg/L and databoxes highlighted yellow indicate soil gas data in µg/m³.

N

0 300 600

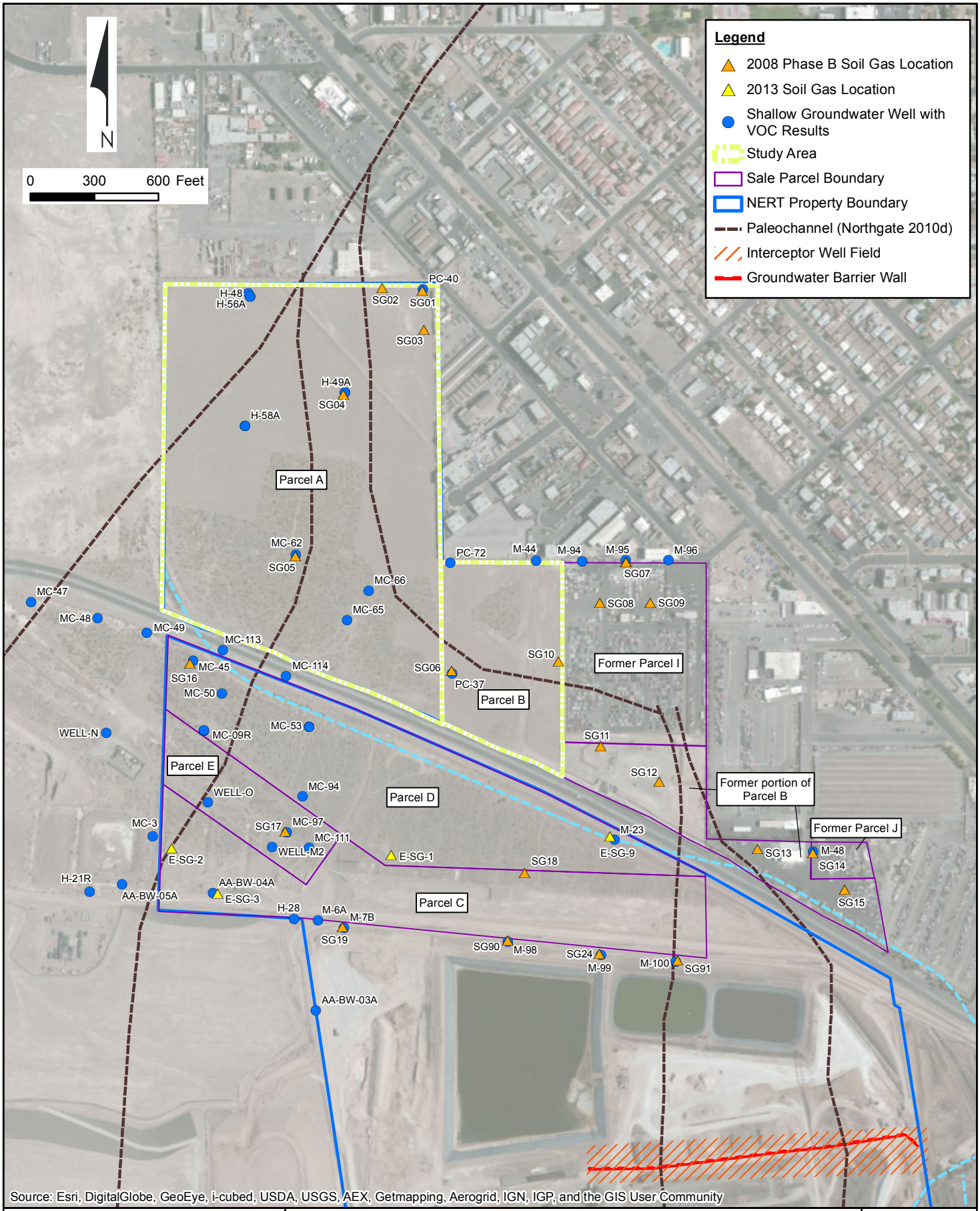
SCALE IN FEET

ENVIRON

Soil Gas & Shallow Groundwater Results for Benzene, Chloroform, & 1,4-Dichlorobenzene

Nevada Environmental Response Trust Site
Henderson, Nevada

Date:	Contract Number:		Figure
04/26/13	21-32100GA		1
Drafter: RS	Approved:	Revised:	



Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

ENVIRON

Soil Gas & Shallow Groundwater Well Sampling Locations

Nevada Environmental Response Trust Site, Henderson, Nevada

Figure **2**

Drafter:	RS	Date:	4/16/13	Contract Number:	21-32100GA	Approved:	Revised:

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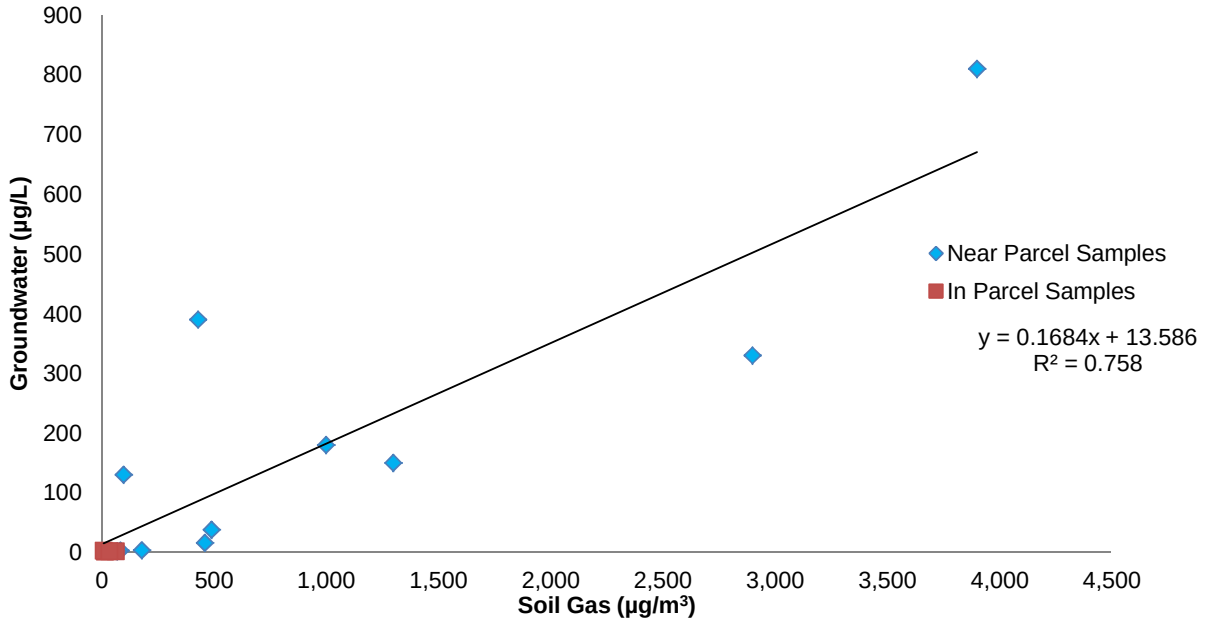
FIGURE 3
Comparison of Chloroform Concentrations in Soil Gas and Shallow Groundwater in Co-located Locations Within and Near Parcels A and B

Location Group	Soil Gas			Groundwater		
	Boring ID	Sample Date	Chloroform ($\mu g/m^3$)	Well ID	Sample Date	Chloroform ($\mu g/L$)
Parcel A	SG01	5/29/2008	14	PC-40	6/18/2008	1.6
	SG04	5/29/2008	8.6	H-49A	6/24/2008	3
	SG05	5/29/2008	62	MC-62	6/23/2008	2.3
Parcel B	SG06	5/20/2008	34	PC-37	6/20/2008	2
Near Parcels A/B	E-SG-2	3/7/2013	460	MC-3	5/27/2009	16
	E-SG-3	3/7/2013	2900	AA-BW-04A	10/20/2011	330
	E-SG-9	3/8/2013	98	M-23	6/25/2008	130
	SG07	5/17/2008	430	M-95	6/27/2008	390
	SG14	5/20/2008	1000	M-48	7/9/2008	180
	SG16	5/18/2008	84	MC-45	6/25/2008	3
	SG17	5/18/2008	180	MC-97	6/25/2008	3.8
	SG19	5/28/2008	70	M-7B	6/26/2008	2.1
	SG24	5/28/2008	1300	M-99	5/6/2010	150
	SG90	5/28/2008	3900	M-98	11/30/2006	810
	SG91	5/21/2008	490	M-100	12/4/2006	38



Attachment A

Chronological Listing of Select Documents for Parcels A and B

Attachment A

Chronological Listing of Select Parcel A and B Documents

Date	Document Title	Revision
November 13, 2008	**Basic Environmental Company (BEC**), 2008. Technical Memorandum – Screening-Level Indoor Air Health Risk Assessment for the 2008 Tronox Parcels A/B Soil Gas Investigation, November 13, 2008.	Revision 0
December 22, 2008	**Nevada Division of Environmental Protection (NDEP)**, 2008. NDEP Response to: Technical Memorandum – Screening-Level Indoor Air Health Risk Assessment for the 2008 Tronox Parcels A/B Soil Gas Investigation, Dated November 13, 2008. December 22, 2008.	Revision 0
March 30, 2010	**BEC**, 2010. Technical Memorandum – Screening-Level Indoor Air Health Risk Assessment for the 2008 Tronox Parcels A/B Soil Gas Investigation, March 30, 2010.	Revision 1
May 13, 2010	**NDEP**, 2010. NDEP Response to: Technical Memorandum – Screening-Level Indoor Air Health Risk Assessment for the 2008 Tronox Parcels A/B Soil Gas Investigation, BMI Industrial Complex, Clark County, Nevada, Dated March 30, 2010. May 13.	Revision 1
June 29, 2010	**Northgate Environmental Management, Inc. (Northgate)**, 2010. Technical Memorandum – Screening-Level Indoor Air Health Risk Assessment for the 2008 Tronox Parcels A/B Soil Gas Investigation. June 29, 2010.	Revision 2
August 31, 2010	**NDEP**, 2010. NDEP Response to: Revised Technical Memorandum: Screening-Level Indoor Air Health Assessment for the 2008 Tronox Parcels A/B Soil Gas Investigation And Errata, Tronox LLC, Henderson, Nevada, Dated: June 29, 2010 August 31, 2010.	Revision 2
September 7, 2010	**NDEP**, 2010. Meeting Minutes regarding the Tech Memo of Parcels A/B Indoor Air Health Risk Assessment. September 7.	Revision 2
November 12, 2010	**Northgate**, 2010. Response to Comments re: Revised Technical Memorandum – Screening-Level Indoor Air Health Risk Assessment for the 2008 Tronox Parcels A/B Soil Gas Investigation, Dated June 29, 2010. November 12, 2010.	Revision 3
November 12, 2010	**Northgate**, 2010. Revised Technical Memorandum – Screening-Level Indoor Air Health Risk Assessment for the 2008 Tronox Parcels A/B Soil Gas Investigation. November 12, 2010.	Revision 3
May 23, 2011	**NDEP**, 2011. NDEP Response to: Revised Tech Memo – Screening-Level Indoor Air Health Risk Assessment for the 2008 Tronox Parcels A/B Soil Gas Investigation, Tronox LLC, Henderson, Nevada, Dated: November 12, 2010.	Revision 3

Attachment B

Phase B Source Area Investigation
Soil Gas Survey Work Plan
Tronox LLC Facility Henderson, Nevada
March 2008

(Provided electronically or on CD separately)

Attachment C

Revised Technical Memorandum: Screening-Level Indoor Air Health Risk Assessment for the 2008 Tronox Parcels A/B Soil Gas Investigation
BMI Industrial Complex, Clark County, Nevada
November 12, 2010

(Provided electronically or on CD separately)

Attachment D

Shallow Groundwater Results for Benzene, 1,4-Dichlorobenzene, and Chloroform

Attachment D

Shallow Groundwater Results for Benzene, 1,4-Dichlorobenzene, and Chloroform

Figures

This attachment presents figures developed by Hargis & Associates (H+A) (2012) depicting groundwater concentrations of benzene, chloroform, and 1,4-dichlorobenzene for areas within and upgradient of Parcels A and B (H+A Figures 6, 8, and 10, included in this Attachment). The figures provide information on upgradient sources and current concentrations of these chemicals in groundwater on the adjacent Olin Corporation (Olin) property.

In 2008, benzene was detected in monitoring well MC-62 (within Parcel A) at a concentration of 2,400 micrograms per liter (µg/L) and in two upgradient Parcel D monitoring wells (MC-50 and MC-114) at concentrations of 1,100 and 700 µg/l, respectively (see Figure 1 of this memorandum). The 2008 benzene concentrations in all other nearby wells ranged from less than the detection limit (typically 1 or 2 µg/L to a maximum detected concentration of 6 µg/L. Historical monitoring data from 2005 and 2006 for MC-62 indicate that benzene was either not detected or detected at a lower concentration (maximum detected concentration of 180 µg/L). MC-62 has not been sampled since 2008. However, Olin/Stauffer Management Company, LLC/Syngenta Crop Protection LLC/Montrose Chemical Corporation of California (OSSM) monitor their groundwater treatment system transect wells for volatile organic compounds (VOCs) on a quarterly basis (*de maximis*, *inc.* 2012). Well MC-50, which is located directly upgradient of well MC-62 and along the same paleochannel as well MC-62 (see Figure 2 of this memorandum), is considered to be a good indicator of anticipated concentrations in monitoring well MC-62. Benzene concentrations detected in monitoring well MC-50 have decreased since 2008 to levels below 50 µg/L in 2012, as shown on the H+A Figure 6 included in this Attachment. Concentrations for other upgradient VOCs originating on the Olin property show similar spatial distributions and decreasing concentration trends as those for benzene. Figure 10 from H+A for 1,4-dichlorobenzene is provided in this Attachment as an additional example. Similar to benzene, a comparison of the 2012 1,4-dichlorobenzene concentrations in

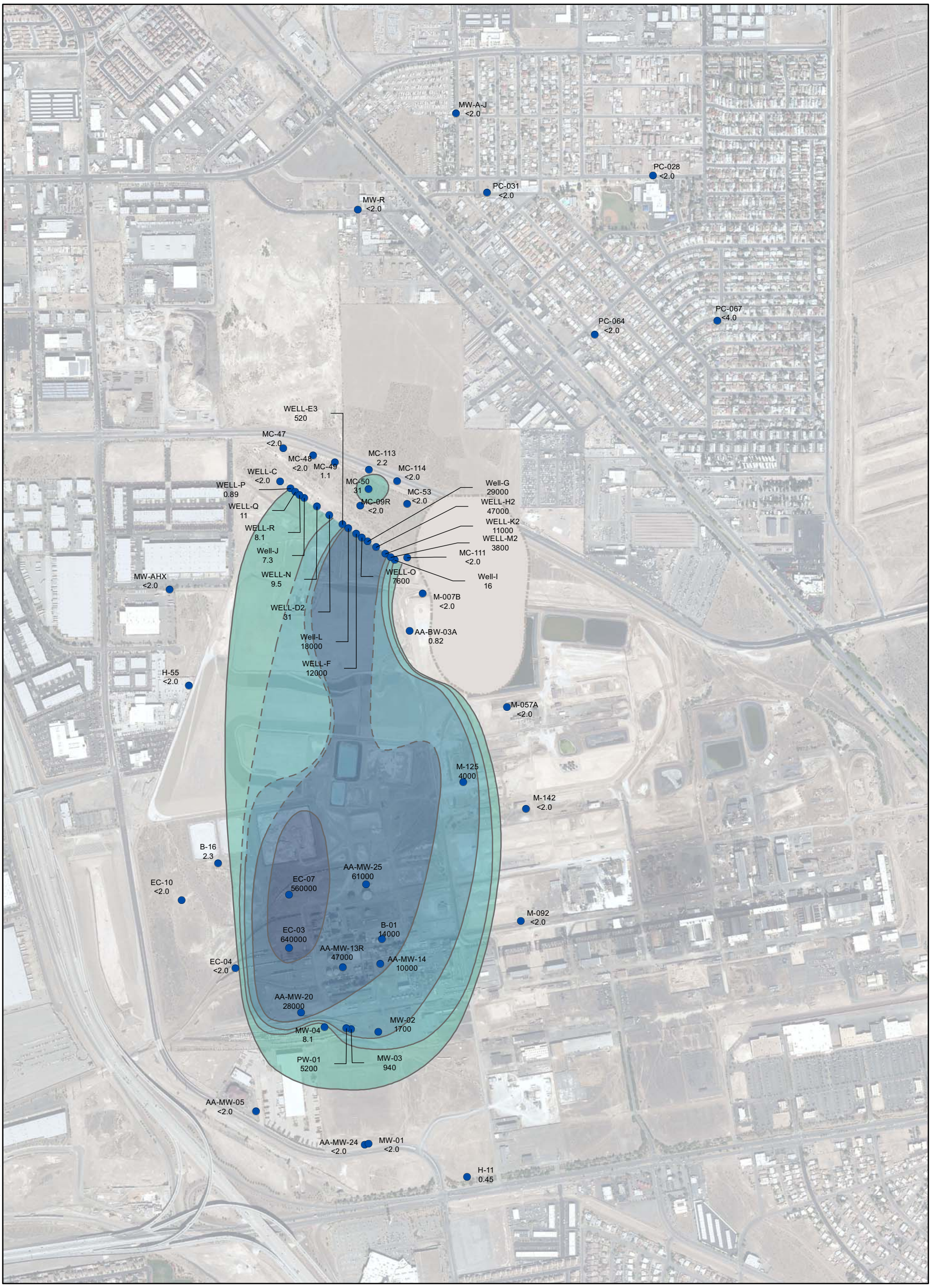
wells to the north of the OSSM treatment system with the 2008 concentrations (see Figure 1 of this memorandum) shows that concentrations in 2012 are less than those measured in 2008.

Overall, the groundwater results suggest that historically, elevated concentrations of benzene and related chemicals (specifically, chlorobenzenes) have been elevated in monitoring wells near the paleochannel and downgradient of the OSSM groundwater treatment system. A comparison of groundwater concentrations in these wells in 2008 with concentrations measured in 2012 indicates that concentrations of benzene and related compounds have decreased substantially. The 2012 benzene concentration of 31 µg/L in upgradient monitoring well MC-50 is well below the risk-based concentration of 420 µg/L (see Table 6 of this memorandum) for the vapor intrusion pathway.

References

de maximis, inc., 2012. Quarterly Operations Report, Groundwater Treatment System, Henderson, Nevada, Third Quarter 2012. November 14. Under NDEP review.

Hargis & Associates, Inc. (H+A), 2012. 2012 Comprehensive Groundwater Data Evaluation Report, Former Montrose and Stauffer Facilities and Current Olin Facility, Henderson, Nevada. August 16. NDEP commented January 22, 2013.



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EXPLANATION

BENZENE CONCENTRATION (ug/l)
EPA METHOD: 8260B

- 5 (BCL, MCL) - 99
- 100 - 999
- 1,000 - 9,999
- 10,000 - 99,999
- 100,000 - 999,999

Boundary of concentration zone is dashed where inferred, queried where uncertain

H-11 0.45 — MONITOR WELL IDENTIFIER; CONCENTRATION IN MICROGRAMS PER LITER; SECOND QUARTER 2012

< — LESS THAN; COMPOUND WAS NOT DETECTED AT OR ABOVE THE REPORTED DETECTION LIMIT

ug/l — MICROGRAMS PER LITER

AREA OF UNCERTAIN SHALLOW ZONE SATURATION

N

0 500 1,000
Feet

Note:
While additional data may be available from other BMI area companies, these maps were prepared based on water quality data generated by the OSSM companies in 2012.

2012 COMPREHENSIVE DATA EVALUATION
MONTROSE, STAUFFER AND OLIN SITES
HENDERSON, NEVADA

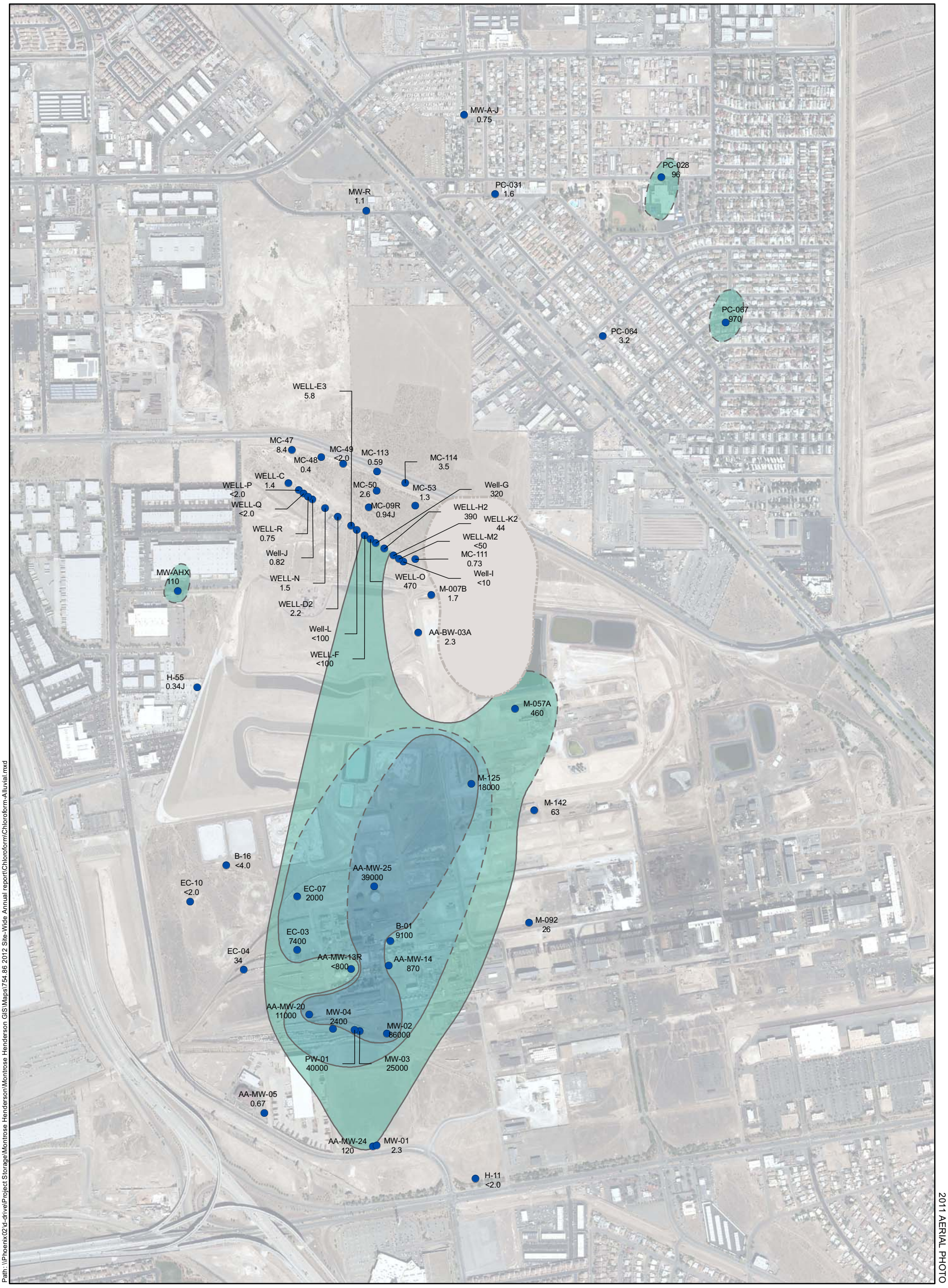
BENZENE
SHALLOW ZONE
SECOND QUARTER 2012

HARGIS + ASSOCIATES, INC.
HYDROGEOLOGY / ENGINEERING

7/23/2012

FIGURE 6

PREP BY DAT REV BY BRW RPT NO 754.86



EXPLANATION

CHLOROFORM CONCENTRATION (ug/l)
EPA METHOD: 8260B

- 80 (TTHM MCL) - 999
- 1,000 - 9,999
- 10,000 - 99,999

Boundary of concentration zone is dashed where inferred, queried where uncertain.

H-11 MONITOR WELL IDENTIFIER
<2.0 CONCENTRATION IN MICROGRAMS PER LITER SECOND QUARTER 2012

<	LESS THAN; COMPOUND WAS NOT DETECTED AT OR ABOVE THE REPORTED DETECTION LIMIT
ug/l	MICROGRAMS PER LITER
TTHM	TOTAL TRIHALOMETHANES (BROMODICHLOROMETHANE + BROMOFORM + CHLOROFORM + DIBROMOCHLOROMETHANE)
J	THE ASSOCIATED VALUE IS AN ESTIMATED QUANTITY.
	AREA OF UNCERTAIN SHALLOW ZONE SATURATION

N

0 500 1,000
Feet

Note:
BCL = 0.193 ug/l

While additional data may be available from other BMI area companies, these maps were prepared based on water quality data generated by the OSSM companies in 2012.

2012 COMPREHENSIVE DATA EVALUATION
MONTROSE, STAUFFER AND OLIN SITES
HENDERSON, NEVADA

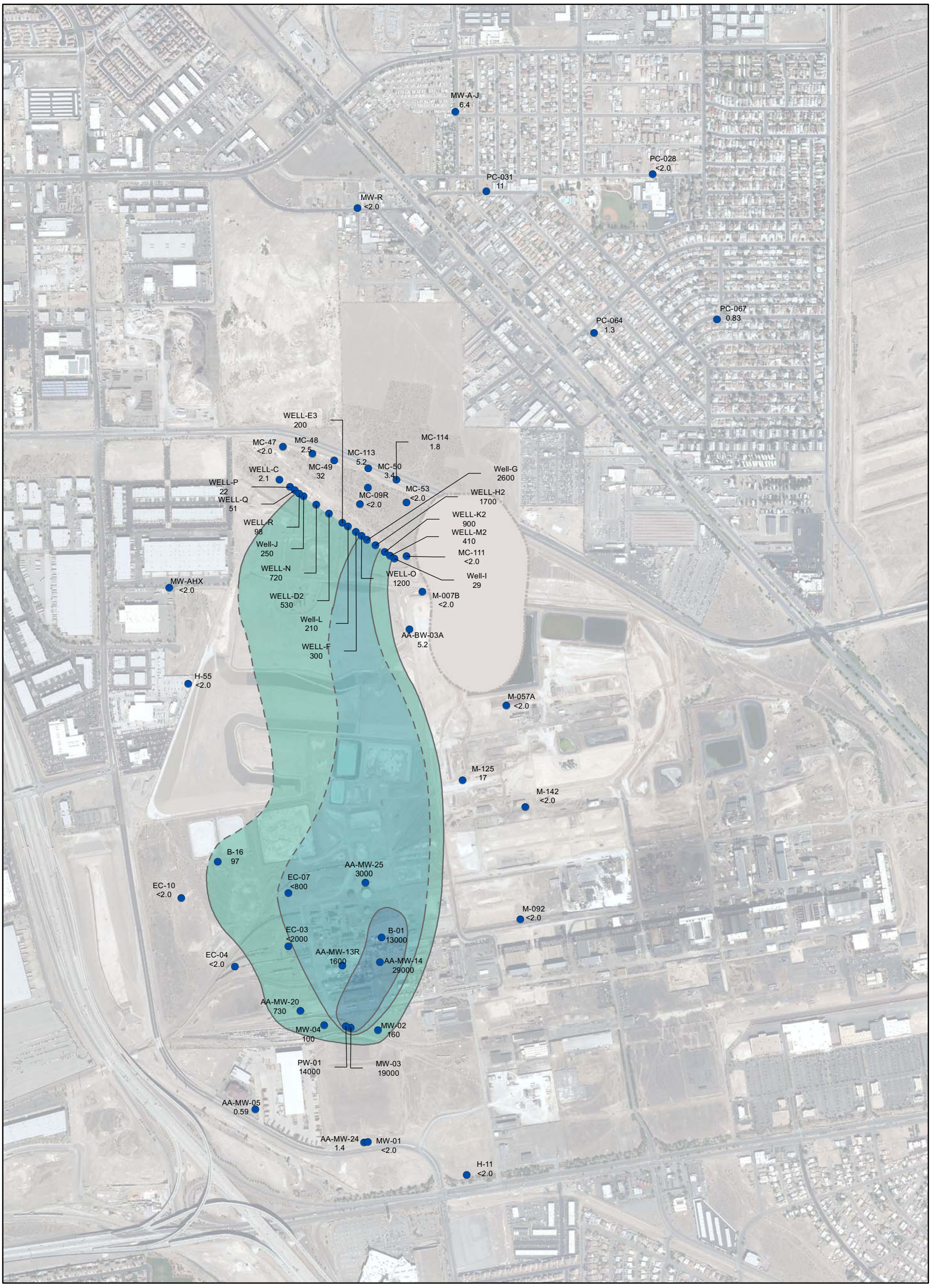
CHLOROFORM
SHALLOW ZONE
SECOND QUARTER 2012

HARGIS + ASSOCIATES, INC.
HYDROGEOLOGY / ENGINEERING

8/14/2012

FIGURE 8

PREP BY DAT REV BY BRW RPT NO 754.86



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EXPLANATION

1,4-DICHLOROBENZENE CONCENTRATION (ug/l)
EPA METHOD: 8260B

- 75 (BCL, MCL) - 999
- 1,000 - 9,999
- 10,000 - 99,999

Boundary of concentration zone is dashed where inferred, queried where uncertain

H-11 <2.0 — MONITOR WELL IDENTIFIER; CONCENTRATION IN MICROGRAMS PER LITER SECOND QUARTER 2012

< — LESS THAN; COMPOUND WAS NOT DETECTED AT OR ABOVE THE REPORTED DETECTION LIMIT

ug/l — MICROGRAMS PER LITER

AREA OF UNCERTAIN SHALLOW ZONE SATURATION

N

0 500 1,000
Feet

Note:
While additional data may be available from other BMI area companies, these maps were prepared based on water quality data generated by the OSSM companies in 2012.

2012 COMPREHENSIVE DATA EVALUATION
MONTROSE, STAUFFER AND OLIN SITES
HENDERSON, NEVADA

1,4-DICHLOROBENZENE
SHALLOW ZONE
SECOND QUARTER 2012

HARGIS + ASSOCIATES, INC.
HYDROGEOLOGY / ENGINEERING

7/23/2012

FIGURE 10

PREP BY DAT REV BY BRW RPT NO 754.86