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NSA CRANE
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EMAIL AND ATTACHED REVISED RESPONSE TO COMMENTS ON THE CORRECTIVE MEASURES PROPOSAL FOR (SWMU 5) NSA CRANE IN
04/17/2014
TETRA TECH NUS INC

Lyons, Karen

From: Karen Lyons <Karen.Lyons@tetratech.com>
Sent: Thursday, April 17, 2014 9:40 AM
To: Brent, Thomas CIV NAVFAC MW, PWD Crane EV
Subject: Revised SWMU 5 CMP & Revised RTCs

Click the links below to download the files. Files will expire Tue Apr 29 08:39:46 2014.
Corrective Measures Proposal Report for SWMU 5.pdf (9,374,712 bytes)
RTCs_5_2_2007 (Rev 4_16_2014)_Redline.pdf (566,833 bytes)
EPA_RTC_1-9-08 (Rev 4_16_2014)_Redline.pdf (62,932 bytes)
EPA_RTC_1_28_2009_Rev 4_16_2014)_Redline.pdf (145,780 bytes)
RTC_EPA_2_23_10 (Rev 4_16_2014)_Redline.pdf (60,459 bytes)
response to EPA March 21 2014 Comment on SWMU 5 MCS_(Rev_4_16_14) .pdf (195,740 bytes)

Package details:
From: Karen.Lyons@tt
To: howard.hickey@navy.mil ; thomas.brent@navy.mil
Subject: Revised SWMU 5 CMP & Revised RTCs
Arrived: Thu Apr 17 08:39:46 2014

Gentlemen,

Attached is the revised SWMU 5 CMP and the revised responses to comments (RTCs) on the document. The RTCs span several years and various changes were made to the document as a result of the changes. Since it can be a little difficult determining if all the changes identified in the RTCs were made because of the many revisions that were made, revisions were made to the RTCs for clarification purposes. I didn't make any changes to the attachments of the RTCs, but I did revise the responses if the text to the report changed. Let me know if you have any questions.

Karen Lyons 412-921-8893

Total file size: 10,406,456 bytes

USEPA COMMENTS ON MEDIA CLEANUP STANDARDS FOR CORRECTIVE MEASURES PROPOSAL
SWMU 5 – OLD BURN PIT
NAVAL SUPPORT ACTIVITY CRANE
CRANE, INDIANA

Dan Mazur's Comments included in Peter Ramanauskas' email dated 03/21/14

EPA Comment: For the revised Table 2-12, under the column heading "Surface Water" the footnotes for "Lead" (2 & 6) need to be deleted. The footnote for the "Surface Water" (2) column heading adequately identifies the source of the value.

The response to your comment on chronic Aquatic Life Criteria is also acceptable with a minor clarification as shown below. I suggest this response be inserted either in the report text or preferably within Table 2-12.

"The lower of the Chronic Aquatic Life, Human Health and Consumption of Aquatic Life, Region 5 RCRA Ecological Screening Level, or IDEM calculated Tier 2 value was used to determine the surface water MSCs."

Response: The Navy does not believe that it is necessary to include the "Human Health and Consumption of Aquatic Life" criteria in the sources to determine the surface water MCS because the streams at SWMU 5 do not support fish that are large enough to be consumed by humans. Section 2.5.2 has been extensively revised, and the t~~T~~he following text will be added to the end of ~~the first paragraph in~~ Section 2.5.2:

"The surface water values in Table 2-12 are the lower of the Water Only, Unprotected Water Supply value of the Chronic Aquatic Life Criteria value listed in Table A-1~~ in Appendix A~~. The Water + Fish values were not used because the streams at SWMU 5 do not support large enough fish to be consumed by humans. Also, the Protected Water Supply values were not selected because the streams at SWMU 5 are not considered protected drinking water supplies."

Tables A-1 and 2-12 were revised to reflect this change (the values that were changed on the tables are shaded in yellow). Also, some other additional changes were made to update the values as follows:

- ~~The aluminum groundwater MSC was revised to be the USEPA Regional Screening Level for tapwater (November 2013).~~
- None of the USEPA Recommended Water Quality Criteria human health values were used as the MCS because they include a consumption of fish component, which is not applicable for SWMU 5. This caused a revision of the values for antimony and manganese.
- The chronic aquatic life values for barium and manganese (210 µg/L and 288 µg/L) are slightly different that the values proposed by USEPA in previous comments (209 µg/L and 287 µg/L). The difference may have been how the values were rounded by USEPA.
- The USEPA Region 5 ESL of 47 µg/L was used as the chronic aquatic life criteria for trichloroethene because it is lower than the IDEM Criteria and Values for Selected Substances Calculated Using the Great Lakes Basin Methodologies.
- The human health water quality standards for trichloroethene, cis-1,2-dichloroethene, and vanadium on Table A-1 were updated based on current reference doses or cancer slope factors. The revised values are also presented in the Human Health Supporting Documentation, which is part of Appendix A.

Originally dated 04/01/14
Revised 04/16/14

- The groundwater values on Table 2-12 were revised to be either the MCL (if one is available) or the IDEM RISC value (in an MCL is not available). The risk-ratio approach, as was previously listed on the table, was not used because MCLs or RISC values are now available for all chemicals.

TABLE 2-12

MEDIA CLEANUP STANDARDS FOR SURFACE WATER AND GROUNDWATER
CMP REPORT FOR SMWU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

CASRN	Chemical	MCS	
		Groundwater(1) (µg/L)	Surface Water(2) (µg/L)
Dioxins			
1746-01-6	Total Dioxin 2,3,7,8-TCDD TEQ(4)	0.00003 (5)	0.0005 (7)
Volatile Organics			
67-66-3	Chloroform	80 (5)	140 (3)
75-35-4	1,1-Dichloroethene	7 (5)	65 (3)
156-59-2	cis-1,2-Dichloroethene	70 (5)	620 (8)
156-60-5	trans-1,2-Dichloroethene	100 (5)	560 (8)
79-01-6	Trichloroethene	5 (5)	47 (3)
75-01-4	Vinyl chloride	2 (5)	47 (7)
Semi-Volatile Organics			
117-81-7	Bis(2-ethylhexyl) phthalate	6 (5)	0.3 (3)
Metals			
7429-90-5	Aluminum	16,000 (6)	87 (9)
7440-36-0	Antimony	6 (5)	80 (3,8)
7440-38-2	Arsenic	10 (5)	46.7 (7)
7440-39-3	Barium	2,000 (5)	210 (8)
7440-50-8	Copper	1,300 (5)	1.58 (3)
7439-89-6	Iron	11,000 (6)	1,000 (9)
7439-92-1	Lead	15 (5)	1.17 (3,10)
7439-96-5	Manganese	320 (6)	288 (8)
7440-62-2	Vanadium	63 (6)	12 (3,8)
7440-66-6	Zinc	4,700 (6)	58 (10)

µg/L - microgram per liter.
CASRN - Chemical Abstract Services Registry Number.
ESL - Ecological Screening Level.
IDEM - Indiana Department of Environmental Management.
USEPA - United States Environmental Protection Agency.
RCRA - Resource Conservation & Recovery Act of 1976.
RISC - Risk Integrated System of Closure.
MCS - Media cleanup standard.

1 MCS assumes that groundwater is used as a domestic water supply source.
2 The Surface Water MCS is the lower of the Human Health Water Only, Unprotected Water Supply value or the chronic aquatic life criteria from Table A-1 in Appendix A.
3 USEPA, Region 5, RCRA ESL (http://www.epa.gov/reg5rcra/ca/ESL.pdf)
4 Dioxin-TEQ concentration as 2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD).
5 USEPA Primary Drinking Water Standard (USEPA, Spring, 2012).
6 IDEM, RISC residential closure levels for tap water/groundwater (IDEM, March 2014)
7 Calculated according to Indiana Administrative Codes 327 IAC 2-1-8-5 and 2-1-8-6.
Note that the cancer target risk for IDEM is 1E-05. See Appendix A for calculation sheets.
8 IDEM, Criteria and Values for Selected Substances Calculated using the Great Lakes Basin Methodologies
9 USEPA Recommended Water Quality Criteria (USEPA, 2013).
http://www.epa.gov/waterscience/criteria/wqctable/index.html
10 IDEM, Water Quality Standards (based on a water hardness of 50 mg/L).
http://www.in.gov/legislative/iac/T03270/A00020.PDF

TABLE A-1

INDIANA HUMAN HEALTH WATER QUALITY STANDARDS AND CHRONIC AQUATIC LIFE CRITERIA
CMP REPORT FOR SMWU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

CASRN	Chemical	Water + Fish(1)		Water only(1)		Chronic Aquatic Life Criteria (µg/L)
		Protected Water Supply (µg/L)	Unprotected Water Supply (µg/L)	Protected Water Supply (µg/L)	Unprotected Water Supply (µg/L)	
Dioxins						
3268-87-9	1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (1,2,3,4,6,7,8,9-OCDD)	0.000002	0.000002	0.008	2	NA
39001-02-0	1,2,3,4,6,7,8-Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF)	0.00000007	0.00000007	0.0002	0.05	NA
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (1,2,3,4,6,7,8-HpCDD)	0.00000007	0.00000007	0.0002	0.05	NA
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)	0.0000000007	0.0000000007	0.000002	0.0005	NA
37871-00-4	Total Heptachlorodibenzo-p-dioxin (Total HpCDD)	NA(2)	NA(2)	NA(2)	NA(2)	NA(2)
38998-75-3	Total Heptachlorodibenzofuran (Total HpCDF)	NA(2)	NA(2)	NA(2)	NA(2)	NA(2)
Volatile Organics						
67-66-3	Chloroform	280	1,400	350	70,000	140 (4)
75-35-4	1,1-Dichloroethene	1,300	4,600	1,800	350,000	65 (4)
156-59-2	cis-1,2-Dichloroethene	57	309	70	14,000	620 (3)
156-60-5	trans-1,2-Dichloroethene	520	2,100	700	140,000	560 (3)
79-01-6	Trichloroethene	3.5	6.4	7.6	1,522	47 (4)
75-01-4	Vinyl chloride	0.2	2	0.2	47	930 (3,4)
Semi-Volatile Organics						
117-81-7	Bis(2-ethylhexyl) phthalate	0.003	0.003	25	5,000	0.3 (4)
Metals						
7429-90-5	Aluminum	33,900	903,000	35,000	7,000,000	87 (5)
7440-36-0	Antimony	9.3	27.7	14	2,800	80 (3,4)
7440-38-2	Arsenic	0.076	0.16	0.23	46.7	148 (3,4)
7440-39-3	Barium	785	884	7,000	1,400,000	210 (3)
7440-50-8	Copper	142	158	1,400	280,000	1.58 (4)
7439-89-6	Iron	7,000	9,780	24,500	4,900,000	1,000 (5)
7439-92-1	Lead	NA	NA	NA	NA	1.17 (4,6)
7439-96-5	Manganese	408	973	700	140,000	288 (3)
7440-62-2	Vanadium	175	35,000	175	35,000	12 (3,4)
7440-66-6	Zinc	393	408	10,500	2,100,000	58 (6)

µg/L - microgram per liter.
CASRN - Chemical Abstract Services Registry Number.
ESL - Ecological Screening Level.
IDEM - Indiana Department of Environmental Management.
USEPA - United States Environmental Protection Agency.
RCRA - Resource Conservation & Recovery Act of 1976.

1 Calculated according to Indiana Administrative Codes 327 IAC 2-1-8-5 and 2-1-8-6. The back-up calculations for these values are presented in the pages following this table. Note that the cancer target risk for IDEM is 1E-05.
2 No cancer slope factor or toxicity equivalent factors are available to estimate alternative water quality standards.
3 IDEM, Criteria and Values for Selected Substances Calculated using the Great Lakes Basin Methodologies
4 US EPA, Region 5, RCRA. ESL (http://www.epa.gov/reg5rcra/ca/ESL.pdf)
5 USEPA Recommended Water Quality Criteria (USEPA, 2013). http://www.epa.gov/waterscience/criteria/wqctable/index.html
6 IDEM, Water Quality Standards (based on a water hardness of 50 mg/L). http://www.in.gov/legislative/iac/T03270/A00020.PDF

SWQS FOR ALUMINUM (with fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

RfD =	1	mg/kg/day
W_h =	70	
MgT =	70	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	2.7	

SWQS =	**33.9**	**protected (mg/L)**	**=**	**33,857**	**protected (µg/L)**
SWQS =	**903**	**unprotected (mg/L)**	**=**	**903,226**	**unprotected (µg/L)**

SWQS FOR ALUMINUM (without fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

RfD =	1	mg/kg/day
W_h =	70	
MgT =	70	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**35**	**protected (mg/L)**	**=**	**35,000**	**protected (µg/L)**
SWQS =	**7,000**	**unprotected (mg/L)**	**=**	**7,000,000**	**unprotected (µg/L)**

SWQS FOR ANTIMONY (with fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

RfD =	0.0004	mg/kg/day
W_h =	70	
MgT =	0.028	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	40	

SWQS =	**0.0093**	**protected (mg/L)**	**=**	**9**	**protected (µg/L)**
SWQS =	**0.0277**	**unprotected (mg/L)**	**=**	**28**	**unprotected (µg/L)**

SWQS FOR ANTIMONY (without fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

RfD =	0.0004	mg/kg/day
W_h =	70	
MgT =	0.028	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**0.014**	**protected (mg/L)**	**=**	**14**	**protected (µg/L)**
SWQS =	**2.8**	**unprotected (mg/L)**	**=**	**2,800**	**unprotected (µg/L)**

SWQS FOR BARIUM (with fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.2	mg/kg/day
W_h =	70	
MgT =	14	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	633	
SWQS =	**0.785**	**protected (mg/L) = 785 protected (µg/L)**
SWQS =	**0.884**	**unprotected (mg/L) = 884 unprotected (µg/L)**

SWQS FOR BARIUM (without fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.2	mg/kg/day
W_h =	70	
MgT =	14	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	
SWQS =	**7.0**	**protected (mg/L) = 7,000 protected (µg/L)**
SWQS =	**1,400**	**unprotected (mg/L) = 1,400,000 unprotected (µg/L)**

SWQS FOR COPPER (with fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.04	mg/kg/day
W_h =	70	
MgT =	2.8	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	710	
SWQS =	**0.142**	**protected (mg/L) = 142 protected (µg/L)**
SWQS =	**0.158**	**unprotected (mg/L) = 158 unprotected (µg/L)**

SWQS FOR COPPER (without fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.04	mg/kg/day
W_h =	70	
MgT =	2.8	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	
SWQS =	**1.4**	**protected (mg/L) = 1,400 protected (µg/L)**
SWQS =	**280**	**unprotected (mg/L) = 280,000 unprotected (µg/L)**

HUMAN HEALTH SUPPORTING DOCUMENTATION FOR INORGANIC COMPOUNDS MEDIA CLEANUP STANDARDS FOR SURFACE WATER AND GROUNDWATER
CMP REPORT FOR SMWU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

SWQS FOR IRON (with fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \text{ x } BCF)}$$

RfD =	0.7	mg/kg/day
W_h =	70	
MgT =	49	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	200	

SWQS =	**7.00**	**protected (mg/L)**	**=**	**7,000**	**protected (µg/L)**
SWQS =	**9.78**	**unprotected (mg/L)**	**=**	**9,780**	**unprotected (µg/L)**

SWQS FOR IRON (without fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \text{ x } BCF)}$$

RfD =	0.7	mg/kg/day
W_h =	70	
MgT =	49	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**24.5**	**protected (mg/L)**	**=**	**24,500**	**protected (µg/L)**
SWQS =	**4,900**	**unprotected (mg/L)**	**=**	**4,900,000**	**unprotected (µg/L)**

SWQS FOR VANADIUM (with fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \text{ x } BCF)}$$

RfD =	0.005	mg/kg/day
W_h =	70	
MgT =	0.35	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =		

SWQS =	**0.175**	**protected (mg/L)**	**=**	**175**	**protected (µg/L)**
SWQS =	**35.00**	**unprotected (mg/L)**	**=**	**35,000**	**unprotected (µg/L)**

SWQS FOR VANADIUM (without fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \text{ x } BCF)}$$

RfD =	0.005	mg/kg/day
W_h =	70	
MgT =	0.35	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**0.175**	**protected (mg/L)**	**=**	**175**	**protected (µg/L)**
SWQS =	**35.0**	**unprotected (mg/L)**	**=**	**35,000**	**unprotected (µg/L)**

SWQS FOR ZINC (with fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.3	mg/kg/day
W_h =	70	
MgT =	21	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	2059	

SWQS =	**0.393**	**protected (mg/L)**	**=**	**393**	**protected (µg/L)**
SWQS =	**0.408**	**unprotected (mg/L)**	**=**	**408**	**unprotected (µg/L)**

SWQS FOR ZINC (without fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.3	mg/kg/day
W_h =	70	
MgT =	21	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**10.5**	**protected (mg/L)**	**=**	**10,500**	**protected (µg/L)**
SWQS =	**2,100**	**unprotected (mg/L)**	**=**	**2,100,000**	**unprotected (µg/L)**

MANGANESE (with fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.02	mg/kg/day
W_h =	70	
MgT =	1.4	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	**400**	

SWQS =	**0.4**	**protected (mg/L)**	**=**	**400**	**protected (µg/L)**
SWQS =	**0.975**	**unprotected (mg/L)**	**=**	**975**	**unprotected (µg/L)**

MANGANESE (without fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.02	mg/kg/day
W_h =	70	
MgT =	1.4	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**0.7**	**protected (mg/L)**	**=**	**700**	**protected (µg/L)**
SWQS =	**140**	**unprotected (mg/L)**	**=**	**140,000**	**unprotected (µg/L)**

SWQS FOR 2,3,7,8-TCDD (without fish consumption)

TR =	1.00E-05	
CSF =	1.50E+05	
D =	6.67E-11	

$$SWQS = \frac{D \text{ x } W_h}{WC + (F \text{ x } BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

log BCFc = 0.847 log Kow - 0.628

	0.847	
	6.8	log Kow
	0.628	
log BCFc :	5.1316	
BCFc	**1.4E+05**	
BCF =	**NA**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**2.3E-09**	**protected (mg/L**	**=**	**2.3E-06**	**protected (µg/L)**
SWQS =	**4.7E-07**	**unprotected (m(**	**=**	**4.7E-04**	**unprotected (µg/L)**

SWQS FOR 2,3,7,8-TCDD (with fish consumption)

TR =	1.00E-05	
CSF =	1.50E+05	
D =	6.67E-11	

$$SWQS = \frac{D \text{ x } W_h}{WC + (F \text{ x } BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

log BCFc = 0.847 log Kow - 0.628

	0.847	
	6.8	log Kow
	0.628	
log BCFc :	5.1316	
BCFc	**1.4E+05**	
BCF =	**2.7E+05**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**6.9E-13**	**protected (mg/L**	**=**	**6.9E-10**	**protected (µg/L)**
SWQS =	**6.9E-13**	**unprotected (m(**	**=**	**6.9E-10**	**unprotected (µg/L)**

SWQS FOR TRICHLOROETHENE (without fish consumption)

TR =	1.00E-05	
CSF =	4.60E-02	
D =	2.17E-04	

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

log BCFc = 0.847 log Kow - 0.628

	0.847	
	2.72	log Kow
	0.628	
log BCFc =	1.67584	
BCFc	**4.7E+01**	
BCF =	**NA**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**7.6E-03**	**protected (mg/L**	**=**	**7.6**	**protected (µg/L)**
SWQS =	**1.5E+00**	**unprotected (mg**	**=**	**1,522**	**unprotected (µg/L)**

SWQS FOR TRICHLOROETHENE (with fish consumption)

TR =	1.00E-05	
CSF =	4.60E-02	
D =	2.17E-04	

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

log BCFc = 0.847 log Kow - 0.628

	0.847	
	2.72	log Kow
	0.628	
log BCFc =	1.67584	
BCFc	**4.7E+01**	
BCF =	**9.5E+01**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**3.5E-03**	**protected (mg/L**	**=**	**3.5**	**protected (µg/L)**
SWQS =	**6.4E-03**	**unprotected (mg**	**=**	**6.4**	**unprotected (µg/L)**

SWQS FOR VINYL CHLORIDE (without fish consumption)

TR = 1.00E-05
CSF = 1.50E+00
D = 6.67E-06

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

log BCFc = 0.847 log Kow - 0.628

0.847
1.5 log Kow
0.628

log BCFc = 0.6425
BCFc **4.4E+00**
BCF = **NA**

Wh = 70 kg
WC = 2 water cosumption rate (L/day) - protected
WC = 0.01 water cosumption rate (L/day) - unprotected
F = **NA** fish consumption rate (kg/day)

SWQS = 2.3E-04 protected (mg/L = 2.3E-01 protected (µg/L)
SWQS = 4.7E-02 unprotected (mg = 4.7E+01 unprotected (µg/L)

SWQS FOR VINYL CHLORIDE (with fish consumption)

TR = 1.00E-05
CSF = 1.50E+00
D = 6.67E-06

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

log BCFc = 0.847 log Kow - 0.628

0.847
1.5 log Kow
0.628

log BCFc = 0.6425
BCFc **4.4E+00**
BCF = **8.8E+00**

Wh = 70 kg
WC = 2 water cosumption rate (L/day) - protected
WC = 0.01 water cosumption rate (L/day) - unprotected
F = 0.025 fish consumption rate (kg/day)

SWQS = 2.1E-04 protected (mg/L = 2.1E-01 protected (µg/L)
SWQS = 2.0E-03 unprotected (mg = 2.0E+00 unprotected (µg/L)

WQS FOR BIS(2-ETHYLHEXYL)PHTHALATE (BEHP) (without fish consumptio

TR = 1.00E-05
CSF = 1.40E-02
D = 7.14E-04

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

log BCFc = 0.847 log Kow - 0.628

$$D = \frac{1x10^{-5}}{CSF(mg/kg/day)^{-1}}$$

	0.847	
	7.3	log Kow
	0.628	
log BCFc :	5.5551	
BCFc	**3.6E+05**	
BCF =	**NA**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**2.5E-02**	**protected (mg/L**	**=**	**2.5E+01**	**protected (µg/L)**
SWQS =	**5.0E+00**	**unprotected (mg**	**=**	**5.0E+03**	**unprotected (µg/L)**

SWQS FOR BEHP (with fish consumption)

TR = 1.00E-05
CSF = 1.40E-02
D = 7.14E-04

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

log BCFc = 0.847 log Kow - 0.628

$$D = \frac{1x10^{-5}}{CSF(mg/kg/day)^{-1}}$$

	0.847	
	7.3	log Kow
	0.628	
log BCFc :	5.5551	
BCFc	**3.6E+05**	
BCF =	**7.2E+05**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**2.8E-06**	**protected (mg/L**	**=**	**2.8E-03**	**protected (µg/L)**
SWQS =	**2.8E-06**	**unprotected (mg**	**=**	**2.8E-03**	**unprotected (µg/L)**

SWQS FOR ARSENIC (without fish consumption)

TR =	1.00E-05	
CSF =	1.50E+00	
D =	6.67E-06	
BCF =	NA	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

$$SWQS = \frac{D \text{ x } W_h}{WC + (F \text{ x } BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

SWQS =	**2.3E-04**	**protected (mg/L**	**=**	**2.3E-01**	**protected (µg/L)**
SWQS =	**4.7E-02**	**unprotected (mg**	**=**	**4.7E+01**	**unprotected (µg/L)**

SWQS FOR ARSENIC (with fish consumption)

TR =	1.00E-05	
CSF =	1.50E+00	
D =	6.67E-06	
BCF =	114	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

$$SWQS = \frac{D \text{ x } W_h}{WC + (F \text{ x } BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

SWQS =	**9.6E-05**	**protected (mg/L**	**=**	**9.6E-02**	**protected (µg/L)**
SWQS =	**1.6E-04**	**unprotected (mg**	**=**	**1.6E-01**	**unprotected (µg/L)**

SWQS FOR CHLOROFORM (without fish consumption)

BCF for Chloroform
log BCFc = 0.847 log Kow - 0.628

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

	0.847	
	1.92	log Kow
	0.628	
log BCFc :	0.99824	
BCFc	9.96	
BCF	**NA**	

MgT = RfD x W_h

RfD =	0.01	mg/kg/day
W_h =	70	
MgT =	0.7	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**0.35**	**protected (mg/L**	**=**	**350**	**protected (µg/L)**
SWQS =	**70.0**	**unprotected (mg**	**=**	**70,000**	**unprotected (µg/L)**

SWQS FOR CHLOROFORM (with fish consumption)

BCF for Chloroform
log BCFc = 0.847 log Kow - 0.628

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

	0.847	
	1.92	log Kow
	0.628	
log BCFc :	0.99824	
BCFc	9.96	
BCF	**19.9**	

MgT = RfD x W_h

RfD =	0.01	mg/kg/day
W_h =	70	
MgT =	0.7	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**0.28**	**protected (mg/L**	**=**	**280**	**protected (µg/L)**
SWQS =	**1.4**	**unprotected (mg**	**=**	**1,378**	**unprotected (µg/L)**

SWQS FOR 1,1-DICHLOROETHENE (without fish consumption)

BCF for 1,1-Dichloroethene
log BCFc = 0.847 log Kow - 0.628

	0.847	
	2.13	log Kow
	0.628	
log BCFc :	1.17611	
BCFc	15.00	
BCF	**NA**	

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.05	mg/kg/day
W_h =	70	
MgT =	3.5	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**1.75**	**protected (mg/L**	**=**	**1,750**	**protected (µg/L)**
SWQS =	**350**	**unprotected (mg**	**=**	**350,000**	**unprotected (µg/L)**

SWQS FOR 1,1-DICHLOROETHENE (with fish consumption)

BCF for 1,1-Dichloroethene
log BCFc = 0.847 log Kow - 0.628

	0.847	
	2.13	log Kow
	0.628	
log BCFc :	1.17611	
BCFc	15.00	
BCF	**30.0**	

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.05	mg/kg/day
W_h =	70	
MgT =	3.5	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**1.27**	**protected (mg/L**	**=**	**1,273**	**protected (µg/L)**
SWQS =	**4.6**	**unprotected (mg**	**=**	**4,605**	**unprotected (µg/L)**

SWQS FOR CIS-1,2-DICHLOROETHENE (without fish consumption)

BCF for cis-1,2-Dichloroethene
log BCFc = 0.847 log Kow - 0.628

	0.847	
	1.86	log Kow
	0.628	
log BCFc :	0.94742	
BCFc	8.86	
BCF	**NA**	

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.002	mg/kg/day
W_h =	70	
MgT =	0.14	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**0.07**	**protected (mg/L**	=	**70**	**protected (µg/L)**
SWQS =	**14**	**unprotected (m**	=	**14,000**	**unprotected (µg/L)**

SWQS FOR CIS-1,2-DICHLOROETHENE (with fish consumption)

BCF for cis-1,2-Dichloroethene
log BCFc = 0.847 log Kow - 0.628

	0.847	
	1.86	log Kow
	0.628	
log BCFc :	0.94742	
BCFc	8.86	
BCF	**17.7**	

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.002	mg/kg/day
W_h =	70	
MgT =	0.14	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**0.06**	**protected (mg/L**	=	**57**	**protected (µg/L)**
SWQS =	**0.3**	**unprotected (m**	=	**309**	**unprotected (µg/L)**

SWQS FOR TRANS-1,2-DICHLOROETHENE (without fish consumption)

BCF for trans-1,2-Dichloroethene
log BCFc = 0.847 log Kow - 0.628

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

	0.847	
	2.07	log Kow
	0.628	
log BCFc :	1.12529	
BCFc	13.34	
BCF	**NA**	

MgT = RfD x W_h

RfD =	0.02	mg/kg/day
W_h =	70	
MgT =	1.4	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**0.7**	**protected (mg/L**	**=**	**700**	**protected (µg/L)**
SWQS =	**140**	**unprotected (m(**	**=**	**140,000**	**unprotected (µg/L)**

SWQS FOR TRANS-1,2-DICHLOROETHENE (with fish consumption)

BCF for trans-1,2-Dichloroethene
log BCFc = 0.847 log Kow - 0.628

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

	0.847	
	2.07	log Kow
	0.628	
log BCFc :	1.12529	
BCFc	13.34	
BCF	**26.7**	

MgT = RfD x W_h

RfD =	0.02	mg/kg/day
W_h =	70	
MgT =	1.4	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**0.52**	**protected (mg/L**	**=**	**525**	**protected (µg/L)**
SWQS =	**2.1**	**unprotected (m(**	**=**	**2,067**	**unprotected (µg/L)**

Originally dated February 23, 2010
Revised April 16, 2014

~~**DRAFT**~~

NOVEMBER 25, 2009 (PETER RAMANAUSKAS) AND DECEMBER 7, 2009 (DANIEL MAZUR) UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (EPA) REQUEST FOR FURTHER CLARIFICATION
REGARDING RESPONSE TO EPA COMMENTS DATED MAY 14, 2008 ON THE DRAFT CORRECTIVE MEASURES PROPOSAL (CMP) FOR OLD BURN PIT (OBP) (SWMU 5)
NAVAL SURFACE WARFARE CENTER (NSWC) CRANE
CRANE, INDIANA

EPA comments are shown in bold font. Navy responses to each comment are shown in regular font. Text changes to the CMP are shown in italic font enclosed in quotation marks within the response.

EPA-1 (11-25-09)
The main thing we should do is cleanup Table 2-12 a bit to reflect only the number that you will use as your target level/MCS for GW/SW. Perhaps Page 2 of the table can be moved someplace else within the CMP document. To help simplify the table for dioxin/furan, consider using your congener specific analytical results to calculate the Dioxin-TEQ concentration and compare to your MCS for 2,3,7,8-TCDD.

Response to EPA-1(11-25-09):
Table 2-12 has been revised to express dioxins as Total Dioxin 2,3,7,8-TCDD TEQ. The revised Table 2-12 is presented in Attachment 1 to this comment response document. Additionally, information other than groundwater and surface water MCSs have been placed into an Appendix as Table A-1. The new Table A-1 is presented as Attachment 2 to this comment response document.

~~The 1st paragraph in~~ Section 2.5.2 has been extensively revised as to explain the approach used to develop the MCSs for these media.~~follows:~~

> ~~*"2.5.2 Groundwater*~~
>
> ~~*"MCSs have been developed for the chemicals that were detected in groundwater during the SWMU 5 RFI investigation and are presented in Table 2-12. Table 2-12 also presents the surface water MCSs. Human Health Water Quality derived for the protected and un-protected water sources and the Chronic Aquatic Life Criteria are presented in Table A-1."*~~

I want to check in with Dan on the Aquatic Life Criteria.

EPA-1 (11-25-09)(12-7-09)a
[Peter Ramanauskas additional comment]
As mentioned in my earlier email to you on this, we should simplify the table a bit. For the Surface Water MCS column, I would recommend we use the chronic Aquatic Life Criteria as they are most conservative in most cases.

Response to EPA-1(11-25-09)(12-7-09)a:
The lower of the Chronic Aquatic Life Criteria, Region 5 RCRA Ecological Screening Level, or IDEM calculated value was used to determine the surface water MCSs. The revised Table 2-12 is presented as Attachment 1 to this comment response document.

Originally dated February 23, 2010
Revised April 16, 2014

~~***DRAFT***~~

EPA-1 (11-25-09)(12-7-09)b
[Daniel Mazur comments on the Aquatic Life Criteria]
I reviewed the proposed media cleanup standards for Chronic Aquatic Life Criteria (Table 2-12, page 1 of 2) and have the following comments:

> **1. For bis (2-ethylhexyl) phthalate the Region 5 RCRA ecological screening levels (ESL) value of 0.3 ug/l needs to be used. See footnote "q" from the ESL table.**
>
> **2. For barium and manganese check the calculation of the Tier 2 values. Using the equations cited for footnote 6 in the Table 2-12, the Tier 2 values are 209 ug/l and 287 ug/l for barium and manganese, respectively.**
>
> **3. The hardness dependent criteria need to be revisited after site water hardness data (including surface water) is collected.**
>
> **4. The url for footnote 6 needs to be updated. www.in.gov/idem/files/great_lakes_criteria_values.pdf**
>
> **5. The label for "Volatile Organics" is misspelled.**

Response to EPA-1(11-25-09)(12-7-09)b:

Item 1: Table 2-12 footnote for bis (2-ethylhexyl) phthalate has been revised to 0.3 µg/L per EPA, Region 5, RCRA. ESL (http://www.epa.gov/reg5rcra/ca/ESL.pdf)

Item 2: Barium surface water MCL has been revised to 209 µg/L. However, the EPA Recommended Water Quality Criteria (WQC) (EPA, 2009). http://www.epa.gov/waterscience/criteria/wqctable/index.html provides for a Human Health for the consumption of water plus organism of 50 µg/L for manganese. Therefore, 50 µg/L is being used because it is lower than the 287 µg/L calculated Tier 2 values.

Item 3: hardness dependent criteria, will be addressed as part of the Corrective Measure Implementation Plan as appropriate and is not discussed as part of the CMP.

Item 4: Due to the incorporation of the EPA recommendation to reorganize Table 2-12, former Footnote 6 is now Footnote 8. Footnote 8 has been revised as follows:

> "*8 USEPA Recommended Water Quality Criteria (USEPA, 2009). http://www.epa.gov/waterscience/criteria/wqctable/index.html*"
>
> Additionally, Footnote 2 has been revised as follows:
>
> *"2 Unless otherwise noted, the MCS is based on Chronic Aquatic Life Criteria. EPA, Region 5, RCRA. ESL (http://www.epa.gov/reg5rcra/ca/ESL.pdf)"*

Item 5: "Volatice Organics" has been correct to "Volatile Organics."

EPA-2 (11-25-09)
Also, please check the table for typos - I noticed "cancer slop factor" in footnote 5, there are two footnotes labeled '6', and "volatice organics" in the table headings.

Response to EPA-2(11-25-09):
The following typographical errors have been corrected in Table 2-12:

- Footnote 5 has been eliminated due to incorporation of EPA recommended Table 2-12 revisions.
- "Volatice Organics" has been correct to "*Volatile Organics*."
- Various Table 2-12 footnotes have been modified to accomodate to this table.

The revised Table 2-12 is presented as Attachment 1 to this comment response document.

EPA-3 (11-25-09)
For EPA-2 (5-14-08)f: the version of table 2-11 that I have (from Oct 08) still has a section titled "National Primary Drinking Water Regulations" even though the table deals with soils.

Response to EPA-3(11-25-09):
"National Primary Drinking Water Regulations" references have been removed from Table 2-11. The revised Table 2-11 is presented as Attachment 3 to this comment response document.

EPA-4 (11-25-09)
For EPA-2 (5-14-08)g: The response is OK, but correct the text in table 2-1 to reflect this.

Response to EPA-4(11-25-09):
The response to EPA-2(5-14-08)g stated, "The CMP recommendation was that groundwater will be monitored (i.e., groundwater cleanup will not be implemented). Hydraulic conductivity data will be collected as part of the first round of groundwater monitoring. Details for groundwater monitoring will be developed in the Corrective Measures Implementation Plan."

The following footnote has been added to the Comments column for Groundwater in Table 2-1 (see Attachment 4 to this comment response document):

> *"2 - Hydraulic conductivity data will be collected as part of the first round of groundwater monitoring. Details for groundwater monitoring will be developed in the Corrective Measures Implementation Plan."*

ATTACHMENT 1

REVISED TABLE 2-12

TABLE 2-12

MEDIA CLEANUP STANDARDS FOR SURFACE WATER AND GROUNDWATER
CMP REPORT FOR SMWU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

CASRN	Chemical	MCS	
		Groundwater[1] (µg/L)	Surface Water[2] (µg/L)
Dioxins			
1746-01-6	Total Dioxin 2,3,7,8-TCDD TEQ[3]	0.00003 (4)	0.0005 (5)
Volatile Organics			
67-66-3	Chloroform*	80 (4)	140
75-35-4	1,1-Dichloroethene	7 (4)	65
156-59-2	cis-1,2-Dichloroethene	70 (4)	620 (6)
156-60-5	trans-1,2-Dichloroethene	100 (4)	560 (5)
79-01-6	Trichloroethene	5 (4)	260 (6)
75-01-4	Vinyl chloride	2 (4)	97 (5)
Semi-Volatile Organics			
117-81-7	Bis(2-ethylhexyl) phthalate	6 (4)	0.3
Metals			
7429-90-5	Aluminum	36,000 (7)	87 (8)
7440-36-0	Antimony	6 (4)	5.6 (8)
7440-38-2	Arsenic	10 (4)	46.7 (5)
7440-39-3	Barium	2,000 (4)	209 (5)
7440-50-8	Copper	1,300 (4)	1.58
7439-89-6	Iron	25,550 (5)	1,000 (5,8)
7439-92-1	Lead	15 (4)	1.17 (2,6)
7439-96-5	Manganese	775	50 (8)
7440-62-2	Vanadium	36.5 (5)	12
7440-66-6	Zinc	11,000 (9)	65.7

µg/L - microgram per liter.
CASRN - Chemical Abstract Services Registry Number.
ESC - Ecological Screen Level
IDEM - Indiana Department of Environmental Management.
USEPA - United States Environmental Protection Agency.
RCRA - Resource Conservation & Recovery Act of 1976.
RISC - Risk Integrated System of Closure.
PRG - Preliminary Remediation Goal.
MCS - Media cleanup standard.

* Asterisks indicate a chemical for which the laboratory reporting limit (RL) exceeds the risk-based target level for the project.

1 MCS assumes that groundwater is used as a domestic water supply source.

2 Unless otherwise noted, the MCS is based on Chronic Aquatic Life Criteria. EPA, Region 5, RCRA. ESL (http://www.epa.gov/reg5rcra/ca/ESL.pdf)

3 Dioxin-TEQ concentration as 2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD).

4 USEPA Primary Drinking Water Standard (USEPA, Summer 2006).

5 Calculated according to Indiana Administrative Codes 327 IAC 2-1-8-5 and 2-1-8-6. Note that the cancer target risk for IDEM is 1E-05.

6 IDEM, Criteria and Values for Selected Substances Calculated Using the Great Lakes Basin Methodologies www.in.gov/idem/files/great_lakes_criteria_values.pdf.

7 USEPA Region 9 PRG Tables (October 2004). PRGs based on cancer are adjusted to meet a target risk of 1E-05, as per IDEM.

8 USEPA Recommended Water Quality Criteria (USEPA, 2009). http://www.epa.gov/waterscience/criteria/wqctable/index.html

9 IDEM, RISC residential closure levels for groundwater (IDEM, January 2006), unless otherwise noted.

ATTACHMENT 2

NEW APPENDIX TABLE A-1

TABLE A-1

INDIANA HUMAN HEALTH WATER QUALITY STANDARDS AND CHRONIC AQUATIC LIFE CRITERIA
CMP REPORT FOR SMWU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

CASRN	Chemical	Water + Fish		Water only		Chronic Aquatic Life Criteria (µg/L)
		Protected Water Supply (µg/L)	Unprotected Water Supply (µg/L)	Protected Water Supply (µg/L)	Unprotected Water Supply (µg/L)	
Dioxins						
3268-87-9	1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (1,2,3,4,6,7,8,9-OCDD)	0.000002	0.000002	0.008	2	NA
39001-02-0	1,2,3,4,6,7,8-Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF)	0.00000007	0.00000007	0.0002	0.05	NA
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (1,2,3,4,6,7,8-HpCDD)	0.00000007	0.00000007	0.0002	0.05	NA
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)*	0.0000000007	0.0000000007	0.000002	0.0005	NA
37871-00-4	Total Heptachlorodibenzo-p-dioxin (Total HpCDD)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)
38998-75-3	Total Heptachlordibenzofuran (Total HpCDF)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)
Volatile Organics						
67-66-3	Chloroform*	280	1,400	350	70,000	140 (3)
75-35-4	1,1-Dichloroethene	1,300	4,600	1,800	350,000	65 (3)
156-59-2	cis-1,2-Dichloroethene	290	1,500	350	70,000	620 (2)
156-60-5	trans-1,2-Dichloroethene	520	2,100	700	140,000	560 (2)
79-01-6	Trichloroethene	12	23	27	5,400	260 (2)
75-01-4	Vinyl chloride	0.2	2	0.2	47	930 (2)
Semi-Volatile Organics						
117-81-7	Bis(2-ethylhexyl) phthalate	0.003	0.003	25	5,000	0.3 (3)

TABLE A-1

INDIANA HUMAN HEALTH WATER QUALITY STANDARDS AND CHRONIC AQUATIC LIFE CRITERIA
CMP REPORT FOR SMWU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

CASRN	Chemical	Water + Fish		Water only		Chronic Aquatic Life Criteria (µg/L)
		Protected Water Supply (µg/L)	Unprotected Water Supply (µg/L)	Protected Water Supply (µg/L)	Unprotected Water Supply (µg/L)	
Metals						
7429-90-5	Aluminum	33,900	903,000	35,000	7,000,000	87 (4)
7440-36-0	Antimony	9.3	27.7	14	2,800	80 (2)
7440-38-2	Arsenic	0.076	0.16	0.23	46.7	150 (4)
7440-39-3	Barium	785	884	7,000	1,400,000	209 (2)
7440-50-8	Copper	142	158	1,400	280,000	1.58 (3,5)
7439-89-6	Iron	7,000	9,780	24,500	4,900,000	1,000 (4)
7439-92-1	Lead	NA	NA	NA	NA	1.17 (3,5)
7439-96-5	Manganese	408	973	700	140,000	50 (4)
7440-62-2	Vanadium	35	7,000	35	7,000	12 (2,3)
7440-66-6	Zinc	393	408	10,500	2,100,000	58 (5)

µg/L - microgram per liter.

CASRN - Chemical Abstract Services Registry Number.

* Asterisks indicate a chemical for which the laboratory reporting limit (RL) exceeds the risk-based target level for the project.

1 No cancer slop factor or toxicity equivalent factors are available to estimate alternative water quality standards.

2 IDEM, Criteria and Values for Selected Substances Calculated Using the Great Lakes Basin Methodologies www.in.gov/idem/files/great_lakes_criteria_values.pdf.

3 EPA, Region 5, RCRA. ESL (http://www.epa.gov/reg5rcra/ca/ESL.pdf)

4 USEPA Recommended Water Quality Criteria (USEPA, 2006). http://www.epa.gov/waterscience/criteria/wqctable/index.html

5 IDEM, Water Quality Standards (based on a water hardness of 50 mg/L). http://www.in.gov/legislative/iac/T03270/A00020.PDF

ATTACHMENT 3

REVISED TABLE 2-11

TABLE 2-11

MEDIA CLEANUP STANDARDS FOR SURFACE AND SUBSURFACE SOIL
CMP REPORT FOR SMWU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

COC	Media Cleanup Standards(1)	
	Surface Soil (mg/kg)	**Subsurface Soil (mg/kg)**
Construction Worker		
Antimony	140(2)	140(2)
Iron	106,000(3)	106,000(3)
Lead	970(2)	970(2)
Manganese	(1)	(1)
Maintenance Worker		
Antimony	620(4)	(1)
Iron	1,000,000(3)	(1)
Lead	1,300(4)	(1)
Manganese	(1)	(1)
Industrial Worker		
Antimony	620(4)	(1)
Iron	1,000,000(3)	(1)
Lead	1,300(4)	(1)
Manganese	(1)	(1)
Future Child Resident		
Antimony	31.3(5)	31.3(5)
Iron	N/A	N/A
Lead	N/A	N/A
Manganese	(1)	(1)
Future Resident		
Lead	400(1)	(1)
Manganese	(1)	(1)
Future Adult Resident		
Manganese	(1)	(1)

1 - The MSC for constituents not specifically listed are the IDEM Closure Level for the appropriate receptor.
2 - IDEM Closure Level for Construction Workers based on direct contact.
3 - MCS calculated based on the SWMU 5 risk assessment (See Section 2.5).
4 - IDEM Industrial Closure Level based on direct contact.
5 - The MSC for manganese is calculated based on USEPA Region IX guidelines. Per USEPA guidelines, the calculation are for the future resident only.

µg/L - micrograms per liter
COC - Chemical of concern.
IDEM - Indiana Department of Environmental Management.
MCL - Maximum Contaminant Level.
MCSs - Media cleanup standards.
mg/kg - milligrams per kilogram
N/A - not applicable to this media for this COC.
RCRA - Resource Conservation and Recovery Act.
RFI - RCRA Facility Investigation.
USEPA - United States Environmental Protection Agency.

ATTACHMENT 4

REVISED TABLE 2-1

TABLE 2-1

SUMMARY OF RFI REPORT HUMAN HEALTH RISK CONCLUSIONS
CMS REPORT FOR SWMU 5 (OLD BURN PIT)
NSWC CRANE
CRANE, INDIANA

Chemical of Concern[1]	Impact on Human Receptors	Comments
SURFACE SOIL		
Dioxins/Furans	Maintenance Worker ILCR = 1.4E-6, Recreational User ILCR = 3.3E-6, Trespasser ILCR = 1.1E-6, Residential ILCR = 5.7E-5	Dioxins were detected in 8 of 8 soil samples. Elevated risks (across all pathways) for dioxins are based on the hypothetical future residential land use. Risks calculated for receptors under current and industrial land use are within the EPA's target risk range. Concentrations of dioxins/furans (as TEQs) in all surfce soil samples were less than the 1 μg/kg preliminary remediation goal established by the U.S. EPA.
Polyaromatic hydrocarbons	Residential ILCR = 1.8E-5	Risks calculated for receptors under current land use are within the EPA's target risk range. Total risks from PAHs in soil are less than 1.0E-4 for all receptors. Concentrations of PAHs in soil are within levels occurring in soil in the U.S.
Antimony	Adult resident HQ = 1.0, Child resident HQ = 9.6	Risks for antimony are based on the hypothetical future residential land use based on the concentration in one soil sample. The sample may represent a "hotspot" at the site.
Iron	Adult resident HQ = 0.24, Child resident HQ = 2.2	Risks for iron are based on the hypothetical future residential land use but do not pose a risk under current land use. Risks calculated for iron are not based on adverse health effects but rather on recommended daily allowances.
Lead	Future Residents - Predicted blood lead levels in children greater than U.S. EPA recommemded levels	Risks for lead are based on the hypothetical future residential land use driven by the concentration in one surface soil sample. The sample may represent a "hotspot" at the site.
SURFACE/SUBSURFACE SOIL		
Dioxins/Furans	Construction Worker ILCR = 2.7E-6	Total lifetime cancer risk for future construction workers across all exposure pathways is within the U.S.EPA's target risk range (1.0E-6 to 1.0E-4). Concentrations of dioxins/furans (as TEQs) in all surface/subsurface soil samples were less than the 1 μg/kg preliminary remediation goal established by the U.S. EPA.
Antimony	Construction Worker HQ = 2.1	Risks for the construction worker are based on the concentration in one surface soil sample. The sample may represent a "hotspot" at the site.
Lead	Construction Worker - More than 5 % of the fetuses born to construction workers predicted to have blood lead levels greater than 10 μg/dL	Risks to the future construction worker are based on the average concentration in soil samples (>1,000 mg/kg). Lead concentrations in approximately 1/2 of subsurface soil samples were greater than 1,000 mg/kg.

TABLE 2-1

SUMMARY OF RFI REPORT HUMAN HEALTH RISK CONCLUSIONS
CMS REPORT FOR SWMU 5 (OLD BURN PIT)
NSWC CRANE
CRANE, INDIANA

Chemical of Concern[1]	Impact on Human Receptors	Comments
GROUNDWATER		
Dioxins/Furans	Construction Worker ILCR = 2.7E-6, Residential ILCR = 4.1E -4	Risks from dioxins in groundwater are based on the hypothetical future residential use but do not pose a risk under current and industrial and use. Dioxins were detected in 10 of 14 groundwater samples indicating that groundwater has been impacted by site activities. Concentrations of dioxins (as TEQs) in all samples were less than the MCL for 2,3,7,8-TCDD.
Bis(2-ethylhexyl)phthalate	Residential ILCR = 6.0E-6	Bis(2-ethylhexyl)phthate was detected in 1 of 14 samples and is a common laboratory contaminant. Estimated risks are based on future residential use of groundwater.
Arsenic	Residential ILCR = 2.5E-5	Risks for arsenic are based on the hypothetical future residential use of groundwater. The maximum concentration in groundwater (1.6 mg/L) is less than the current (50 mg/L) and recently proposed (10 mg/L) MCLs. In addition, the concentrations of arsenic in groundwater samples are similar to the concentrations in the upgradient well.
Manganese	Adult resident HQ = 2.9, Child resident HQ = 10	Risks for manganese are based on the hypothetical future residential use of groundwater.
SURFACE WATER		
1,1-Dichloroethene	Residential ILCR = 5.0E-6	Risks from chlorinated volatiles (especially, vinyl chloride) in surface water are based on the hypothetical future land use but do not pose a risk under current or industrial land use. The risks are overestimated based on potential residential exposure to surface water which assumes that future residents are assumed to be exposed to surface water 350 days/year. Vinyl chloride was detected in 2 of 4 samples which appear to be hydraulically connected.[2]
cis-1,2-Dichloroethene	Adult resident HQ = 0.21; Child resident HQ = 0.21	
Trichloroethene	Adult resident HQ = 0.21; Child resident HQ = 0.21, Residential ILCR = 5.8E-6	
Vinyl Chloride	Adult resident HQ = 0.17, Child resident HQ = 0.16, Residential ILCR = 3.2E-4	

HQ - Hazard Quotient.
ILCR - Incremental Lifetime Cancer Risk
1 Any carcinogenic chemical with a ILCR greater than 1.0E-6 or a noncarcinogenic chemical contributing to target organ hazard indices (HI) greater than 1.0.
2 Hydraulic conductivity data will be collected as part of the first round of groundwater monitoring. Details for groundwater monitoring will be developed in the

TABLE 2-1

SUMMARY OF RFI REPORT HUMAN HEALTH RISK CONCLUSIONS
CMS REPORT FOR SWMU 5 (OLD BURN PIT)
NSWC CRANE
CRANE, INDIANA

Chemical of Concern[1]	Impact on Human Receptors	Comments

Corrective Measures Implementation Plan.

Originally dated January 28, 2009
Revised April 16, 2014

~~Draft~~

**MAY 14, 2008 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (EPA) REQUEST FOR ADDITIONAL CLARIFICATION
REGARDING RESPONSE TO EPA COMMENTS DATED JANUARY 8, 2008 FOR DRAFT CORRECTIVE MEASURES PROPOSAL (CMP) FOR OLD BURN PIT (OBP) (SWMU 5)
NAVAL SURFACE WARFARE CENTER (NSWC) CRANE
CRANE, INDIANA**

EPA comments are shown in bold font. Navy responses to each comment are shown in regular font. Text changes to the CMP are shown in italic font enclosed in quotation marks within the response.

EPA-1(5-14-08) Regarding Response to EPA-6 dated 1-3-2008:
There is a typo in the new text referring to the lead hotspot location - 06SB06.

Response to EPA-1(5-14-08):
Agreed. "06SB06" has been revised to "*05SB06*."

EPA-2(5-14-08) Regarding Response EPA-7 dated 1-3-2008:

EPA-2(5-14-08)a: The constituents and calculated values presented in Tables 2-11 & 2-12 need to be revisited. There are seven dioxins/furans listed on page 2-1 as being human health COPCs, but Table 2-12 only contains 5.

Response to EPA-2(5-14-08)a:
Toxicity data (cancer slope factors or toxicity equivalent factors) are required to calculate the MCS. For 4 of the 7 dioxins/furan congeners listed in Section 2.0, Subsection Groundwater (Human Health), this information is available. However for the remaining three dioxins/furans (i.e., total HpCDD, HpCDF, and total TCDD), neither the cancer slope factors nor the toxicity equivalent factors are available. Therefore, an MCS cannot be calculated for the total HpCDD, HpCDF, and total TCDD.

The dioxins/furans presented in Section 2.0 have been added to Table 2-12. For total heptachlorodibenzo-p-dioxin (Total HpCDD), total heptachlorodibenzofuran (Total HpCDF), and total 2,3,7,8-TCDD (Total TCFD as 2,3,7,8-TCDD TEQ), the following footnote has been added:

> *"5 No cancer slope factor or toxicity equivalent factors are available to estimate alternative water quality standard."*

EPA-2(5-14-08)b: The tables should contain MCS for appropriate ecological risk COPCs (metals/dioxins) as well.

Response to EPA-2(5-14-08)b:
Ecological criteria have been added to Table 2-12 to evaluate chemical concentrations in surface water. Table 2-12 is provided as Attachment 1 to this comment response document.

There is an EPA Region 5 ecological criteria for dioxin. However, the EPA Region 5 value is based on risks to wildlife eating fish. Because the criteria are based on risks to wildlife from consuming fish living in surface water and the surface water bodies at SWMU 5 are small and support very few, if any fish, this exposure pathway is essentially incomplete. No other dioxin values were available.

Ecological criteria were not added to Table 2-11 since, as presented in the last two sentences of Section 2.4.2 of the CMP, "…potential risks to ecological receptors at SWMU 5 are not great enough to warrant basing any decisions in the CMP on risks to these receptors. Therefore, ecological receptors will not be carried forward in this CMP." For this reason, it is not necessary to include ecological criteria on Table 2-11 because MCS are developed only for chemicals carried forwarded in the CMP.

No change has been made to the CMP in response to this comment.

EPA-2(5-14-08)c: The surface water MCS values presented in Table 2-12 should be reevaluated using 327 IAC 2-1-6 as a guide. It is stated in footnote 3 that these are calculated according IDEM RISC guidance, but I do not see where such calculations exist in that guidance. Perhaps this is meant to be 327 IAC 2?

Response to EPA-2(5-14-08)c:
The surface water MSC values presented in Table 2-12 were calculated based on the guidance and equations in 327 IAC 2-1-1 through 2-1-8. The equations presented in 327 IAC 2-1-8-5 and 2-1-8-6 were used to calculate the Surface Water Quality Standard (SWQS) values. The IDEM RISC guidance was not used in the calculations. Footnote 3 in Table 2-12 has been revised to indicate that the MCSs were calculated in accordance with 327 IAC 2-1-1 through 2-1-8. A revised Table 2-12 is provided as Attachment 1.

EPA-2(5-14-08)d: Provide the example calculations. If existing state values exist, use them.

Response to EPA-2(5-14-08)d:
A new Appendix A that contains the Media Cleanup Standards and Indiana Water Quality Standards Calculations has been added to the document. The new Appendix A is provided in Attachment 2 to this comment response document.

EPA-2(5-14-08)e: Appropriate aquatic life and human health surface water protection values should be calculated and evaluated similar to what was done for explosives at Rockeye.

Response to EPA-2(5-14-08)e:
Aquatic life protection values were not calculated because ecological surface water criteria were available for all chemicals, except dioxins (see response to earlier comment).

No change has been made to the CMP in response to this comment.

EPA-2(5-14-08)f: Why does Table 2-11 contain the heading "National Primary Drinking Water Regulations"?

Response to EPA-2(5-14-08)f:
This heading was incorrect. The heading in Table 2-11 has been changed to *"Media Cleanup Standards for Surface and Subsurface Soil."* The revised Table 2-11 is provided as Attachment 3 to this comment response document.

EPA-2(5-14-08)g: The response did not address the question on the collection of hydraulic conductivity data to support the CMP as identified in Table 2-1. Groundwater seepage velocities should be determined.

Response to EPA-2(5-14-08)e:
The CMP recommendation was that groundwater will be monitored (i.e., groundwater cleanup will no be implemented). Hydraulic conductivity data will be collected as part of the first round of groundwater monitoring. Details for groundwater monitoring will be developed in the Corrective Measures Implementation Plan.

ATTACHMENT 1

TABLE 2-12

TABLE 2-12

MEDIA CLEANUP STANDARDS FOR SURFACE WATER AND GROUNDWATER
CMP REPORT FOR SMWU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

CASRN	Chemical	MCS Groundwater[1] (µg/L)		MCS Surface Water[2] (µg/L)		Chronic Aquatic Life Criteria (µg/L)	
Dioxins							
3268-87-9	1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (1,2,3,4,6,7,8,9-OCDD)	0.019	(3)	2.00	(3)	NA	
39001-02-0	1,2,3,4,6,7,8-Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF)	0.00057	(3)	0.050	(3)	NA	
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (1,2,3,4,6,7,8-HpCDD)	0.00057	(3)	0.050	(3)	NA	
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)*	0.00003	(4)	0.0005	(3)	NA	
37871-00-4	Total Heptachlorodibenzo-p-dioxin (Total HpCDD)	NA(5)		NA(5)		NA(5)	
38998-75-3	Total Heptachlorodibenzofuran (Total HpCDF)	NA(5)		NA(5)		NA(5)	
Volatice Organics							
67-66-3	Chloroform*	80	(4)	70,000	(3)	170	(6)
75-35-4	1,1-Dichloroethene	7	(4)	350,000	(3)	210	(6)
156-59-2	cis-1,2-Dichloroethene	70	(4)	70,000	(3)	620	(6)
156-60-5	trans-1,2-Dichloroethene	100	(4)	140,000	(3)	560	(6)
79-01-6	Trichloroethene	5	(4)	5,400	(3)	260	(6)
75-01-4	Vinyl chloride	2	(4)	97	(3)	930	(6)
Semi-Volatile Organics							
117-81-7	Bis(2-ethylhexyl) phthalate	6	(4)	5,000	(3)	NA	
Metals							
7429-90-5	Aluminum	36,000	(7)	7,000,000	(3)	87	(8)
7440-36-0	Antimony	6	(4)	2,800	(3)	80	(6)
7440-38-2	Arsenic	10	(4)	46.7	(3)	190	(9)
7440-39-3	Barium	2,000	(4)	1,400,000	(3)	226	(6,10)
7440-50-8	Copper	1,300	(4)	280,000	(3)	6.3	(9)
7439-89-6	Iron	25,550	(3)	4,900,000	(3)	1,000	(8)
7439-92-1	Lead	15	(4)	NA		1.2	(9)
7439-96-5	Manganese	880	(4)	168,000		220	(6,10)
7440-62-2	Vanadium	36.5	(3)	7,000	(3)	12	(6)
7440-66-6	Zinc	11,000	(11)	2,100,000	(3)	58	(9)

TABLE 2-12

MEDIA CLEANUP STANDARDS FOR SURFACE WATER AND GROUNDWATER
CMP REPORT FOR SMWU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

CASRN	Chemical	Indiana Standard Water Quality Standards Human Health			
		Protected Water Supply Water + Fish (µg/L)	Unprotected Water Supply Water + Fish (µg/L)	Protected Water Supply Water only (µg/L)	Unprotected Water Supply Water only (µg/L)
Dioxins					
3268-87-9	1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (1,2,3,4,6,7,8,9-OCDD)	0.000002	0.000002	0.008	2
39001-02-0	1,2,3,4,6,7,8-Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF)	0.00000007	0.00000007	0.0002	0.05
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (1,2,3,4,6,7,8-HpCDD)	0.00000007	0.00000007	0.0002	0.05
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)*	0.0000000007	0.0000000007	0.000002	0.0005
37871-00-4	Total Heptachlorodibenzo-p-dioxin (Total HpCDD)	NA(5)	NA(5)	NA(5)	NA(5)
38998-75-3	Total Heptachlorodibenzofuran (Total HpCDF)	NA(5)	NA(5)	NA(5)	NA(5)
Volatice Organics					
67-66-3	Chloroform*	280	1,400	350	70,000
75-35-4	1,1-Dichloroethene	1,300	4,600	1,800	350,000
156-59-2	cis-1,2-Dichloroethene	290	1,500	350	70,000
156-60-5	trans-1,2-Dichloroethene	520	2,100	700	140,000
79-01-6	Trichloroethene	12	23	27	5,400
75-01-4	Vinyl chloride	0.2	2	0.2	47
Semi-Volatile Organics					
117-81-7	Bis(2-ethylhexyl) phthalate	0.003	0.003	25	5,000
Metals					
7429-90-5	Aluminum	33,900	903,000	35,000	7,000,000
7440-36-0	Antimony	9.3	27.7	14	2,800
7440-38-2	Arsenic	0.076	0.16	0.23	46.7
7440-39-3	Barium	785	884	7,000	1,400,000
7440-50-8	Copper	142	158	1,400	280,000
7439-89-6	Iron	7,000	9,780	24,500	4,900,000
7439-92-1	Lead	NA	NA	NA	NA
7439-96-5	Manganese	408	973	700	140000
7440-62-2	Vanadium	35	7000	35	7000
7440-66-6	Zinc	393	408	10,500	2,100,000

CASRN - Chemical Abstract Services Registry Number.
IDEM - Indiana Department of Environmental Management.
NA - Not Available.
USEPA - United States Environmental Protection Agency.
RISC - Risk Integrated System of Closure.
PRG - Preliminary Remediation Goal.
MCS - Media cleanup standard.

* Asterisks indicate a chemical for which the laboratory reporting limit (RL) exceeds the risk-based target level for the project.

1 MCS assumes that groundwater is used as a domestic water supply source.
2 MCS assumes incidental surface water contact during trespass/recreational use of surface water source.
3 Calculated according to Indiana Administrative Codes 327 IAC 2-1-8-5 and 2-1-8-6. Note that the cancer target risk for IDEM is 1E-05.
4 USEPA Primary Drinking Water Standard (USEPA, Summer 2006).
5 No cancer slop factor or toxicity equivalent factors are available to estimate alternative water quality standards.
6 IDEM, Criteria and Values for Selected Substances Calculated Using the Great Lakes Basin Methodologies
http://www.in.gov/idem/programs/water/quality/greatlakes/index.html.
7 USEPA Region 9 PRG Tables (October 2004). PRGs based on cancer are adjusted to meet a target risk of 1E-05, as per IDEM.
8 USEPA Recommended Water Quality Criteria (USEPA, 2006). http://www.epa.gov/waterscience/criteria/wqctable/index.html
6 IDEM, Water Quality Standards (based on a water hardness of 50 mg/L). http://www.in.gov/legislative/iac/T03270/A00020.PDF
10 Calculated using a water hardness of 50 mg/L.
11 IDEM, RISC residential closure levels for groundwater (IDEM, January 2006), unless otherwise noted.

ATTACHMENT 2

SUPPORTING CALCULATIONS

SWQS FOR 2,3,7,8-TCDD (without fish consumption)

TR = 1.00E-05
CSF = 1.50E+05
D = 6.67E-11

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

log BCFc = 0.847 log Kow - 0.628

$$D = \frac{1 \times 10^{-5}}{CSF(mg/kg/day)^{-1}}$$

	0.847	
	6.8	log Kow
	0.628	
log BCFc :	5.1316	
BCFc	**1.4E+05**	
BCF =	**NA**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**2.3E-09**	**protected (mg/L**	**=**	**2.3E-06**	**protected (µg/L)**
SWQS =	**4.7E-07**	**unprotected (m(**	**=**	**4.7E-04**	**unprotected (µg/L)**

SWQS FOR 2,3,7,8-TCDD (with fish consumption)

TR = 1.00E-05
CSF = 1.50E+05
D = 6.67E-11

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

log BCFc = 0.847 log Kow - 0.628

$$D = \frac{1 \times 10^{-5}}{CSF(mg/kg/day)^{-1}}$$

	0.847	
	6.8	log Kow
	0.628	
log BCFc :	5.1316	
BCFc	**1.4E+05**	
BCF =	**2.7E+05**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**6.9E-13**	**protected (mg/L**	**=**	**6.9E-10**	**protected (µg/L)**
SWQS =	**6.9E-13**	**unprotected (m(**	**=**	**6.9E-10**	**unprotected (µg/L)**

SWQS FOR TRICHLOROETHENE (without fish consumption)

TR = 1.00E-05
CSF = 1.30E-02
D = 7.69E-04

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

log BCFc = 0.847 log Kow - 0.628

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

	0.847	
	2.72	log Kow
	0.628	
log BCFc :	1.67584	
BCFc	**4.7E+01**	
BCF =	**NA**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**2.7E-02**	**protected (mg/L**	**=**	**27**	**protected (µg/L)**
SWQS =	**5.4E+00**	**unprotected (m**	**=**	**5,385**	**unprotected (µg/L)**

SWQS FOR TRICHLOROETHENE (with fish consumption)

TR = 1.00E-05
CSF = 1.30E-02
D = 7.69E-04

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

log BCFc = 0.847 log Kow - 0.628

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

	0.847	
	2.72	log Kow
	0.628	
log BCFc :	1.67584	
BCFc	**4.7E+01**	
BCF =	**9.5E+01**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**1.2E-02**	**protected (mg/L**	**=**	**12**	**protected (µg/L)**
SWQS =	**2.3E-02**	**unprotected (m**	**=**	**23**	**unprotected (µg/L)**

SWQS FOR VINYL CHLORIDE (without fish consumption)

TR =	1.00E-05	
CSF =	1.50E+00	
D =	6.67E-06	

$$SWQS = \frac{D \text{ x } W_h}{WC + (F \text{ x } BCF)}$$

log BCFc = 0.847 log Kow - 0.628

$$D = \frac{1\text{x}10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

	0.847	
	1.5	log Kow
	0.628	
log BCFc :	0.6425	
BCFc	**4.4E+00**	
BCF =	**NA**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**2.3E-04**	**protected (mg/L**	**=**	**2.3E-01**	**protected (µg/L)**
SWQS =	**4.7E-02**	**unprotected (mg**	**=**	**4.7E+01**	**unprotected (µg/L)**

SWQS FOR VINYL CHLORIDE (with fish consumption)

TR =	1.00E-05	
CSF =	1.50E+00	
D =	6.67E-06	

$$SWQS = \frac{D \text{ x } W_h}{WC + (F \text{ x } BCF)}$$

log BCFc = 0.847 log Kow - 0.628

$$D = \frac{1\text{x}10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

	0.847	
	1.5	log Kow
	0.628	
log BCFc :	0.6425	
BCFc	**4.4E+00**	
BCF =	**8.8E+00**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**2.1E-04**	**protected (mg/L**	**=**	**2.1E-01**	**protected (µg/L)**
SWQS =	**2.0E-03**	**unprotected (mg**	**=**	**2.0E+00**	**unprotected (µg/L)**

WQS FOR BIS(2-ETHYLHEXYL)PHTHALATE (BEHP) (without fish consumptio

TR =	1.00E-05	
CSF =	1.40E-02	
D =	7.14E-04	

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

log BCFc = 0.847 log Kow - 0.628

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

	0.847	
	7.3	log Kow
	0.628	
log BCFc :	5.5551	
BCFc	**3.6E+05**	
BCF =	**NA**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**2.5E-02**	**protected (mg/L**	**=**	**2.5E+01**	**protected (µg/L)**
SWQS =	**5.0E+00**	**unprotected (m**	**=**	**5.0E+03**	**unprotected (µg/L)**

SWQS FOR BEHP (with fish consumption)

TR =	1.00E-05	
CSF =	1.40E-02	
D =	7.14E-04	

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

log BCFc = 0.847 log Kow - 0.628

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

	0.847	
	7.3	log Kow
	0.628	
log BCFc :	5.5551	
BCFc	**3.6E+05**	
BCF =	**7.2E+05**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**2.8E-06**	**protected (mg/L**	**=**	**2.8E-03**	**protected (µg/L)**
SWQS =	**2.8E-06**	**unprotected (m**	**=**	**2.8E-03**	**unprotected (µg/L)**

SWQS FOR ARSENIC (without fish consumption)

TR =	1.00E-05	
CSF =	1.50E+00	
D =	6.67E-06	
BCF =	NA	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

SWQS =	**2.3E-04**	**protected (mg/L**	**=**	**2.3E-01**	**protected (µg/L)**
SWQS =	**4.7E-02**	**unprotected (mg**	**=**	**4.7E+01**	**unprotected (µg/L)**

SWQS FOR ARSENIC (with fish consumption)

TR =	1.00E-05	
CSF =	1.50E+00	
D =	6.67E-06	
BCF =	114	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

SWQS =	**9.6E-05**	**protected (mg/L**	**=**	**9.6E-02**	**protected (µg/L)**
SWQS =	**1.6E-04**	**unprotected (mg**	**=**	**1.6E-01**	**unprotected (µg/L)**

SWQS FOR CHLOROFORM (without fish consumption)

BCF for Chloroform
log BCFc = 0.847 log Kow - 0.628

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

	0.847	
	1.92	log Kow
	0.628	
log BCFc =	0.99824	
BCFc	9.96	
BCF	**NA**	

MgT = RfD x W_h

RfD =	0.01	mg/kg/day
W_h =	70	
MgT =	0.7	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**0.35**	**protected (mg/L**	**=**	**350**	**protected (µg/L)**
SWQS =	**70.0**	**unprotected (mg**	**=**	**70,000**	**unprotected (µg/L)**

SWQS FOR CHLOROFORM (with fish consumption)

BCF for Chloroform
log BCFc = 0.847 log Kow - 0.628

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

	0.847	
	1.92	log Kow
	0.628	
log BCFc =	0.99824	
BCFc	9.96	
BCF	**19.9**	

MgT = RfD x W_h

RfD =	0.01	mg/kg/day
W_h =	70	
MgT =	0.7	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**0.28**	**protected (mg/L**	**=**	**280**	**protected (µg/L)**
SWQS =	**1.4**	**unprotected (mg**	**=**	**1,378**	**unprotected (µg/L)**

SWQS FOR 1,1-DICHLOROETHENE (without fish consumption)

BCF for 1,1-Dichloroethene
log BCFc = 0.847 log Kow - 0.628

	0.847	
	2.13	log Kow
	0.628	
log BCFc :	1.17611	
BCFc	15.00	
BCF	**NA**	

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.05	mg/kg/day
W_h =	70	
MgT =	3.5	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**1.75**	**protected (mg/L**	**=**	**1,750**	**protected (µg/L)**
SWQS =	**350**	**unprotected (m**	**=**	**350,000**	**unprotected (µg/L)**

SWQS FOR 1,1-DICHLOROETHENE (with fish consumption)

BCF for 1,1-Dichloroethene
log BCFc = 0.847 log Kow - 0.628

	0.847	
	2.13	log Kow
	0.628	
log BCFc :	1.17611	
BCFc	15.00	
BCF	**30.0**	

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.05	mg/kg/day
W_h =	70	
MgT =	3.5	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**1.27**	**protected (mg/L**	**=**	**1,273**	**protected (µg/L)**
SWQS =	**4.6**	**unprotected (m**	**=**	**4,605**	**unprotected (µg/L)**

SWQS FOR CIS-1,2-DICHLOROETHENE (without fish consumption)

BCF for cis-1,2-Dichloroethene
log BCFc = 0.847 log Kow - 0.628

	0.847	
	1.86	log Kow
	0.628	
log BCFc :	0.94742	
BCFc	8.86	
BCF	**NA**	

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.01	mg/kg/day
W_h =	70	
MgT =	0.7	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**0.35**	**protected (mg/L**	**=**	**350**	**protected (µg/L)**
SWQS =	**70**	**unprotected (m(**	**=**	**70,000**	**unprotected (µg/L)**

SWQS FOR CIS-1,2-DICHLOROETHENE (with fish consumption)

BCF for cis-1,2-Dichloroethene
log BCFc = 0.847 log Kow - 0.628

	0.847	
	1.86	log Kow
	0.628	
log BCFc :	0.94742	
BCFc	8.86	
BCF	**17.7**	

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.01	mg/kg/day
W_h =	70	
MgT =	0.7	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**0.29**	**protected (mg/L**	**=**	**287**	**protected (µg/L)**
SWQS =	**1.5**	**unprotected (m(**	**=**	**1,545**	**unprotected (µg/L)**

SWQS FOR TRANS-1,2-DICHLOROETHENE (without fish consumption)

BCF for trans-1,2-Dichloroethene
log BCFc = 0.847 log Kow - 0.628

	0.847	
	2.07	log Kow
	0.628	
log BCFc :	1.12529	
BCFc	13.34	
BCF	**NA**	

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.02	mg/kg/day
W_h =	70	
MgT =	1.4	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**0.7**	**protected (mg/L**	**=**	**700**	**protected (µg/L)**
SWQS =	**140**	**unprotected (m**	**=**	**140,000**	**unprotected (µg/L)**

SWQS FOR TRANS-1,2-DICHLOROETHENE (with fish consumption)

BCF for trans-1,2-Dichloroethene
log BCFc = 0.847 log Kow - 0.628

	0.847	
	2.07	log Kow
	0.628	
log BCFc :	1.12529	
BCFc	13.34	
BCF	**26.7**	

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.02	mg/kg/day
W_h =	70	
MgT =	1.4	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**0.52**	**protected (mg/L**	**=**	**525**	**protected (µg/L)**
SWQS =	**2.1**	**unprotected (m**	**=**	**2,067**	**unprotected (µg/L)**

SWQS FOR ALUMINUM (with fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	1	mg/kg/day
W_h =	70	
MgT =	70	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	2.7	

SWQS =	**33.9**	**protected (mg/L)**	**=**	**33,857**	**protected (µg/L)**
SWQS =	**903**	**unprotected (mg/L)**	**=**	**903,226**	**unprotected (µg/L)**

SWQS FOR ALUMINUM (without fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	1	mg/kg/day
W_h =	70	
MgT =	70	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**35**	**protected (mg/L)**	**=**	**35,000**	**protected (µg/L)**
SWQS =	**7,000**	**unprotected (mg/L)**	**=**	**7,000,000**	**unprotected (µg/L)**

SWQS FOR ANTIMONY (with fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.0004	mg/kg/day
W_h =	70	
MgT =	0.028	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	40	

SWQS =	**0.0093**	**protected (mg/L)**	**=**	**9**	**protected (µg/L)**
SWQS =	**0.0277**	**unprotected (mg/L)**	**=**	**28**	**unprotected (µg/L)**

SWQS FOR ANTIMONY (without fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.0004	mg/kg/day
W_h =	70	
MgT =	0.028	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**0.014**	**protected (mg/L)**	**=**	**14**	**protected (µg/L)**
SWQS =	**2.8**	**unprotected (mg/L)**	**=**	**2,800**	**unprotected (µg/L)**

SWQS FOR BARIUM (with fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

RfD =	0.2	mg/kg/day
W_h =	70	
MgT =	14	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	633	

SWQS =	**0.785**	**protected (mg/L)**	**=**	**785**	**protected (µg/L)**
SWQS =	**0.884**	**unprotected (mg/L)**	**=**	**884**	**unprotected (µg/L)**

SWQS FOR BARIUM (without fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

RfD =	0.2	mg/kg/day
W_h =	70	
MgT =	14	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**7**	**protected (mg/L)**	**=**	**7,000**	**protected (µg/L)**
SWQS =	**1,400**	**unprotected (mg/L)**	**=**	**1,400,000**	**unprotected (µg/L)**

SWQS FOR COPPER (with fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

RfD =	0.04	mg/kg/day
W_h =	70	
MgT =	2.8	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	710	

SWQS =	**0.142**	**protected (mg/L)**	**=**	**142**	**protected (µg/L)**
SWQS =	**0.158**	**unprotected (mg/L)**	**=**	**158**	**unprotected (µg/L)**

SWQS FOR COPPER (without fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

RfD =	0.04	mg/kg/day
W_h =	70	
MgT =	2.8	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**1.4**	**protected (mg/L)**	**=**	**1,400**	**protected (µg/L)**
SWQS =	**280**	**unprotected (mg/L)**	**=**	**280,000**	**unprotected (µg/L)**

SWQS FOR IRON (with fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

RfD =	0.7	mg/kg/day			
W_h =	70				
MgT =	49				
WC =	2	water cosumption rate (L/day) - protected			
WC =	0.01	water cosumption rate (L/day) - unprotected			
F =	0.025	fish consumption rate (kg/day)			
BCF =	200				
SWQS =	**7.0**	**protected (mg/L)**	**=**	**7,000**	**protected (µg/L)**
SWQS =	**9.78**	**unprotected (mg/L)**	**=**	**9,780**	**unprotected (µg/L)**

SWQS FOR IRON (without fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

RfD =	0.7	mg/kg/day			
W_h =	70				
MgT =	49				
WC =	2	water cosumption rate (L/day) - protected			
WC =	0.01	water cosumption rate (L/day) - unprotected			
F =	**NA**	fish consumption rate (kg/day)			
BCF =	**NA**				
SWQS =	**24.5**	**protected (mg/L)**	**=**	**24,500**	**protected (µg/L)**
SWQS =	**4,900**	**unprotected (mg/L)**	**=**	**4,900,000**	**unprotected (µg/L)**

SWQS FOR VANADIUM (with fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

RfD =	0.001	mg/kg/day			
W_h =	70				
MgT =	0.07				
WC =	2	water cosumption rate (L/day) - protected			
WC =	0.01	water cosumption rate (L/day) - unprotected			
F =	0.025	fish consumption rate (kg/day)			
BCF =					
SWQS =	**0.035**	**protected (mg/L)**	**=**	**35**	**protected (µg/L)**
SWQS =	**7.0**	**unprotected (mg/L)**	**=**	**7,000**	**unprotected (µg/L)**

SWQS FOR VANADIUM (without fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

RfD =	0.001	mg/kg/day			
W_h =	70				
MgT =	0.07				
WC =	2	water cosumption rate (L/day) - protected			
WC =	0.01	water cosumption rate (L/day) - unprotected			
F =	**NA**	fish consumption rate (kg/day)			
BCF =	**NA**				
SWQS =	**0.035**	**protected (mg/L)**	**=**	**35**	**protected (µg/L)**
SWQS =	**7.0**	**unprotected (mg/L)**	**=**	**7,000**	**unprotected (µg/L)**

SWQS FOR ZINC (with fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.3	mg/kg/day
W_h =	70	
MgT =	21	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	2059	

SWQS =	**0.393**	**protected (mg/L)**	**=**	**393**	**protected (µg/L)**
SWQS =	**0.408**	**unprotected (mg/L)**	**=**	**408**	**unprotected (µg/L)**

SWQS FOR ZINC (without fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.3	mg/kg/day
W_h =	70	
MgT =	21	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**10.5**	**protected (mg/L)**	**=**	**10,500**	**protected (µg/L)**
SWQS =	**2,100**	**unprotected (mg/L)**	**=**	**2,100,000**	**unprotected (µg/L)**

MANGANESE (with fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.02	mg/kg/day
W_h =	70	
MgT =	1.4	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	**400**	

SWQS =	**0.4**	**protected (mg/L)**	**=**	**400**	**protected (µg/L)**
SWQS =	**0.975**	**unprotected (mg/L)**	**=**	**975**	**unprotected (µg/L)**

MANGANESE (without fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.02	mg/kg/day
W_h =	70	
MgT =	1.4	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**0.7**	**protected (mg/L)**	**=**	**700**	**protected (µg/L)**
SWQS =	**140**	**unprotected (mg/L)**	**=**	**140,000**	**unprotected (µg/L)**

Derivation of a Surface Water Quality Standard for Bis(2-ethylhexyl)phthalate

Surface water quality standards (WQS) for bis(2-ethylhexyl)phthalate (BEHP) were calculated according to the guidance provided in Indiana Administrative Codes 327 IAC 2-1-8-5 and 2-1-8-6. Since BEHP is classified as a carcinogen by the U.S. EPA, the derivation of the WQS was performed primarily according to Code 327 IAC 2-1-8-6 (Determination of concentrations providing an acceptable degree of protection to public health for cancer). The following general formula for deriving a WQS for carcinogens is provided in 327 IAC 2-1-8-6:

$$C = \frac{D \text{ x } W_h}{WC + (F \text{ x } BCF)} \quad \text{(Equation 1)}$$

Where:

C = derived surface water quality standard for BEHP
D = dose
W_h = average human adult body weight = 70 kg
WC = daily water consumption
= 0.01 L per day for surface water not protected for drinking water supply
= 2 L per day surface water protected for drinking water supply
F = daily fish consumption rate = 0.025 kg per day
BCF = water to fish tissue bioconcentration factor

The dose (D) can be derived using one of several options provided in 327 IAC 2-1-8-6 (b) (1) (A), (B), and (C). Subsection (B) states that the goal for cancer "shall be a concentration estimated to cause one (1) additional cancer over the background rate in one hundred thousand (100,000) individuals exposed to that concentration". This corresponds to a $1\text{x}10^{-5}$ cancer risk.

Subsection (B)(ii) indicates that the dose (D) can be determined by dividing the cancer slope factor, known as q_1* (or CSF) by $1\text{x}10^{-5}$. Therefore, the U.S. EPA CSF for BEHP currently published in IRIS (0.014 $(\text{mg/kg/day})^{-1}$) was used to calculate D. This CSF was has been used to assess risks and to derive cleanup concentrations in other media at Crane and it is appropriate that the CSF be used to derive the WQS for surface water. This CSF has also been used by U.S. EPA Regions 3 and 9 to develop their soil and water remediation goals. Using the method recommended in Subsection (B)(ii), the value of D is:

$$D = \frac{1\text{x}10^{-5}}{0.014(\text{mg/kg/d})^{-1}} \quad \text{(Equation 2)}$$

$$D = 7.14 \text{ x } 10^{-4} \text{ mg/kg/day}$$

The BCF for BEHP was calculated according to Code 327 IAC 2-1-8-7. There are a number of BCFs for BEHP published in the literature. For example TOXNET (online at http://toxnet.nlm.nih.gov/) provides a range of measured BCFs of 4 to 5.9 L/kg for BEHP. However, according to this rule, the measured BCFs must be normalized by the percent lipid content of the fish used in the measurements. Since the percent lipid content was not known, it was necessary to estimate the BCF using equations provided in Code 327 IAC 2-1-8-7.

The 1st step in deriving a BCF is to derive a calculated BCF from the octanol/water partition coefficient (K_{ow}) using the following equation:

$$\text{Log } BCF_c = 0.847 \log K_{ow} - 0.628 \text{ (Equation 3)}$$

Where:
BCFc = the calculated BCF
Log Kow for BEHP = 7.3 (U.S. EPA Soil Screening Guidance, May 1996)

Using Equation 3, $BCF_c = 3.59x10^5$ L/kg

The 2nd step in deriving a BCF is to normalize BCF_c for lipid content using the formula:

$$BCF_f = BCF_c\ (9.6/4.8)\ \text{(Equation 4)}$$

Where BCF_f = the final bioconcentration factor = $3.59x10^5$ x 2 = $7.18x10^5$ L/kg

Based on the above equation and exposure factors, the following surface water WQS were calculated for BEHP:

- WQS for surface water protected for drinking water supply = 0.003 µg/L
- WQS for surface water not protected for drinking water supply = 0.003 µg/L

<u>Example Calculation for Protected Water Supply</u>

$$C = \frac{7.14x10^{-4}\ \text{x}\ 70\,\text{kg}}{2\text{L/d} + \left(0.025\ \text{kg/day x}\ 7.18x10^{5}\ \text{L/kg}\right)}$$

$$= \frac{5.0x10^{-2}\ \text{mg}}{1.79x10^{4}\ \text{L}}$$

$$\mathbf{= 2.79x10^{-6}\ mg/L}$$

= 0.003 µg/L

Note that a WQS could also be calculated according to 327 IAC 2-1-8-5 for the non-carcinogenic health effects of BEHP (on the prostate). However, calculations show that the non-carcinogenic WQS would be greater than the WQS based on cancer. Only the more conservative carcinogenic WQS is presented.

<u>Example Calculation for Unprotected Water Supply</u>

$$C = \frac{7.14x10^{-4}\ \text{x}\ 70\,\text{kg}}{0.01\text{L/d} + \left(0.025\ \text{kg/day x}\ 7.18x10^{5}\ \text{L/kg}\right)}$$

$$= \frac{5.0x10^{-2}\ \text{mg}}{1.79x10^{4}\ \text{L}}$$

$$\mathbf{= 2.79x10^{-6}\ mg/L}$$

= 0.003 µg/L

Using TtNUS' significant figures policy for organic chemicals, this value rounds off to 0.003 µg/L.

Derivation of a Surface Water Quality Standard for Cis-1,2-Dichloroethene

Surface water quality standards (WQS) for cis-1,2-dichloroethene were calculated according to the guidance provided in Indiana Administrative Codes 327 IAC 2-1-8-5 and 2-1-8-6. Because cis-1,2-dichloroethene is classified as a noncarcinogen by the U.S. EPA, the derivation of the WQS was performed primarily according to Code 327 IAC 2-1-8-5 [Determination of the human life cycle safe concentration (HLSC)]. The following general formula for deriving a WQS for noncarcinogens is provided in 327 IAC 2-1-8-5:

$$HLSC = \frac{MgT\ (mg/day)}{WC + (F \text{ x } BCF)} \text{ (Equation 1)}$$

Where:

HLSC = the human life cycle safe concentration (µg/L)
MgT = maximum milligrams of toxicant per day causing no adverse effects to humans daily for a lifetime (mg/day)
WC = daily water consumption
= 0.01 L per day for surface water not protected for drinking water supply
= 2 L per day surface water protected for drinking water supply
F = daily fish consumption rate = 0.025 kg per day
BCF = water to fish tissue bioconcentration factor

MgT can be derived using one of several options provided in 327 IAC 2-1-8-5 (1) or (2) using a U.S. EPA MCL (if available) or a No Observable Adverse Effect Level (NOAEL) from a human or animal study. No MCL is currently available for cis-1,2-dichloroethene. Therefore, the MgT was derived from the reference dose (RfD) currently used by the U.S. EPA for cis-1,2-dichloroethene which is based on a NOAEL. The most recently published RfD for cis-1,2-dichloroethene is 0.01 mg/kg/day. This value was developed by the U.S. EPA's National Center for Environmental Assessment (NCEA) and listed in the U.S. EPA Region 3 Risk-based concentrations (RBC) tables (U.S. EPA Region 3, October 2007) and the Region 9 PRG Tables (U.S. EPA, October, 2004). The MgT was derived as follows:

$$MgT = RfD \text{ x } W_h \text{ (Equation 2)}$$

Where:

RfD = noncarcinogenic reference dose for cis-1,2-dichloroethene
W_h = average human adult body weight = 70 kg (327 IAC 2-1-8-5 (2)(C)

Therefore:

MgT = 0.01 mg/kg/day x 70 kg

= 0.7 mg/day

The BCF for cis-1,2-dichloroethene was calculated according to Code 327 IAC 2-1-8-7, as follows:

The 1st step in deriving a BCF is to derive a calculated BCF from the octanol/water partition coefficient (K_{ow}) using the following equation:

$$\text{Log } BCF_c = 0.847 \log K_{ow} - 0.628 \text{ (Equation 3)}$$

Where:
BCFc = the calculated BCF
Log Kow for cis-1,2-dichloroethene = 1.86 (Kow = 72.4)

Using Equation 3, BCF_c = 8.86 L/kg

The 2nd step in deriving a BCF is to normalize BCF_c for lipid content using the formula from Code 327 IAC 2-1-8-7 (4):

$$BCF_f = BCF_c\ (9.6/4.8)\ \text{(Equation 4)}$$

Where BCF_f = the final bioconcentration factor = 8.86 x 2 = 17.72 L/kg

Based on the above equation and exposure factors, the following surface water WQS were calculated for cis-1,2-dichloroethene:

- WQS for surface water protected for drinking water supply = 290 µg/L
- WQS for surface water not protected for drinking water supply = 1,500 µg/L

<u>Example Calculation for Protected Water Supply</u>

$$\text{HLSC} = \frac{0.7\ \text{mg/day}}{2\text{L/d} + (0.025\ \text{kg/day x } 17.72\ \text{L/kg})}$$

$$= \frac{0.7\ \text{mg}}{2.443\ \text{L}}$$

= 0.287 mg/L

= 287 µg/L

Using TtNUS' significant figures policy for organic chemicals, this value rounds off to 290 µg/L.

<u>Example Calculation for Unprotected Water Supply</u>

$$\text{HLSC} = \frac{0.7\ \text{mg/day}}{0.01\text{L/d} + (0.025\ \text{kg/day x } 17.72\ \text{L/kg})}$$

$$= \frac{0.7\ \text{mg}}{0.453\ \text{L}}$$

= 1.545 mg/L

= 1,545 µg/L

Using TtNUS' significant figures policy for organic chemicals, this value rounds off to 1,500 µg/L.

ATTACHMENT 3

TABLE 2-11

TABLE 2-11

MEDIA CLEANUP STANDARDS FOR SURFACE AND SUBSURFACE SOIL
CMP REPORT FOR SMWU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

COC	Media Cleanup Standards(1)	
	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)
Construction Worker		
Antimony	460(2)	460(2)
Iron	106,000(3)	106,000(3)
Lead	970(2)	970(2)
Manganese	(1)	(1)
Maintenance Worker		
Antimony	620(4)	(1)
Iron	1,000,000(3)	(1)
Lead	1,300(4)	(1)
Manganese	(1)	(1)
Industrial Worker		
Antimony	620(4)	(1)
Iron	1,000,000(3)	(1)
Lead	1,300(4)	(1)
Manganese	(1)	(1)
Future Child Resident		
Manganese	(1)	(1)
Future Resident		
Manganese	(1)	(1)
Future Adult Resident		
Manganese	(1)	(1)
National Primary Drinking Water Regulations		
Antimony	(1)	(1)
Dixon/furans	(1)	(1)
Iron	(1)	(1)
Manganese	(1)	(1)

1 - The MSC for constituents not specifically listed are the IDEM Closure Level for the appropriate receptor.
2 - IDEM Closure Level for Construction Workers based on direct contact.
3 - MCS calculated based on the SWMU 5 risk assessment (See Section 2.5).
4 - IDEM Industrial Closure Level based on direct contact.

µg/L - micrograms per liter
COC - Chemical of concern.
IDEM - Indiana Department of Environmental Management.
MCL - Maximum Contaminant Level.
MCSs - Media cleanup standards.
mg/kg - milligrams per kilogram
N/A - not applicable to this media for this COC.
RCRA - Resource Conservation and Recovery Act.
RFI - RCRA Facility Investigation.
USEPA - United States Environmental Protection Agency.

Originally submitted January 9, 2008
Revised 04/16/14

REQUEST FOR ADDITIONAL CLARIFICATION FROM EPA DATED JUNE 14, 2007 REGARDING RESPONSE TO EPA COMMENTS DATED DECEMBER 19, 2006 FOR DRAFT CORRECTIVE MEASURES PROPOSAL (CMP) FOR OLD BURN PIT (OBP) (SWMU 5) NAVAL SURFACE WARFARE CENTER (NSWC) CRANE CRANE, INDIANA

EPA comments are shown in bold font. Navy responses to each comment are shown in regular font. Text changes to the SWMU 5 CMP are shown in italic font enclosed in quotation marks within the response.

EPA-6(12-16-06): We would like to see some effort made by the Navy at housekeeping, if you will, for debris which can be easily removed without excessive destruction of ecosystem, subsurface digging, or fear of hillside collapse.

Please evaluate another option where some intermediate level of work to remove hotspots and easily removable debris can be done. For example, a sweep and removal of exposed (surface) debris on the flat-top portion of the SWMU which would not cause excessive ecosystem destruction or stability concerns and those which can be easily extracted or cut to ground surface should be considered.

Similarly, if there is debris resting in the valley portion of the SWMU which could be easily removed (i.e. no digging into the steep hillside required/winch it out of the valley), an attempt to do so should be made.

There could be decision rules in the CMIP developed for such cases: if the debris item cannot be removed by manually digging/winching it out or by cutting safely to ground surface, it will be noted and left in place. Also, removal of the lead surface soil hotspot area at 05SB06 (16,900 ppm) to a one foot depth and laterally to 1,100 ppm and backfilling should be considered. From our recent site-visit, this area appears to be in an open, flat clearing which is easily accesible. We understand that this undertaking would be limited in scope compared to the debris field present, but it would show that an attempt at improving the area was made.

Response EPA-6(12-20-06): The following subsection has been added to Section 3.1.1.2:

"Debris Field/Hotspots

"The non-constructible area contains debris field that consists of debris which is partially-embedded into the soil within a relatively flat area and a steeply slopped area (i.e., a hillside area along the south bank of an un-named tributary). Sample logbook entries indicate that many of the soil samples were collected at or near debris items (i.e., rusted drum or other metal items). There is a lead hotspot (06SB06) that is most likely associated with a debris item. If the lead hotspot was removed, the risk from lead for the current human receptors would be acceptable.

"The debris field resulted from hauling miscellaneous materials from the old burn pit to the hillside, dumping it over the hillside, and then covering it with a layer of soil. The action of covering the hauled debris resulted in extending the flat area towards the north and the creation a steep hillside [i.e., hillside slope exceeds a 1 to 3 ratio (1:3)]. The number of times that this hauling / dumpling / covering process was repeated is not known. However, it is reasonable to assume a minimum of five layer of debris covered with soil are present along the hillside.

"SWMU 5 debris removal is problematic at best because the extent of contamination is unknown (i.e., depth and distance from the visible debris is unknown). The majority of the exposed debris at SWMU 5 is located along the steep hillside . Any disturbance of

the hillside would require stabilization of the hillside [i.e., re-grading / re-sloping of the hillside to achieve a 1:3 slope and re-vegetation of the hillside].

"The SWMU 5 debris field exists in several layers resulting from debris being repeatedly dumped over a hillside and then buried. The following remedial actions were evaluated for SWMU 5:

1.) *Cutting the exposed debris to ground surface with a torch,*
2.) *Exposed debris removal,*
3.) *Soil covering of the exposed debris, and*
4.) *Removal of Hotspot 05SB06 and readily removable debris.*

"Option 1, cutting the exposed material to ground level with a torch, would require establishing a non-flammable zone around the flat and hillside debris areas. Because the existing hillside is so steep, the cleared areas along the hillside would be unstable even after re-vegetation and would require re-sloping. The re-sloping could be accomplished by extending of the hillside into the valley, which would eliminate the existing valley. It is likely that the hillside would collapse during remediation or re-sloping activities; resulting in the exposure of additional debris and a high potential for personnel injury. Another re-sloping option is to cut into the existing flat area. This would result in exposure of additional debris and a high potential for personnel injury from instability of the hillside during re-sloping.

"This option would result in uncertain contamination removal effectiveness while negatively impacting a thriving ecosystem with the destruction of habitat from clearing areas around the debris to establish a non-flammable zone around the debris.

"Option 2, removal of the exposed debris on the flat area, would require digging out the unexposed portion of the material. Manual digging is impractical because the depth of each debris item is unknown (e.g., buried construction and building structural components could be several feet under the ground surface). Therefore, excavation equipment to remove the debris was evaluated. As debris material is removed, other layers of debris would be exposed and the extent of remediation is unknown. Additionally, the excavation equipment would probably require temporary roads

"Removal of the exposed debris within the hillside area, would also require digging out the unexposed portion of the material. Again, manual digging is impractical because the depth of each debris item is unknown (e.g., buried construction and building structural components could be several feet under the ground surface). Therefore, excavation equipment to remove the debris was evaluated. As debris material is removed, other layers of debris would be exposed and the extent of remediation is unknown. Additionally, the excavation equipment would probably require temporary roads.

"The probability of the hillside collapsing and resulting in the exposure of additional debris is likely for both activities. Due to the unknown debris depth, an arbitrary removal depth and distance around pieces of debris would need to be established. After debris removal, the following restorative activities would need to occur:

- *Backfill of the areas where the debris was removed,*
- *Remove then restore the areas where temporary roads were constructed,*
- *Cover the newly exposed debris with clean material,*
- *Re-slope / re-grade the hillside to 1:3 slope, and*
- *Re-vegetate the disturbed areas.*

These activities would have a negative impact to the existing-thriving ecosystem.

"Option 3, a soil cover for the exposed debris along the flat area, would require removal of the existing vegetation (i.e., trees). Soil cover for the exposed debris along the hillside would require removal of the existing vegetation and then re-sloping of the hillside to achieve a 1:3 ratio. To achieve this slope, the hillside would need to be cut back into the existing flat area or the valley would need to be filled backfilled. Either approach would result in extensive disturbance of the existing ecosystem, which is thriving.

"This option would not remove but would negatively-impact a thriving ecosystem with the removal of vegetation, excavation, and road construction.

"Option 4, hotspot (05SB06) removal and manual surface debris removable, would involve the removing a predetermined amount of exposed surface debris on the flat area and flat and hillside areas of the SWMU. This option is anticipated to result in the minimal ecosystem destruction and in nominal hillside stability concerns.

"The surface debris removal will be conducted using manual cutting tool (i.e., no open flame) and manual or mechanical lifting that will result in limited soil disturbance (i.e., no digging will be conducted along the steep hillside, mechanical cutting tools with no open flame for debris removal, etc.). For costing development, this manual removal is anticipated to take two weeks.

"Decision rules will be developed in the Work Plan to determine what the debris item cannot be safely removed by manually digging/winching or by mechanical cutting to ground surface (i.e., left in place).

"Also, the lead surface soil hotspot area (05SB06) will be remediated to a depth of 1 foot and laterally to 1,100 ppm. The area will then be backfilled with clean fill.

"Option 4 will be carried through the CMP."

"The following three CMs will be considered for metals in soils in the non-constructible area:

- *No Action, designated as Alternative S-1*
- *Limited Action, consisting of LUCs, long-term monitoring (LTM), and designated as Alternative S-2. The purpose of this alternative is to prevent human receptors exposure to soils and to monitor for unacceptable contamination migration.*
- *Limited Removal Action, consisting of hotspot removal, aesthetic surface debris removal, LUCs, LTM, and designated as Alternative S-3. The purpose of this alternative is to prevent human receptors exposure to soils and to monitor for unacceptable contamination migration.*

Section 4.1.2.3 has been modified as follows to eliminate the discussion regarding no further action for removal of the lead hotspot:

*"**4.1.2.3 Source Control***

"Alternative S-2 does not provide for source control."

A new alternative (Alternative S-3) has been added as a new Section 4.1.3 associated with the addition of Surface Debris Removal and Lead Hotspot Removal as follows:

*"**4.1.3 Alternative S-3: Limited Removal Action - Land Use Control, Surface Debris Removal, and Lead Hotspot Removal (Non-Constructible Area)***

*"**4.1.3.1 Protection of Human Health and the Environment***

Alternative S-3 would be protective of human health and the environment. LUCs would protect human health by preventing exposure to contaminated soils in the non-constructible area as long as antimony, iron, and lead concentrations remain unacceptable. Surface debris removal would protect human health by preventing exposure to surface debris in the non-constructible area. Hotspot removal would protect human health by eliminating a source of lead contaminated soils in the non-constructible area.

*"**4.1.3.2 Attainment of Media Cleanup Standards***

"Alternative S-3 would not attain the antimony and iron MCSs.

However, LUCs would protect human health by preventing exposure of future residents and construction workers to metals-contaminated soils in the non-constructible area as long as concentrations of these metals remain unacceptable. Debris removal would protect human health by preventing exposure of future residents and construction workers to exposed metals-contamination. Finally, the lead hotspot removal would protect human health by preventing exposure of future residents and construction workers to an area of high lead-contaminated soil and would attain the lead MCS for this area.

*"**4.1.3.3 Source Control***

"Alternative S-3 provides for source control in the lead hotspot area.

*"**4.1.3.4 Compliance with Waste Management Standards***

"Waste management standards would be followed during the removal of surface debris and lead-contaminated soil.

*"**4.1.3.5 Other Factors***

"Long-Term Reliability and Effectiveness

"Alternative S-3 would be reliable and effective in the long term for protection of human health from antimony, iron, and lead contamination. LUCs would reliably and effectively prevent potential current and future exposure to metals-contaminated soils and ensure that land use remains military/industrial. However, it is uncertain if soil weathering would result in additional exposure of the buried debris along the hillside.

"Reduction in Toxicity, Mobility, and Volume

"Alternative S-3 would reduce contaminant toxicity, mobility, and volume of lead-contaminated soil by the removal of the lead hotspot.

"Short-Term Effectiveness

"Alternative S-3 would involve administration of LUCs. Implementation of this alternative would not result in any short-term threat to the surrounding community or to ecological receptors. Surface debris and hotspot removal and disposal would be managed using appropriate personal protective equipment (PPE) and an approved disposal facility that

would not result in any short-term threat to the surrounding community. However, it is anticipated that remedial efforts in the non-construction area would result in a temporary adverse impact to the ecological habitat, which currently does not show obvious adverse impacts from the contamination.

"Implementability

Alternative S-3 would be readily implementable. LUCs would be readily implementable because SWMU 5 is completely contained within NSWC Crane, and LUCs would be similar to those implemented at other environmental sites within NSWC Crane. Surface debris and hotspot removal would be readily implementable because similar activities have been implemented at other environmental sites within NSWC Crane.

"Alternative S-3 could be implemented within approximately 12 months.

"Cost

"The following costs are estimated for Alternative S-3: Limited Removal Action - LUCs, Surface Debris Removal, and Lead Hotspot Removal:

Capital Cost:	*$15550,000*
30-Year NPW of O&M Costs:	*$2,000 per year; plus $7,000 additional every 5 years40,000*
30-Year NPW:	*$190,000*

"The above cost figures have been rounded to the nearest $1,000 to reflect the preliminary nature of these estimates. Detailed cost estimates are provided in Appendix BA-21.

EPA-6(12-20-06) (continued): Finally, the response does not provide explanation of the differences between debris removal at this site versus SWMU 15. I believe the site-visit discussion points touched on this, but a better explanation should be included in the response to comment.

Response EPA-6(12-20-06) (continued): At SWMU 15, debris dumping consisted of hauling the debris to the hillside and then dumping it over the hillside. No material or soil was placed over the SWMU 15 hillside debris resulting in a debris field that was truly surface debris (i.e., the SWMU 15 debris was not buried under soil).

At SWMU 5, the debris dumping consisted of several cycles of hauling the debris to the hillside, dumping it over the hillside, and then pushing soil the hillside to cover the debris. The number of layers of debris cover with soil is not known.

As previously discussed in the original response, total removal of debris at SWMU 5 would result in the destruction of the existing ecosystem through the cutting down of trees and construction of access roads and destabilization of the hillside. Additionally, the small un-named stream would be destroyed during the remediation efforts.

EPA-7(12-20-06): Please modify Table 2-11 to include MCSs for all groundwater/surface water constituents you will monitor for as noted in the response and not simply the risk drivers (i.e. MCSs for metals, dioxins/furans, VOC/SVOC).

Response EPA-7(12-20-06) (continued): A new Table 2-12 (Attachment 1) has been added that includes the constituents that were detected in surface water and groundwater during the RFI investigations.

Additionally, the 1st paragraph in Section 2.5.2 has been revised as follows:

> *"MCSs have been developed for the constituents that were detected in groundwater during the SWMU 5 RFI investigation and are presented in Table 2-12."*

EPA-7(12-20-06) (continued): Instead of presenting numerical MCS for soils at this time, a reference can simply be made in the text that soil cleanup standards for SWMU 5 would be Indiana RISC cleanup standards for appropriate land use (residential/industrial).

Response EPA-7(12-20-06) (continued): Table 2-11 (Attachment 2) has been revised to eliminate MCSs for groundwater~~soil~~. Additionally, a new footnote has been added to Table 2-11 as follows:

> *"1 - The MSC for constituents not specifically listed are the IDEM Closure Level for the appropriate receptor."*

EPA-7(12-20-06) (continued): Table 2-11 currently has blanks for antimony and iron in groundwater. The antimony MCL is 6 ug/L and the iron secondary MCL is 300 ug/L (or present calculated risk-based MCS for those COCs with no MCLs).

Response EPA-7(12-20-06) (continued): A new table (Table 2-12; Attachment 1) has been developed for constituents detected in surface water and groundwater during the RFI investigations excluding the essential nutrients calcium, magnesium, and sodium. Groundwater MCSs for these constituents were developed for the Final Groundwater Monitoring Plan (TtNUS, 1999). Surface water MCSs were developed assuming incidental contact with surface water during trespassing/recreational use (i.e., fish ingestion pathway is not applicable due to the nature of the surface water body) according to Indiana Administrative Code (IAC) 327 for unprotected surface water supply.

The following has been added to the reference section of SWMU 5 CMP:

> *"TtNUS (Tetra Tech, NUS, Inc.), 1999. Final Ground Water Monitoring Plan for the Ammunition Burning Grounds, Old Rifle Range, and Demolition Range. Naval Surface Warfare Center Crane Division, Crane, Indiana. Southern Division Naval Facilities Engineering Command. September."*

EPA-7(12-20-06) (continued): What is the basis for a two year groundwater sampling frequency? Did you collect additional hydraulic conductivity data as noted in Table 2-1?

Response EPA-7(12-20-06) (continued): The intent of monitoring is to determine long-term trends. Due to the lack of downstream receptors, an aggressive monitoring program was not warranted.

No change has been made to the SWMU 5 CMP in response to this comment.

EPA-7(12-20-06) (continued): What are the groundwater seepage velocities for the SWMU areas?

Response EPA-7(12-20-06) (continued): Groundwater seepage velocities for the SWMU 5 areas are not known.

NAVAL SURFACE WARFARE CENTER CRANE
CRANE, INDIANA
SWMU 5
Alternative S-3: Land Use Controls, Surface Debris Removal, and Lead Hotspot Removal
Annual Cost

Item	Item Cost Years 1 - 30	Item Cost Every 5 Years Through 30 Years	Notes
Site Inspection	$1,000		To verify continued implementation of institutional controls.
Report	$500		Document sampling events and results, $1,000 per report.
Site Review		$7,500	Site review every 5 years for 30 years.
TOTALS	**$1,500**	**$7,500**	

NAVAL SURFACE WARFARE CENTER CRANE
CRANE, INDIANA
SWMU 5
Alternative S-3: Land Use Controls, Surface Debris Removal, and Lead Hotspot Removal
Capital Cost

				Unit Cost				Total Cost				Total Direct
	Item	Quantity	Unit	Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	Cost
Plans, Permits, Reports												
1	Health & Safety Plan	40	hr			$35.00		$0	$0	$1,400	$0	$1,400
2	Environmental Protection Plan	16	hr			$35.00		$0	$0	$560	$0	$560
3	Work Plan	60	hr			$35.00		$0	$0	$2,100	$0	$2,100
4	Waste Management Plan	8	hr			$35.00		$0	$0	$280	$0	$280
5	Meetings	24	hr			$35.00		$0	$0	$840	$0	$840
6	Prepare LUC RD Documents	80	hr			$35.00		$0	$0	$2,800	$0	$2,800
Site Support												
1	Site Superintendent	30	day			$400.00		$0	$0	$12,000	$0	$12,000
2	H & S; QA/QC Site Support	30	day			$350.00		$0	$0	$10,500	$0	$10,500
3	Labor, Common (3 laborers for 30 days)	90	day				$232.16	$0	$0	$0	$20,894	$20,894
4	Pick-up Truck (2 trucks for 30 days)	60	day				$100.00	$0	$0	$0	$6,000	$6,000
5	Sanitary Facilities	2	mo				$180.00	$0	$0	$0	$360	$360
6	Utilities (phones, water, etc.)	30	day				$30.00	$0	$0	$0	$900	$900
7	Decon Facilities - Materials	1	ls		$400.00			$0	$400	$0	$0	$400
8	Decon Facilities - Equipment (duration x number of pads)	30	day				$80.00	$0	$0	$0	$2,400	$2,400
9	Dewatering Facilities - Materials	1	ls		$7,000.00			$0	$7,000	$0	$0	$7,000
10	Survey Support	2	day	$975.00				$1,950	$0	$0	$0	$1,950
Site Preparation												
1	Utility Survey	1	ls	$3,500.00				$3,500	$0	$0	$0	$3,500
2	Backhoe/Loader	3	day			$289.20	$410.00	$0	$0	$868	$1,230	$2,098
3	Temporary Access Road Surface, mulch & straw	444	sy		$1.86			$0	$826	$0	$0	$826
4	Stone Construction Entrance	1	ea		$1,100.00			$0	$1,100	$0	$0	$1,100
5	E&S Silt Fence	900	lf		$0.34			$0	$306	$0	$0	$306
6	Clear Site, cut & chip trees	2	day				$252.40	$0	$0	$0	$505	$505
7	Mob/demob Equipment	3	ea			$118.00	$248.00	$0	$0	$354	$744	$1,098
Excavation												
1	Backhoe/Loader	10	day			$289.20	$410.00	$0	$0	$2,892	$4,100	$6,992
2	Verification Sampling	1	ea	$500.00	$50.00	$40.00	$20.00	$500	$50	$40	$20	$610
3	Common Fill	29	cy		$21.00			$0	$609	$0	$0	$609
4	Top Dress Top Soil	6	cy		$21.00			$0	$126	$0	$0	$126
5	Seed	5	msf		$17.80			$0	$89	$0	$0	$89
Debris Removal												
1	Skid Steer	10	day				$222.20	$0	$0	$0	$2,222	$2,222
2	Cutoff Saw	10	day				$53.00	$0	$0	$0	$530	$530
3	Install Signs	38	ea		$146.50			$0	$5,567	$0	$0	$5,567
Transportation & Disposal												
1	T & D of Site Debris	50	cy	$53.80				$2,690	$0	$0	$0	$2,690
2	Waste Disposal Characterization / Analytical	1	ea	$1,050.00				$1,050	$0	$0	$0	$1,050
3	T & D of Lead Contaminated Soil	53	ton	$105.00				$5,565	$0	$0	$0	$5,565
4	Box Rental per Month	5	ea	$262.50				$1,313	$0	$0	$0	$1,313

NAVAL SURFACE WARFARE CENTER CRANE
CRANE, INDIANA
SWMU 5
Alternative S-3: Land Use Controls, Surface Debris Removal, and Lead Hotspot Removal
Capital Cost

Item	Quantity	Unit	Unit Cost: Subcontract	Unit Cost: Material	Unit Cost: Labor	Unit Cost: Equipment	Total Cost: Subcontract	Total Cost: Material	Total Cost: Labor	Total Cost: Equipment	Total Direct Cost
Subtotal							$16,568	$16,073	$34,634	$39,905	$107,179
Overhead on Labor Cost @ 30%									$10,390		$10,390
G & A on All Cost @ 10%							$1,657	$1,607	$3,463	$3,991	$10,718
Taxes on Materials & Equipment @ 6%								$964		$2,394	$3,359
Total Direct Cost							$18,224	$18,644	$48,487	$46,290	$131,646
Indirects on Total Direct Cost @ 10%											$13,165
Profit on Total Direct Cost @ 8%											$10,532
TOTAL COST											**$155,342**

NAVAL SURFACE WARFARE CENTER CRANE
CRANE, INDIANA
SWMU 5
Alternative S-3: Land Use Controls, Surface Debris Removal, and Lead Hotspot Removal
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$155,342		$155,342	1.000	$155,342
1		$1,500	$1,500	0.935	$1,403
2		$1,500	$1,500	0.873	$1,310
3		$1,500	$1,500	0.816	$1,224
4		$1,500	$1,500	0.763	$1,145
5		$9,000	$9,000	0.713	$6,417
6		$1,500	$1,500	0.666	$999
7		$1,500	$1,500	0.623	$935
8		$1,500	$1,500	0.582	$873
9		$1,500	$1,500	0.544	$816
10		$9,000	$9,000	0.508	$4,572
11		$1,500	$1,500	0.475	$713
12		$1,500	$1,500	0.444	$666
13		$1,500	$1,500	0.415	$623
14		$1,500	$1,500	0.388	$582
15		$9,000	$9,000	0.362	$3,258
16		$1,500	$1,500	0.339	$509
17		$1,500	$1,500	0.317	$476
18		$1,500	$1,500	0.296	$444
19		$1,500	$1,500	0.277	$416
20		$9,000	$9,000	0.258	$2,322
21		$1,500	$1,500	0.242	$363
22		$1,500	$1,500	0.226	$339
23		$1,500	$1,500	0.211	$317
24		$1,500	$1,500	0.197	$296
25		$9,000	$9,000	0.184	$1,656
26		$1,500	$1,500	0.172	$258
27		$1,500	$1,500	0.161	$242
28		$1,500	$1,500	0.150	$225
29		$1,500	$1,500	0.141	$212
30		$9,000	$9,000	0.131	$1,179
				TOTAL PRESENT WORTH	**$190,126**

ATTACHMENT 1

NEW TABLE 2-12

TABLE 2-12

MEDIA CLEANUP STANDARDS FOR SURFACE WATER AND GROUNDWATER
CMP REPORT FOR SMWU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

CASRN	Chemical	MCS Groundwater[(1)] (µg/L)		MCS Surface Water[(2)] (µg/L)	
Dioxins					
3268-87-9	1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (1,2,3,4,6,7,8,9-OCDD)	1.9E-02	(3)	2.00E+00	(3)
39001-02-0	1,2,3,4,6,7,8-Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF)	5.7E-04	(3)	5.00E-02	(3)
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (1,2,3,4,6,7,8-HpCDD)	5.7E-04	(3)	5.00E-02	(3)
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)*	3.0E-05	(4)	5.00E-04	(3)
37871-00-4	Total Heptachlorodibenzo-p-dioxin (Total HpCDD)	--		--	
Volatice Organics					
67-66-3	Chloroform*	80	(4)	70,000	(3)
75-35-4	1,1-Dichloroethene	7	(4)	350,000	(3)
156-59-2	cis-1,2-Dichloroethene	70	(4)	70,000	(3)
156-60-5	trans-1,2-Dichloroethene	100	(4)	140,000	(3)
79-01-6	Trichloroethene	5	(4)	5,400	(3)
75-01-4	Vinyl chloride	2	(4)	97	(3)
Semi-Volatile Organics					
117-81-7	Bis(2-ethylhexyl) phthalate	6	(4)	5,000	(3)
Metals					
7429-90-5	Aluminum	36,000	(6)	7,000,000	(3)
7440-36-0	Antimony	6	(4)	2,800	(3)
7440-38-2	Arsenic	10	(4)	46.7	(3)
7440-39-3	Barium	2,000	(4)	1,400,000	(3)
7440-50-8	Copper	1,300	(4)	280,000	(3)
7439-89-6	Iron	25,550	(3)	4,900,000	(3)
7439-92-1	Lead	15	(4)	NA	
7439-96-5	Manganese	880	(3)	168,000	(3)
7440-62-2	Vanadium	36.5	(3)	7,000	(3)
7440-66-6	Zinc	11,000	(5)	2,100,000	(3)

µg/L - micrograms per liter.
CASRN - Chemical Abstract Services Registry Number.
IDEM - Indiana Department of Environmental Management.
NA - Not Available.
USEPA - United States Environmental Protection Agency.
RISC - Risk Integrated System of Closure.
PRG - Preliminary Remediation Goal.
MCS - Media cleanup standard.

* Asterisks indicate a chemical for which the laboratory reporting limit (RL) exceeds the risk-based target level for the project.

1 MCS assumes that groundwater is used as a domestic water supply source.
2 MCS assumes incidental surface water contact during trespass/recreational use of surface water source.
3 Calculated according to IDEM RISC guidance (IDEM, January 2006). Note that the cancer target risk for IDEM is 1E-05.
4 U.S. EPA Primary Drinking Water Standard (USEPA, Summer 2006).
5 IDEM, RISC residential closure levels for groundwater (IDEM, January 2006), unless otherwise noted.
6 USEPA Region 9 PRG Tables (October 2004). PRGs based on cancer are adjusted to meet a target risk of 1E-05, as per IDEM

ATTACHMENT 2

REVISED TABLE 2-11

TABLE 2-11

MEDIA CLEANUP STANDARDS FOR SURFACE AND SUBSURFACE SOIL
CMP REPORT FOR SMWU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

COC	Media Cleanup Standards(1)	
	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)
Construction Worker		
Antimony	460(2)	460(2)
Iron	106,000(3)	106,000(3)
Lead	970(2)	970(2)
Manganese	(1)	(1)
Maintenance Worker		
Antimony	620(4)	(1)
Iron	1,000,000(3)	(1)
Lead	1,300(4)	(1)
Manganese	(1)	(1)
Industrial Worker		
Antimony	620(4)	(1)
Iron	1,000,000(3)	(1)
Lead	1,300(4)	(1)
Manganese	(1)	(1)
Future Child Resident		
Manganese	(1)	(1)
Future Resident		
Manganese	(1)	(1)
Future Adult Resident		
Manganese	(1)	(1)
National Primary Drinking Water Regulations		
Antimony	(1)	(1)
Dixon/furans	(1)	(1)
Iron	(1)	(1)
Manganese	(1)	(1)

1 - The MSC for constituents not specifically listed are the IDEM Closure Level for the appropriate receptor.
2 - IDEM Closure Level for Construction Workers based on direct contact.
3 - MCS calculated based on the SWMU 5 risk assessment (See Section 2.5).
4 - IDEM Industrial Closure Level based on direct contact.

µg/L - micrograms per liter
COC - Chemical of concern.
IDEM - Indiana Department of Environmental Management.
MCL - Maximum Contaminant Level.
MCSs - Media cleanup standards.
mg/kg - milligrams per kilogram
N/A - not applicable to this media for this COC.
RCRA - Resource Conservation and Recovery Act.
RFI - RCRA Facility Investigation.
USEPA - United States Environmental Protection Agency.

Originally dated 5/2/2007
Revised 4/16/2014

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (EPA) COMMENTS ON DRAFT CORRECTIVE MEASURES PROPOSAL (CMP) FOR OLD BURN PIT (OBP) (SWMU 5) DATED DECEMBER 19, 2006 NAVAL SURFACE WARFARE CENTER (NSWC) CRANE CRANE, INDIANA

EPA comments are shown in bold font. Navy responses to each comment are shown in regular font. Text changes to the CMP are shown in italic font enclosed in quotation marks within the response.

Comment EPA-1: Section 1.4.4.1: Figure 1-6 is missing.

Response to EPA-1: Figure 1-6 is provided as Attachment 1 to this comment response document.

Comment EPA-2: Section 2.2.1, Lead: The last sentence and second to last sentence of this subsection refer to iron and should be deleted or corrected.

Response to EPA-2: The last two sentences in Section 2.2.1, Subsection Lead have been deleted.

Comment EPA-3: Residential Child Risks, page 2-8: The references to tables 2-4 and 2-5 in the second paragraph appear to be in error.

Response to EPA-3: For consistency with the text, old Table 2-4 has been renumbered as Table 2-5 and old Table 2-5 has been renumbered as Table 2-4.

Comment EPA-4: Section 2.5: The media cleanup standards should simply be the appropriate MCLs and IDEM RISC Residential/Industrial Default Closure values. ACLs may be calculated those COCs where such values are not available.

Response to EPA-4: Agreed. Table 2-11 for soil has been updated using the Indiana Department of Environmental Management (IDEM) Risk Information Support Center (RISC) Default Closure Levels for Direct Contact with soil values for antimony, iron, and lead. ~~Because there is no IDEM RISC value for iron, the iron MCS was calculated based on the SWMU 5 risk assessment.~~

Additionally, the MCSs for groundwater in Table 2-12~~1~~ have been updated to include ~~groundwater dioxin Media Cleanup Standard (MCS) has been updated to~~ the EPA Maximum Contaminant Levels (MCLs) and Action Levels, and if none of these values were available, IDEM RISC Default Closure Levels for Direct Contact for a residential exposure scenario (i.e., groundwater used as tapwater).

~~Because a primary drinking water MCL is not available for manganese, the drinking water MCS was calculated based on the SWMU 5 risk assessment.~~

Comment EPA-5: Multiple tables in Section 2 appear to present data for antimony, iron, and lead from the 1990 soil investigation. Provide figures showing the historical soil consitituents (1990) exceeding screening values along with the most recent RFI data as shown in the figures of the 2005 RFI report. This will help provide additional qualitative information on the risk and extent of contamination known to date.

Response to EPA-5: A surface soil figure (Figure 2-2~~3~~) and a subsurface soil figure (Figure 2-43) has been added to Section 2 that present the 1990 Soils Investigation and 2005 RFI Report data for antimony, iron, and lead. These figures include a comparison to the EPA Region 5 Ecological

Data Quality Levels, the EPA Region 9 Preliminary Remediation Goals (PRGs), IDEM default industrial closure levels for direct contact with soil, and EPA generic soil screening level for migration from soil to groundwater for a dilution attenuation factor of 1 for antimony, iron, and lead.

A new 3rd paragraph has been added to Section 2.4.2, Subsection Conclusions as follows:

> *"Figure 2-23 presents historical surface soil data including a comparison of surface soil concentrations to the EPA Region 5 Ecological Data Quality Levels for antimony, iron, and lead."*

~~A new final sentence has been added to the 1st paragraph of Section 2.5.1, Subsection Antimony as follows:~~

> ~~*"Figure 2-3 presents historical surface soil data and a comparison of surface soil concentrations to the EPA Region 9 Preliminary Remediation Goals (PRGs), IDEM default industrial closure levels for direct contact with soil, and EPA generic soil screening level for migration from soil to groundwater for a dilution attenuation factor of 1 for antimony."*~~

~~A new final sentence has been added to the 2nd paragraph of Section 2.5.1, Subsection Antimony as follows:~~

> ~~*"Figure 2-4 presents historical subsurface soil data and a comparison of subsurface soil concentrations to the EPA Region 9 PRGs, IDEM default industrial closure levels for direct contact with soil, and EPA generic soil screening level for migration from soil to groundwater for a dilution attenuation factor of 1 for antimony."*~~

A new final sentence has been added to the 1st paragraph of Section 2.45.1.1, sSubsection labeled HHRA Updated for the Constructible Area ~~Iron~~ as follows:

> *"Figures 2-32 (surface soil) and 2-43 (subsurface soil) illustrate the ~~present historical soil data and a comparison of soil~~ concentrations of antimony, iron, and lead detected in the soil at SWMU 5~~to the EPA Region 9 PRGs, IDEM Industrial closure levels for direct contact with soil, and EPA generic soil screening level for migration from soil to groundwater for a dilution attenuation factor of 1 for iron~~."*

The same sentence will be added at the end of the first paragraph of the same subsection labeled HHRA Update for Non-Constructible Area.

~~A 3rd paragraph has been added to Section 2.5.1, Subsection Lead as follows:~~

> ~~*"Figures 2-3 and 2-4 present historical surface soil data including a comparison of soil concentrations to the EPA Region 9 PRGs, IDEM Industrial closure levels for direct contact with soil, and EPA generic soil screening level for migration from soil to groundwater for a dilution attenuation factor of 1 for lead."*~~

Comment EPA-6: Table 2-1 presents the recommendations for corrective measures based on risk to receptors (from the RFI). This table recommended that the CMP evaluate soil hot spot removal (antimony, lead) and debris removal at the toe of the dump. As currently written, the CMP addresses this with two sentences in one bullet of Section 4.3.2. The CMP should flesh this out more by presenting exactly what it would take to perform the removals of: 1) hotspots and 2) debris; namely, the size/locations of soil hotspots and debris areas which would need removal, the corresponding destruction of habitat for each such area, and an evaluation of the cost versus benefit of performing such action in order to fully present why this option would not be beneficial to the environment. Provide an

explanation of the differences between debris removal at this site versus the debris removal done at SWMU 15 where an extensive debris field was present in a similar environment, yet the Navy chose to perform the removal. Lead is present in soils at levels which would most probably fail TCLP.

Response to EPA-6: The following subsection has been added to Section 3.1.1.2:

"Debris Field/Hot Spots

"The non-constructible area contains a debris field. Within the debris field are partially exposed debris and a lead hot spot. If the lead hot spot were removed, the risk from lead for the current human receptors would be acceptable.

"The SWMU 5 debris field exists in several layers resulting from debris being repeatedly dumped over a hillside and then buried. The remediation options were evaluated for SWMU 5:

1.) *Cutting the exposed debris to ground surface with a torch,*
2.) *Exposed debris removal, and*
3.) *Soil covering of the exposed debris.*

"The majority of the exposed debris at SWMU 5 is located on a hillside along the south bank of an un-named tributary along a very steep hillside [i.e., hillside slope exceeds a 1 to 3 ratio (1:3)]. Any disturbance of the hillside would require stabilization of the hillside [i.e., re-grading of the hillside to achieve a 1 to 3 (1:3) slope and re-vegetation of the hillside].

"Option 1, cutting the exposed material to ground level with a torch, would require establishing a non-flammable zone around the debris. Because the existing hillside is so steep, the cleared area would be unstable and would require re-sloping even after re-vegetation. The probability of the hillside collapsing during the remediation and resulting in the exposure of additional debris is likely for this option. Additionally, the potential for personnel injury is high should the hillside become unstable.

"Option 2, removal of the exposed debris, would require digging out the unexposed portion of the material. Manual digging is impractical because the depth of each debris item is unknown (e.g., buried construction and building structural components could be several feet under the ground surface). Therefore, excavation equipment to remove the debris was evaluated. As debris material is removed, other layers of debris would be exposed and the extent of remediation is unknown. Additionally, the excavation equipment would probably require the removal of the existing vegetation, which would then require stabilization of the hillside. The probability of the hillside collapsing and resulting in the exposure of additional debris is likely for this option. Furthermore, debris removal with excavation equipment requires the construction of temporary access roads that would result in extensive disturbance of the ecosystem.

"Option 3, a soil cover for the exposed debris, would require the hillside to be sloped to a 1:3 ratio. To achieve this slope, either cutting of the hillside or filling of the valley would be required. Both of these approaches would result in extensive disturbance of the ecosystem.

"SWMU 5 visible debris removal is problematic at best because the extent of contamination is unknown (i.e., depth and distance from the visible debris is unknown). The most likely option is Option 2. However, due to the unknown depth of the debris an arbitrary removal depth and distance around would need to be established. Then the remediated areas would need to be backfilled and the newly exposed debris would need to be covered with clean material to achieve a 1:3 slope.

> *"Logbook entries indicate that many of the soil samples were actually samples of the debris (i.e., rusted drum or other metal items). The lead hot spot is most likely associated with some debris item. The remediation of this lead hot spot would be similar to Option 2 because the extent of the debris causing the contamination is unknown and any digging would result unburying additional debris (i.e., more exposed debris).*
>
> *"These remediation options would result in uncertain contamination removal effectiveness while negatively impact a thriving ecosystem with the excavation and road construction.*
>
> *"Therefore, debris removal will not be carried forward in this CMP. However, long-term groundwater and surface water monitoring for risk drivers identified in the RFI report (i.e., VOCs, SVOCs, PAHs, and metals) will be conducted every two years."*

Comment EPA-7: The CMP proposes Land Use Controls alone as the favored remedy for the soils and groundwater of SWMU 5. However, if the eventual chosen remedy were to leave waste in place at SWMU 5, then, in addition to LUCs, groundwater, surface water, and sediment monitoring will be required. The Navy has proposed cleanup standards (see also comment 4) but has not proposed any way to monitor the SWMU for achievement of these standards. These media must be monitored for those constituents known to be present at SWMU 5 to ensure migration of contaminants is not taking place. Groundwater must be monitored for appropriate organics (e.g. TCE and degradation products, PAHs), dioxins, manganese, lead.

Surface water/sediment must be monitored for organics.

Response to EPA-7: The Navy is proposing to conduct groundwater and surface water monitoring every two years for metals, dioxins/furans, VOCs, and SVOCs. This monitoring will be conducted to ensure that unacceptable migration of contaminants does not occur.

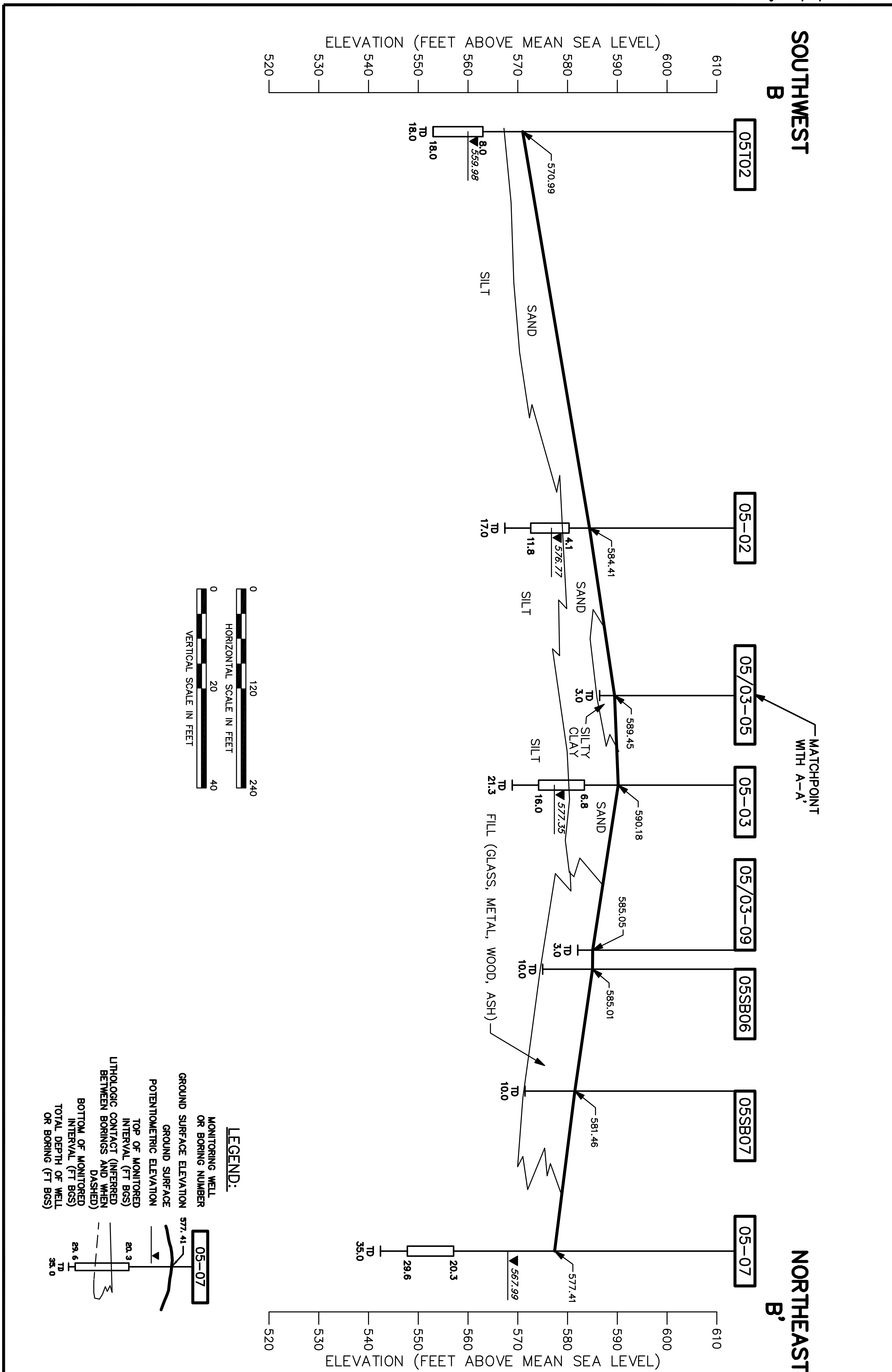
Contamination known to be present at SWMU 5 includes dioxins/furans, VOCs, SVOCs, PAHs, and metals. Only certain contaminants were shown to be risk drivers to one or more receptors in the RFI Report. In the case of soil, three~~two~~ metals (antimony,~~ and~~ iron, and lead) were the risk drivers. In the case of groundwater, dioxins/furans, BEHP, arsenic and manganese were the risk drivers.

Table 2-12~~1~~ has been modified to include groundwater protection standards for ~~the ~~all constituents detected in the groundwater and surface water samples collected ~~identified in~~during the RFI.~~ Report as risk drivers. For all other contaminants, comparisons will be made to ~~MCLs and Action Levels will be used, where available. Water quality standards ~~These groundwater standards ~~will ~~also ~~apply to surface water. It is anticipated that four groundwater monitoring wells and three surface water locations will be sampled. The details will be provided when the Corrective Measures Implementation Plan (CMIP) / Quality Assurance Project Plan (QAPP) is developed.

Comment EPA-8: Is pH data available for groundwater/surface water?

Response to EPA-8: Groundwater sample data dates range from 12/7/1981 through 6/17/1986. pH ranged from 0.4 Standard Units (S.U.) at well 05-07 on 7-29-1983 to 7.9 S.U. at well 05-13 on 6/14/1968. Attachment 2.A contains a summary table of the available groundwater pH data for SWMU 5.

Surface water sample data were collected on 12/18/2000 and 12/19/2000. pH ranged from 7.89 S.U. at sample location 05SW/SD001 to 8.20 S.U. at well 05SW/SD005 on 12/19/2000. Attachment 2.B contains a summary table of the available surface water pH data for SWMU 5.



DRAWN BY MF — DATE 8/3/06	NAVFAC	GEOLOGIC CROSS SECTION B-B' CMP REPORT FOR SWMU 5 - OLD BURN PIT NSWC CRANE CRANE, INDIANA	CONTRACT NO. 4267
CHECKED BY — DATE			OWNER NO. 0000
REVISED BY — DATE			APPROVED BY — DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1-6 — REV. 0

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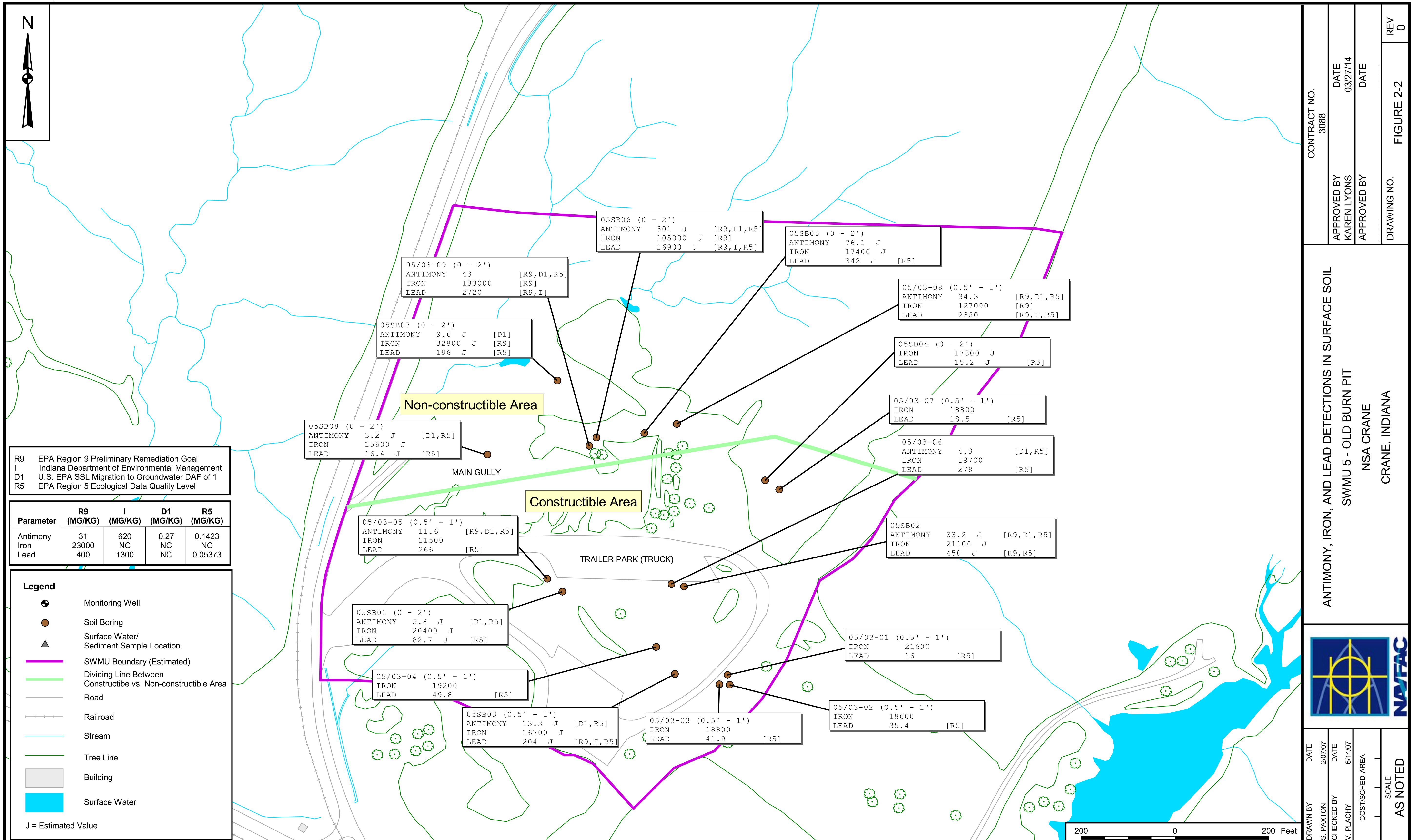
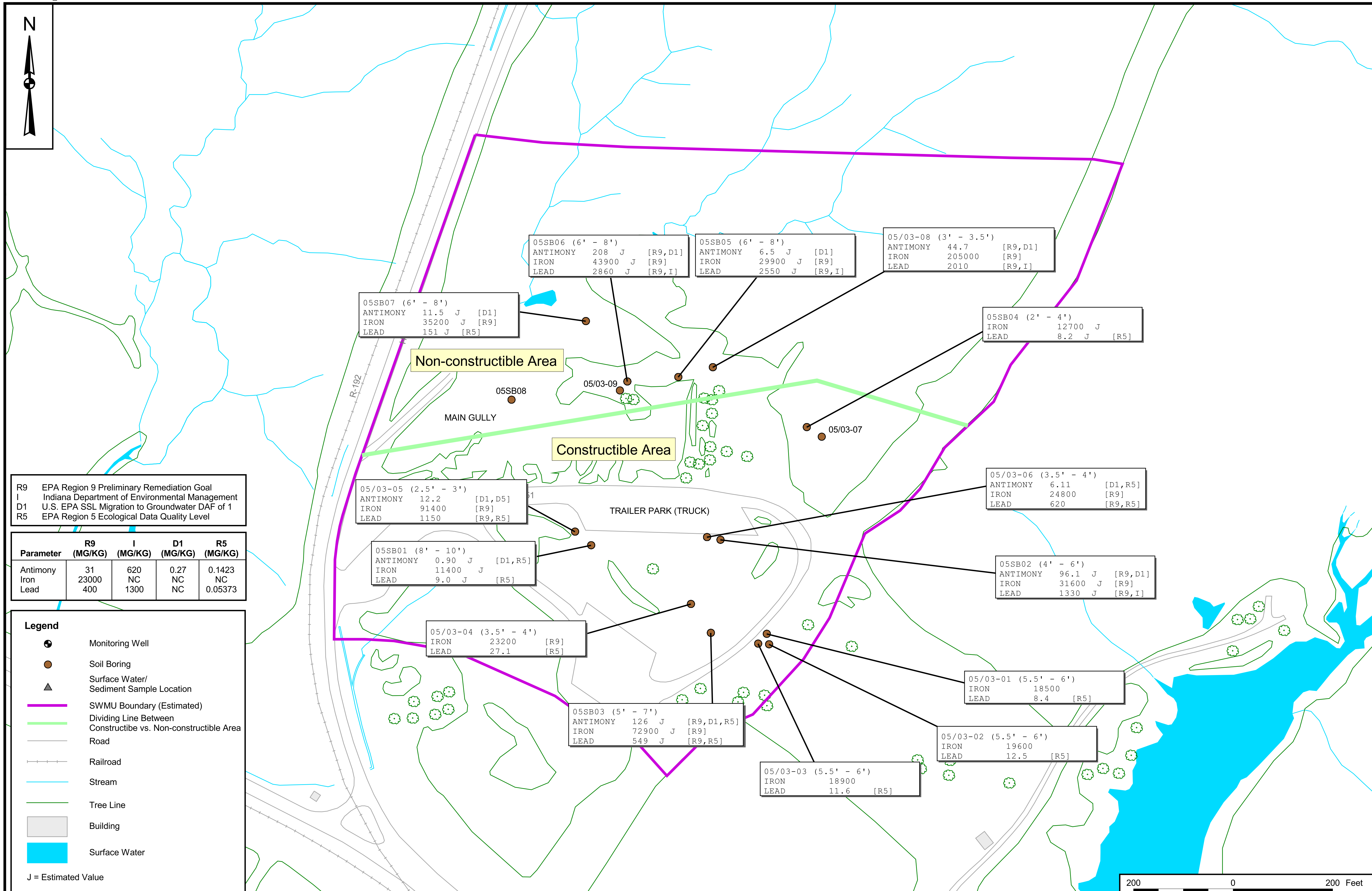


P:\GIS\CRANE_NSWC\MAPDOCS\APR\SWMU05.APR DETECTIONS OF SB, FE, AND PB IN SUBSURFACE SOIL LAYOUT 4/9/14 KM



Parameter	R9 (MG/KG)	I (MG/KG)	D1 (MG/KG)	R5 (MG/KG)
Antimony	31	620	0.27	0.1423
Iron	23000	NC	NC	NC
Lead	400	1300	NC	0.05373

CONTRACT NO. 3088
APPROVED BY KAREN LYONS DATE 03/27/14
APPROVED BY DATE
DRAWING NO. FIGURE 2-3
REV 0

ANTIMONY, IRON, AND LEAD DETECTIONS IN SUBSURFACE SOIL
SWMU 5 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA

NAVFAC

DRAWN BY S. PAXTON DATE 2/07/07
CHECKED BY V. PLACHY DATE 6/14/07
COST/SCHED-AREA
SCALE AS NOTED

ATTACHMENT 2.A
SUMMARY OF pH DATA FOR GROUNDWATER
SWMU 5 (OLD BURN PIT)
NSWC CRANE
CRANE, INDIANA

Location ID Number	Sample ID Number	Sample Date	pH (S.U.)
05-01	05-01 (81) (12/07/81)	12/7/1981	6.4
05-07	05-07 (81) (12/07/81)	12/7/1981	7.2
05-08	05-08 (81) (12/07/81)	12/7/1981	6.7
05-02	05-02 (81) (12/07/81)	12/7/1981	6.8
05-03	05-03 (81) (12/07/81)	12/7/1981	6.1
05-04	05-04 (81) (12/07/81)	12/7/1981	6.4
05-05	05-05 (81) (12/07/81)	12/7/1981	6.6
05-06	05-06 (81) (12/07/81)	12/7/1981	7
05-01	05-01 (82a) (03/05/82)	3/5/1982	6.4
05-03	05-03 (82a) (03/05/82)	3/5/1982	6.1
05-04	05-04 (82a) (03/05/82)	3/5/1982	6.4
05-06	05-06 (82b) (04/13/82)	4/13/1982	6.7
05-07	05-07 (82b) (04/13/82)	4/13/1982	6.6
05-08	05-08 (82b) (04/13/82)	4/13/1982	6.5
05-01	05-01 (82b) (04/13/82)	4/13/1982	6.1
05-02	05-02 (82b) (04/13/82)	4/13/1982	6.1
05-03	05-03 (82b) (04/13/82)	4/13/1982	5.9
05-04	05-04 (82b) (04/13/82)	4/13/1982	6.1
05-05	05-05 (82b) (04/13/82)	4/13/1982	6.4
05-06	05-06 (82c) (07/20/82)	7/20/1982	6.9
05-07	05-07 (82c) (07/20/82)	7/20/1982	6.9
05-08	05-08 (82c) (07/20/82)	7/20/1982	6.5
05-01	05-01 (82c) (07/20/82)	7/20/1982	6.1
05-02	05-02 (82c) (07/20/82)	7/20/1982	6.1
05-03	05-03 (82c) (07/20/82)	7/20/1982	5.9
05-04	05-04 (82c) (07/20/82)	7/20/1982	6.1
05-05	05-05 (82c) (07/20/82)	7/20/1982	6.4
05-05	05-05 (82e) (09/27/82)	9/27/1982	6.6
05-06	05-06 (82e) (09/28/82)	9/28/1982	6.8
05-07	05-07 (82e) (09/28/82)	9/28/1982	6.8
05-08	05-08 (82e) (09/28/82)	9/28/1982	6.4
05-01	05-01 (82e) (09/28/82)	9/28/1982	6.7
05-02	05-02 (82e) (09/28/82)	9/28/1982	6.4
05-03	05-03 (82e) (09/28/82)	9/28/1982	6.8
05-04	05-04 (82e) (09/28/82)	9/28/1982	6.4
05-04	05-04 (82f) (11/04/82)	11/4/1982	6.4
05-08	05-08 (83a) (01/14/83)	1/14/1983	6.4
05-02	05-02 (83a) (01/14/83)	1/14/1983	6.4
05-04	05-04 (83a) (01/14/83)	1/14/1983	6.4
05-06	05-06 (83b) (02/26/83)	2/26/1983	7.2
05-08	05-08 (83b) (02/26/83)	2/26/1983	6.8
05-01	05-01 (83b) (02/26/83)	2/26/1983	6.7
05-02	05-02 (83b) (02/26/83)	2/26/1983	6.4
05-03	05-03 (83b) (02/26/83)	2/26/1983	6.2
05-04	05-04 (83b) (02/26/83)	2/26/1983	6.1

ATTACHMENT 2.A
SUMMARY OF pH DATA FOR GROUNDWATER
SWMU 5 (OLD BURN PIT)
NSWC CRANE
CRANE, INDIANA

Location ID Number	Sample ID Number	Sample Date	pH (S.U.)
05-05	05-05 (83b) (02/26/83)	2/26/1983	6.6
05-06	05-06 (83d) (07/29/83)	7/29/1983	7.6
05-07	05-07 (83d) (07/29/83)	7/29/1983	0.4
05-08	05-08 (83d) (07/29/83)	7/29/1983	6.8
05-01	05-01 (83d) (07/29/83)	7/29/1983	7.1
05-02	05-02 (83d) (07/29/83)	7/29/1983	6.4
05-03	05-03 (83d) (07/29/83)	7/29/1983	6.4
05-04	05-04 (83d) (07/29/83)	7/29/1983	6.8
05-05	05-05 (83d) (07/29/83)	7/29/1983	5.9
05-06	05-06 (84a) (02/04/84)	2/4/1984	7.1
05-07	05-07 (84a) (02/04/84)	2/4/1984	7.2
05-08	05-08 (84a) (02/04/84)	2/4/1984	6.8
05-01	05-01 (84a) (02/04/84)	2/4/1984	6.7
05-02	05-02 (84a) (02/04/84)	2/4/1984	6.6
05-04	05-04 (84a) (02/04/84)	2/4/1984	6.3
05-05	05-05 (84a) (02/04/84)	2/4/1984	6.9
05-03	05-03 (84a) (02/06/84)	2/6/1984	6.2
05-06	05-06 (84b) (06/12/84)	6/12/1984	7.6
05-11	05-11 (84b) (06/12/84)	6/12/1984	7.8
05-12	05-12 (84b) (06/12/84)	6/12/1984	7.3
05-17	05-17 (84b) (06/12/84)	6/12/1984	7
05-19	05-19 (84b) (06/12/84)	6/12/1984	7.6
05-07	05-07 (84b) (06/14/84)	6/14/1984	7.3
05-08	05-08 (84b) (06/14/84)	6/14/1984	7.1
05-13	05-13 (84b) (06/14/84)	6/14/1984	7.9
05-01	05-01 (84b) (06/14/84)	6/14/1984	7.1
05-02	05-02 (84b) (06/14/84)	6/14/1984	7
05-03	05-03 (84b) (06/14/84)	6/14/1984	6.7
05-04	05-04 (84b) (06/14/84)	6/14/1984	6.3
05-05	05-05 (84b) (06/14/84)	6/14/1984	7.4
05-06	05-06 (85a) (01/29/85)	1/29/1985	7
05-07	05-07 (85a) (01/29/85)	1/29/1985	7.5
05-08	05-08 (85a) (01/29/85)	1/29/1985	7.1
05-09	05-09 (85a) (01/29/85)	1/29/1985	7.8
05-10	05-10 (85a) (01/29/85)	1/29/1985	7.3
05-11	05-11 (85a) (01/29/85)	1/29/1985	7.3
05-12	05-12 (85a) (01/29/85)	1/29/1985	7.4
05-13	05-13 (85a) (01/29/85)	1/29/1985	7.3
05-14	05-14 (85a) (01/29/85)	1/29/1985	7.4
05-15	05-15 (85a) (01/29/85)	1/29/1985	7.1
05-16	05-16 (85a) (01/29/85)	1/29/1985	7.5
05-17	05-17 (85a) (01/29/85)	1/29/1985	7.5
05-18	05-18 (85a) (01/29/85)	1/29/1985	7.3
05-19	05-19 (85a) (01/29/85)	1/29/1985	7.2
05-01	05-01 (85a) (01/29/85)	1/29/1985	6.8

ATTACHMENT 2.A
SUMMARY OF pH DATA FOR GROUNDWATER
SWMU 5 (OLD BURN PIT)
NSWC CRANE
CRANE, INDIANA

Location ID Number	Sample ID Number	Sample Date	pH (S.U.)
05-02	05-02 (85a) (01/29/85)	1/29/1985	7.2
05-03	05-03 (85a) (01/29/85)	1/29/1985	7.6
05-05	05-05 (85a) (01/29/85)	1/29/1985	7.4
05-06	05-06 (85b) (06/18/85)	6/18/1985	7.8
05-07	05-07 (85b) (06/18/85)	6/18/1985	7.3
05-08	05-08 (85b) (06/18/85)	6/18/1985	7.5
05-09	05-09 (85b) (06/18/85)	6/18/1985	6.5
05-10	05-10 (85b) (06/18/85)	6/18/1985	7.2
05-11	05-11 (85b) (06/18/85)	6/18/1985	6.7
05-12	05-12 (85b) (06/18/85)	6/18/1985	7.1
05-13	05-13 (85b) (06/18/85)	6/18/1985	7.8
05-14	05-14 (85b) (06/18/85)	6/18/1985	7.1
05-15	05-15 (85b) (06/18/85)	6/18/1985	7.2
05-16	05-16 (85b) (06/18/85)	6/18/1985	7.2
05-17	05-17 (85b) (06/18/85)	6/18/1985	7.4
05-18	05-18 (85b) (06/18/85)	6/18/1985	7.6
05-19	05-19 (85b) (06/18/85)	6/18/1985	7.4
05-01	05-01 (85b) (06/18/85)	6/18/1985	7.5
05-02	05-02 (85b) (06/18/85)	6/18/1985	7.2
05-03	05-03 (85b) (06/18/85)	6/18/1985	6.3
05-05	05-05 (85b) (06/18/85)	6/18/1985	6
05-06	05-06 (86a) (02/06/86)	2/6/1986	7.3
05-07	05-07 (86a) (02/06/86)	2/6/1986	7.3
05-08	05-08 (86a) (02/06/86)	2/6/1986	6.8
05-09	05-09 (86a) (02/06/86)	2/6/1986	7.1
05-10	05-10 (86a) (02/06/86)	2/6/1986	6.9
05-01	05-01 (86a) (02/06/86)	2/6/1986	6.7
05-02	05-02 (86a) (02/06/86)	2/6/1986	6.5
05-04A	05-04A (86a) (02/06/86)	2/6/1986	7.1
05-05	05-05 (86a) (02/06/86)	2/6/1986	7.2
05-11	05-11 (86a) (02/07/86)	2/7/1986	6.8
05-12	05-12 (86a) (02/07/86)	2/7/1986	6.4
05-13	05-13 (86a) (02/07/86)	2/7/1986	7
05-14	05-14 (86a) (02/07/86)	2/7/1986	6.7
05-15	05-15 (86a) (02/07/86)	2/7/1986	6.8
05-16	05-16 (86a) (02/07/86)	2/7/1986	6.8
05-17	05-17 (86a) (02/07/86)	2/7/1986	6.4
05-18	05-18 (86a) (02/07/86)	2/7/1986	6.7
05-19	05-19 (86a) (02/07/86)	2/7/1986	7
05-03	05-03 (86a) (02/07/86)	2/7/1986	5.7
05-06	05-06 (86b) (06/17/86)	6/17/1986	6.7
05-07	05-07 (86b) (06/17/86)	6/17/1986	6.7
05-08	05-08 (86b) (06/17/86)	6/17/1986	6.3
05-09	05-09 (86b) (06/17/86)	6/17/1986	6.7
05-10	05-10 (86b) (06/17/86)	6/17/1986	6.3

ATTACHMENT 2.A
SUMMARY OF pH DATA FOR GROUNDWATER
SWMU 5 (OLD BURN PIT)
NSWC CRANE
CRANE, INDIANA

Location ID Number	Sample ID Number	Sample Date	pH (S.U.)
05-11	05-11 (86b) (06/17/86)	6/17/1986	6.6
05-12	05-12 (86b) (06/17/86)	6/17/1986	6.2
05-13	05-13 (86b) (06/17/86)	6/17/1986	6.5
05-14	05-14 (86b) (06/17/86)	6/17/1986	6.4
05-15	05-15 (86b) (06/17/86)	6/17/1986	6.6
05-16	05-16 (86b) (06/17/86)	6/17/1986	6.7
05-17	05-17 (86b) (06/17/86)	6/17/1986	6.5
05-18	05-18 (86b) (06/17/86)	6/17/1986	6.6
05-19	05-19 (86b) (06/17/86)	6/17/1986	6.8
05-01	05-01 (86b) (06/17/86)	6/17/1986	6.8
05-02	05-02 (86b) (06/17/86)	6/17/1986	6.2
05-03	05-03 (86b) (06/17/86)	6/17/1986	5.4
05-04A	05-04A (86b) (06/17/86)	6/17/1986	6.7
05-05	05-05 (86b) (06/17/86)	6/17/1986	6.5
		Minium pH:	0.4
		Maximum pH:	7.9

S.U - Standard Units.
NSWC - Naval Surface Warfare Crane.
ID - Identification.

ATTACHMENT 2.B
SUMMARY OF pH DATA FOR SURFACE WATER
SWMU 5 (OLD BURN PIT)
NSWC CRANE
CRANE, INDIANA

Location ID Number	Sample ID Number	Sample Date	pH (S.U.)
05SW0101	05SW/SD001	12/19/2000	7.89
05SW0201	05SW/SD002	12/19/2000	7.99
05SW0301	05SW/SD003	12/19/2000	8.20
05SW0401	05SW/SD004	12/19/2000	8.10
05SW0501	05SW/SD005	12/18/2000	7.93
		Minium pH:	7.89
		Maximum pH:	8.20

S.U - Standard Units.
NSWC - Naval Surface Warfare Crane.
ID - Identification.

Corrective Measures Proposal Report

for

SWMU 5 - Old Burn Pit

Naval Support Activity Crane
Crane, Indiana

Naval Facilities Engineering Command
Midwest

Contract Number N62470-08-D-1001
Contract Task Order F27H

April 2014

090607/P

CORRECTIVE MEASURES PROPOSAL REPORT
FOR
SWMU 5 - OLD BURN PIT

NAVAL SUPPORT ACTIVITY CRANE
CRANE, INDIANA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Naval Facilities Engineering Command Midwest
201 Decatur Avenue
Building IA, Code EV
Great Lakes, Illinois 60088

Submitted by:
Tetra Tech
234 Mall Boulevard, Suite 260
King of Prussia, Pennsylvania 19406

CONTRACT NUMBER N62470-08-D-1001
CONTRACT TASK ORDER F27H

APRIL 2014

PREPARED UNDER THE DIRECTION OF:

____

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ACRONYMS

°F	Degrees Fahrenheit
µg/dL	Micrograms per deciliter
µg/L	Micrograms per liter
2,4,5-T	2,4,5-Trichlorophenoxyacetic
ALPEC	Ammunition Loading and Production Engineering Center
B&RE	Brown and Root Environmental
BEHP	bis(2-Ethylhexyl) phthalate
bgs	Below ground surface
BRAC	Base Realignment and Closure
CAAA	Crane Army Ammunition Activity
CASCO	Central Ammunition Supply Control Office
CASRN	Chemical Abstract Services Registry Number
CDI	Chronic Daily Intake
CEC	Cation exchange capacity
CFR	Code of Federal Regulations
Cgw	Groundwater exposure point concentration
CLEAN	Comprehensive Long-Term Environmental Action Navy
CM	Corrective measure
CMP	Corrective Measures Proposal
COC	Chemical of Concern
COPC	Chemical of Potential Concern
Cs	Soil concentration
CTE	Central Tendency Exposure
CTO	Contract Task Order
DCE	Dichloroethene
EMR	Environmental Monitoring Report
EPC	Exposure point concentration
ERA	Ecological Risk Assessment
ESI	Engineering-Science, Inc.
ft/day	feet per day
HHRA	Human Health Risk Assessment
HpCDD	Heptachlorodibenzo-p-dioxin
HpCDF	Heptachlorodibenzofuran

HQ	Hazard quotient
HSWA	Hazardous and Solid Waste Amendments
HxCDD	Hexachlorodibenzo-p-dioxin
HxCDF	Hexachlorodibenzofuran
IA	Installation Assessment
IAS	Initial Assessment Study
IDEM	Indiana Department of Environmental Management
IEUBK	Integrated Exposure Uptake Biokinetic
ILCR	Incremental Lifetime Cancer Risk
in/yr	Inches per year
IR	Installation Restoration
K_h	Hydraulic conductivity
LTM	Long-term monitoring
LUC	Land use control
MCL	Maximum Contaminant Level
MCS	Media cleanup standard
mg/kg	Milligrams per kilogram
mph	Miles per hour
msl	Mean sea level
NAD	Naval Ammunition Depot
NAVFAC SE	Naval Facilities Engineering Command Southeast
NEESA	Naval Energy and Environmental Support Activity
NFA	No further action
NOAA	National Oceanic and Atmospheric Administration
NPW	Net Present Worth
NSA	Naval Support Actvity
NWSCC	Naval Weapons Support Center Crane
O&M	Operation and Maintenance
OBP	Old Burn Pit
OCDD	Octachlorodibenzo-p-dioxin
OCDF	Octachlorodibenzofuran
OSWER	Office of Solid Waste and Emergency Response
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PeCDD	Pentachlorodibenzo-p-dioxin

PeCDF	Pentachlorodibenzofuran
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goal
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RfD	Reference dose
RFI	RCRA Facility Investigation
RISC	Risk Integrated System of Closure
RME	Reasonable Maximum Exposure
SSL	Soil Screening Level
SVOC	Semivolatile organic compound
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCDD	Tetrachlorodibenzo-p-dioxin
TCDF	Tetrachlorodibenzofuran
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxicity Equivalent
TOC	Total organic carbon
TRW	Technical Review Workgroup
TSD	Treatment, storage, or disposal
TSS	Total suspended solids
TtNUS	Tetra Tech NUS, Inc.
UCL	Upper confidence limit
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOC	Volatile organic compound
WES	Waterways Experiment Station

EXECUTIVE SUMMARY

This Corrective Measure Proposal (CMP) Report for Solid Waste Management Unit (SWMU) 5, Old Burn Pit (OBP) at the Naval Support Activity (NSA) facility located in Crane, Indiana summarizes the potential human and ecological risks associated with the site, identifies risk-based action levels that are protective of human health and the environment, and identifies, develops, and evaluates corrective measures (CMs) alternatives to mitigate the potential unacceptable risks associated with exposure to contaminated site media.

SWMU 5 is an inactive site that was used from 1942 to 1972. Undefined amounts of rubbish including wood, paper, construction material, and industrial wastes were burned at the site in the burn pit area. Reportedly, no explosive materials or wastes were burned at the OBP. Residual ash and metal debris from the burning activities were buried in the gully north of the burn pit area. This area contains miscellaneous metal debris including decomposed drums and other metal objects that are partially buried or exposed. The burn pit area of the site has been covered with gravel and is used as a parking area for delivery trailers. The gully north of the former burn pit area has been revegetated.

Currently, the flat area at SWMU 5 is used as a parking area for trucks. However, the remainder of the site, which is primarily wooded, is not used for any specific purpose. Any future land uses at the site are expected to be limited to industrial uses.

Various site investigations, including a Phase III Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) (TtNUS, 2005), were completed at SWMU 5 from 1981 to 2003 as part of several multi-site, phased investigations. A human health risk assessment (HHRA) and an ecological risk assessment (ERA) were conducted with the data collected for the Phase III RFI, and unacceptable risks [in excess of United States Environmental Protection Agency (USEPA) benchmarks] were identified for the following receptors:

- Hypothetical future residents exposed to dioxins/furans, polycyclic aromatic hydrocarbons (PAHs), antimony, iron, and lead in surface soil; dioxins/furans, bis(2-ethylhexyl)phthalate (BEHP), arsenic and manganese in groundwater; and trichloroethene (TCE) and vinyl chloride in surface water.

- Future construction workers exposed to antimony and lead in surface/subsurface soil.

- Terrestrial plants and/or invertebrates exposed to antimony, barium, chromium, copper, lead, silver, tin, and zinc in surface soil.

- Insectivorous/herbivorous mammals and birds exposed to dioxins/furans, cadmium, chromium, copper, lead, mercury, silver, and zinc through the food chain.

Risks to potential human receptors under current land use were acceptable (i.e., less than or within USEPA's benchmarks).

As part of this CMP, a re-evaluation of the human health and ecological risks for exposure to soil at the site were conducted. For human receptors, risks for soil were refined assuming that the flat area of the site (i.e., the constructible area) could potentially be developed in the future, whereas the gully/sloped area (i.e., non-constructible area) would not be available for future development. For ecological receptors, potential impacts on ecological populations were evaluated to determine whether significant risks exist. The following conclusions regarding risks to potential receptors from exposure to soil and the need for CMs were identified as a result of the re-evaluation:

- Potential risks to ecological receptors are not great enough to warrant CMs for these receptors. The site constitutes a small percentage (less than 5 percent) of the contiguous forested area at NSA Crane, and it does not appear that local populations of plants/invertebrates and/or the plant/invertebrate community are being significantly impacted by soil contaminated as a result of site activities. Even if there are subtle impacts to ecological receptors from chemicals in surface soil at the site, these impacts would be localized to the areas where chemical concentrations are elevated.

- For the constructible area, refined risks for hypothetical future child residents and future construction workers exposed to soil were acceptable.

- Because of the absence of unacceptable human health and ecological risks, no CMs are required for soil in the constructible area.

- CMs need to be evaluated to address unacceptable human health risks for exposure to soil in the non-constructible area of the site. For this area, the refined risks for hypothetical future child residents exposed to antimony, iron, and lead in surface soil and for future construction workers exposed to antimony and lead in surface/subsurface soil exceed USEPA's benchmarks.

In addition, to the CMs for soil, CMs are required to address the unacceptable risks associated with hypothetical future residential exposure to groundwater and surface water. Media cleanup standards were developed for the following chemicals in this CMP:

- Soil – antimony, iron, and lead
- Groundwater and Surface Water – dioxins/furans, chloroform, 1,1-dichloroethene (DCE), cis-1,2-DCE, trans-1,2-DCE, TCE, vinyl chloride, BEHP, aluminum, antimony, arsenic, barium, copper, iron, lead, manganese, vanadium, and zinc

The list of soil chemicals for which MCSs were developed include those chemicals associated with unacceptable risks for future human receptors. In general, MCSs for groundwater and surface water consist of all chemicals detected in these environmental media. The list of chemicals for groundwater and surface water was combined because of the potential interaction/migration between these media (i.e., discharge of shallow groundwater to surface water).

The corrective action objectives for SWMU 5 are: 1) prevent human exposure to groundwater and surface water containing chemical concentrations greater than the MCSs and 2) prevent exposure to contaminated soil and groundwater at SWMU 5 by restricting development and use of the site for residential housing and similar exposure scenarios, such as elementary and secondary schools, child care facilities, and playgrounds.

For soil in the non-constructible area, three remedial alternatives were developed and evaluated in this CMP. Alternative S-1 is a no-action alternative. Alternative S-2 (limited action) consists of land use controls (LUCs) to prevent human exposure to contaminated soil as long as soil concentrations exceed MCSs. Alternative S-3 (limited removal action) includes LUCs to prevent human exposure to contaminated soil as long as soil concentrations exceed MCSs, surface debris removal to enhance the aesthetic appearance of the land, and lead hotspot removal to mitigate the unacceptable future human health risks associated with lead in soil.

Two remedial alternatives, applicable to both groundwater and surface water, were developed and evaluated for these environmental media. Alternative GW-1 is a no-action alternative. Alternative GW-2 (limited action) consists of LUCs to prevent human residential exposure to contaminated groundwater as long as groundwater concentrations exceed MCSs and long-term monitoring (LTM) of groundwater and surface water to monitor unacceptable contaminant migration (i.e., concentration in excess of MCSs).

Alternative S-3 (limited removal action) for soil in the non-constructible area and GW-2 (limited action) for groundwater and surface water are the recommended alternatives for SWMU 5. Both of the alternatives would be protective of human health and the environment by controlling potential human exposure via LUCs, which are readily implementable at NSA Crane. The property is non-residential and groundwater at this SWMU or in the vicinity of the SWMU is not used as a potable water supply; these conditions are expected to remain throughout the foreseeable future. LUCs would remain in place until site concentrations are less than MCSs. Under Alternative S-3, limited removal activities would be conducted for soil in the non-constructible area to enhance the aesthetic appearance of the site (via surface debris removal) and mitigate the unacceptable risks associated with lead exposure (i.e., hotspot soil removal). In addition, groundwater and surface water quality would be monitored under Alternative GW-2 to confirm that contaminants are not migrating offsite at unacceptable levels.

Prior to finalization of this CMP, the Navy, in consultation with the United States Protection Agency (USEPA) and Indiana Department of Environmental Management (IDEM), conducted interim measures at SWMU 5 from March to April 2010. These measures consisted of the limited soil removal action activities identified under Alternative S-3. Details of these activities can be found in the SWMU 5 Interim Measures report (Tetra Tech, 2014).

1.0 INTRODUCTION

1.1 SCOPE AND OBJECTIVES

This Corrective Measures Proposal (CMP) Report was prepared for Solid Waste Management Unit (SWMU) 5 [Old Burn Pit (OBP)] at the Naval Support Activity (NSA) facility located in Crane, Indiana for the United States Navy, Naval Facilities Engineering Command (NAVFAC) Midwest under Contract Task Order (CTO) F27H of the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Number N62470-08-D-1001.

This work is part of the Navy's Installation Restoration (IR) Program, which is designed to identify contamination of Navy and Marine Corps lands/facilities resulting from past operations and to institute corrective measures (CMs) as needed. There are typically four distinct phases of work conducted for IR sites. Phase 1 is the Preliminary Assessment [formerly known as the Initial Assessment Study (IAS)]. Phase 2 is a Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA), which augments the information collected in the Preliminary Assessment. Phase 3 is the RCRA Facility Investigation (RFI)/CMP, which characterizes the contamination at a facility and develops options for remediation of the site. Phase 4 is the CMs Implementation, which results in the control or cleanup of contamination at the site. This report has been prepared under Phase 3 of the IR Program. The Indiana Department of Environmental Management (IDEM) is the lead oversight agency. However, under a work-sharing agreement, United States Environmental Protection Agency (USEPA) Region 5 is responsible for all phases of the RFI/CMP at SWMU 5.

This work was conducted in accordance with the requirements of the Indiana State RCRA Hazardous Waste Permit for the facility (IN5170023498), which went into effect on October 18, 2001.

The submittal of a CMP is appropriate for SWMU 5 based upon the following:

- NSA Crane is a fenced military installation controlled by the Navy.
- NSA Crane was not included in the 2005 Base Realignment and Closure (BRAC) process and will remain a military installation for the indefinite future.
- Foreseeable land uses are military (i.e., industrial).

- Residential land uses occur only in very limited areas, none of which are located within or adjacent to SWMU 5.

- Unique topography at SWMU 5 generally prevents future groundwater contaminant plume migration.

The objectives of the CMP for SWMU 5 are as follows:

- Identify risk-based action levels that are protective of current human health receptors and the environment.
- Identify and screen CMs technologies.
- Develop CMs.

1.2 ORGANIZATION OF THE CORRECTIVE MEASURES PROPOSAL

The CMP consists of four sections. Section 1.0 is this introduction. Section 2.0 provides a description of the current situation and presents the media cleanup standards (MCSs) for SWMU 5. Section 3.0 describes the CMs recommendations. Section 4.0 provides the details of the CMs evaluations for the CMs that were considered and the conclusions of the evaluations.

1.3 BACKGROUND INFORMATION

1.3.1 <u>Facility Location</u>

NSA Crane is located in a rural, sparsely populated area of south-central Indiana, approximately 75 miles southwest of Indianapolis and 71 miles northwest of Louisville, Kentucky, immediately east of Crane Village and Burns City (Figure 1-1).

NSA Crane encompasses 62,463 acres (approximately 98 square miles), most of which are located in the northern portion of Martin County. Smaller portions are located in Greene, Daviess, and Lawrence Counties.

NSA Crane provides naval support for equipment, shipboard weapons systems, and ordnance. In addition, NSA Crane supports the Crane Army Ammunition Activity (CAAA) with production, renovation, storage, shipment, demilitarization, and disposal of conventional ammunition.

There is no State or local planning within the vicinity of NSA Crane. The only zoning and land use regulations are found in the municipalities within the region. None of these municipalities are close enough to have an impact on NSA Crane. None of the areas adjacent to NSA Crane are zoned, and zoning is not anticipated in the near future. There are no known land use or community actions under consideration or proposed at this time.

1.3.2 SWMU 5 Location

SWMU 5 is located in the northwestern corner of NSA Crane (Figure 1-1). The site occupies approximately 25 acres and is bounded on the west by Highway 331, on the south by a gravel lot south of the burn pit, and on the east by the power line running along a ridge north of Lake Oberline. Additional site information and the approximate boundaries of the site can be obtained from Figure 1-2.

1.3.2 Facility History

This section provides general information on the history of NSA Crane and its activities.

1.3.2.1 History of Ownership and Operation

In 1940, Congress authorized construction of a Naval Ammunition Depot (NAD) in southern Indiana; NAD Burns City was commissioned in late 1941. In 1943, NAD Burns City was renamed NAD Crane, and the Town of Crane was built to house the rapidly growing number of civil service employees. NAD Crane's overall mission was to load, prepare, renovate, receive, store, and issue ammunition to the fleet.

During World War II, NAD Crane's mission expanded to include pyrotechnics production, mine filling, rocket assembly, field storage, torpedo storage, and ordnance spare parts and mobile equipment storage. During the 1950s, several new departments were created. The Ammunition Loading and Production Engineering Center (ALPEC) was transferred to NSA Crane, and the Central Ammunition Supply Control Office (CASCO) was established. NAD Crane supplied ammunition to the fleet during the Korean and Vietnam Conflicts. During the Vietnam Conflict, the number of full-time employees at NAD Crane increased to 6,800.

In 1975, NAD Crane was redesignated Naval Weapons Support Center Crane (NWSCC). Its new mission was to provide support for ships, aircraft, equipment, shipboard weapons systems, and assigned ordnance items and to perform additional functions as directed.

In 1977, the Single Manager Concept was implemented, the CAAA was created, and the Army assumed ordnance production, storage, and related responsibilities as a tenant organization. Other functions remained under Navy control, and currently the Navy retains ownership of all real estate and facilities at NSA Crane. Responsibility for overall station safety, security, and environmental protection remains with the Commanding Officer, NSA Crane. Currently, more than 5,000 people are employed at NSA Crane.

1.3.2.2 History of Regulatory Actions

Following promulgation of the USEPA RCRA hazardous waste regulatory program, NSA Crane filed notification and application to operate as a RCRA hazardous waste treatment, storage, or disposal (TSD) facility in October 1980. Interim status was granted subject to operating requirements and applicable technical standards found in Title 40 of the Code of Federal Regulations (CFR), Part 265.

Corrective action programs established as part of the 1984 RCRA Hazardous and Solid Waste Amendments (HSWA) required NSA Crane to address past releases of hazardous waste or hazardous constituents at SWMUs. Accordingly, NSA Crane submitted a Hazardous Waste Management Report and an RFA was conducted to characterize the potential for releases of hazardous waste or constituents from 100 SWMUs identified during the RFA.

On December 23, 1989, USEPA issued the federal portion of the Final RCRA Part B permit for NSA Crane to the Navy. USEPA renewed the permit in 1995. IDEM now has responsibility for the federal Corrective Action Program. IDEM renewed the Corrective Action Permit in October 18, 2001. However, certain ongoing corrective actions, including corrective actions at SWMU 5, will continue under the USEPA/IDEM Work Sharing Agreement for Corrective Action Activities.

1.3.3 <u>Project Site</u>

1.3.3.1 Site Description

SWMU 5 is an inactive site that was used from 1942 to 1972. Undefined amounts of rubbish including wood, paper, construction material, and industrial wastes were burned at the site in the burn pit area. Reportedly, no explosive materials or wastes were burned at the OBP. Residual ash and metal debris from the burning activities were buried in the gully north of the burn pit area. This area contains miscellaneous metal debris including decomposed drums and other metal objects that are partially buried or exposed. The burn pit area of the site has been covered with gravel and is used as a parking area for delivery trailers. The gully north of the former burn pit area has been revegetated. SWMU 5 is located in the northwestern corner of NSA Crane, approximately 2,000 feet east of Crane Gate No. 4. The site is bounded on the west by Highway 331, on the south by a gravel lot south of the burn pit, and on the east by a power line running along a ridge north of Lake Oberlin.

1.3.3.2 Land Usage

The current land use at SWMU 5 is truck parking in one area. Otherwise, SWMU 5 is inactive. No waste disposal activities occur at this site. Any future land uses at SWMU 5 are expected to be limited to industrial uses.

1.3.3.3 Corrective Action Stages

The RFI Report (TtNUS, 2005) has been completed, and unacceptable risk has been determined as follows:

- For the future construction worker, there is unacceptable risk from exposure to antimony and lead in soils.
- For hypothetical future residents, there is unacceptable risk from exposure to dioxins/furans, polycyclic aromatic hydrocarbons (PAHs), antimony, iron, and lead in soil; dioxins/furans, bis(2-ethylhexyl)phthalate (BEHP), arsenic, and manganese in groundwater; and trichloroethene and vinyl chloride in surface water.
- For terrestrial plants and/or invertebrates, there is unacceptable risk from soils containing antimony, barium, chromium, copper, lead, silver, tin, and zinc.
- For mammals and birds, there is unacceptable risk to insectivorous/herbivorous mammals and birds for dioxins/furans, cadmium, chromium, copper, lead, mercury, silver, and zinc through the food chain.

1.3.3.4 Preliminary Remedial Actions

No preliminary remedial action has occurred at SWMU 5 because 1991 Toxicity Characteristic Leaching Procedure (TCLP) test results (ESI, 1991) for surficial soil surrounding drums and for the materials within the drums located in the gully north of the burn pit were less than regulatory limits. Therefore, the soils and the material in the drums were not classified as a RCRA hazardous waste.

1.3.3.5 Site Investigations

The following is a brief description of the historical data collection activities conducted at SWMU 5.

Various investigations were completed from 1981 to 2003 at SWMU 5 as part of several multi-site investigations. The first was the IAS (NEESA, 1983a). The IAS at SWMU 5 consisted of the installation of a total of 19 monitoring wells throughout the site. The first round of wells that were installed included one upgradient and two downgradient of the site. Upon identification of constituents in the groundwater, additional wells were installed along the anticipated perimeter of the site. During the installation of these wells, soil samples were collected and tested for various soil characteristics. After installation of the wells, groundwater samples were collected and analyzed for a comprehensive list of constituents and RCRA water-quality parameters. As part of the IAS, quarterly and semi-annual sampling of the monitoring wells was conducted at SWMU 5. Based on the initial conclusions of this groundwater study, SWMU 5 was not determined to represent an immediate human health and environmental threat. However, the site was recommended for further study to evaluate potential long-term impacts.

In response to the recommendation from the IAS, an RFI Phase II Soils Release Characterization was performed at SWMU 5 in 1990 (USACE WES, 1998). The objective of this study was to determine soil conditions around the site, to identify and characterize the material burned in the pit and the residual material buried in the gully north of the burn pit, and to characterize the potential for release of hazardous constituents into the surrounding environment. Nine soil borings were installed. Both surface and subsurface samples were collected from these borings and analyzed for a comprehensive list of constituents.

In 1991, a draft work plan for an RFI Phase III Ground Water Release Characterization was prepared by the United States Army Corps of Engineers (USACE) Waterways Experiment Station (WES) (USACE WES, 1991). The objective of this sampling effort was to determine the rate and extent of constituent migration in the groundwater. This study included the collection of samples from the existing 19 monitoring wells and the installation of additional wells. Because of funding constraints, only a portion of the work proposed in the work plan was conducted in 1992. Only one of the proposed monitoring wells (05C01) was installed, and not all groundwater samples collected were analyzed for all proposed chemical constituents or for the same list of constituents per sample. A Release Characterization Report was not generated for the sampling effort because of funding issues.

The most recent investigation was the Phase III RFI (TtNUS, 2005). The objectives of this investigation were as follows:

- To estimate the nature and extent of contamination.
- To develop information necessary to conduct a baseline Human Health Risk Assessment (HHRA) and a screening level ecological risk assessment.

The analytical program for SWMU 5 was developed on the basis of chemical categories represented by the list of detected chemicals of interest identified during various historical site investigations. Soil, sediment, surface water, and groundwater samples were collected and analyzed for the full list of Appendix IX constituents [volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and metals] and miscellaneous inorganics. Surface water samples also were analyzed for total and dissolved metals, hardness, and total suspended solids (TSS), and sediment samples were analyzed for total organic carbon (TOC) to assist in assessing the potential risks for ecological receptors. Additionally, soil characteristic parameters [cation exchange capacity (CEC), pH, and TOC] were analyzed to determine the likelihood of the potential fate and transport of contaminants at the site and the potential for risks outside the site boundaries.

1.4 PHYSICAL CHARACTERISTICS OF STUDY AREA

SWMU 5 is located in the northwestern corner of NSA Crane, approximately 2,000 feet east of Crane Gate No. 4. SWMU 5 occupies approximately 25 acres and is bounded on the west by Highway H-331, on the south by a gravel lot, and on the east by the power line running along a ridge north of Lake Oberlin. The northern boundary (at the gully) is undetermined.

1.4.1 Climate and Meteorology

The climate in the region of NSA Crane can be described as temperate (NOAA, 1988). Precipitation is distributed evenly throughout the year, and there is no pronounced wet or dry season for this region. Rainfall in the spring and summer is produced mostly from showers and thunderstorms. A peak rainfall of about 2½ inches in a 24-hour period can be expected about once a year. Snowfalls of 3 inches or more occur an average of two or three times per winter season.

Mean monthly temperatures for the region are shown in Table 1-1. Temperatures range from a minimum of 27.9 degrees Fahrenheit (°F) in January to a maximum of 75.7°F in July. Relative humidity for the local area is generally highest in the early morning hours of June through September and generally ranges between 80 to 88 percent on average. Historically, the lowest values of relative humidity have occurred during the period March through October, when values average between 54 and 58 percent. The mean annual temperature for the area is 52.6°F. The annual mean monthly distribution of rain and snow for the area is shown in Table 1-2. The annual rainfall total is about 40 inches per year (in/yr), with the highest mean monthly totals occurring in the late spring and early summer period of May through July. Snowfall averages about 23 in/yr, with most occurring in the winter months of December through February.

Long-term climatological records (NOAA, 1988) for the area indicate that the monthly prevailing wind direction is southwest during the month of April through December, then shifts to the northwest during the months of January through March. The annual prevailing wind direction for the region is from the southwest. The annual average wind speed for the area is about 9.6 miles per hour (mph).

1.4.2 Topography

NSA Crane is in the unglaciated area of the Crawford Uplands Physiographic Province. This province is a rugged, highly vegetated, dissected plateau bounded by the Mitchell Plain Physiographic Province to the east and the Wabash Lowland Physiographic Province to the west (Murphy and Wade, 1988). The Mitchell Plain is a low, dissected, limestone plateau characterized by sinkholes and karst topographic features. The boundary between the Crawford Upland and the Mitchell Plain is marked by the highly irregular, eastern facing Chester Escarpment. Springs, caverns, caves, and other solution weathering features can be found along this escarpment and on the eastern edge of the NSA Crane facility. The boundary between the Crawford Upland and the Mitchell Plain near the western boundary of NSA Crane is gradual (Murphy and Wade, 1988).

The terrain is predominantly rolling with moderately incised stream valleys throughout and occasional flat areas in the central and northern portions of NSA Crane. Most of the region is covered by deciduous trees and shrubs. The elevations across NSA Crane range from about 500 feet above mean sea level (msl) at the southern drainageway to about 850 feet above msl on the ridge in the west-central portion of the facility. V-shaped drainageways in the north progress to 2,000-foot-wide floodplains in the south and rise to approximately 150 to 200 feet above msl at the ridgelines (NEESA, 1983a).

1.4.2.1 SWMU 5

The topography at SWMU 5 consists of undulating terrain dissected by many small drainageways. Several drainageways exist in the northern portion of SWMU 5 and convey surface water from the northeast to the west, toward an unnamed drainageway that flows through a culvert beneath Highway 331 and the railroad tracks that form the western border of SWMU 5. The unnamed drainageway then joins several other gullies to form a larger tributary stream that flows southward for about 700 feet and ultimately discharges into Culpepper Branch. Another drainageway is located in the southwestern corner of SWMU 5 that flows southwest toward Culpepper Branch.

Surface elevations range from slightly over 550 feet above msl along the unnamed creek to the west of SWMU 5 to 680 feet above msl on the northeastern side of SWMU 5. Thus, there is about 130 feet of relief at the SWMU.

1.4.3 Surface Water Hydrogeology

The surface drainage at NSA Crane has formed a dense, dendritic pattern throughout the installation that flows generally to the south and southwest. Seven primary creeks in five drainage basins carry surface water off the installation, where it eventually drains into the East Fork of the White River and then to the Wabash River to the southwest. The seven creeks that drain NSA Crane include Furst Creek, Sulphur Creek, Little Sulphur Creek, Boggs Creek, Turkey Creek, Indiana Creek, and Seed Tick Creek. Figure 1-1 shows the surface drainage features and the individual drainage basins at NSA Crane.

Drainage Basin IV consists of Boggs and Turkey Creeks, which are the primary drainageways for the installation and drain the majority of the area. The northern and northwestern sections (Basin I) are drained by Furst Creek, the eastern portion (Basin III) is drained by the Sulphur Creek complex, the extreme eastern portion (Basin II) is drained by Indiana Creek, and the southwestern section (Basin V) is drained by Seed Tick Creek.

Also located within the installation are several small ponds and Lake Greenwood, an 800-acre man-made, spring-fed lake in the northwestern portion of the installation. Lake Greenwood is the main source of water at NSA Crane and is also used for recreation (NEESA, 1983a). SWMU 5 drains into Culpepper Branch, which flows into Furst Creek. Furst Creek then flows westward off of NSA Crane property.

1.4.3.1 SWMU 5

Surface water runoff from SWMU 5 drains into Culpepper Branch, a tributary of Furst Creek. Several dendritic drainageways exist in the northern portion of SWMU 5 that convey surface water from the northeast to the west, toward a stream that flows through a culvert beneath the road and railroad tracks that form the western border of SWMU 5. The stream joins with several other streams to form a larger tributary stream that flows south, ultimately discharging into Culpepper Branch. Another drainageway that flows southwestern toward Culpepper Branch is located in the southwestern corner of SWMU 5.

1.4.4 Geology and Soils

NSA Crane is located on the eastern flank of the Illinois Basin. Beneath unconsolidated colluvial and alluvial deposits, Paleozoic-age sedimentary rocks underlying NSA Crane have been deformed to yield a gentle dip of 50 feet per mile towards the west-southwest. The bedrock surface at NSA Crane is made up of Lower Pennsylvanian- and Upper Mississippian-age sandstones, limestones, and shales.

In general, Mississippian-age Chester Series sandstones, shales, and limestones are exposed in the valley walls of eastern portions of NSA Crane and in the lower elevations of deep valleys in the western portions. Pennsylvanian-age Mansfield Formation sandstone, siltstones, claystones, and shales are found at the crests of hills and ridges in eastern portions of NSA Crane, and as the surficial bedrock unit further west (see Figure 1-3). The contact between the Mississippian units and overlying Pennsylvanian units is an unconformity formed by long-time erosion of the Mississippian surface (Murphy and Ciocco, 1990).

1.4.4.1 SWMU 5

Most of SWMU 5 is situated in the dissected alluvial valley of Culpepper Branch. Soils representing two depositional environments have been mapped at SWMU 5 (Kvale, 1992), including residual soil derived from Pennsylvanian bedrock in the SWMU 5 area and alluvium in the floodplain along the south-flowing tributary stream to Culpepper Branch located west of SWMU 5. Glacial outwash has also been mapped both southeast and further west of SWMU 5.

Two geologic cross sections (A-A’ and B-B’) have been developed for SWMU 5 at locations shown on Figure 1-4 and are included as Figures 1-5 (A-A’) and 1-6 (B-B’). The materials include only the near-surface fill, natural unconsolidated materials, and Pennsylvanian bedrock. Fill was encountered in borings in the north-central portion of SWMU 5 and extended to a maximum depth of 10 feet below ground surface (bgs). The fill consisted of glass, metal, wood, and ash mixed with sand and silt. Natural unconsolidated materials underlie the fill and exist at the ground surface where the fill is not present. The natural unconsolidated materials consist predominantly of fine sediments including varying amounts of clay, silt, and sand derived from Pennsylvanian bedrock. The natural unconsolidated materials extend to approximately 45 feet bgs, where Pennsylvanian bedrock consisting of shale was encountered in borings advanced to this depth.

1.4.5 Hydrogeology

1.4.5.1 SWMU 5

Groundwater is present beneath SWMU 5 at depths less than 5 feet bgs in low areas near surface water bodies. Depth to groundwater increases to greater than 20 feet at the higher elevations on the eastern and northeastern sides of the SWMU. Groundwater exists in natural unconsolidated materials and was not found in the fill. Shallow groundwater flow direction in the natural unconsolidated materials is generally to the northwest toward a tributary of Culpepper Branch and to the southwest toward Culpepper Branch. The hydraulic gradient at the site is about 0.04 (ft/ft). Information on groundwater in the bedrock at this SWMU is unknown because no wells have been installed in the bedrock.

To characterize the hydraulic properties of the unconsolidated overburden materials, seven slug tests were performed. The horizontal hydraulic conductivity (K_h) values determined from these tests ranged from 0.04 to 30 feet per day (ft/day). In general, the higher K_h values (4.1 to 30 ft/day) were found in wells where the screens intersected saturated sands (e.g., 05-02, 05-04, and 05-09) on the southwestern side of SWMU 5. Low K_h values (0.04 to 0.44 ft/day) were determined in three wells (05-03, 05-07, and 05-13) on the northwestern side of SWMU 5 that are screened primarily in silt and clay. An anomalously high K_h value of 22 ft/day was determined for well 05-08 in the northwestern corner of SWMU 5.

1.4.6 Water Supply

Groundwater at SWMU 5 is not currently used and is not anticipated to be used in the future as a potable drinking water source. Lake Greenwood is the source of potable water for NSA Crane.

1.4.7 Surrounding Land Use

NSA Crane is located in south-central Indiana, immediately east of Crane Village and Burns City, in a rural, sparsely populated area. Most of NSA Crane is forested, and the surrounding area is wooded or farmed land. The communities in the region are in a period of transition from an economic base of agriculture, mining, and quarrying to an economy built on manufacturing and service industries. The patterns of settlement, population statistics, and median income are similar throughout the region.

SWMU 5 is contained completely within NSA Crane. The current and likely future land use at areas surrounding the SWMU is expected to be limited to industrial uses.

TABLE 1-1

CLIMATOLOGICAL MEAN MONTHLY TEMPERATURES[1]
CMP REPORT FOR SWMU 5 – OLD BURN PIT
NSA CRANE,
CRANE, INDIANA

Month	Mean Monthly Temperature (°F)
January	27.9
February	30.6
March	40.3
April	52.0
May	62.5
June	71.7
July	75.7
August	73.6
September	66.8
October	55.3
November	42.0
December	31.8
Mean Annual	52.6

1 Reference: National Oceanic and Atmospheric Administration, 1988.

°F – Degrees Fahrenheit.

TABLE 1-2

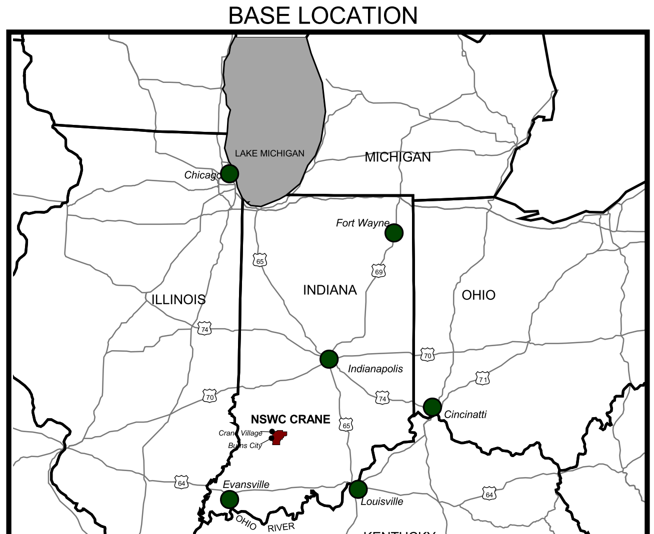
CLIMATOLOGICAL MEAN MONTHLY RAINFALL AND SNOWFALL AMOUNTS[1]
CMP REPORT FOR SWMU 5 – OLD BURN PIT
NSA CRANE
CRANE, INDIANA

Month	Mean Monthly Rainfall (inches)	Mean Monthly Snowfall (inches)
January	2.89	6.3
February	2.52	5.9
March	3.78	3.5
April	3.66	0.5
May	3.93	(2)
June	4.06	0
July	3.89	0
August	3.28	0
September	3.11	0
October	2.68	(2)
November	3.21	1.9
December	2.95	4.8
Annual	39.98	23.0

1 Reference: National Oceanic and Atmospheric Administration, 1988.
2 Indicates snowfall amounts less than 0.01 inch.

P:\GIS\NSWC_CRANE\0087_R1.APR SURFACE DRAINAGE LAYOUT - B SIZE 4/9/14 KM

BASE LOCATION



MAJOR SURFACE DRAINAGE BASINS

I FURST CREEK DRAINAGE BASIN

II INDIANA CREEK DRAINAGE BASIN

III SULPHUR CREEK COMPLEX DRAINAGE BASIN

IV BOGGS & TURKEY CREEKS DRAINAGE BASIN

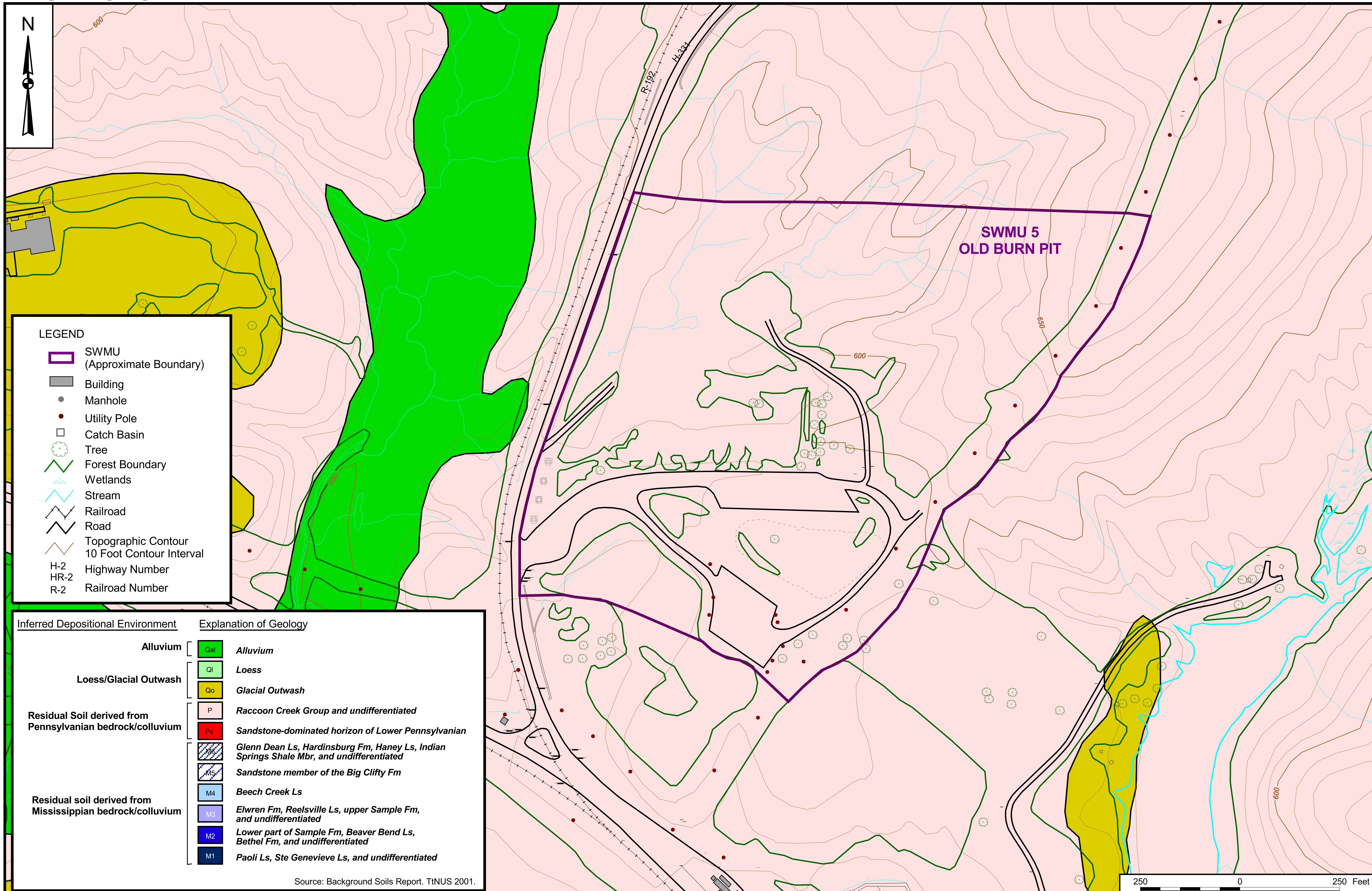
V SEED TICK DRAINAGE BASIN

SOURCE: "Initial Assessment Study of Naval Weapons Support Center Crane, Indiana." Naval Energy and Environment Support Activity, May 1983.

1.5 0 1.5 3 Miles

DRAWN BY	DATE			
J. LAMEY	4/19/99	SITE LOCATION AND SURFACE DRAINAGE AT THE NAVAL SUPPORT ACTIVITY CMP REPORT FOR SWMU 5 - OLD BURN PIT NSA CRANE CRANE, INDIANA	CONTRACT NUMBER 3088	
CHECKED BY	DATE		APPROVED BY KAREN LYONS	DATE 03/27/14
V. PLACHY	8/02/06		APPROVED BY	DATE
COST/SCHEDULE-AREA			DRAWING NO. FIGURE 1 - 1	REV 0
SCALE AS NOTED		NAVFAC		

P:\GIS\NSWC_CRANE\CTO-10_SWMU05_01.APR SITE FEATURES LAYOUT 4/9/14 KM



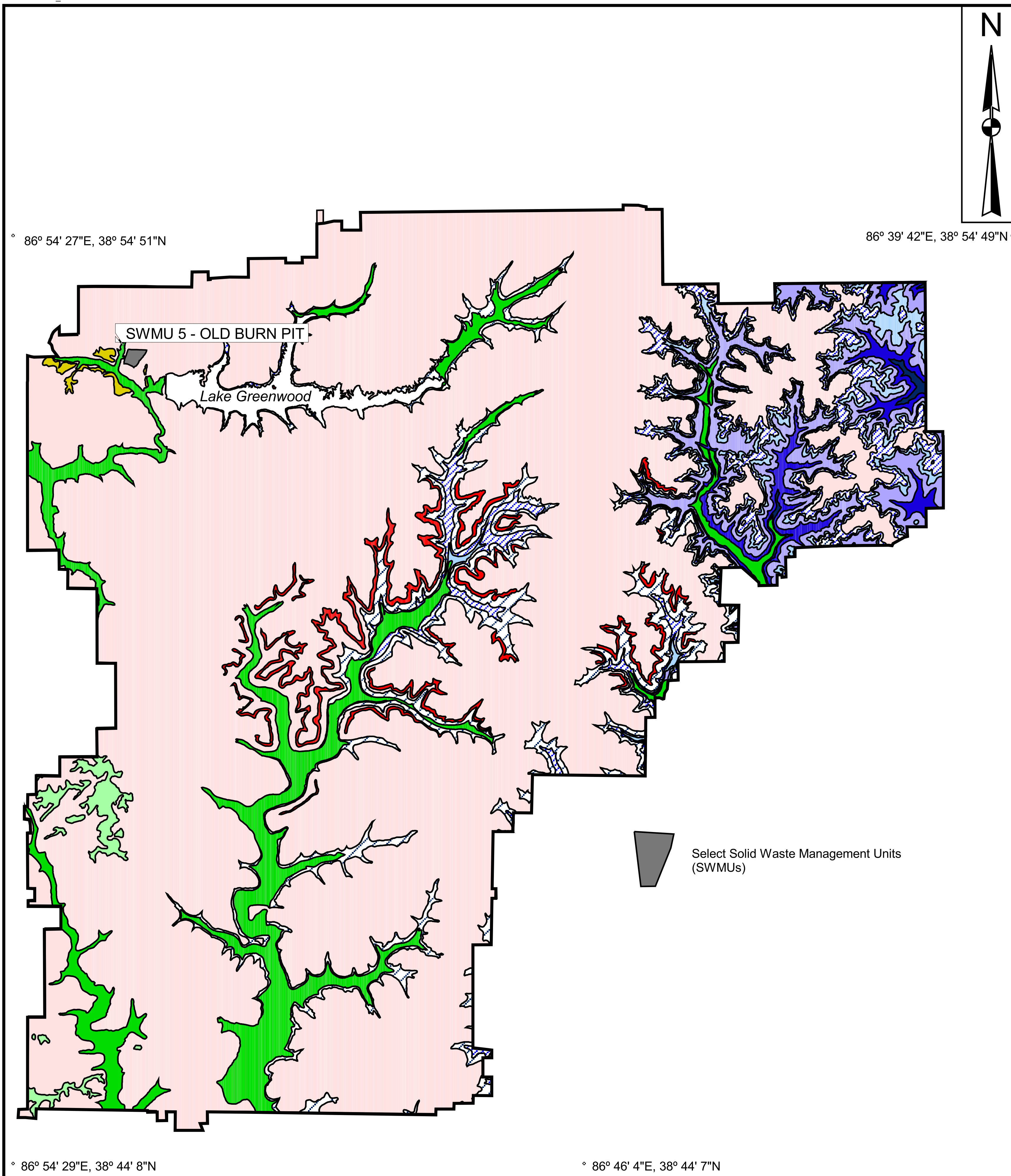
CONTRACT NO. 3088	
APPROVED BY KAREN LYONS	DATE 03/27/14
APPROVED BY	DATE
DRAWING NO. FIGURE 1 - 2	REV 0

SITE FEATURES MAP
CMP REPORT FOR SWMU 05 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA

NAVFAC

DRAWN BY A. JANOCHA	DATE 3/16/04
CHECKED BY V. PLACHY	DATE 9/20/06
COST/SCHED-AREA	
SCALE AS NOTED	

P:\GIS\NSWC_CRANE\0087.APR SURFACIAL GEOLOGY MAP LAYOUT - B SIZE 4/9/14 KM



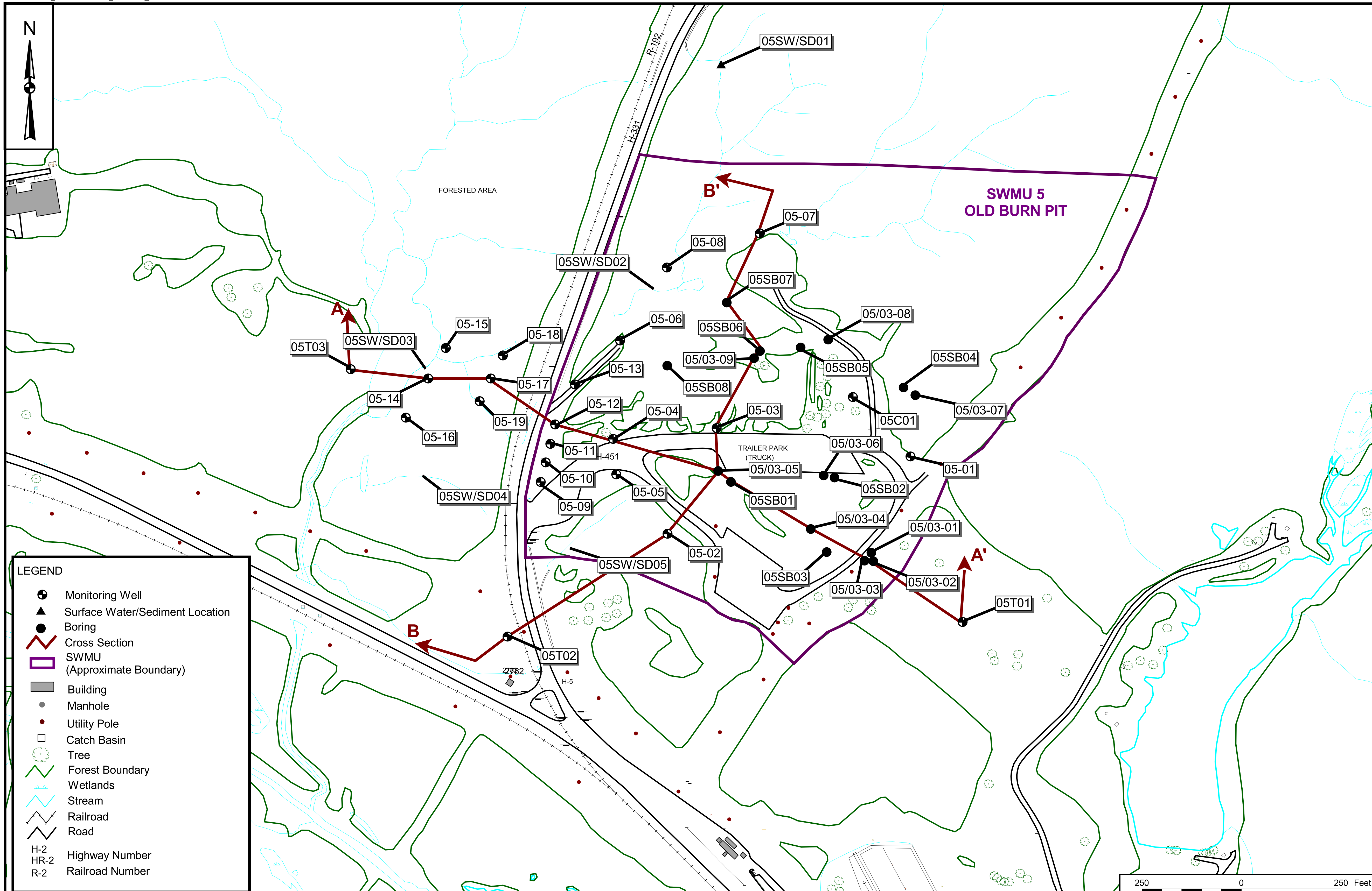
Inferred Depositional Environment	Symbol	Explanation of Geology
Alluvium	Qal	***Alluvium***
Loess/Glacial Outwash	Ql	***Loess***
	Qo	***Glacial Outwash***
Residual Soil derived from Pennsylvanian bedrock/colluvium	P	***Raccoon Creek Group and undifferentiated***
	Ps	***Sandstone-dominated horizon of Lower Pennsylvanian***
Residual soil derived from Mississippian bedrock/colluvium	M6	***Glenn Dean Ls, Hardinsburg Fm, Haney Ls, Indian Springs Shale Mbr, and undifferentiated***
	M5	***Sandstone member of the Big Clifty Fm***
	M4	***Beech Creek Ls***
	M3	***Elwren Fm, Reelsville Ls, upper Sample Fm, and undifferentiated***
	M2	***Lower part of Sample Fm, Beaver Bend Ls, Bethel Fm, and undifferentiated***
	M1	***Paoli Ls, Ste Genevieve Ls, and undifferentiated***

Source: Background Soils Report. TtNUS 2001. (Modified from Blunck, 1995).

1.5 0 1.5 3 Miles

DRAWN BY D. PERRY	DATE 3/15/99	SURFICIAL GEOLOGY AND DEPOSITIONAL ENVIRONMENTS CMP REPORT FOR SWMU 5 - OLD BURN PIT NSA CRANE CRANE, INDIANA	CONTRACT NUMBER 3088
CHECKED BY V. PLACHY	DATE 9/20/06		APPROVED BY KAREN LYONS — DATE 03/27/14
COST/SCHEDULE-AREA			APPROVED BY — DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1 - 3 — REV 0

P:\GIS\NSWC_CRANE\CTO-10_SWMU05_01.APR CROSS SECTION LOCATION MAP LAYOUT 4/9/14 KM



CONTRACT NO.
3088

APPROVED BY
KAREN LYONS
DATE
03/27/14

APPROVED BY
DATE

DRAWING NO.
FIGURE 1 - 4

REV
0

CROSS SECTION LOCATION MAP
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA

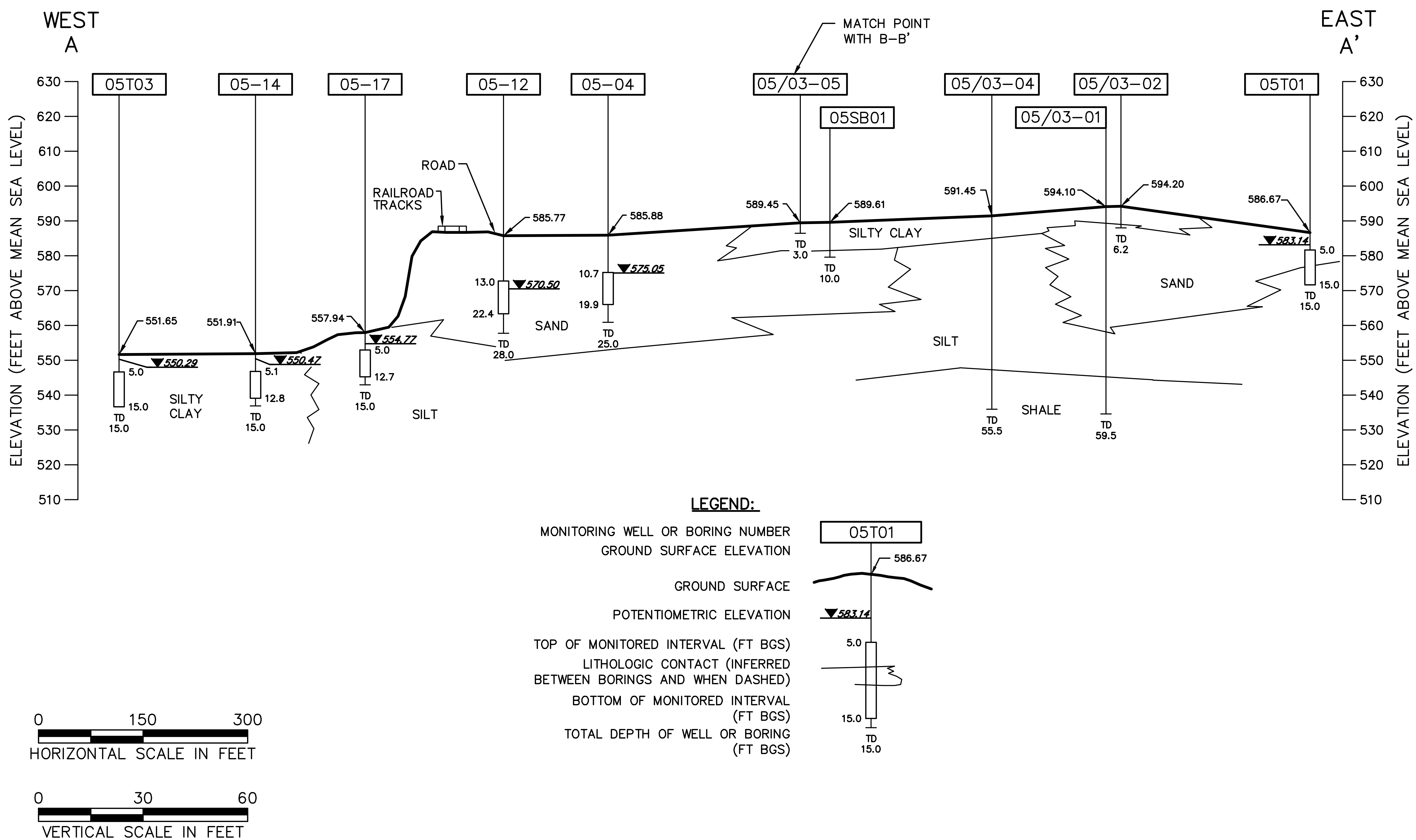
NAVFAC

DRAWN BY
K. PEILA
DATE
5/21/02

CHECKED BY
V. PLACHY
DATE
9/20/06

COST/SCHED-AREA

SCALE
AS NOTED



CONTRACT NO. 3088

OWNER NO. F27H

APPROVED BY KL

DATE 3/27/14

SIZE B

REV. 0

DRAWING NO. FIGURE 1–5

GEOLOGIC CROSS-SECTION A–A'
CMP REPORT FOR
SWMU 5 – OLD BURN PIT
NSA CRANE
CRANE, INDIANA

NAVFAC

DRAWN BY MF — DATE 8/3/08

CHECKED BY — DATE

REVISED BY NN — DATE 4/10/14

SCALE AS NOTED

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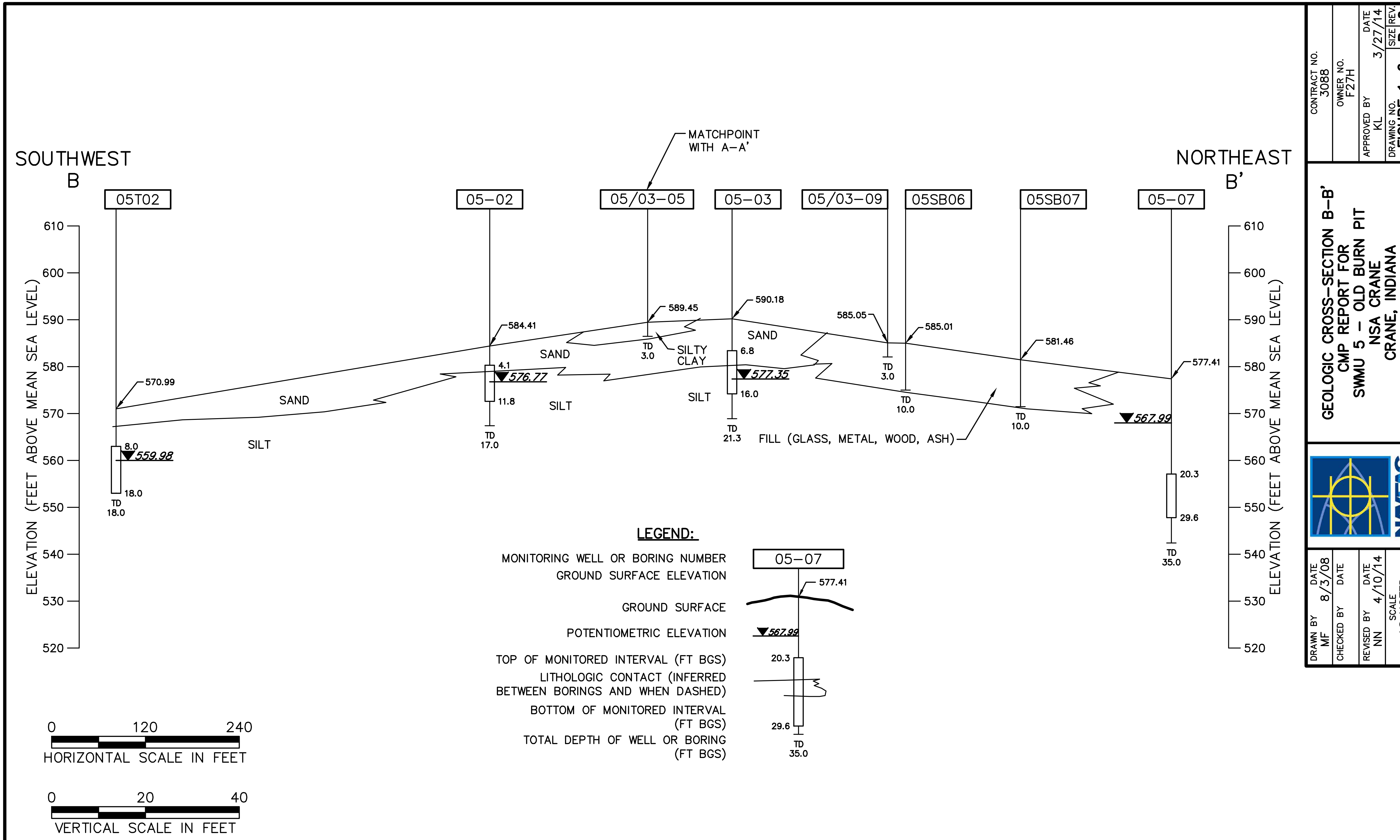


R:\3088 – NSA Crane SWMU 5\Figures\3088FG002.dwg PIT NICHOLE.NAJESKI 4/10/2014 10:11:52 AM

2.0 DESCRIPTION OF CURRENT CONDITIONS AT SWMU 5 AND MEDIA CLEANUP STANDARDS

Various historical investigations and risk assessments have been conducted at SWMU 5. As a result of these studies, the following have been identified as Chemicals of Concern (COCs) for human health and ecological risk at the SWMU:

Soils (Human Health and Ecological):

- Metals
  - Antimony, iron, and lead (human health)
    Antimony, barium, chromium, copper, lead, silver, tin, and zinc (ecological – terrestrial plant and/or invertebrates)
  - Cadmium, chromium, copper, lead, mercury, silver, and zinc (ecological – food chain)

- Dioxins/Furans (human health and ecological food chain)

- PAHs (human health)

Groundwater (Human Health):

- Metals
  - Arsenic and manganese

- Dioxins/Furans [evaluated in terms of 2,3,7,8-TCDD Toxic Equivalents (TEQs)]

- BEHP

Surface Water (Human Health)

- TCE and vinyl chloride

This section presents a summary of the current contamination conditions for SWMU 5 (TtNUS, 2005). The nature and extent of contamination and human health and ecological risk drivers are discussed, and a reassessment of the human health and ecological risks in particular areas of SWMU 5 based on sampling data for specific areas within the SWMU is also presented.

2.1 HISTORICAL INVESTIGATIONS

This section provides a general overview of the RFI and results that were used as the basis for determining which media required consideration in the CMP. Additional information can be found in the RFI Report for SWMUs 4 (McComish Gorge), 5 (Old Burn Pit), 9 (Pesticide Control Area/R-150 Tank Area), and 10 (Rockeye) (TtNUS, 2005).

2.1.1 Surface/Subsurface Soil Contamination

Surface Soil

Eight surface soil samples were collected in support of the RFI Report (TtNUS, 2005). All eight surface soil samples were analyzed for Appendix IX VOCs, SVOCs, pesticides, PCBs, herbicides, and dioxins/furans, Target Analyte List (TAL) metals (plus tin), and cyanide. Additionally, one surface soil sample was analyzed for CEC, pH, and TOC.

Subsurface Soil

Fourteen subsurface soil samples were collected at seven locations to evaluate the nature and extent of contamination. All subsurface soil samples were analyzed for Appendix IX VOCs, SVOCs, pesticides, PCBs, herbicides, and dioxin/furans, TAL metals (plus tin), and cyanide. Additionally, three subsurface soil samples were analyzed for CEC, pH, and TOC.

For evaluating human health risk, subsurface soil sample results were combined with surface soil sample results. Sixteen surface/subsurface soil samples were collected at SWMU 5 from depths of 2 to 10 feet bgs (subsurface soil samples were co-located with surface soil samples).

The following chemicals were retained as COPCs for surface/subsurface soil:

- Volatiles - 1,1-DCE, benzene, cis-1,2-DCE, PCE, TCE, methylene chloride, and vinyl chloride

- Polynuclear aromatic hydrocarbons (PAHs) - benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, 2-methylnaphthalene, and naphthalene

- Pesticides - dieldrin

- PCBs - Aroclor-1254 and Aroclor-1260
- SVOCs - pentachlorophenol
- Dioxins/furans
- Inorganics - antimony, arsenic, barium, cadmium, chromium (total), copper, iron, lead, manganese, mercury, nickel, silver, and zinc

2.1.2 Groundwater

Fourteen groundwater samples were collected to evaluate the nature and extent of contamination. All groundwater samples were analyzed for Appendix IX VOCs, SVOCs, pesticides, PCBs, herbicides, and dioxin/furans, total TAL metals (plus tin), and cyanide. Two groundwater samples (05GW0301 and 05GW1301) were also analyzed for dissolved TAL metals. One groundwater sample (05GW0101) was collected as the SWMU 5 upgradient groundwater sample.

The following chemicals were retained as COPCs in groundwater:

- Volatile - chloroform
- Semi-volatile - BEHP
- Dioxins/furans
- Inorganics - aluminum, arsenic, iron, and manganese

2.1.3 Surface Water

Filtered and unfiltered surface water samples were collected at four locations to evaluate the nature and extent of contamination. There was no significant difference between the filtered and unfiltered results, indicating that turbidity did not significantly impact the unfiltered sample results. All surface water samples were analyzed for Appendix IX VOCs, SVOCs, pesticides, PCBs, herbicides, and dioxin/furans, total and dissolved TAL metals (plus tin), cyanide, hardness, and TSS. Sample 05SW0101 was selected to represent the SWMU 5 upgradient surface water sample.

The following chemicals were retained as COPCs in surface water:

- Volatiles - 1,1-DCE, cis-1,2-DCE, TCE, and vinyl chloride
- Inorganics - aluminum, arsenic, iron, and manganese

2.1.4 Sediment

Four sediment samples were analyzed for Appendix IX VOCs, SVOCs, pesticides, PCBs, herbicides, and dioxin/furans, TAL metals (plus tin), cyanide, and TOC. Sample 05SD010006 (designated as the upgradient sediment sample) was analyzed for the same parameters.

The following chemicals were retained as COPCs in sediment:

- Dioxins/furans
- Inorganics - aluminum, antimony, and manganese

2.2 HUMAN HEALTH RISK DRIVERS

Table 2-1 presents the conclusions from the RFI Report for contaminants associated with human health risk (TtNUS, 2005). The following presents a discussion by medium regarding human health risk [Incremental Lifetime Cancer Risks (ILCRs) greater than 1 x 10^{-4} and hazard quotients (HQs) greater than 1] where thresholds were exceeded and including the contaminant causing the exceedance.

2.2.1 Surface Soil

Dioxins/Furans

The residential ILCR for dioxins/furans in surface soil was 5.7 x 10^{-5}. The elevated risks for these chemicals in surface soil are based on hypothetical future residential land use no current and industrial land use. Surface soil concentrations of dioxins/furans (evaluated as TEQs) were less than the preliminary remediation goal (1 µg/kg) established by the USEPA. Therefore, no action was considered to be warranted for dioxins/furans in surface soil.

Polycyclic Aromatic Hydrocarbons

The residential ILCR for PAHs in surface soil was 1.8 x 10^{-5}. The elevated risks for these chemicals in surface soil are based on hypothetical future residential land use not current and industrial land use. Surface soil concentrations of PAHs are within levels commonly occurring in the U.S. Therefore, no action was considered to be warranted for PAHs in surface soil.

Antimony

The child resident antimony HQ in surface soil was 9.6. The risks for antimony are based on the hypothetical future residential land use, but concentrations of antimony do not pose a risk under current and industrial land use. Elevated risks for this chemical are based on hypothetical future land use and are driven by the concentration in one surface soil sample (05SB06). The sample may represent a hotspot at the site.

Iron

The National Center for Environmental Assessment (NCEA) provisional Reference Dose (RfD) for iron, which is based on allowable daily intakes rather than adverse effect levels, was used to estimate risks from exposure to iron. The HQ for the child resident exposed to surface soil was 4.5. Because provisional RfDs are not based on adverse health effects, the risks associated with iron are likely overstated.

Lead

Predicted blood lead levels in future child residents were greater than USEPA recommended levels. Elevated risks for lead are based on hypothetical future residential land use and are driven by the concentration in one surface soil sample (05SB06). The sample may represent a hotspot at the site.

2.2.2 Surface/Subsurface Soil

Antimony

The future construction worker HQ in surface/subsurface soil was 2.1. Elevated risks for the construction worker are based on the concentration in one surface soil sample (05SB06). The sample may represent a hotspot at the site.

Lead

More than 5 percent of the fetuses born to future construction workers are predicted to have blood lead levels greater than 10 micrograms per deciliter (µg/dL). The risks to the future construction worker are based on the average concentration in soil samples [greater than 1,000 milligrams per kilogram (mg/kg)]. Lead concentrations in approximately one-half of subsurface soil samples were greater than 1,000 mg/kg.

2.2.3 Groundwater

Dioxins/Furans

The residential ILCR for dioxins/furans in groundwater was 4.1 x 10^{-4}. The elevated risks from dioxins/furans in groundwater are based on hypothetical future residential use, but concentrations of dioxins/furans do not pose a risk under current and future industrial land use. Dioxins/furans were detected in 10 of 14 groundwater samples, indicating that groundwater has been impacted by site activities. However, concentrations of dioxins/furans (as TEQs) in all samples were less than the Maximum Contaminant Level (MCL) for total 2,3,7,8,-TCDD [3 x 10^{-5} micrograms per liter (µg/L)].

Bis(2-ethylhexyl)phthalate

The residential ILCR for this chemical in groundwater was 6.0 x 10^{-6}. The elevated risks for BEHP in groundwater are based on hypothetical future residential land use not current and industrial land use. This chemical was detected in only one of 14 samples and is a common laboratory contaminant.

Arsenic

The residential ILCR for arsenic in groundwater was 2.5 x 10^{-5}. The elevated risks for this chemical in surface soil are based on hypothetical future residential land use not current and industrial land use. The maximum arsenic concentration in groundwater (1.6 mg/L) is less than the current MCL (10 mg/L). In addition, concentrations of this chemical in site wells are similar to concentrations detected in the upgradient well.

Manganese

The adult and child resident HQs were 2.9 and 10, respectively. The risks for manganese are based on the hypothetical future residential use of groundwater.

2.2.4 Surface Water

Trichloroethene

The residential ILCR for this TCE in surface water was 2.1 x 10^{-4}. In addition, the adult and child resident HQs were 4.1 for both adult and child future residents. The elevated risks for this chemical in surface water are based on hypothetical future residential land use not current and industrial land use. This exposure scenario assumes that future residents are exposed to groundwater 350 days/year. Also, water in the creek was covered with ice at the time the surface water samples were collected. Because TCE is extremely volatile, it is unlikely that the observed concentrations are representative of surface water concentrations throughout the year.

Vinyl Chloride

The residential ILCR for this this chemical in surface water was 3.2 x 10^{-4}. The elevated risks for this chemical in surface water are based on hypothetical future residential land use not current and industrial land use. This exposure scenario assumes that future residents are exposed to groundwater 350 days/year. Also, water in the creek was covered with ice at the time the surface water samples were collected. Because vinyl chloride is extremely volatile, it is unlikely that the observed concentrations are representative of surface water concentrations throughout the year.

2.2.5 Sediment

There are no significant potential health risks for human receptors exposed to sediment under current or future land use.

2.3 ECOLOGICAL RISK DRIVERS

Table 2-2 presents the conclusions from the RFI Report for contaminants associated with ecological risk. The following presents a discussion by receptor regarding unacceptable ecological risks, including the contaminant causing the unacceptable risk.

2.3.1 Terrestrial Plants and Invertebrates

Surface Soil

Unacceptable risk was determined for terrestrial plants and/or invertebrates contacting soils containing antimony, barium, chromium, copper, silver, tin, and zinc.

Sediment

There is no unacceptable ecological risk to terrestrial plants and invertebrates associated with sediment.

Surface Water

There is no unacceptable ecological risk to terrestrial plants and invertebrates associated with surface water.

2.3.2 Insectivorous/Herbivorous Mammals and Birds

Unacceptable risk was determined for insectivorous/herbivorous mammals and birds through the food chain for soils containing dioxins/furans, cadmium, chromium, copper, lead, mercury, silver, and zinc.

2.3.3 Aquatic Organisms

Sediment

There is no unacceptable ecological risk to aquatic organisms associated with sediment.

Surface Water

There is no unacceptable ecological risk to aquatic organisms associated with surface water.

2.4 RE-EVALUATION OF HUMAN HEALTH AND ECOLOGICAL RISKS

A re-evaluation of the human health and ecological risks was conducted for this CMP.

2.4.1 Human Health

Two future land use options were considered for the refinement of human health risks - one for the flat area of the site that has the potential to be utilized for construction (i.e., constructible area) and one for the gully/sloped area (i.e., non-constructible area) that would not likely be developed.

2.4.1.1 Soils

Section 2.2 summarizes the RFI HHRA for residential and construction worker receptors. The main assumption in developing the RFI HHRA was that the entire SWMU 5 area would be available to human receptors for all activities, including future residential and construction scenarios. However, based on the geography of SWMU 5, the non-constructible area of the SWMU will not be developed [i.e., with land use controls (LUCs), there will be no potential exposure to residential and construction activities in this area].

To determine the appropriate human health CMs associated with soils for SWMU 5, a human health risk screening evaluation for the constructible and non-constructible areas at SWMU 5 was developed.

HHRA Updated for the Constructible Area

The RFI Report identified antimony (surface soil for child residents and surface/subsurface soil for construction workers), iron (surface soil for child residents), and lead (surface/subsurface soil child residents and construction workers) as contaminants that required further action in the CMP. As part of the CMP, an HHRA for the constructible area was prepared for antimony, iron, and lead based on the RFI Report sampling results (see Table 2-3). Figures 2-2 (surface soil) and 2-3 (subsurface soil) illustrate the concentrations of these chemicals detected in the soil at SWMU 5.

Residential Child Risks

The updated risk assessment process for the hypothetical future child resident involved calculating non-carcinogenic HQs for antimony and iron and evaluating risks from exposure to lead using USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) Model for lead in children (USEPA, 2001). The exposure point concentrations (EPCs) for antimony and iron were upper confidence limits (UCLs) calculated for surface soil in the constructible area according to the USEPA's ProUCL guidance (Singh et. al, 2004). As recommended by USEPA guidance for lead, the EPC for lead was the arithmetic average of surface soil data in the constructible area (USEPA, 1994).

Table 2-4 presents the exposure factors used in the risk calculations for the future child resident. Table 2-5 presents the calculation of non-carcinogenic HQs for exposure of the future child resident [Reasonable Maximum Exposure (RME)] to antimony and iron in surface soil in the constructible area. According to current USEPA dermal guidance (USEPA, 2004), dermal risks are not calculated for antimony and iron. The HQs for future child residents from exposure to antimony (HQ = 1) and iron (HQ = 0.9) in surface soil for the constructible area were equal to or less than the USEPA's goal of unity.

The average lead concentration for surface soil in the constructible area was 138 mg/kg, which is less than the USEPA screening level for lead-contaminated soil in a residential setting where children are frequently present (400 mg/kg). The results of the IEUBK Model evaluation using a surface soil concentration of 138 mg/kg indicate that the estimated geometric mean blood-lead level for a child resident is 1.6 µg/dL. This blood-lead level is less than the established level of concern (10 µg/dL). Approximately 0.38 percent of children are expected to experience blood-lead levels greater than 10 µg/dL. This estimate is less than the USEPA's goal of limiting exposure to lead so that no more than

5 percent of exposed children have estimated blood-lead levels greater than the established level of concern (i.e., 10 µg/dL). The results of the IEUBK Model analysis therefore indicate that the predicted blood-lead levels of children exposed to lead in soil in the constructible area of SWMU 5 are within acceptable levels.

Construction Worker Risks

The updated risk assessment process for the future construction worker involved calculating the HQ for antimony in combined surface/subsurface soil and evaluating risks from exposure to lead using the USEPA's Adult Lead Model (USEPA, 2003a). The EPC for antimony was the UCL calculated for combined surface soil/subsurface soil in the constructible area. The EPC for lead was the arithmetic average of surface/subsurface soil data in the constructible area.

Table 2-6 presents the exposure factors used to estimate risks for the construction worker, and Table 2-7 presents the calculation of the HQ for exposure of the future construction worker (RME) to antimony in surface/subsurface soil.

The HQ for the construction worker from exposure to antimony in surface/subsurface soil (HQ = 0.6) was less than USEPA's goal of unity.

The average lead concentration for surface/subsurface soil in the constructible area was 245 mg/kg, which is less than the USEPA's screening level for industrial exposures (800 mg/kg). The results of the Adult Lead Model evaluation using a soil concentration of 245 mg/kg indicate that the predicted blood-lead levels of workers (e.g., blood-level of a pregnant worker's fetuses) exposed to lead in the constructible area are less than the USEPA goal of 10 µg/dL and that the probability of exceeding 10 µg/dL is less than the goal of 5 percent.

Conclusions

The risks calculated for the future child resident for exposure to antimony, iron, and lead in the constructible area meet USEPA goals. The risks calculated for the future construction worker for the constructible area are also less than USEPA's benchmarks.

Therefore, no further action is required for soil remediation for the constructible area. The constructible area will not be carried forward in this CMP for purposes of addressing human health risk.

HHRA Update for Non-Constructible Area

This section presents the updated risk assessment for antimony, iron, and lead based on sampling results for the non-constructible area. The analytical data used in the risk assessment for the non-constructible area are presented in Table 2-8. Figures 2-2 (surface soil) and 23 (subsurface soil) illustrate the concentrations of antimony, iron, and lead detected in the soil at SWMU 5.

Residential Child Risks

The EPCs for antimony and iron were the maximum detected concentrations in surface soil for the non-constructible area because the surface soil dataset consists of less than 10 samples. As recommended by USEPA guidance for lead, the EPC for lead was the arithmetic average of surface soil data in the non-constructible area.

Table 2-4 presents the exposure factors used to estimate risks for future child residents. Table 2-9 presents the calculation of non-carcinogenic HQs for exposure of future child residents (RME) to antimony and iron in surface soil in the non-constructible area. According to current USEPA dermal guidance, dermal risks are not calculated for antimony and iron in soil. The HQs for future child residents from exposure to antimony (HQ = 10) and iron (HQ = 1.5) in surface soil in the non-constructible area exceeded USEPA's goal of unity.

The average lead concentration for surface soil in the non-constructible area was 3,754 mg/kg, which exceeds the USEPA screening level for lead-contaminated soil in a residential setting where children are frequently present (400 mg/kg). The results of the IEUBK Model evaluation using a surface soil concentration of 3,754 mg/kg indicate that the estimated geometric mean blood-lead level for a child resident is 22.7 µg/dL. This blood-lead level is greater than the established level of concern (10 µg/dL). Approximately 96 percent of children are expected to experience blood-lead levels greater than 10 µg/dL. This estimate exceeds USEPA's goal of limiting exposure to lead so that no more than 5 percent of exposed children have an estimated blood-lead level greater than the established level of concern (i.e., 10 µg/dL). The results of the IEUBK Model analysis indicate that the predicted blood-lead levels of children exposed to lead in soil at SWMU 5 within the non-constructible area exceed USEPA benchmarks.

Construction Workers Risks

The updated risk assessment process for the future construction worker in the non-constructible area involved calculating the HQ for antimony in combined surface/subsurface soil and evaluating risks from exposure to lead using the USEPA's Adult Lead Model. The EPC for antimony was the UCL calculated for combined surface soil/subsurface soil in the non-constructible area. The EPC for lead was the arithmetic average of surface/subsurface soil data in the non-constructible area.

Table 2-6 presents the exposure factors used to estimate risks for the construction worker, and Table 2-10 presents the calculation of the HQ for exposure of the future construction worker (RME) to antimony in surface/subsurface soil in the non-constructible area. The HQ for the construction worker from exposure to antimony (HQ = 1.3) in surface/subsurface soil slightly exceeds USEPA's goal of unity.

The average lead concentration for surface/subsurface soil in the non-constructible area was 3,010 mg/kg, which is greater than the USEPA's screening level for industrial exposures (800 mg/kg). The results of the Adult Lead Model evaluation using a soil concentration of 3,010 mg/kg indicate that the predicted blood-lead levels of fetuses of workers exposed to lead in soil in the non-constructible area of SWMU 5 exceed the USEPA goal of 10 µg/dL and that the probability of exceeding 10 µg/dL is greater than the goal of 5 percent.

Conclusions

The risks calculated for the future child resident for exposure to antimony, iron, and lead in the non-constructible area exceed USEPA goals. The risks calculated for the future construction worker for the non-constructible area also exceed USEPA's benchmarks.

Therefore, the non-constructible area will be carried forward in this CMP for purposes of addressing human health risk.

2.4.1.2 Groundwater

Elevated risks from dioxins/furans, BEHP, arsenic, and manganese were based on hypothetical future residential use; no unacceptable risks are indicated under current and future industrial land use. Therefore, the CM for groundwater will be LUCs prohibiting withdrawl of groundwater. In addition, the concentrations of dioxins/furans in groundwater are less than the MCL (0.00000003 mg/L) (USEPA, 2012).

2.4.2 <u>Ecological</u>

Section 2.3 summarizes the RFI Ecological Risk Assessment. Ecological impacts on individual members of species in the immediate vicinity of the contamination were evaluated. No evaluations were conducted regarding the extent of contamination in relation to the greater contiguous landscape (i.e., impacts were for individual species rather than populations).

In this section, the results of the RFI Ecological Risk Assessment are re-evaluated to discuss impacts of contamination at SWMU 5 on ecological populations. The SWMU 5 contamination is small in areal extent when compared to the contiguous surrounding ecosystem. SWMU 5 was evaluated as a small-scale contaminant release resulting in small patches of potentially impacted habitat within a primarily intact habitat. Potential impacts on populations were then evaluated to determine whether significant risks existed. The following presents the re-evaluation of ecological risks to populations for these areas.

Figure 2-2 presents historical surface soil data including a comparison of surface soil concentrations to the USEPA Region 5 Ecological Data Quality Levels for antimony, iron, and lead.

NSA Crane

A biological characterization of NSA Crane, including a listing of plants and animals found at the facility, was presented in the Installation Assessment (IA) (Army, 1978) and the IAS (NEESA, 1983), and is summarized in the Environmental Monitoring Reports (EMRs) (Halliburton NUS, 1992a and 1992b). A list of the species that may inhabit NSA Crane and that are protected under the United States Endangered Species Act, Indiana Department of Natural Resources Heritage Data Center, or the United States Fish and Wildlife Service is summarized in the RCRA Facility Permit (USEPA, 1995). The following paragraphs briefly summarize the environmental setting at the installation.

Eighty percent of NSA Crane's 63,463 acres are classified as Central Hardwoods Forest of the United States (NEESA, 1983). In addition, some agricultural fields are in various stages of succession. Openings on dry upland sites contain almost pure stands of grasses with some clumps of woody plants such as persimmon, sassafras, and sumac. Wetter sites have river birch, willow, sycamore, and cottonwood. Hillside communities have mostly hickory, white and black oak, red and sugar maple, tulip poplar, ash, and beech (NEESA, 1983).

The great variety of habitats at NSA Crane (i.e., many stages of forest succession, streams, ponds, Lake Greenwood, grassy open spaces) has lead to a high diversity of animal species (NEESA, 1983). Some of these species include (but are not limited to) mammals such as white-tailed deer, beaver, coyote, hawks, red fox, rabbits, raccoons, mice; birds such as ducks, geese, wild turkey, bobwhite quail, red-tailed hawks, and American robins; and various amphibians, reptiles, fish, and invertebrates.

The bird population includes a number of State or federal threatened, endangered, or species of special concern that use NSA Crane as their home range. These species include the bald eagle, osprey, sharp-shinned hawk, red-shouldered hawk, broad-winged hawk, black and white warbler, hooded warbler, and the worm-eating warbler (B&RE, 1997). Also, the Indiana bat, a federal endangered species, is known to forage at NSA Crane. During a mist net and radiotelemetry survey conducted for NSA Crane, a male Indiana bat was captured along Furst Creek, which is approximately 1.5 miles west of SWMU 10. SWMU 10 is approximately 6.2 miles due east of SWMU 5. No Indiana bats were captured near SWMU 5. Because of the bat and its potential habitat, the cutting of trees is restricted to certain times during the year, and the cutting of shagbark hickory trees is prohibited.

SWMU 5

SWMU 5 consists of approximately 25 acres located in the alluvial valley of Culpepper Branch and is surrounded by hills and ridges. Of the 25 acres, approximately 16 acres are forested, 6.5 acres are grass covered, and 2.5 are light industrial (i.e., gravel parking areas). A gully to the north of the site is forested with mixed hardwoods and shrubs. The walls of the gully are eroded and have steep slopes. This area contains old waste drums and metallic debris and has an average to good quality stand of mixed hardwoods. Canopy species encountered include maples (red, sugar, and boxelder), sycamore, oaks, hickories, black cherry, yellow poplar (tulip tree), and American elm, with black locust as the dominant species in the highly disturbed areas. Commonly encountered understory species included maples, white ash, bitternut hickory, flowering dogwood, multiflora rose, and poison ivy.

During a site visit by Tetra Tech NUS, Inc. (TtNUS) in October 2001, the water in the unnamed creek (e.g., drainageway north of SWMU 5) was observed to be 2 to 3 feet wide and less than 1 foot deep. The water flow was slow, and there were some stagnant pools. The sediment was silty with some sand. No fish were observed in the unnamed creek, and the small size of the creek would limit the fish population to a few small fish, if fish are present at all.

Figure 2-4 is an aerial photograph of SWMU 5 and the surrounding area. As can be seen from the figure, the forested part of SWMU 5 comprises a very small percentage of the contiguous forested area. It is also apparent from Figure 2-1 (which is an enlargement of a portion of Figure 2-4), that the forested habitat at SWMU 5 appears to be similar to the habitat in the surrounding forested area. In fact, if the SWMU boundary line was removed from the figure, it would not be possible to determine the boundaries of the SWMU.

An animal survey was not conducted at SWMU 5, but spring peepers were vocally confirmed and wild turkey tracks were observed during one of the site visits. Based on the habitat, a variety of small mammals and birds would be expected to inhabit SWMU 5 and the surrounding area. Although roads west, north, and south of the SWMU 5 may limit the movement of some very small mammals, in general, mammals and birds are free to roam throughout the SWMU, as well as in the adjacent forested areas immediately surrounding the SWMU. In fact, as seen in Figure 2-4, SWMU 5 comprises a small percentage (less than 5 percent) of the overall habitat for mammals and birds in this area of NSA Crane.

Summary of Ecological Risk Assessment

Terrestrial Plants and Invertebrates

Many metals detected in surface soil samples were found at concentrations that exceeded plant and invertebrate benchmarks, so there is a potential risk to these receptors at the SWMU. Most of the metals retained as COPCs for risks to plants and invertebrates had their greatest detected concentrations in the northern area of the SWMU, specifically in sample 05SB060002. This sample was located in the forested area of SWMU 5 and contained metal shavings that contributed to the very high concentrations of metals in that sample (some of the shavings were likely analyzed along with the soil).

As shown in Figure 5-7 in the SWMU 5 RFI Report (the inorganic soil tag map), other soil samples collected in the forested area (05SB05002, 05SB07002, and 05SB08002) had much lower concentrations of metals. Various metal debris piles are located throughout the forested area (and the steep drop-off into the main gully) and include rusted drums, metal shavings, and other pieces of metal. Because of this debris, high concentrations of metals may be present in soil within these areas, but lower concentrations are expected at locations where metal debris are not present.

Although soil samples at several locations in the forested area had concentrations of metals greater than plant and invertebrate benchmarks, there is uncertainty as to whether plants and invertebrates are actually being impacted. Metals in freshly salt-spiked soils, which are typically used in toxicity tests to develop plant and invertebrate benchmarks, are typically much more toxic than equivalent metals concentrations in field soils (Allen, 2002). This is supported by observations made during several site visits, as documented in photographs (see Figure 1-9 in the RFI Report), showing that SWMU 5 is heavily vegetated where metal debris is present. Therefore, the metals at SWMU 5 do not appear to be significantly impacting the plant community in these areas. Also, it is unlikely that invertebrates are being impacted to any significant degree because if invertebrates were not present to break down plant material, aerate the soil, etc, the plant community would be impacted.

In summary, based on observations during site visits and the apparent similarity between the forested area at and surrounding SWMU 5 (as seen in Figure 2-4), it does not appear that local populations of plants/invertebrates and/or the plant/invertebrate community are being significantly impacted by metals in surface soils at SWMU 5. This is especially true because SWMU 5 comprises such a small portion of the available habitat in this area of NSA Crane.

Risks to Insectivorous/Herbivorous Mammals and Birds

The 16 forested acres and 6.5 acres of grass at SWMU 5 are of sufficient size to support some small mammals and birds that have been identified at NSA Crane and may be present at the site. These include organisms such as shrews and robins. The ecological risk assessment concluded that small mammals and birds may experience some reproductive effects from exposure to dioxins/furans and metals in soil at SWMU 5, but there was significant uncertainty in the conclusion because the bioavailability of the chemicals in the soil is not known. This was especially true because metal shavings were present in the soil sample that had some of the greatest detected concentrations of metals at the site. Because the metal shavings will not be very bioavailable, calculated risks were likely overestimated. Also, the bioavailability of dioxins/furans in the soil is not known, but it is likely to be low because a portion of the dioxins/furans will be bound to the organic matter in the soil. However, for the conservative ecological risk assessment, it was assumed that 100 percent of the chemicals were bioavailable.

In the ecological risk assessment food-chain modeling, the potential risks for small mammals (i.e., shrew) were lower than the potential risks estimated for small birds (i.e., robin and, to a lesser extent, quail), based on the shrew food-chain modeling having much lower ecological effects. Although it is possible that there may be some reproductive impacts to some birds and small mammals at SWMU 5, a decrease in reproduction of these species at SWMU 5 will not impact the populations and/or communities of these receptors in this area at NSA Crane because SWMU 5 comprises such a small portion of the available habitat in this area.

<u>Conclusions</u>

As presented above, it is possible that some individual plants and/or invertebrates are being impacted at locations where metals concentrations in soil are elevated. However, as discussed in OSWER Directive 9285.7-28P, Issuance of Final Guidance: Ecological Risk Assessment and Risk Management Principles for Superfund Sites, remedial actions generally should not be designed to protect organisms on an individual basis (with the exception of certain protected species) but to protect local populations and communities of biota (1999).

SWMU 5 comprises a very small percentage (less than 5 percent) of the contiguous forested area at NSA Crane (see Figure 2-4). Based on observations during site visits and the apparent similarity between the forested area at and surrounding SWMU 5 (as seen in Figure 2-4), it does not appear that local populations of plants/invertebrates and/or the plant/invertebrate community are being significantly impacted by metals at SWMU 5. Also, even if there are subtle impacts to ecological receptors from chemicals in surface soil at the site, these impacts would be localized to the areas where chemical concentrations are elevated. Because the site comprises only a small portion of the overall habitat for ecological receptors in this area, any localized impacts to ecological receptors (including wildlife) at SWMU 5 will not impact the overall ecology in this area of NSA Crane. Furthermore, approximately half of SWMU 5 may be developed in the future (see Figure 2-1), which would limit the exposure of ecological receptors to site chemicals in this area. For these reasons, potential risks to ecological receptors at SWMU 5 are not great enough to warrant basing any decisions in the CMP on risks to these receptors. Therefore, ecological receptors will not be carried forward in this CMP.

Figure 2-3 presents historical surface soil data including a comparison of surface soil concentrations to the EPA Region 5 Ecological Data Quality Levels for antimony, iron, and lead.

2.5 MEDIA CLEANUP STANDARDS

MCSs for SWMU 5 were developed for surface and subsurface soil, groundwater, and surface water. There are no unacceptable risks associated with sediment at the site. Therefore, MCSs were not developed for this environmental medium.

2.5.1 Soil

MCSs for soil were developed for the COCs and receptors associated with unacceptable risks. As identified in Section 2.4.1.1, unacceptable human health risks for the non-constructible area at SWMU 5 were identified for future construction workers exposed to antimony and lead in surface/subsurface soil and future child residents exposed to antimony, iron, and lead in surface soil. The human health risks associated with the constructible area of SWMU 5 were acceptable. In addition, as identified in Section 2.4.2, potential risks to ecological receptors at SWMU 5 (the constructible area and the non-constructible area) are not great enough to warrant remedial actions. Therefore, MCSs were not identified for these receptors.

Table 2-11 contains the MCSs for SWMU 5. For future construction workers, MCSs for surface/subsurface soil were set at the direct contact IDEM Closure Levels (IDEM, 2014) for an excavation exposure scenario. Direct contact IDEM Closure Levels for a residential exposure scenario were used as MCSs for future child residents; MCSs for this receptor are applicable to surface soil only.

2.5.2 Groundwater and Surface Water

Although only a few chemicals (dioxins/furans, BEHP, arsenic, and manganese in groundwater and trichloroethene and vinyl chloride in surface water) were identified as COCs in Sections 2.2.3 (groundwater) and 2.2.4 (surface water), MCSs have been developed for all chemicals detected in these environmental media during the RFI, with the exception of selenium. Selenium was not included in the list because this chemical was detected in only one of 14 unfiltered groundwater samples, was not detected in the associated filtered groundwater sample, and was not detected in any other environmental media (surface/subsurface soil, surface water, and sediment) sampled during the RFI. The list of chemicals for groundwater and surface water was combined because of the potential interaction/migration between groundwater and surface water (i.e., discharge of shallow groundwater to surface water) and includes the following:

- Dioxins/Furans
- VOCs – chloroform, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, TCE, and vinyl chloride
- BEHP
- Metals – aluminum, antimony, arsenic, barium, copper, iron, lead, manganese, vanadium, and zinc

Groundwater MCSs for SWMU 5 are presented in Table 2-12. In general, USEPA Primary Drinking Water Standards MCLs and Action Levels were used as the MCSs for groundwater. MCLs and Action Levels are not available for aluminum, iron, manganese, vanadium, and zinc; therefore, groundwater MCSs for these chemicals were set at the direct contact IDEM Closure Levels (IDEM, 2014) for a residential exposure scenario.

Table 2-12 also presents the surface water MCSs. Appendix A presents the supporting calculations for these values. Human Health Water Quality derived for the protected and un-protected water sources and the Chronic Aquatic Life Criteria are presented in Appendix A, Table A-1. The surface water values in Table 2-12 are the lower of the Water Only, Unprotected Water Supply value of the Chronic Aquatic Life Criteria value listed in Table A-1. The Water + Fish values were not used because the streams at SWMU 5 do not support large enough fish to be consumed by humans. Also the Protected Water Supply values were not selected because the streams at SWMU 5 are not considered protected drinking water supplies.

TABLE 2-1

SUMMARY OF RFI REPORT HUMAN HEALTH RISK CONCLUSIONS
CMS REPORT FOR SWMU 5 (OLD BURN PIT)
NSA CRANE
CRANE, INDIANA

Chemical of Concern[1]	Unacceptable Impact on Human Receptors	Comments
SURFACE SOIL		
Dioxins/Furans	Residential ILCR = 5.7E-5	Dioxins were detected in 8 of 8 soil samples. Elevated risks (across all pathways) for dioxins are based on the hypothetical future residential land use. Risks calculated for receptors under current and industrial land use are within the USEPA's target risk range. Concentrations of dioxins/furans (as TEQs) in all surface soil samples were less than the 1 μg/kg preliminary remediation goal established by the USEPA. Therefore, no action is warranted for dioxins/furans in soil.
PAHs	Residential ILCR = 1.8E-5	Elevated risks are for future residential receptors. Risks calculated for receptors under current land use are within the USEPA's target risk range. Total risks from PAHs in soil are less than 1.0E-4 for all receptors. Concentrations of PAHs in soil are within levels occurring in soil in the U.S. Therefore, no acton is warranted for PAHs.
Antimony	Child resident HQ = 9.6	Elevated risks for antimony are based on the hypothetical future residential land use based on the concentration in one soil sample, but the concentrations do not pose a risk under current and industrial land use. The sample may represent a "hotspot" at the site.
Iron	Child resident HQ = 4.5	Elevated risks for iron are based on the hypothetical future residential land use, but these concentrations do not pose a risk under current and industrial land use. Risks calculated for iron are not based on adverse health effects but rather on recommended daily allowances.
Lead	Future Residents - Predicted blood lead levels in children greater than USEPA recommemded levels	Elevated risks for lead are based on the hypothetical future residential land use driven by the concentration in one surface soil sample. The sample may represent a "hotspot" at the site.
SURFACE/SUBSURFACE SOIL		
Antimony	Construction Worker HQ = 2.1	Elevated risks for the construction worker are based on the concentration in one surface soil sample. The sample may represent a "hotspot" at the site.
Lead	Construction Worker - More than 5% of the fetuses born to construction workers predicted to have blood lead levels greater than 10 μg/dL	Elevated risks to the future construction worker are based on the average concentration in soil samples (>1,000 mg/kg). Lead concentrations in approximately 1/2 of subsurface soil samples were greater than 1,000 mg/kg.

TABLE 2-1

SUMMARY OF RFI REPORT HUMAN HEALTH RISK CONCLUSIONS
CMS REPORT FOR SWMU 5 (OLD BURN PIT)
NSA CRANE
CRANE, INDIANA

Chemical of Concern[(1)]	Unacceptable Impact on Human Receptors	Comments
GROUNDWATER		
Dioxins/Furans	Residential ILCR = 4.1E-4	Elevated risks from dioxins in groundwater are based on the hypothetical future residential use, but these concentrations do not pose a risk under current and industrial land use. Dioxins were detected in 10 of 14 groundwater samples indicating that groundwater has been impacted by site activities. Concentrations of dioxins (as TEQs) in all samples were less than the MCL for 2,3,7,8-TCDD.
Bis(2-ethylhexyl)phthalate	Residential ILCR = 6.0E-6	Bis(2-ethylhexyl)phthate was detected in 1 of 14 samples and is a common laboratory contaminant. Elevated risks are based on future residential use of groundwater.
Arsenic	Residential ILCR = 2.5E-5	Elevated risks for arsenic are based on the hypothetical future residential use of groundwater. The maximum concentration in groundwater (1.6 mg/L) is less than the current MCL (10 mg/L). In addition, the concentrations of arsenic in groundwater samples from site wells are similar to the concentrations in the upgradient well.
Manganese	Adult resident HQ = 2.9, Child resident HQ = 10	Elevated risks for manganese are based on the hypothetical future residential use of groundwater.
SURFACE WATER		
Trichloroethene	Adult resident HQ = 4.1; Child resident HQ = 4.1, Residential ILCR = 2.1E-4	Elevated risks from chlorinated volatiles in surface water are based on the hypothetical future land use, but these concentrations do not pose a risk under current or industrial land use. The risks are overestimated based on potential residential exposure to surface water that assumes that future residents are assumed to be exposed to surface water 350 days/year. Trichloroethene and vinyl chloride were detected in 2 of 4 samples, which appear to be hydraulically connected.[(2)]
Vinyl Chloride	Residential ILCR = 3.2E-4	

HQ - Hazard Quotient.
ILCR - Incremental Lifetime Cancer Risk
MCL - Maximum Contaminant Level
PAH - Polycyclic aromatic hydrocarbon
TEQ - Toxicity equivalent
USEPA - United States Environmental Protection Agency
1 Any carcinogenic chemical with a ILCR greater than 1.0E-6 or a noncarcinogenic chemical contributing to target organ hazard indices (HI) greater than 1.0.
2 Hydraulic conductivity data will be collected as part of the first round of groundwater monitoring. Details for groundwater monitoring will be developed in the Corrective Measures Implementation Plan.

TABLE 2-2

SUMMARY OF RFI REPORT ECOLOGICAL RISK CONCLUSIONS
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA

Receptor Population	Environmental Media	Overall Risk	Critical Pathways and Chemicals of Concern	Recommendations
Terrestrial Plants and Invertebrates	Surface Soil	Unacceptable	Terrestrial plants and/or invertebrates contacting soils (antimony, barium, chromium, copper, lead, silver, tin, and zinc)	Proceed to CMS
Mammals and Birds	Surface Soil	Unacceptable	Insectivorous/herbivorous mammals and birds through the food chain (dioxins/furans, cadmium, chromium, copper, lead, mercury, silver, and zinc)	Proceed to CMS
	Sediment and Surface Water	Acceptable	NA	NFA
Aquatic Organisms	Surface Water and Sediment	Acceptable	NA	NFA

NA - Not applicable.
NFA - No further action.
CMS - Corrective Measures Study.

TABLE 2-3

ANTIMONY, IRON, AND LEAD CONCENTRATIONS IN CONSTRUCTIBLE AREA
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA

SAMPLE NUMBER	SAMPLE LOCATION	DEPTH RANGE (feet)	ANTIMONY (mg/kg)	IRON (mg/kg)	LEAD (mg/kg)
0 to 2 Feet Approximate Depth Range					
05SB010002	05SB01	0 - 2	5.8 J	20,400 J	82.7 J
05SB020002	05SB02	0 - 2	33.2 J	21,100 J	450. J
05SB030002	05SB03	0 - 2	13.3 J	16,700 J	204. J
05SB040002	05SB04	0 - 2	0.9 U	17,300 J	15.2 J
05/03-01-90 #1	05/03-01-90	0.5 - 1	1.5 U	21,600	16.
05/03-02-90 #1	05/03-02-90	0.5 - 1	1.5 U	18,600	35.4
05/03-03-90 #1	05/03-03-90	0.5 - 1	1.5 U	18,800	41.9
05/03-04-90 #1	05/03-04	0.5 - 1	1.5 U	19,200	49.8
05/03-05-90 #1	05/03-05	0.5 - 1	11.6	21,500	266.
05/03-05-90 #1 D	05/03-05	0.5 - 1	8.1	21,900	198.
05/03-06-90 #1	05/03-06	0.5 - 1	4.3	19,700	278.
05/03-07-90 #1	05/03-07	0.5 - 1	1.5 U	18,800	18.5
2 to 4 Feet Approximate Depth Range					
05SB040204	05SB04	2 - 4	0.84 U	12,700 J	8.2 J
05/03-04-90 #2	05/03-04	3.5 - 4	1.5 U	23,200	27.1
05/03-05-90 #2	05/03-05	2.5 - 3	12.2	91,400	1,150.
05/03-06-90 #2	05/03-06	3.5 - 4	6.11	24,800	620.
4 to 6 Feet Approximate Depth Range					
05SB020406	05SB02	4 - 6	96.1 J	31,600 J	1,330. J
05SB030507	05SB03	5 - 7	126. J	72,900 J	549. J
05/03-01-90 #2	05/03-01-90	5.5 - 6	1.5 U	18,500	8.4
05/03-02-90 #2	05/03-02-90	5.5 - 6	1.5 U	19,600	12.5
05/03-03-90 #2	05/03-03-90	5.5 - 6	1.5 U	18,900	11.6
6 to 10 Feet Approximate Depth Range					
05SB010810	05SB01	8 - 10	0.9 J	11,400 J	9. J

mg/kg - Milligrams per kilogram.

TABLE 2-4

CALCULATION OF NON-CANCER HAZARDS FROM EXPOSURE OF FUTURE CHILD RESIDENTS TO SURFACE SOIL
REASONABLE MAXIMUM EXPOSURE
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Entire Site
Receptor Population: Residents
Receptor Age: Child (0 - 6 years)

Exposure Route	Parameter Code	Parameter Definition	Unit	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Cs	Chemical Concentration in Soil	mg/kg	95% UCL	USEPA, 1993	95% UCL	USEPA, 1993	Ingestion CDI (mg/kg/day) =
	IR	Ingestion Rate of Soil	mg/day	200	USEPA, 1993	100	USEPA, 1993	Cs x IR x Fi x EF x ED x CF
	Fi	Fraction ingested	unitless	1.0	USEPA, 1993	1.0	USEPA, 1993	BW x AT
	EF	Exposure Frequency	days/year	350	USEPA, 1993	234	USEPA, 1993	USEPA, 1989.
	ED	Exposure Duration	years	6	USEPA, 1993	2	USEPA, 1993	
	CF	Conversion Factor	kg/mg	1.0E-06	USEPA, 1989	1.0E-06	USEPA, 1989	
	BW	Body Weight	kg	15	USEPA, 1993	15	USEPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA, 1989	25,550	USEPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	2,190	USEPA, 1989	730	USEPA, 1989	
Dermal	Cs	Chemical Concentration in Soil	mg/kg	95% UCL	USEPA, 1993	95% UCL	USEPA, 1993	Dermal CDI (mg/kg/day) =
	CF	Conversion Factor	kg/mg	1.0E-06	USEPA, 1989	1.0E-06	USEPA, 1989	Cs x CF x SA x AF x ABS x EF x ED
	SA	Skin Surface Area	cm^2/day	2,000	USEPA, 1997	1,745	USEPA, 1997	BW x AT
	AF	Soil to Skin Adherence Factor	mg/cm^2	0.2	USEPA, 2004	0.04	USEPA, 2004	USEPA, 1989.
	ABS	Dermal Absorption Factor (Solid)	unitless	chemical specific	USEPA, 2004	chemical specific	USEPA, 2004	
	EF	Exposure Frequency	days/year	350	USEPA 1993	234	USEPA 1993	
	ED	Exposure Duration	years	6	USEPA, 1989	2	USEPA, 1989	
	BW	Body Weight	kg	15	USEPA, 1993	15	USEPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA, 1989	25,550	USEPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	2,190	USEPA, 1989	730	USEPA, 1989	

1 Surface soil is defined as soil collected from depths of 0 to 2 feet below ground surface.

Daily Intake Calculations
Ingestion Intake = (IR x Fi x EF x ED x CF) / (BW x AT)
Dermal Intake = (CF x SA x AF x ABS x EF x ED) / (BW x AT)

Cancer Ingestion Intake - RME = 1.10E-06
Noncancer Ingestion Intake - RME = 1.28E-05

Cancer Dermal Intake - RME = 2.19E-06
Noncancer Dermal Intake - RME = 2.56E-05

Cancer Ingestion Intake - CTE = 1.22E-07
Noncancer Ingestion Intake - CTE = 4.27E-06

Cancer Dermal Intake - CTE = 8.52E-08
Noncancer Dermal Intake - CTE = 2.98E-06

CTE - Central Tendency Exposure.
CDI - Chronic Daily Intake.
kg - kilograms.
mg - milligrams.

RME - Reasonable Maximum Exposure.
UCL - Upper confidence limit.
USEPA - United States Environmental Protection Agency.

TABLE 2-5

VALUES OF DAILY INTAKE CALCULATIONS FOR EXPOSURE OF FUTURE CHILD RESIDENTS TO SURFACE SOIL IN CONSTUCTIBLE AREA CMP REPORT FOR SWMU 5 - OLD BURN PIT NSA CRANE CRANE, INDIANA

Scenario Timeframe: Future
Medium: Surface Soil
Exposure Medium: Surface Soil
Exposure Point: Entire Site
Receptor Population: Residents
Receptor Age: Child (0 - 6 years)

Exposure Route	COPC	Medium EPC Value (mg/kg)	Route EPC Value (mg/kg)	EPC Selected for Hazard Calculation	Intake (Non-Cancer) (mg/kg-day)	RfD (mg/kg-day)	Reference Concentration	HQ
Ingestion	Antimony	3.30E+01	3.30E+01	Medium	4.2E-04	4.00E-04	NA	1
	Iron	8.08E+04	8.08E+04	Medium	1.0E+00	1.10E+00	NA	0.9
Dermal	Antimony	3.30E+01	3.30E+01	Medium	NA	6.00E-05	NA	NA
	Iron	8.08E+04	8.08E+04	Medium	NA	1.10E+00	NA	NA

Dermal Absorption Fraction from Soil (ABS) (USEPA 2004):

Antimony - No ABS value provided

COPC - Chemical of Potential Concern.
EPC - Exposure point concentration.
RfD - Reference dose.
HQ - Hazard quotent.
ABS - Absorption.
NA - Not applicable.
USEPA - United States Environmental Protection Agency.

TABLE 2-6

VALUES OF DAILY INTAKE CALCULATIONS FOR EXPOSURE OF CONSTRUCTION WORKERS TO SURFACE / SUBSURFACE SOIL
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA

Scenario Timeframe: Future
Medium: Surface Soil/Subsurface Soil
Exposure Medium: Surface Soil/Subsurface Soil
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Unit	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Cs	Chemical Concentration in Soil	mg/kg	95% UCL	USEPA, 1993	95% UCL	USEPA, 1993	Ingestion CDI (mg/kg/day) =
	IR	Ingestion Rate of Soil	mg/day	480	USEPA, 1991	240	1/2 RME value	Cs x IR x Fi x EF x ED x CF
	Fi	Fraction Ingested	unitless	1.0	Professional Judgement	1.0	Professional Judgement	BW x AT
	EF	Exposure Frequency	days/year	150	Professional Judgement	150	Professional Judgement	USEPA, 1989.
	ED	Exposure Duration	years	1	Professional Judgement	1	Professional Judgement	
	CF	Conversion Factor	kg/mg	1.0E-06	USEPA, 1989	1.0E-06	USEPA, 1989	
	BW	Body Weight	kg	70	USEPA, 1993	70	USEPA, 1989	
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA, 1989	25,550	USEPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	365	USEPA, 1989	365	USEPA, 1989	
Dermal	Cs	Chemical Concentration in Soil	mg/kg	95% UCL	USEPA, 1989	95% UCL	USEPA, 1993	Dermal CDI (mg/kg/day) =
	CF	Conversion Factor	kg/mg	1.0E-06	USEPA, 1989	1.0E-06	USEPA, 1989	Cs x CF x SA x AF x ABS x EF x ED
	SA	Skin Surface Area	cm^2/day	5,800	USEPA ,1997	5,000	USEPA, 1997	BW x AT
	AF	Soil to Skin Adherence Factor	mg/cm^2	0.3	USEPA, 2004	0.1	USEPA, 2004	USEPA, 1989.
	ABS	Dermal Absorption Factor (Solid)	unitless	chemical specific	USEPA, 2004	chemical specific	USEPA, 2004	
	EF	Exposure Frequency	days/year	150	Professional Judgement	150	Professional Judgement	
	ED	Exposure Duration	years	1	Professional Judgement	1	Professional Judgement	
	BW	Body Weight	kg	70	USEPA, 1993	70	USEPA, 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA, 1989	25,550	USEPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	365	USEPA, 1989	365	USEPA, 1989	

1 Surface / subsurface soil is defined as soil collected from depths of 0 to 10 foot below ground surface.

Daily Intake Calculations

Ingestion Intake = (IR x Fi x EF x ED x CF) / (BW x AT)
Dermal Intake = (CF x SA x AF x ABS x EF x ED) / (BW x AT)

Cancer Ingestion Intake - RME = 4.03E-08
Noncancer Ingestion Intake - RME = 2.82E-06

Cancer Ingestion Intake - CTE = 2.01E-08
Noncancer Ingestion Intake - CTE = 1.41E-06

Cancer Dermal Intake - RME = 1.46E-07
Noncancer Dermal Intake - RME = 1.02E-05

Cancer Dermal Intake - CTE = 4.19E-08
Noncancer Dermal Intake - CTE = 2.94E-06

CTE - Central Tendency Exposure.
CDI - Chronic Daily Intake.
RME - Reasonable Maximum Exposure.
UCL - Upper confidence limit.
USEPA - United States Environmental Protection Agency.

TABLE 2-7

CALCULATION OF NON-CANCER HAZARDS
FROM EXPOSURE OF CONSTRUCTION WORKERS TO SURFACE/SUBSURFACE SOIL IN CONSTRUCTIBLE AREA
REASONABLE MAXIMUM EXPOSURE
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA

Scenario Timeframe: Future
Medium: Surface Soil/Subsurface Soil
Exposure Medium: Surface Soil/Subsurface Soil
Exposure Point: Entire Site
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	COPC	Medium EPC Value (mg/kg)	Route EPC Value (mg/kg)	EPC Selected for Hazard Calculation	Intake (Non-Cancer) (mg/kg-day)	RfD (mg/kg-day)	Reference Concentration	HQ
Ingestion	Antimony	8.71E+01	8.71E+01	Medium	2.5E-04	4.00E-04	NA	6.1E-01
Dermal	Antimony	8.71E+01	8.71E+01	Medium	NA	6.00E-05	NA	NA

Dermal Absorption Fraction from Soil (ABS) (USEPA 2004):

Antimony - No ABS value provided

EPC - Exposure point concentration.
ABS - Absorption.
COPC - Chemical of Potential Concern.
HQ - Hazard quotient.
NA - Not applicable.
RfD - Reference dose.
USEPA - United States Environmental Protection Agency.

TABLE 2-8

ANTIMONY, IRON, AND LEAD CONCENTRATIONS IN NON-CONSTRUCTIBLE AREA
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA

SAMPLE NUMBER	SAMPLE LOCATION	DEPTH RANGE (feet)	ANTIMONY (mg/kg)	IRON (mg/kg)	LEAD (mg/kg)
0 to 2 Feet Approximate Depth Range					
05SB050002	05SB05	0 - 2	76.1 J	17,400. J	342. J
05SB060002	05SB06	0 - 2	301. J	105,000. J	16,900. J
05SB070002	05SB07	0 - 2	9.6 J	32,800. J	196. J
05SB080002	05SB08	0 - 2	3.2 J	15,600. J	16.4 J
05/03-08-90 #1 (90)	05/03-08	0.5 - 1	34.3	127,000.	2,350.
05/03-09-90 #1 (90)	05/03-09	0.5 - 1	43.	133,000.	2,720.
2 to 4 Feet Approximate Depth Range					
05/03-08-90 #2 (90)	05/03-08	3 - 3.5	44.7	205,000.	2,010.
6 to 10 Feet Approximate Depth Range					
05SB050608	05SB05	6 - 8	6.5 J	29,900. J	2,550. J
05SB060608	05SB06	6 - 8	208. J	43,900. J	2,860. J
05SB070608	05SB07	6 - 8	11.5 J	35,200. J	151. J

mg/kg - miligram per kilogram.

TABLE 2-9

VALUES OF DAILY INTAKE CALCULATIONS FOR EXPOSURE OF FUTURE CHILD RESIDENTS TO SURFACE SOIL IN NON-CONSTRUCTIBLE AREA CMP REPORT FOR SWMU 5 - OLD BURN PIT NSA CRANE CRANE, INDIANA

Scenario Timeframe: Future Medium: Surface Soil Exposure Medium: Surface Soil Exposure Point: Non-Constructible Area Receptor Population: Residents Receptor Age: Child (0 - 6 years)

Exposure Route	COPC	Medium EPC Value (mg/kg)	Route EPC Value (mg/kg)	EPC Selected for Hazard Calculation [1]	Intake (Non-Cancer) (mg/kg-day)	RfD (mg/kg-day)	Reference Concentration	HQ
Ingestion	Antimony	3.01E+02	3.01E+02	Medium	3.8E-03	4.00E-04	NA	10
	Iron	1.33E+05	1.33E+05	Medium	1.7E+00	1.10E+00	NA	1.5
Dermal	Antimony	3.01E+02	3.01E+02	Medium	NA	6.00E-05	NA	NA
	Iron	1.33E+05	1.33E+05	Medium	NA	1.10E+00	NA	NA

1 - Dermal Absorption Fraction from Soil (ABS) (USEPA, 2004): Antimony and iron - No ABS value provided.

ABS - Absorption factor from soil.
COPC - Chemical of Potential Concern.
EPC - Exposure point concentration.
HQ - Hazard quotent.
mg/kg - Milligram per kilogram.
mg/kg-day - Milligram per kilogram per day.
NA - Not applicable.
RfD - Reference dose.
USEPA - United States Environmental Protection Agency.

TABLE 2-10

REASONABLE MAXIMUM EXPOSURE
CALCULATION OF NON-CANCER HAZARDS
FROM EXPOSURE OF CONSTRUCTION WORKERS TO SURFACE/SUBSURFACE SOIL IN NON-CONSTRUCTIBLE AREA
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA

Scenario Timeframe: Future
Medium: Surface Soil/Subsurface Soil
Exposure Medium: Surface Soil/Subsurface Soil
Exposure Point: Non-Constructible Area
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	COPC	Medium EPC Value (mg/kg)	Route EPC Value (mg/kg)	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer) (mg/kg-day)	RfD (mg/kg-day)	Reference Concentration	HQ
Ingestion	Antimony	1.78E+02	1.78E+02	Medium	5.0E-04	4.00E-04	NA	1.3E+00
Dermal	Antimony	1.78E+02	1.78E+02	Medium	NA	6.00E-05	NA	NA

1 - Dermal Absorption Fraction from Soil (ABS) (USEPA, 2004): Antimony - No ABS value provided.

EPC - Exposure point concentration.
ABS - Absorption factor from soil.
COPC - Chemical of Potential Concern.
HQ - Hazard quotient.
kg - kilograms.
mg - milligrams.
NA - not applicable.
RfD - Reference dose.
USEPA - United States Environmental Protection Agency.

TABLE 2-11

MEDIA CLEANUP STANDARDS FOR SURFACE AND SUBSURFACE SOIL
CMP REPORT FOR SMWU 5 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA

Chemical	Media Cleanup Standards[1]	
	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)
Future Construction Worker		
Antimony	690	690
Lead	1,000	1,000
Future Child Resident		
Antimony	43	NA[2]
Iron	77,000	NA[2]
Lead	400	NA[2]

1 - The MSCs listed are the direct contact IDEM Closure Levels (IDEM, 2014) for an excavation exposure scenario for construction workers and a residential exposure scenario for future child residents.
2 - Future child residents are not exposed to subsurface soil.

IDEM - Indiana Department of Environmental Management.
MCSs - Media cleanup standards.
mg/kg - milligrams per kilogram.
N/A - not applicable.

TABLE 2-12

MEDIA CLEANUP STANDARDS FOR GROUNDWATER AND SURFACE WATER
CMP REPORT FOR SMWU 5 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA

CASRN	Chemical	MCS Groundwater[1] (µg/L)	MCS Surface Water[2] (µg/L)
Dioxins/Furans			
1746-01-6	Total Dioxin 2,3,7,8-TCDD TEQ[4]	0.00003 [5]	0.0005 [7]
Volatile Organics			
67-66-3	Chloroform	80 [5]	140 [3]
75-35-4	1,1-Dichloroethene	7 [5]	65 [3]
156-59-2	cis-1,2-Dichloroethene	70 [5]	620 [8]
156-60-5	trans-1,2-Dichloroethene	100 [5]	560 [8]
79-01-6	Trichloroethene	5 [5]	47 [3]
75-01-4	Vinyl chloride	2 [5]	47 [7]
Semi-Volatile Organics			
117-81-7	Bis(2-ethylhexyl) phthalate	6 [5]	0.3 [3]
Metals			
7429-90-5	Aluminum	16,000 [6]	87 [9]
7440-36-0	Antimony	6 [5]	80 [3,8]
7440-38-2	Arsenic	10 [5]	46.7 [7]
7440-39-3	Barium	2,000 [5]	210 [8]
7440-50-8	Copper	1,300 [5]	1.58 [3]
7439-89-6	Iron	11,000 [6]	1,000 [9]
7439-92-1	Lead	15 [5]	1.17 [3,10]
7439-96-5	Manganese	320 [6]	288 [8]
7440-62-2	Vanadium	63 [6]	12 [3,8]
7440-66-6	Zinc	4,700 [6]	58 [10]

µg/L - microgram per liter.
CASRN - Chemical Abstract Services Registry Number.
ESL - Ecological Screening Level.
IDEM - Indiana Department of Environmental Management.
USEPA - United States Environmental Protection Agency.
RCRA - Resource Conservation & Recovery Act of 1976.
RISC - Risk Integrated System of Closure.
MCS - Media cleanup standard.

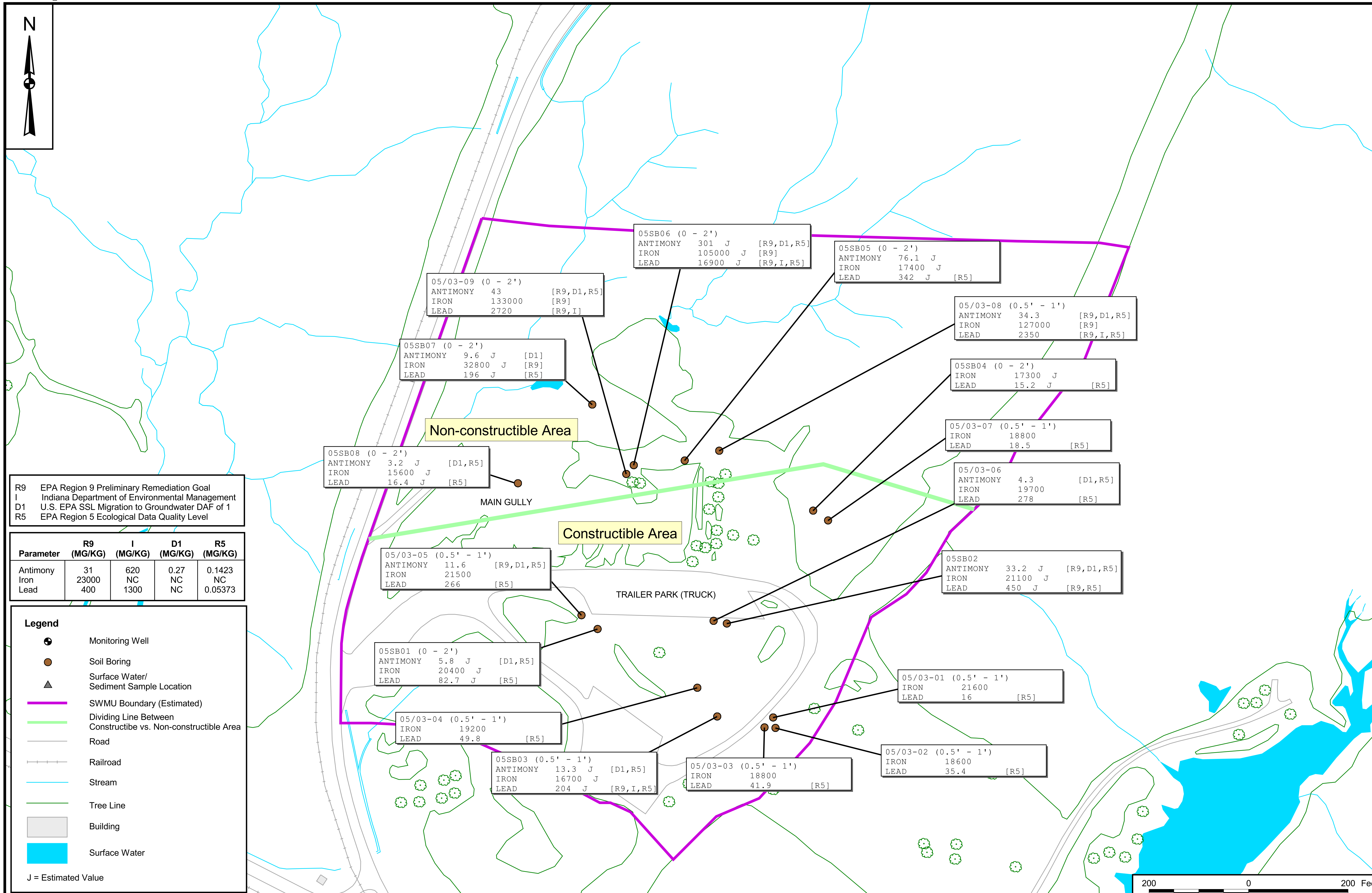
1 MCS assumes that groundwater is used as a domestic water supply source.
2 The Surface Water MCS is the lower of the Human Health Water Only, Unprotected Water Supply value or the chronic aquatic life criteria from Table A-1 in Appendix A.
3 USEPA, Region 5, RCRA ESL. http://www.epa.gov/reg5rcra/ca/ESL.pdf
4 Dioxin-TEQ concentration as 2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD).
5 USEPA Primary Drinking Water Standard (USEPA, 2012).
6 IDEM, RISC residential closure levels for tap water/groundwater (IDEM, 2014).
7 Calculated according to Indiana Administrative Codes 327 IAC 2-1-8-5 and 2-1-8-6. Note that the cancer target risk for IDEM is 1E-05. See Appendix A for calculation sheets.
8 IDEM, Criteria and Values for Selected Substances Calculated Using the Great Lakes Basin Methodologies.
9 USEPA Recommended Water Quality Criteria (USEPA, 2013). http://www.water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm
10 IDEM, Water Quality Standards (based on a water hardness of 50 mg/L). http://www.in.gov/legislative/iac/T03270/A00020.pdf

PGH:P:\GIS\CRANE_NSWC\MAPDOCS\MXD\SWMU05_CONSTRUCT_AREAS.MXD 4/9/2014

CONSTRUCTIBLE AND NON-CONSTRUCTIBLE AREAS
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA

CONTRACT NUMBER 3088		CTO NUMBER	
APPROVED BY KAREN LYONS	DATE 03/27/14	APPROVED BY —	DATE —
FIGURE NO. 2-1		REV 0	
DRAWN BY K. PEILA	DATE 6/2/05		
CHECKED BY V. PLACHY	DATE 8/2/06		
REVISED BY K. MOORE	DATE 03/27/14		
SCALE AS NOTED			

P:\GIS\CRANE_NSWC\MAPDOCS\APR\SWMU05.APR DETECTIONS OF SB, FE, AND PB IN SURFACE SOIL LAYOUT 4/9/14 KM



Parameter	R9 (MG/KG)	I (MG/KG)	D1 (MG/KG)	R5 (MG/KG)
Antimony	31	620	0.27	0.1423
Iron	23000	NC	NC	NC
Lead	400	1300	NC	0.05373

CONTRACT NO. 3088

APPROVED BY KAREN LYONS DATE 03/27/14

APPROVED BY DATE

DRAWING NO. FIGURE 2-2

REV 0

ANTIMONY, IRON, AND LEAD DETECTIONS IN SURFACE SOIL
SWMU 5 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA

NAVFAC

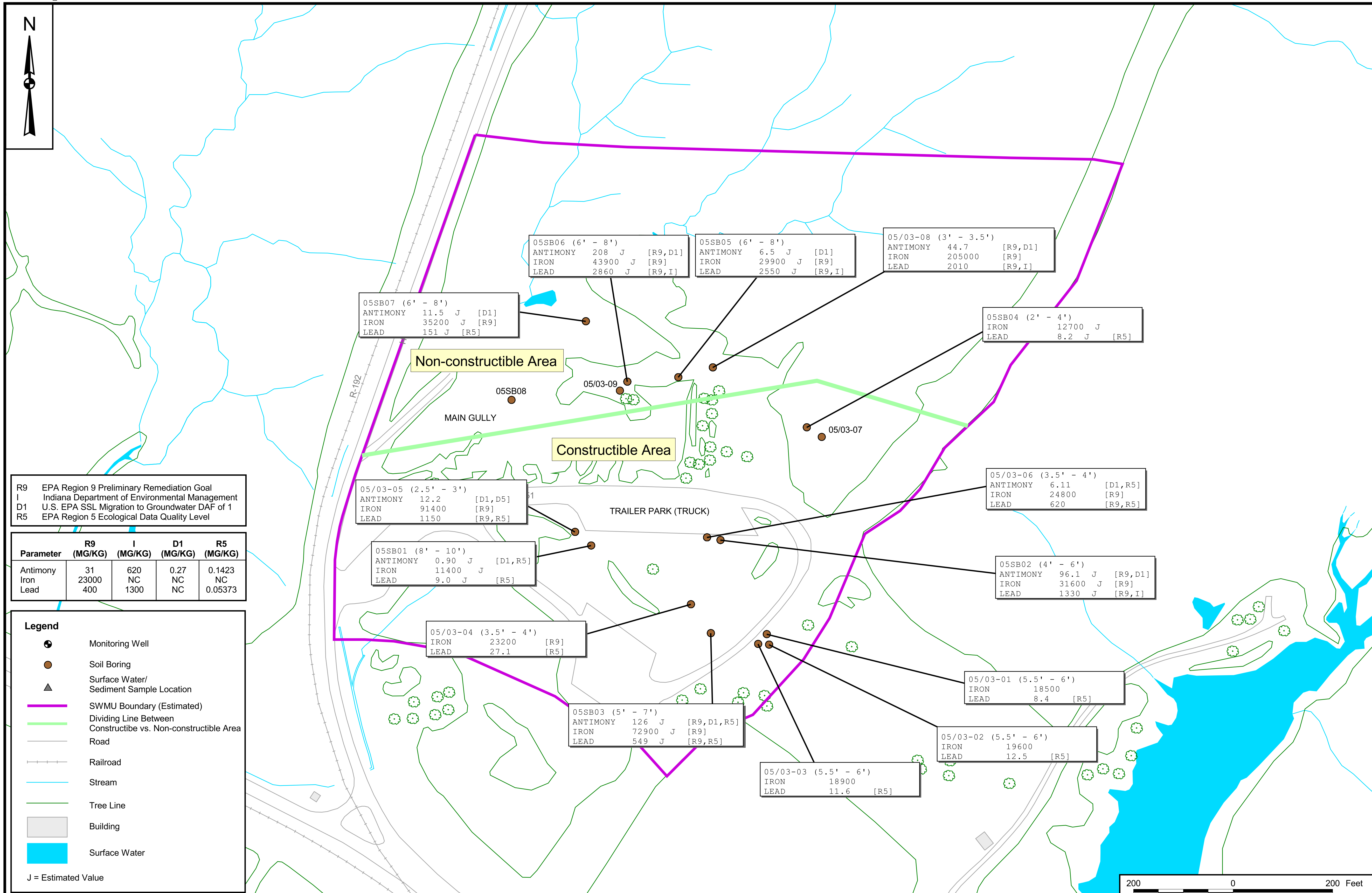
DRAWN BY S. PAXTON DATE 2/07/07

CHECKED BY V. PLACHY DATE 6/14/07

COST/SCHED-AREA

SCALE AS NOTED

P:\GIS\CRANE_NSWC\MAPDOCS\APR\SWMU05.APR DETECTIONS OF SB, FE, AND PB IN SUBSURFACE SOIL LAYOUT 4/9/14 KM



Parameter	R9 (MG/KG)	I (MG/KG)	D1 (MG/KG)	R5 (MG/KG)
Antimony	31	620	0.27	0.1423
Iron	23000	NC	NC	NC
Lead	400	1300	NC	0.05373

CONTRACT NO. 3088

APPROVED BY KAREN LYONS DATE 03/27/14

APPROVED BY DATE

DRAWING NO. FIGURE 2-3 REV 0

ANTIMONY, IRON, AND LEAD DETECTIONS IN SUBSURFACE SOIL
SWMU 5 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA

NAVFAC

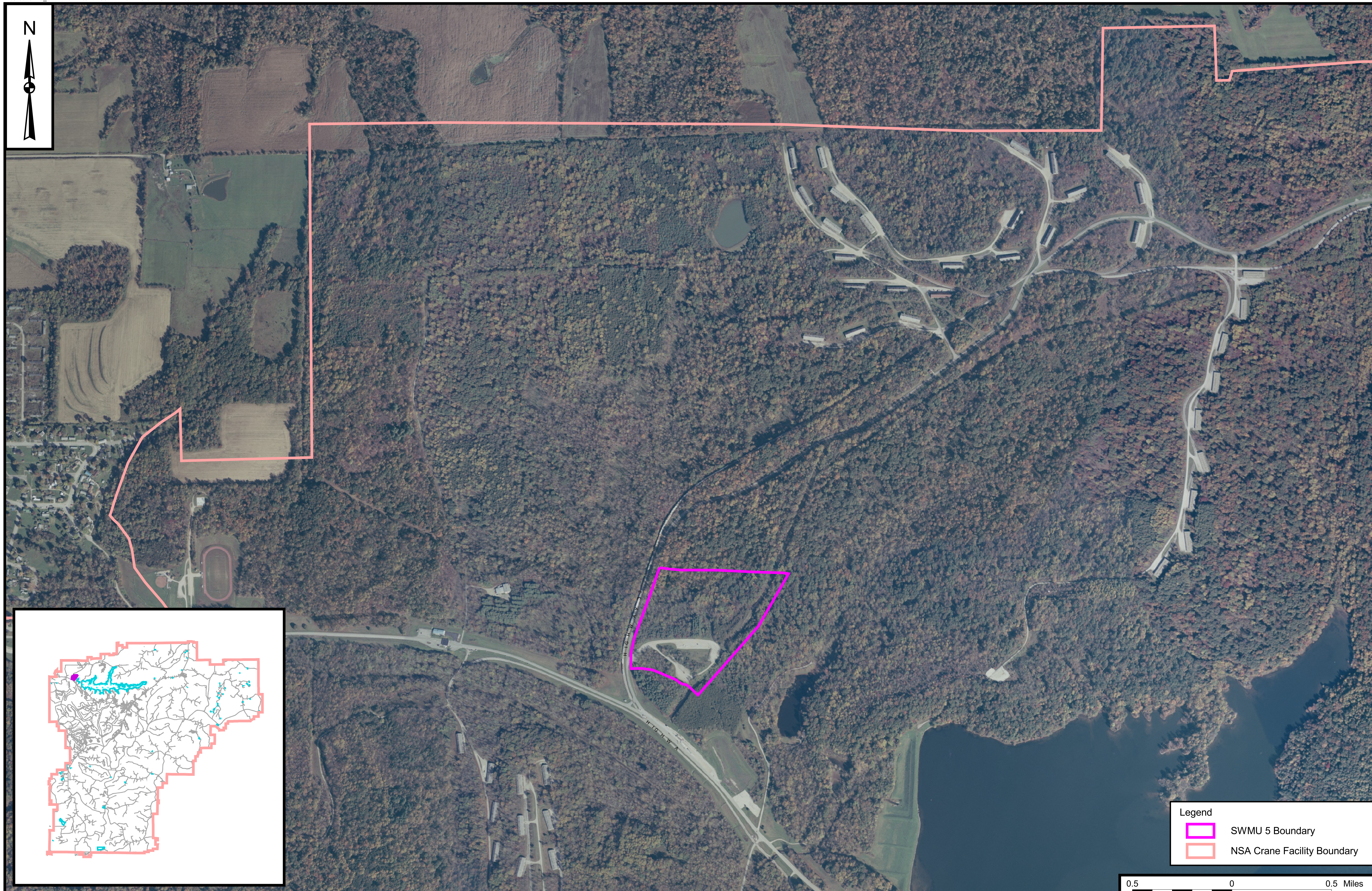
DRAWN BY S. PAXTON DATE 2/07/07

CHECKED BY V. PLACHY DATE 6/14/07

COST/SCHED-AREA

SCALE AS NOTED

P:\GIS\NSWC_CRANE\APR\SWMU5.APR SWMU 5 FACILITY 4/9/14 KM



AERIAL PHOTOGRAPH (2003)
SWMU 5 AND SURROUNDING AREAS
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSWC CRANE
CRANE, INDIANA

DRAWN BY K. PEILA	DATE 6/2/05	CONTRACT NO. 3088
CHECKED BY V. PLACHY	DATE 8/2/06	APPROVED BY KAREN LYONS — DATE 03/27/14
COST/SCHED-AREA		APPROVED BY — DATE —
SCALE AS NOTED		DRAWING NO. FIGURE 2-4 — REV —

NAVFAC

3.0 DEVELOPMENT OF CORRECTIVE MEASURES RECOMMENDATIONS

The corrective action objectives for SWMU 5 are: 1) prevent human exposure to groundwater and surface water containing chemical concentrations greater than the MCSs and 2) prevent exposure to contaminated soil and groundwater at SWMU 5 by restricting development and use of the site for residential housing and similar exposure scenarios, such as elementary and secondary schools, child care facilities, and playgrounds.

Based on the current and future uses of SWMU 5 constructible and non-constructible areas that are described in Sections 1.0 and 2.0, the following CMs recommendations are made. Table 3-1 depicts the process used to arrive at these recommendations for SWMU 5.

As previously discussed, SWMU 5 is an inactive facility, and human receptors and pathways of exposure are limited to the existing land use scenario (military/industrial). A relatively flat area of SWMU 5 has a development potential (i.e., constructible area) (Figure 2-1). The constructible area future land use scenarios evaluated in this CMP are residential and construction worker. The use of the hilly/gully area of SWMU 5 (i.e., non-constructible area) will continue to be as an ecological habitat.

3.1 CORRECTIVE MEASURES

3.1.1 Soils

3.1.1.1 Constructible Area

No unacceptable soil risk has been identified for the constructible area of SWMU 5. Therefore, no CMs evaluation [e.g., no further action (NFA)] is required for soil contamination associated with the constructible area of SWMU 5.

3.1.1.2 Non-Constructible Area

Debris Field/Hotspots

The non-constructible area contains a debris field that consists of debris which is partially-embedded into the soil within a relatively flat area and a steeply slopped area (i.e., a hillside area along the south bank of an un-named tributary). Sample logbook entries indicate that many of the soil samples were collected at or near debris items (i.e., rusted drum or other metal items). There is a lead hotspot (05SB06) that is most likely associated with a debris item. If the lead hotspot was removed, the risks from lead for the all human receptors would be acceptable.

The debris field resulted from hauling miscellaneous materials from the old burn pit to the hillside, dumping it over the hillside, and then covering it with a layer of soil. The action of covering the hauled debris resulted in extending the flat area towards the north and the creation a steep hillside [i.e., hillside slope exceeds a 1 to 3 ratio (1:3)]. The number of times that this hauling / dumpling / covering process was repeated is not known. However, it is reasonable to assume a minimum of five layer of debris covered with soil are present along the hillside.

SWMU 5 debris removal is problematic at best because the extent of contamination is unknown (i.e., depth and distance from the visible debris is unknown). The majority of the exposed debris at SWMU 5 is located along the steep hillside. Any disturbance of the hillside would require stabilization of the hillside [i.e., re-grading / re-sloping of the hillside to achieve a 1:3 slope and re-vegetation of the hillside].

The SWMU 5 debris field exists in several layers resulting from debris being repeatedly dumped over a hillside and then buried. The following remedial actions were evaluated for SWMU 5:

1) Cutting the exposed debris to ground surface with a torch,
2) Exposed debris removal,
3) Soil covering of the exposed debris, and
4) Removal of Hotspot 05SB06 and readily removable debris.

Option 1, cutting the exposed material to ground level with a torch, would require establishing a non-flammable zone around the flat and hillside debris areas. Because the existing hillside is so steep, the cleared areas along the hillside would be unstable even after re-vegetation and would require re-sloping. The re-sloping could be accomplished by extending of the hillside into the valley, which would eliminate the existing valley. It is likely that the hillside would collapse during remediation or re-sloping activities; resulting in the exposure of additional debris and a high potential for personnel injury. Another re-sloping option is to cut into the existing flat area. This would result in exposure of additional debris and a high potential for personnel injury from instability of the hillside during re-sloping.

This option would result in uncertain contamination removal effectiveness while negatively impacting a thriving ecosystem with the destruction of habitat from clearing areas around the debris to establish a non-flammable zone around the debris.

Option 2, removal of the exposed debris on the flat area, would require digging out the unexposed portion of the material. Manual digging is impractical because the depth of each debris item is unknown (e.g., buried construction and building structural components could be several feet under the ground surface). Therefore, excavation equipment to remove the debris was evaluated. As debris material is removed, other layers of debris would be exposed and the extent of remediation is unknown. Additionally, the excavation equipment would probably require the creation of temporary roads.

Removal of the exposed debris within the hillside area, would also require digging out the unexposed portion of the material. Again, manual digging is impractical because the depth of each debris item is unknown (e.g., buried construction and building structural components could be several feet under the ground surface). Therefore, the use of excavation equipment to remove the debris was evaluated. As debris material is removed, other layers of debris would be exposed and the extent of remediation is unknown. Additionally, the excavation equipment would probably require the creation of temporary roads.

The probability of the hillside collapsing and resulting in the exposure of additional debris is likely for both activities. Due to the unknown debris depth, an arbitrary removal depth and distance around pieces of debris would need to be established. After debris removal, the following restorative activities would need to occur:

- Backfill of the areas where the debris was removed,
- Remove then restore the areas where temporary roads were constructed,
- Cover the newly exposed debris with clean material,
- Re-slope / re-grade the hillside to 1:3 slope, and
- Re-vegetate the disturbed areas.

These activities would have a negative impact to the existing-thriving ecosystem.

Option 3, a soil cover for the exposed debris along the flat area, would require removal of the existing vegetation (i.e., trees). Soil cover for the exposed debris along the hillside would require removal of the existing vegetation and then re-sloping of the hillside to achieve a 1:3 ratio. To achieve this slope, the hillside would need to be cut back into the existing flat area or the valley would need to be filled backfilled. Either approach would result in extensive disturbance of the existing ecosystem, which is thriving.

This option would not remove but would negatively-impact a thriving ecosystem with the removal of vegetation, excavation, and road construction.

Option 4, hotspot (05SB06) removal and manual surface debris removable, would involve the removing a predetermined amount of exposed surface debris on the flat area and flat and hillside areas of the SWMU. This option is anticipated to result in the minimal ecosystem destruction and in nominal hillside stability concerns.

The surface debris removal will be conducted using manual means [cutting tool (i.e., hand pickup of loose debris, manual cutting {i.e., cutting tools that do not have an open flame}, and manual or mechanical lifting that will result in limited soil disturbance {i.e., no digging will be conducted along the steep hillside, mechanical cutting tools with no open flame for debris removal, etc.})]. For costing development, this manual removal is anticipated to take two weeks.

Decision rules will be developed in the Work Plan to determine when the debris item cannot be safely removed by manually digging/winching or by mechanical cutting to ground surface (i.e., left in place).

Also, the lead surface soil hotspot area (05SB06) will be remediated to a depth of 1 foot and laterally to 1,100 ppm. The area will then be backfilled with clean fill.

Option 4 will be carried through the CMP.

The following three CMs will be considered for metals in soils in the non-constructible area:

- No Action, designated as Alternative S-1
- Limited Action, consisting of LUCs, and designated as Alternative S-2. The purpose of this alternative is to prevent unacceptable human receptor exposure to soils.
- Limited Removal Action, consisting of lead hotspot removal, aesthetic surface debris removal, and LUCs, designated as Alternative S-3. The purpose of this alternative is to prevent unacceptable human receptors exposure to soils via LUCs, enhance the appearance of the land via surface debris removal, and mitigate the risks associated with lead via hotspot removal.

3.1.2 Groundwater/Surface Water

It has been determined that the same CMs [No Action and Limited Action - LUCs and long-term monitoring (LTM)] will be evaluated for groundwater in the constructible and non-constructible areas and surface water. Two CMs considered for groundwater and surface water are as follows:

- No Action, designated as Alternative GW-1.
- Limited Action, consisting of LUCs and LTM, designated as Alternative GW-2. The purpose of this alternative is to prevent use of groundwater and to monitor unacceptable contaminant migration. Residential exposure to surface water would be addressed via the implementation of LUCs for soil (Alternative S-2). Therefore, additional LUCs for surface water are not required.

TABLE 3-1

REMEDY EVALUATION PROCESS SUMMARY
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA
PAGE 1 OF 2

INVESTIGATION PHASE				REMEDIAL ACTION EVALUATION PHASE		
Medium (Receptor)	**Document**	**Findings / Evaluations**	**Conclusion**	**Considerations**	**Evaluation Conclusions**	**Remedy**
Soils – Human Health[(1)]						
Metals (antimony, iron, and lead)	RFI Report (TtNUS, 2005)	Excess risks from antimony for future construction workers exposed to surface/subsurface soil and future residents exposed to surface soil Excess risks from iron for future residents exposed to surface soil Blood-lead levels for future child residents exposed to surface soil exceeded USEPA's goal of 10 µg/dL using the IEUBK Model; also, more than 5 percent of future child residents were estimated to have blood-lead levels greater than USEPA's goal Probability of future construction workers exposed to surface/subsurface soil having children with blood-lead levels greater than 10 µg/dL slightly exceeded USEPA's goal of 5 percent using the TRW Adult Lead Model If the hot spot area was to be removed, the average surface soil concentration would be 220 mg/kg and lead would not have been selected as a COPC for the site (i.e., risks for all receptors would be acceptable)	• Proceed to CMP • Further evaluate "hot spot" removal • Further evaluation of surface debris removal • Excess risk from iron to future child residents based on the daily recommended allowances	• SWMU consists of constructible area and non-constructible area • Current and future land use of constructible area: military/industrial • Current and future land use of non-constructible area: ecological habitat only • Re-evaluate HHRA for current land use and current receptors • Lead hot spot is within debris field • Depth of debris is unknown • Disturbance of the debris along the hillside would require grading to a slope of 1:3 disturbing more debris or covering the valley	• No unacceptable risks for future child residents exposed to surface soil and future construction workers exposed to surface/subsurface soil were identified for the constructible area • Unacceptable risks from antimony, iron, and lead to future child residents exposed to surface soil and from antimony and lead to construction workers exposed to surface/subsurface soil were identified for the non-constructible area • NFA for antimony, iron, and lead is required for the constructible area • For the non-constructible area, three alternatives were evaluated – no action, limited action (LUCs), and limited removal action (LUCs, surface debris removal, and lead hotspot removal)	• Constructible area: NFA • Non-constructible area recommended alternative: Limited removal action including LUCs to prevent exposure to soil, surface debris removal to enhance the appearance of the land, and hotspot removal to mitigate the risks associated with lead
Soils – Ecological						
Metals (antimony, barium, cadmium, chromium, copper, lead, mercury, silver, tin, and zinc)	RFI Report (TtNUS, 2005)	Unacceptable risks for terrestrial plans and/or invertebrates contacting soils containing antimony, barium, chromium, copper, lead, silver, tin, and zinc	• Proceed to CMP	• Re-evaluate ecological risk in context of contiguous ecological system	• ERA conducted as part of CMP determined that there are no adverse ecological impacts that warrant a remedial action when considering the contiguous ecological system	• NFA
Dioxins/Furans		Unacceptable risks for insectivorous/herbivorous mammals and birds exposed to dioxins/furans, cadmium, chromium, copper, lead, mercury, silver, and zinc through the food chain				
Groundwater – Human Health						
Dioxins/Furans BEHP Metals (arsenic and manganese)	RFI Report (TtNUS, 2005)	Excess risks for future residents from potable use of groundwater containing dioxins/furans, BEHP, arsenic, and manganese Concentrations of dioxins/furans (as 2,3,7,8,-TCDD TEQs) in all samples were less than the MCL for 2,3,7,8,-TCDD (0.00003 µg/L) BEHP is a common laboratory contaminant and was only detected in one of 14 samples The maximum concentration of arsenic in groundwater is less than the 10 mg/L MCL; also, concentrations of arsenic in site wells are similar to concentrations in the upgradient well	• Proceed to CMP	• Risks are based on hypothetical future residential use • Groundwater is not used under current and future industrial land uses	• NFA and limited action (LUCs and LTM) were two alternatives evaluated; evaluation combined with surface water	• Recommended alternative: LUCs to prevent use of groundwater and LTM to ensure that unacceptable contaminant migration does not occur
Surface Water – Human Health						
Trichloroethene and vinyl chloride	RFI Report (TtNUS, 2005)	Excess risks for future residents exposed to surface water 350 days/year Surface water samples were collected beneath ice and reported concentrations of VOCs are not considered to be representative of site conditions throughout the year; therefore, excess risks are overestimated	• NFA; risks are overestimated and do not warrant a remedial action	• Risks are based on hypothetical future residential use • Risks for current receptors are acceptable • Contaminant concentration information is needed to confirm groundwater and surface water interaction and whether VOCs are a concern	• NFA and limited action (LTM) were two alternatives evaluated; evaluation combined with groundwater	• Recommended alternative: LTM to ensure that unacceptable contaminant migration does not occur

TABLE 3-1

REMEDY EVALUATION PROCESS SUMMARY
CMP REPORT FOR SWMU 5 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA

µg/dL - micrograms per deciliter.
BEHP - Bis(2-ehtylhexyl)phthalate. MP - Corrective Measures Proposal.
COPC - Chemicals of Potential Concern.
ERA - Environmental Risk Assessment.
HHRA - Human Health Risk Assessment.
IEUBK - Integrated Exposure Uptake Biokinetic.
LUC - Land use control.
MCL - Maximum Contaminant Level.
mg/kg - milligrams per kilogram.
NFA - No further action.
RCRA - Resource Conservation and Recovery Act.
RFI - RCRA Facility Investigation.
SWMU - Solid Waste Management Unit.
TCDD - Tetrachlorodibenzo-p-dioxin.
TEQ - Toxicity Equivalents.
TRW - Technical Review Workgroup.
USEPA - United States Environmental Protection Agency
VOCs – Volatile Organic Compounds

1 The risks associated with dioxins/furans and polycyclic aromatic hydrocarbons in soils are not discussed in this table because no remedial actions are warranted for these chemicals, as identified in Section 2.2.1 of this CMP.

4.0 CORRECTIVE MEASURES COMPARISON

This section evaluates the CMs presented in Section 3.0 and summarized in Table 3-1. Section 4.4 presents the conclusions from the CMP.

As previously discussed, the OBP is an inactive site contained entirely within NSA Crane. NSA Crane, including the OBP, is a military facility; therefore, only current OBP receptors (i.e., construction workers and trespassers) will be addressed in this CMP. LUCs will be implemented to ensure that the site remains military/industrial (e.g., no residential receptors).

The alternatives were evaluated using the following criteria set forth in the draft Statement of Work for a Corrective Measures Proposal developed by USEPA Region 5 (USEPA, 2005):

- Protection of human health and the environment
- Attainment of MCSs
- Control of release sources
- Compliance with applicable standards for waste management
- Other factors including:
  - Long-term reliability and effectiveness
  - Reduction in toxicity, mobility, or volume of wastes
  - Short-term effectiveness
  - Implementability
  - Cost

4.1 SOIL ALTERNATIVES

As previously discussed, there is no risk to current or future receptors associated with soils in the constructible area. Therefore, the soil alternatives will address the non-constructible area of SWMU 5.

4.1.1 Alternative S-1: No Action (Non-Constructible Area)

4.1.1.1 Protection of Human Health and the Environment

Alternative S-1 is considered primarily as a baseline for comparison to other CMs. This alternative would not be protective of human health because of lack of institutional controls. Alternative S-1 would not prevent exposure to metals-contaminated soils (antimony, iron, and lead) that could result in unacceptable human health risks in the non-constructible area. Alternative S-1 would not ensure that the land use remained military/industrial (i.e., would not prevent future use of the land for residential development), which could result in additional unacceptable human health risks.

4.1.1.2 Attainment of Media Cleanup Standards

Alternative S-1 would not attain the metals MCSs because it would leave soils in place in the area where unacceptable antimony, iron, and lead contamination results in risk to construction workers and/or the future residential receptors.

4.1.1.3 Source Control

Localized metals-contaminated soil has been identified in the non-constructible area (TtNUS, 2005). Alternative S-1 would not involve any source control measures.

4.1.1.4 Compliance with Waste Management Standards

There are no removal actions to be implemented for Alternative S-1 and therefore no waste would be generated.

4.1.1.5 Other Factors

Long-Term Reliability and Effectiveness

Alternative S-1 would not be reliable and effective in the long term because no action would occur. The localized area of antimony, iron, and lead contamination would remain. The potential threat to human health would remain because there would be no controls to prevent future residential land use or construction activities in the non-constructible area.

Reduction in Toxicity, Mobility, and Volume

Alternative S-1 would not reduce contaminant toxicity, mobility, or volume.

Short-Term Effectiveness

Alternative S-1 would not involve any action and therefore would not pose any risks to on-site workers during remedy implementation, and no environmental impacts would be expected.

Implementability

Because no action would occur, Alternative S-1 would be readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable.

Cost

There are no costs associated with No Action, Alternative S-1.

4.1.2 Alternative S-2: Limited Action - Land Use Controls (Non-Constructible Area)

4.1.2.1 Protection of Human Health and the Environment

Alternative S-2 would be protective of human health and the environment. LUCs would protect human health by preventing exposure to contaminated soils in the non-constructible area as long as antimony, iron, and lead concentrations remain unacceptable.

4.1.2.2 Attainment of Media Cleanup Standards

Alternative S-2 would not attain the antimony, iron, or lead MCSs; however, LUCs would protect human health by preventing exposure of future residents and construction workers to metals-contaminated soils in the non-constructible area as long as concentrations of these metals remain unacceptable.

4.1.2.3 Source Control

Alternative S-2 does not provide for source control.

4.1.2.4 Compliance with Waste Management Standards

Alternative S-2 would not involve any removal of contaminated soils; therefore, residues would not be generated.

4.1.2.5 Other Factors

Long-Term Reliability and Effectiveness

Alternative S-2 would be reliable and effective in the long term for protection of human health from antimony, iron, and lead contamination. LUCs would reliably and effectively prevent potential future exposure to metals-contaminated soils and ensure that land use remains military/industrial.

Reduction in Toxicity, Mobility, and Volume

Alternative S-2 would not reduce contaminant toxicity, mobility, or volume.

Short-Term Effectiveness

Alternative S-2 would involve administration of LUCs. Implementation of this alternative would not result in any short-term threat to the surrounding community or to ecological receptors.

Implementability

Alternative S-2 would be readily implementable. LUCs would be readily implementable because SWMU 5 is completely contained within NSA Crane, and LUCs would be similar to those implemented at other environmental sites within NSA Crane.

Alternative S-2 could be implemented within approximately 12 months.

Cost

The following costs are estimated for Alternative S-2: Limited Action - LUCs:

Capital Cost:	$ 3,000
Annual and Operation and Maintenance (O&M) Costs:	$ 3,000 per year; plus $1,000 every additional 5 years
30-Year Net Present Worth (NPW):	$ 39,000

The above cost figures have been rounded to the nearest $1,000 to reflect the preliminary nature of these estimates. Detailed cost estimates are provided in Appendix B-1.

4.1.3 Alternative S-3: Limited Removal Action- Land Use Controls, Surface Debris Removal, and Lead Hotspot Removal (Non-Constructible Area)

4.1.3.1 Protection of Human Health and the Environment

Alternative S-3 would be protective of human health and the environment. LUCs would protect human health by preventing future exposure to contaminated soils in the non-constructible area as long as antimony, iron, and lead concentrations remain unacceptable. Surface debris removal would protect human health by preventing exposure to surface debris in the non-constructible area. Hotspot removal would protect human health by eliminating a source of lead-contaminated soils in the non-constructible area.

4.1.3.2 Attainment of Media Cleanup Standards

Alternative S-3 would not attain the antimony and iron MCSs.

However, LUCs would protect human health by preventing exposure of future residents and construction workers to metals-contaminated soils in the non-constructible area as long as concentrations of these metals remain unacceptable. Debris removal would protect human health by preventing exposure of future residents and construction workers to exposed metals-contamination. Finally, the lead hotspot removal would protect human health by preventing exposure of future residents and construction workers to an area of high lead-contaminated soil and would attain the lead MCS for this area.

4.1.3.3 Source Control

Alternative S-3 provides for source control in the lead hotspot area.

4.1.3.4 Compliance with Waste Management Standards

Waste management standards would be followed during the removal of surface debris and lead-contaminated soil.

4.1.3.5 Other Factors

Long-Term Reliability and Effectiveness

Alternative S-3 would be reliable and effective in the long term for protection of human health from antimony, iron, and lead contamination. LUCs would reliably and effectively prevent potential current and future exposure to metals-contaminated soils and ensure that land use remains military/industrial. However, it is uncertain if soil weathering would result in additional exposure of the buried debris along the hillside.

Reduction in Toxicity, Mobility, and Volume

Alternative S-3 would reduce toxicity, mobility, and volume of lead-contaminated soil by the removal of the lead hotspot.

Short-Term Effectiveness

Alternative S-3 would involve administration of LUCs. Implementation of this alternative would not result in any short-term threat to the surrounding community or to ecological receptors. Surface debris and hotspot removal and disposal would be managed using appropriate personal protective equipment (PPE) and an approved disposal facility that would not result in any short-term threat to the surrounding community. However, it is anticipated that remedial efforts in the non-constructible area would result in a temporary adverse impact to the ecological habitat, which currently does not show obvious adverse impacts from the contamination.

Implementability

Alternative S-3 would be readily implementable. LUCs would be readily implementable because SWMU 5 is completely contained within NSA Crane, and LUCs would be similar to those implemented at other environmental sites within NSA Crane. Surface debris and hotspot removal would be readily implementable because similar activities have been implemented at other environmental sites within NSA Crane.

Alternative S-3 could be implemented within approximately 12 months.

Cost

The following costs are estimated for Alternative S-3: Limited Removal Action - LUCs, Surface Debris Removal, and Lead Hotspot Removal:

Capital Cost:	$155,000
Annual and O&M Costs:	$2,000 per year; plus $7,000 additional every 5 years
30-Year NPW:	$190,000

The above cost figures have been rounded to the nearest $1,000 to reflect the preliminary nature of these estimates. Detailed cost estimates are provided in Appendix B-2.

4.2 GROUNDWATER AND SURFACE WATER ALTERNATIVES

4.2.1 Alternative GW-1: No Action

4.2.1.1 Protection of Human Health and the Environment

Alternative GW-1 is considered primarily as a baseline for comparison to other CMs. This alternative would not be protective of human health because of lack of monitoring and institutional controls. There are no current users of groundwater at SWMU 5 and no residential exposure to surface water; thus no unacceptable risks to human receptors exist under current land use. However, Alternative GW-1 would not prevent future use of the groundwater aquifer as a drinking water source, which could result in unacceptable human health risks.

Although there are no current risks for groundwater and surface water for human and ecological receptors, continued contaminant migration could potentially lead to unacceptable risks and, in the absence of LTM, there would be no warning of the unacceptable risks.

4.2.1.2 Attainment of Media Cleanup Standards

Alternative GW-1 would not attain the MCSs.

4.2.1.3 Source Control

Alternative GW-1 would not involve any source control because no action would be performed as part of this alternative and no sources of contamination have been identified.

4.2.1.4 Compliance with Waste Management Standards

There are no actions to be implemented for Alternative GW-1 and therefore no waste would be generated.

4.2.1.5 Other Factors

Long-Term Reliability and Effectiveness

Alternative GW-1 would not be reliable and effective in the long term because no action would occur. The potential threat to human health and the environment would remain because there would be no controls to prevent future residential use of groundwater and surface water and no monitoring would be conducted to warn of potential unacceptable risks from contaminant migration.

Reduction in Toxicity, Mobility, and Volume

Alternative GW-1 would not reduce contaminant toxicity, mobility, or volume.

Short-Term Effectiveness

Alternative GW-1 would involve no action and therefore would not pose any risks to on-site workers during remedy implementation, and no environmental impacts would be expected.

Implementability

Because no action would occur, Alternative GW-1 would be readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable.

Cost

There are no costs associated with the No Action, Alternative GW-1.

4.2.2 Alternative GW-2: Limited Action - Land Use Controls and Long-Term Monitoring

4.2.2.1 Protection of Human Health and the Environment

Alternative GW-2 would be protective of human health and the environment. LUCs would protect human health by preventing exposure to contaminated groundwater. LUCs to be implemented for soil (Alternative S-2) would prevent residential development of the land and residential exposure to surface water.

4.2.2.2 Attainment of MCSs

Alternative GW-2 would not attain the MCSs but would prevent exposure to contaminated groundwater and, as indicated previously, residential use of surface water would be prevented by LUCs to be implemented for soil (Alternative S-2).

Although there are no current risks for groundwater and surface water for human and ecological receptors, continued migration of contaminants could potentially lead to unacceptable risks and, in the absence of LTM, there could be no warning of these unacceptable risks.

4.2.2.3 Source Control

Alternative GW-2 would not involve any source control because no sources of contamination have been identified.

4.2.2.4 Compliance with Waste Management Standards

Alternative GW-2 would not involve any removal or ex-situ treatment of contaminated groundwater and surface water; therefore, no residues would be generated.

4.2.2.5 Other Factors

Long-Term Reliability and Effectiveness

Alternative GW-2 would be reliable and effective in the long term because LUCs would prevent potential future exposure to contaminated groundwater and surface water (via LUCs for soil).

Reduction in Toxicity, Mobility, and Volume

Alternative GW-2 would not reduce contaminant toxicity, mobility, or volume.

Short-Term Effectiveness

Alternative GW-2 would involve administration of LUCs. The short-term human health risks associated with these limited remedial activities would be minimal. Implementation of this alternative would not result in any short-term threat to the surrounding community or to ecological receptors.

Implementability

Alternative GW-2 would be readily implementable. LUCs would be readily implementable because SWMU 5 is completely contained within NSA Crane, and they would be similar to those implemented at other environmental sites within NSA Crane.

Alternative GW-2 could be implemented within approximately 12 months.

Cost

The following costs are estimated for Alternative GW-2: Limited Action - LUCs and LTM:

Capital Cost:	$3,000
Annual and O&M Costs:	$2,000 to $48,000 depending on the year
30-Year NPW:	$330,000

The above cost figures have been rounded to the nearest $1,000 to reflect the preliminary nature of these estimates. Detailed cost estimates are provided in Appendix B-3.

4.3 SWMU 5 CMP CONCLUSIONS

The following sections summarize conclusions of the CMP for SWMU 5. These conclusions are based on existing and planned future uses for the constructible and non-constructible areas of SWMU 5 (military/industrial).

4.3.1 Groundwater and Surface Water

The following conclusions are made for SWMU 5 groundwater and surface water:

- Screening and detailed evaluations of alternatives to address excess risks from groundwater by site maintenance workers, adult recreational users, and adolescent trespassers at SWMU 5 are not necessary because none of these current receptors are exposed to groundwater, and dermal exposure to groundwater during excavation activities for future construction workers does not result in unacceptable risks. All future exposure to groundwater can be prevented by implementing LUCs.

- No residential exposure (350 days/year) to surface water occurs at SWMU 5. Future residential exposure to surface water can be prevented by implementing LUCs for soil.

- Alternative GW-2: Limited Action - LUCs and LTM is the recommended alternative for contamination in groundwater and surface water. LUCs for groundwater should be evaluated to assure that no withdraw of or contact with groundwater occurs, that the constructible and non-constructible areas are maintained, and that no changes occur in current military/industrial use of SWMU 5. LUCs are not necessary for surface water since LUCs to be implemented for soil will prevent residential land use and residential exposure to surface water. LTM of groundwater and surface water should be evaluated to assure the contamination migration does not result in unacceptable risks. Although there are no current risks for groundwater and surface water for human health and ecological receptors, continued contaminant migration could potentially lead to unacceptable risks. Therefore, LTM for select VOCs, BEHP, dioxins/furans, and select metals (see Table 2-12) should be evaluated in the Corrective Measures Implementation Plan to assure that contamination migration does not result in unacceptable risks.

4.3.2 Soils

The following conclusions are made for SWMU 5 soils:

- Most of the contaminated soil and miscellaneous debris (e.g., old waste drums, metal shavings) within the non-constructible area cannot be removed without disturbing the existing habitat (e.g., cutting trees and shrubs). It is anticipated that any remedial efforts in the non-constructible area would adversely impact the ecological habitat, which currently does not show obvious adverse impacts from the contamination.

- Screening and detailed evaluations of alternatives to address excess risks from exposure to metals-contaminated soils for site maintenance workers, adult recreational users, and adolescent trespassers at SWMU 5 are not necessary because none of these receptors would experience unacceptable risks to soil and all future exposure to soils resulting in unacceptable risks can be prevented by implementing LUCs.

- Alternative S-3: LUCs, Surface Debris Removal, and Lead Hotspot Removal is the recommended alternative. LUCs should be evaluated for the non-constructible area to prevent future exposures to contaminated soils containing antimony, iron and lead as long as the concentrations remain unacceptable. Surface debris removal should be evaluated for aesthetic purposes. Lead hot spot removal in the non-constructible area should be evaluated to mitigate the elevated risks associated with the high lead concentration at 05SB06.

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APPENDIX A

DERIVATION OF WATER QUALITY STANDARDS

TABLE A-1

INDIANA HUMAN HEALTH WATER QUALITY STANDARDS AND CHRONIC AQUATIC LIFE CRITERIA
CMP REPORT FOR SMWU 5 - OLD BURN PIT
NSA CRANE
CRANE, INDIANA

CASRN	Chemical	Water + Fish[1] Protected Water Supply (µg/L)	Water + Fish[1] Unprotected Water Supply (µg/L)	Water only[1] Protected Water Supply (µg/L)	Water only[1] Unprotected Water Supply (µg/L)	Chronic Aquatic Life Criteria (µg/L)
Dioxins/Furans						
3268-87-9	1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (1,2,3,4,6,7,8,9-OCDD)	0.000002	0.000002	0.008	2	NA
39001-02-0	1,2,3,4,6,7,8-Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF)	0.00000007	0.00000007	0.0002	0.05	NA
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (1,2,3,4,6,7,8-HpCDD)	0.00000007	0.00000007	0.0002	0.05	NA
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)	0.0000000007	0.0000000007	0.000002	0.0005	NA
37871-00-4	Total Heptachlorodibenzo-p-dioxin (Total HpCDD)	NA[2]	NA[2]	NA[2]	NA[2]	NA[2]
38998-75-3	Total Heptachlorodibenzofuran (Total HpCDF)	NA[2]	NA[2]	NA[2]	NA[2]	NA[2]
Volatile Organics						
67-66-3	Chloroform	280	1,400	350	70,000	140 [4]
75-35-4	1,1-Dichloroethene	1,300	4,600	1,800	350,000	65 [4]
156-59-2	cis-1,2-Dichloroethene	57	309	70	14,000	620 [3]
156-60-5	trans-1,2-Dichloroethene	520	2,100	700	140,000	560 [3]
79-01-6	Trichloroethene	3.5	6.4	7.6	1,522	47 [4]
75-01-4	Vinyl chloride	0.2	2	0.2	47	930 [3,4]
Semi-Volatile Organics						
117-81-7	Bis(2-ethylhexyl) phthalate	0.003	0.003	25	5,000	0.3 [4]
Metals						
7429-90-5	Aluminum	33,900	903,000	35,000	7,000,000	87 [5]
7440-36-0	Antimony	9.3	27.7	14	2,800	80 [3,4]
7440-38-2	Arsenic	0.076	0.16	0.23	46.7	148 [3,4]
7440-39-3	Barium	785	884	7,000	1,400,000	210 [3]
7440-50-8	Copper	142	158	1,400	280,000	1.58 [4]
7439-89-6	Iron	7,000	9,780	24,500	4,900,000	1,000 [5]
7439-92-1	Lead	NA	NA	NA	NA	1.17 [4,6]
7439-96-5	Manganese	408	973	700	140,000	288 [3]
7440-62-2	Vanadium	175	35,000	175	35,000	12 [3,4]
7440-66-6	Zinc	393	408	10,500	2,100,000	58 [6]

µg/L - microgram per liter.
CASRN - Chemical Abstract Services Registry Number.
ESL - Ecological Screening Level.
IDEM - Indiana Department of Environmental Management.
USEPA - United States Environmental Protection Agency.
RCRA - Resource Conservation & Recovery Act of 1976.

1 Calculated according to Indiana Administrative Codes 327 IAC 2-1-8-5 and 2-1-8-6. The back-up calculations for these values are presented in the pages following this table. Note that the cancer target risk for IDEM is 1E-05.
2 No cancer slope factor or toxicity equivalent factors are available to estimate alternative water quality standards.
3 IDEM, Criteria and Values for Selected Substances Calculated using the Great Lakes Basin Methodologies.
4 US EPA, Region 5, RCRA. ESL (http://www.epa.gov/reg5rcra/ca/ESL.pdf)
5 USEPA Recommended Water Quality Criteria (USEPA, 2013). http://www.epa.gov/waterscience/criteria/wqctable/index.html
6 IDEM, Water Quality Standards (based on a water hardness of 50 mg/L). http://www.in.gov/legislative/iac/T03270/A00020.pdf

SWQS FOR 2,3,7,8-TCDD (without fish consumption)

TR =	1.00E-05	
CSF =	1.50E+05	
D =	6.67E-11	

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

log BCFc = 0.847 log Kow - 0.628

	0.847	
	6.8	log Kow
	0.628	
log BCFc :	5.1316	
BCFc	**1.4E+05**	
BCF =	**NA**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**2.3E-09**	**protected (mg/L**	**=**	**2.3E-06**	**protected (µg/L)**
SWQS =	**4.7E-07**	**unprotected (mg**	**=**	**4.7E-04**	**unprotected (µg/L)**

SWQS FOR 2,3,7,8-TCDD (with fish consumption)

TR =	1.00E-05	
CSF =	1.50E+05	
D =	6.67E-11	

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

log BCFc = 0.847 log Kow - 0.628

	0.847	
	6.8	log Kow
	0.628	
log BCFc :	5.1316	
BCFc	**1.4E+05**	
BCF =	**2.7E+05**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**6.9E-13**	**protected (mg/L**	**=**	**6.9E-10**	**protected (µg/L)**
SWQS =	**6.9E-13**	**unprotected (mg**	**=**	**6.9E-10**	**unprotected (µg/L)**

HUMAN HEALTH SUPPORTING DOCUMENTATION FOR ORGANIC COMPOUNDS MEDIA CLEANUP STANDARDS FOR SURFACE WATER AND GROUNDWATER

CMP REPORT FOR SMWU 5 - OLD BURN PIT

NSWC CRANE

CRANE, INDIANA

SWQS FOR TRICHLOROETHENE (without fish consumption)

TR =	1.00E-05	
CSF =	4.60E-02	
D =	2.17E-04	

$$SWQS = \frac{D \text{ x } W_h}{WC + (F \text{ x } BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

<u>log BCFc = 0.847 log Kow - 0.628</u>

	0.847	
	2.72	log Kow
	0.628	
log BCFc =	1.67584	
BCFc	**4.7E+01**	
BCF =	**NA**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
SWQS =	**7.6E-03**	**protected (mg/L** **=** **7.6** **protected (µg/L)**
SWQS =	**1.5E+00**	**unprotected (mg** **=** **1,522** **unprotected (µg/L)**

SWQS FOR TRICHLOROETHENE (with fish consumption)

TR =	1.00E-05	
CSF =	4.60E-02	
D =	2.17E-04	

$$SWQS = \frac{D \text{ x } W_h}{WC + (F \text{ x } BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

<u>log BCFc = 0.847 log Kow - 0.628</u>

	0.847	
	2.72	log Kow
	0.628	
log BCFc =	1.67584	
BCFc	**4.7E+01**	
BCF =	**9.5E+01**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
SWQS =	**3.5E-03**	**protected (mg/L** **=** **3.5** **protected (µg/L)**
SWQS =	**6.4E-03**	**unprotected (mg** **=** **6.4** **unprotected (µg/L)**

SWQS FOR VINYL CHLORIDE (without fish consumption)

TR =	1.00E-05	
CSF =	1.50E+00	
D =	6.67E-06	

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

log BCFc = 0.847 log Kow - 0.628

	0.847	
	1.5	log Kow
	0.628	
log BCFc :	0.6425	
BCFc	**4.4E+00**	
BCF =	**NA**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**2.3E-04**	**protected (mg/L**	**=**	**2.3E-01**	**protected (µg/L)**
SWQS =	**4.7E-02**	**unprotected (mg**	**=**	**4.7E+01**	**unprotected (µg/L)**

SWQS FOR VINYL CHLORIDE (with fish consumption)

TR =	1.00E-05	
CSF =	1.50E+00	
D =	6.67E-06	

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

log BCFc = 0.847 log Kow - 0.628

	0.847	
	1.5	log Kow
	0.628	
log BCFc :	0.6425	
BCFc	**4.4E+00**	
BCF =	**8.8E+00**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**2.1E-04**	**protected (mg/L**	**=**	**2.1E-01**	**protected (µg/L)**
SWQS =	**2.0E-03**	**unprotected (mg**	**=**	**2.0E+00**	**unprotected (µg/L)**

WQS FOR BIS(2-ETHYLHEXYL)PHTHALATE (BEHP) (without fish consumptio

TR = 1.00E-05
CSF = 1.40E-02
D = 7.14E-04

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

log BCFc = 0.847 log Kow - 0.628

$$D = \frac{1 \times 10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

	0.847	
	7.3	log Kow
	0.628	
log BCFc :	5.5551	
BCFc	**3.6E+05**	
BCF =	**NA**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**2.5E-02**	**protected (mg/L**	**=**	**2.5E+01**	**protected (µg/L)**
SWQS =	**5.0E+00**	**unprotected (mg**	**=**	**5.0E+03**	**unprotected (µg/L)**

SWQS FOR BEHP (with fish consumption)

TR = 1.00E-05
CSF = 1.40E-02
D = 7.14E-04

$$SWQS = \frac{D \times W_h}{WC + (F \times BCF)}$$

log BCFc = 0.847 log Kow - 0.628

$$D = \frac{1 \times 10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

	0.847	
	7.3	log Kow
	0.628	
log BCFc :	5.5551	
BCFc	**3.6E+05**	
BCF =	**7.2E+05**	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**2.8E-06**	**protected (mg/L**	**=**	**2.8E-03**	**protected (µg/L)**
SWQS =	**2.8E-06**	**unprotected (mg**	**=**	**2.8E-03**	**unprotected (µg/L)**

SWQS FOR ARSENIC (without fish consumption)

TR =	1.00E-05	
CSF =	1.50E+00	
D =	6.67E-06	
BCF =	NA	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

$$SWQS = \frac{D \text{ x } W_h}{WC + (F \text{ x } BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

SWQS =	**2.3E-04**	**protected (mg/L**	**=**	**2.3E-01**	**protected (µg/L)**
SWQS =	**4.7E-02**	**unprotected (mg**	**=**	**4.7E+01**	**unprotected (µg/L)**

SWQS FOR ARSENIC (with fish consumption)

TR =	1.00E-05	
CSF =	1.50E+00	
D =	6.67E-06	
BCF =	114	
Wh =	70	kg
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

$$SWQS = \frac{D \text{ x } W_h}{WC + (F \text{ x } BCF)}$$

$$D = \frac{1x10^{-5}}{CSF(mg/kg/\ day)^{-1}}$$

SWQS =	**9.6E-05**	**protected (mg/L**	**=**	**9.6E-02**	**protected (µg/L)**
SWQS =	**1.6E-04**	**unprotected (mg**	**=**	**1.6E-01**	**unprotected (µg/L)**

SWQS FOR CHLOROFORM (without fish consumption)

BCF for Chloroform
log BCFc = 0.847 log Kow - 0.628

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

	0.847	
	1.92	log Kow
	0.628	
log BCFc :	0.99824	
BCFc	9.96	
BCF	**NA**	

MgT = RfD x W_h

RfD =	0.01	mg/kg/day
W_h =	70	
MgT =	0.7	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**0.35**	**protected (mg/L**	**=**	**350**	**protected (µg/L)**
SWQS =	**70.0**	**unprotected (m(**	**=**	**70,000**	**unprotected (µg/L)**

SWQS FOR CHLOROFORM (with fish consumption)

BCF for Chloroform
log BCFc = 0.847 log Kow - 0.628

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

	0.847	
	1.92	log Kow
	0.628	
log BCFc :	0.99824	
BCFc	9.96	
BCF	**19.9**	

MgT = RfD x W_h

RfD =	0.01	mg/kg/day
W_h =	70	
MgT =	0.7	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**0.28**	**protected (mg/L**	**=**	**280**	**protected (µg/L)**
SWQS =	**1.4**	**unprotected (m(**	**=**	**1,378**	**unprotected (µg/L)**

SWQS FOR 1,1-DICHLOROETHENE (without fish consumption)

BCF for 1,1-Dichloroethene
log BCFc = 0.847 log Kow - 0.628

	0.847	
	2.13	log Kow
	0.628	
log BCFc =	1.17611	
BCFc	15.00	
BCF	**NA**	

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.05	mg/kg/day
W_h =	70	
MgT =	3.5	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**1.75**	**protected (mg/L**	**=**	**1,750**	**protected (µg/L)**
SWQS =	**350**	**unprotected (m(**	**=**	**350,000**	**unprotected (µg/L)**

SWQS FOR 1,1-DICHLOROETHENE (with fish consumption)

BCF for 1,1-Dichloroethene
log BCFc = 0.847 log Kow - 0.628

	0.847	
	2.13	log Kow
	0.628	
log BCFc =	1.17611	
BCFc	15.00	
BCF	**30.0**	

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.05	mg/kg/day
W_h =	70	
MgT =	3.5	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**1.27**	**protected (mg/L**	**=**	**1,273**	**protected (µg/L)**
SWQS =	**4.6**	**unprotected (m(**	**=**	**4,605**	**unprotected (µg/L)**

SWQS FOR CIS-1,2-DICHLOROETHENE (without fish consumption)

BCF for cis-1,2-Dichloroethene
log BCFc = 0.847 log Kow - 0.628

	0.847	
	1.86	log Kow
	0.628	
log BCFc :	0.94742	
BCFc	8.86	
BCF	**NA**	

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.002	mg/kg/day
W_h =	70	
MgT =	0.14	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**0.07**	**protected (mg/L**	**=**	**70**	**protected (µg/L)**
SWQS =	**14**	**unprotected (mg**	**=**	**14,000**	**unprotected (µg/L)**

SWQS FOR CIS-1,2-DICHLOROETHENE (with fish consumption)

BCF for cis-1,2-Dichloroethene
log BCFc = 0.847 log Kow - 0.628

	0.847	
	1.86	log Kow
	0.628	
log BCFc :	0.94742	
BCFc	8.86	
BCF	**17.7**	

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.002	mg/kg/day
W_h =	70	
MgT =	0.14	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**0.06**	**protected (mg/L**	**=**	**57**	**protected (µg/L)**
SWQS =	**0.3**	**unprotected (mg**	**=**	**309**	**unprotected (µg/L)**

SWQS FOR TRANS-1,2-DICHLOROETHENE (without fish consumption)

BCF for trans-1,2-Dichloroethene

log BCFc = 0.847 log Kow - 0.628

	0.847	
	2.07	log Kow
	0.628	
log BCFc :	1.12529	
BCFc	13.34	
BCF	**NA**	

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.02	mg/kg/day
W_h =	70	
MgT =	1.4	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)

SWQS =	**0.7**	**protected (mg/L**	**=**	**700**	**protected (µg/L)**
SWQS =	**140**	**unprotected (mg**	**=**	**140,000**	**unprotected (µg/L)**

SWQS FOR TRANS-1,2-DICHLOROETHENE (with fish consumption)

BCF for trans-1,2-Dichloroethene

log BCFc = 0.847 log Kow - 0.628

	0.847	
	2.07	log Kow
	0.628	
log BCFc :	1.12529	
BCFc	13.34	
BCF	**26.7**	

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.02	mg/kg/day
W_h =	70	
MgT =	1.4	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)

SWQS =	**0.52**	**protected (mg/L**	**=**	**525**	**protected (µg/L)**
SWQS =	**2.1**	**unprotected (mg**	**=**	**2,067**	**unprotected (µg/L)**

SWQS FOR ALUMINUM (with fish consumption)

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	1	mg/kg/day
W_h =	70	
MgT =	70	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	2.7	

SWQS =	**33.9**	**protected (mg/L)**	**=**	**33,857**	**protected (µg/L)**
SWQS =	**903**	**unprotected (mg/L)**	**=**	**903,226**	**unprotected (µg/L)**

SWQS FOR ALUMINUM (without fish consumption)

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	1	mg/kg/day
W_h =	70	
MgT =	70	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**35**	**protected (mg/L)**	**=**	**35,000**	**protected (µg/L)**
SWQS =	**7,000**	**unprotected (mg/L)**	**=**	**7,000,000**	**unprotected (µg/L)**

SWQS FOR ANTIMONY (with fish consumption)

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.0004	mg/kg/day
W_h =	70	
MgT =	0.028	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	40	

SWQS =	**0.0093**	**protected (mg/L)**	**=**	**9**	**protected (µg/L)**
SWQS =	**0.0277**	**unprotected (mg/L)**	**=**	**28**	**unprotected (µg/L)**

SWQS FOR ANTIMONY (without fish consumption)

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

MgT = RfD x W_h

RfD =	0.0004	mg/kg/day
W_h =	70	
MgT =	0.028	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**0.014**	**protected (mg/L)**	**=**	**14**	**protected (µg/L)**
SWQS =	**2.8**	**unprotected (mg/L)**	**=**	**2,800**	**unprotected (µg/L)**

SWQS FOR BARIUM (with fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

RfD =	0.2	mg/kg/day
W_h =	70	
MgT =	14	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	633	
SWQS =	**0.785**	**protected (mg/L) = 785 protected (µg/L)**
SWQS =	**0.884**	**unprotected (mg/L) = 884 unprotected (µg/L)**

SWQS FOR BARIUM (without fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

RfD =	0.2	mg/kg/day
W_h =	70	
MgT =	14	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	
SWQS =	**7.0**	**protected (mg/L) = 7,000 protected (µg/L)**
SWQS =	**1,400**	**unprotected (mg/L) = 1,400,000 unprotected (µg/L)**

SWQS FOR COPPER (with fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

RfD =	0.04	mg/kg/day
W_h =	70	
MgT =	2.8	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	710	
SWQS =	**0.142**	**protected (mg/L) = 142 protected (µg/L)**
SWQS =	**0.158**	**unprotected (mg/L) = 158 unprotected (µg/L)**

SWQS FOR COPPER (without fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\ (mg/day)}{WC + (F \times BCF)}$$

RfD =	0.04	mg/kg/day
W_h =	70	
MgT =	2.8	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	
SWQS =	**1.4**	**protected (mg/L) = 1,400 protected (µg/L)**
SWQS =	**280**	**unprotected (mg/L) = 280,000 unprotected (µg/L)**

SWQS FOR IRON (with fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.7	mg/kg/day
W_h =	70	
MgT =	49	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	200	

SWQS =	**7.00**	**protected (mg/L)**	**=**	**7,000**	**protected (µg/L)**
SWQS =	**9.78**	**unprotected (mg/L)**	**=**	**9,780**	**unprotected (µg/L)**

SWQS FOR IRON (without fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.7	mg/kg/day
W_h =	70	
MgT =	49	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**24.5**	**protected (mg/L)**	**=**	**24,500**	**protected (µg/L)**
SWQS =	**4,900**	**unprotected (mg/L)**	**=**	**4,900,000**	**unprotected (µg/L)**

SWQS FOR VANADIUM (with fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.005	mg/kg/day
W_h =	70	
MgT =	0.35	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =		

SWQS =	**0.175**	**protected (mg/L)**	**=**	**175**	**protected (µg/L)**
SWQS =	**35.00**	**unprotected (mg/L)**	**=**	**35,000**	**unprotected (µg/L)**

SWQS FOR VANADIUM (without fish consumption)

MgT = RfD x W_h

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.005	mg/kg/day
W_h =	70	
MgT =	0.35	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**0.175**	**protected (mg/L)**	**=**	**175**	**protected (µg/L)**
SWQS =	**35.0**	**unprotected (mg/L)**	**=**	**35,000**	**unprotected (µg/L)**

SWQS FOR ZINC (with fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.3	mg/kg/day
W_h =	70	
MgT =	21	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	2059	

SWQS =	**0.393**	**protected (mg/L)**	**=**	**393**	**protected (µg/L)**
SWQS =	**0.408**	**unprotected (mg/L)**	**=**	**408**	**unprotected (µg/L)**

SWQS FOR ZINC (without fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.3	mg/kg/day
W_h =	70	
MgT =	21	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**10.5**	**protected (mg/L)**	**=**	**10,500**	**protected (µg/L)**
SWQS =	**2,100**	**unprotected (mg/L)**	**=**	**2,100,000**	**unprotected (µg/L)**

MANGANESE (with fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.02	mg/kg/day
W_h =	70	
MgT =	1.4	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	0.025	fish consumption rate (kg/day)
BCF =	**400**	

SWQS =	**0.4**	**protected (mg/L)**	**=**	**400**	**protected (µg/L)**
SWQS =	**0.975**	**unprotected (mg/L)**	**=**	**975**	**unprotected (µg/L)**

MANGANESE (without fish consumption)

$MgT = RfD \times W_h$

$$SWQS = \frac{MgT\,(mg/day)}{WC + (F \times BCF)}$$

RfD =	0.02	mg/kg/day
W_h =	70	
MgT =	1.4	
WC =	2	water cosumption rate (L/day) - protected
WC =	0.01	water cosumption rate (L/day) - unprotected
F =	**NA**	fish consumption rate (kg/day)
BCF =	**NA**	

SWQS =	**0.7**	**protected (mg/L)**	**=**	**700**	**protected (µg/L)**
SWQS =	**140**	**unprotected (mg/L)**	**=**	**140,000**	**unprotected (µg/L)**

CRITERIA AND VALUES FOR SELECTED SUBSTANCES CALCULATED USING THE GREAT LAKES BASIN METHODOLOGIES

CAS Number	Substance	Acute Aquatic Life (µg/L)	Date	Chronic Aquatic Life (µg/L)	Date	Human Health Cancer (µg/L)	Date	Human Health Noncancer (µg/L)	Date	Wildlife (µg/L)	Date
83329	Acenaphthene	140[T2]	8/17/00	27[T2]	8/17/00			1,200 (D)[T2] 4,200 (ND)	3/20/00		
208968	Acenaphthylene	ID	8/8/01	ID	8/8/01			ID	3/20/00		
75070	Acetaldehyde[C]	1200[T2]	8/17/00	130[T2]	8/17/00	ID	3/20/00	ID	3/20/00		
34256821	Acetochlor	ID	3/30/01	ID	3/30/01			450 (D)[T1] 2,300 (ND)	3/30/01		
67641	Acetone	15,000[T1]	8/17/00	1,700[T2]	8/17/00			2,800 (D)[T1] 220,000 (ND)	3/20/00		
107028	Acrolein	0.85[T2]	8/18/00	0.19[T2]	8/18/00			ID	3/21/00		
107131	Acrylonitrile[C]	570[T2]	8/18/00	63[T2]	8/18/00	0.53 (D)[T1] 3.0 (ND)	3/21/00	ID	3/21/00		
15972608	Alachlor	190[T2]	8/21/00	21[T2]	8/21/00			210 (D)[T1] 820 (ND)	3/21/00		
309002	Aldrin[C,BCC]	0.15[T2]	8/21/00	0.035[T2]	8/21/00	2.4×10^{-6} (D)[T2] 2.4×10^{-6} (ND)	3/23/00	8.2×10^{-5} (D)[T2] 8.2×10^{-5} (ND)	4/4/00		
7429905	Aluminum	UR	9/25/01	UR	9/25/01			970 (D)[T2] 4,500 (ND)	3/23/00		
120127	Anthracene	6.1[T2]	8/22/00	0.68[T2]	8/22/00			590 (D)[T2] 630 (ND)	3/24/00		
7440360	Antimony	720[T2]	8/22/00	80[T2]	8/22/00			10 (D)[T1] 2,000 (ND)	3/24/00		
7440382	Arsenic[C]	339.8[R]	8/26/98	147.9[R]	8/26/98	UR	5/16/01	10 (D)[T1] 230 (ND)	3/24/00		
1912249	Atrazine	330[T1]	10/13/99	12[T1]	10/13/99			920 (D)[T2] 15,000 (ND)	3/24/00		

7440393	Barium	$e^{1.0629(\ln(hardness))+2.2354}$ [T2]	12/4/02	$e^{1.0629(\ln(hardness))+1.1869}$ [T2]	12/4/02						
71432	Benzene[C]	880[T2]	8/22/00	98[T2]	8/22/00	12 (D)[R] 310 (ND)	8/26/98	19 (D)[R] 510 (ND)	8/26/98		
92875	Benzidine[C]	14[T2]	8/22/00	1.5[T2]	8/22/00	1.5×10^{-3} (D)[T1] 7.5×10^{-2} (ND)	3/24/00	74 (D)[T1] 3,700 (ND)	4/4/00		
56553	Benzo(*a*)anthracene[C]	0.23[T2]	8/23/00	0.025[T2]	8/23/00	ID	3/28/00	ID	3/28/00		
205992	Benzo(*b*)fluoranthene[C]	ID	4/1/97	ID	4/1/97	ID	3/28/00	ID	3/28/00		
207089	Benzo(*k*)fluoranthene[C]	ID	8/11/99	ID	8/11/99	ID	3/28/00	ID	3/28/00		
191242	Benzo[g,h,i]perylene[C]	ID	7/29/99	ID	7/29/99	ID	3/28/00	ID	3/28/00		
65850	Benzoic Acid	ID	4/15/98	ID	4/15/98			110,000 (D)[T1] 3,900,000 (ND)	3/28/00		
50328	Benzo(*a*)pyrene[C]	UR	5/31/02	UR	5/31/02	0.032 (D)[T1] 0.096 (ND)	12/4/02	ID	4/4/00		
7440417	Beryllium[C]	$e^{2.528(\ln(hardness))-8.572}$ [T2]	4/6/99	$e^{2.528(\ln(hardness))-10.77}$ [T2]	4/6/99	ID	3/28/00	40 (D)[T1] 300 (ND)	3/28/00		
108601	bis(2-chloroisopropyl) ether	ID	9/18/97	ID	9/18/97			990 (D)[T1] 48,000 (ND)	3/31/00		
542881	bis(chloromethyl)ether[C]	ID	6/18/99	ID	6/18/99	0.0016 (D)[T1] 0.11 (ND)	3/31/00	ID	3/31/00		
117817	Bis(2-ethylhexyl) phthalate (DEHP)[C]	N/A	12/17/98	N/A	12/17/98	2.5 (D)[T2] 2.8 (ND)	4/3/00	54 (D)[T2] 60 (ND)	4/3/00		
7440428	Boron	3,200[T2]	8/23/00	360[T2]	8/23/00			ID	4/3/00		
75252	Bromoform[C]	1,100[T2]	8/23/00	61[T2]	8/23/00	42 (D)[T1] 710 (ND)	4/7/00	470 (D)[T1] 8,100 (ND)	4/7/00		
78933	2-Butanone	120,000[T2]	8/23/00	14,000[T2]	8/23/00			16 (D)[T1] 1300 (ND)	4/7/00		
7440439	Cadmium[C]	$e^{1.128(\ln(hardness))-3.6867}$ [R]	8/26/98	$e^{0.7852(\ln(hardness))-2.715}$ [R]	8/26/98	ID	4/7/00	14 (D)[T1] 1400 (ND)	4/7/00		
75150	Carbon Disulfide							3,000 (D)[T1] 100,000 (ND)	4/7/00		

56235	Carbon Tetrachloride[C]	360[T2]	10/04/00	40[T2]	10/04/00	2.4 (D)[T1] 19 (ND)	4/11/00	17 (D)[T1] 120 (ND)	4/11/00		
10599903	Chloramine	ID	6/06/02	ID	6/06/02						
57749	Chlordane[C,BCC]					0.00025 (D)[R] 0.00025 (ND)	8/26/98	0.0014 (D)[R] 0.0014 (ND)	8/26/98		
	Chlorides	860,000[R]	8/26/98	230,000[R]	8/26/98						
7782505	Chlorine (total residual)	19[R]	8/26/98	11[R]	8/26/98						
7782505	Chlorine (intermittent)	200[R]	8/26/98								
108907	Chlorobenzene							470 (D)[R] 3,200 (ND)	8/26/98		
124481	Chlorodibromomethane[C]	ID	10/2798	ID	10/27/98	4 (D)[T1] 86 (ND)	4/11/00	570 (D)[T1] 12,000 (ND)	4/11/00		
75003	Chloroethane	ID	10/2798	ID	10/2798			ID	4/11/00		
110758	2-Chloroethyl vinyl ether	ID	10/2898	ID	10/2898			ID	4/11/00		
67663	Chloroform[C]	1300[T2]	10/05/00	170[T2]	10/05/00	56 (D)[T1] 1,700 (ND)	4/11/00	350 (D)[T1] 11,000 (ND)	4/11/00		
74873	Chloromethane (methyl chloride)	ID	10/2898	ID	10/2898						
16065831	Chromium III	$e^{0.819(\ln(hardness))+3.7256}$ [R]	8/26/98	$e^{0.819(\ln(hardness))+0.6848}$ [R]	8/26/98			410,000 (D)[T1] 43,000,000 (ND)	4/11/00		
18540299	Chromium VI	16.02[R]	8/26/98	10.98[R]	8/26/98			230 (D)[T1] 25,000 (ND)	4/11/00		
218019	Chrysene[C]	ID	9/3/96	ID	9/3/96	ID	4/11/00	ID	4/11/00		
7440484	Cobalt	120[T2]	1/12/01	19[T2]	1/12/01			ID	4/11/00		
7440508	Copper	$e^{0.9422(\ln(hardness))-1.700}$ [R]	8/26/98	$e^{0.8545(\ln(hardness))-1.702}$ [R]	8/26/98			280 (D)[T1] 56,000 (ND)	4/12/00		
21725462	Cyanazine	2,500[2]	3/29/01	270[T2]	3/29/01			ID	4/12/00		
57125	Cyanide	22[R]	8/26/98	5.2[R]	8/26/98			600 (D)[R] 48,000 (ND)	8/26/98		

94757	2,4-D	2,500[T2]	2/8/01	240[T2]	2/8/01			250 (D)[T1] 2,000 (ND)	4/12/00		
50293	DDT[C,BCC]	0.45[T1]	2/26/97	0.032[T2]	2/26/97	0.00015 (D)[R] 0.00015 (ND)	8/26/98	0.002 (D)[R] 0.002 (ND)	8/26/98	$1.1x10^{-5}$[R]	10/1/98
333415	Diazinon	0.09[T1]	9/29/99								
53703	Dibenz[a,h]anthracene[C]	ID	8/11/99	ID	8/11/99	ID	4/12/00	ID	4/12/00		
132649	Dibenzofuran	65[T2]	1/3/97	7.3[T2]	1/3/97			ID	4/12/00		
111922	Dibutylamine	ID	6/23/98	ID	6/23/98			ID	4/12/00		
84742	Dibutyl phthalate[BCC]	34[T2]	3/30/01	19[T2]	3/30/01			31 (D)[T2] 31 (ND)	4/13/00		
95501	1,2-Dichlorobenzene	130[T2]	9/24/97	14[T2]	9/24/97			1700 (D)[T1] 6000 (ND)	4/13/00		
541731	1,3-Dichlorobenzene	310[T2]	9/25/97	52[T2]	9/25/97			ID	4/13/00		
106467	1,4-Dichlorobenzene	80[T2]	6/21/99	16[T2]	6/21/99			ID	4/13/00		
91941	3,3'-Dichlorobenzidine[C]	ID	6/21/99	ID	6/21/99	0.43 (D)[T1] 0.95 (ND)	4/13/00	ID	4/13/00		
75274	Dichlorobromomethane[C]	ID	10/19/98	ID	10/19/98	5.5 (D)[T1] 150 (ND)	4/17/00	480 (D)[T1] 13,000 (ND)	4/17/00		
75343	1,1-Dichloroethane	6,600[T2]	6/26/01	740[T2]	6/26/01			1,100 (D)[T2] 27,000 (ND)	4/17/00		
107062	1,2-Dichloroethane[C]	7,300[T2]	11/24/98	980[T2]	11/15/02	3.8 (D)[T1] 210 (ND)	4/17/00	ID	4/17/00		
75354	1,1-Dichloroethylene	1,900[T2]	6/22/99	210[T2]	6/22/99	N/A	11/25/02	240 (D)[T1] 4,100 (ND)	4/17/00		
156592	1,2-*cis*-Dichloroethylene	5,500[T2]	6/26/01	620[T2]	6/26/01			ID	4/17/00		
156605	1,2-*trans*-Dichloroethylene	5,000[T2]	9/19/01	560[T2]	9/19/01			470 (D)[T1] 25,000 (ND)	4/17/00		
120832	2,4-Dichlorophenol	120[T2]	4/06/01	17[T2]	4/06/01			71 (D)[T1] 450 (ND)	9/9/99		
542756	1,3-Dichloropropene[C]	17[T2]	12/1/98	1.9[T2]	12/1/98	3.4 (D)[T1] 170 (ND)	9/12/00	940 (D)[T1] 46,000 (ND)	9/12/00		

60571	Dieldrin[C,BCC]	0.24[R]	8/26/98	0.056[R]	8/26/98	$6.5x10^{-6}$ (D)[R] $6.5x10^{-6}$ (ND)	8/26/98	0.00041 (D)[R] 0.00041 (ND)	8/26/98	$7.0x10^{-5}$ [T1]	10/5/98
84662	Diethyl Phthalate							21,000 (D)[T1] 1,200,000 (ND)	3/7/00		
105679	2,4-Dimethylphenol	140[T2]	4/06/01	21[T2]	4/06/01			450 (D)[R] 8,700 (ND)	8/26/98		
131113	Dimethyl phthalate	2,800[T2]	4/3/01	1,000[T2]	4/3/01			ID	4/18/00		
80466	Dimethylpropyl phenol	ID	4/06/01	ID	4/06/01			ID	4/18/00		
51285	2,4-Dinitrophenol							55 (D)[R] 2,800 (ND)	8/26/98		
122667	1,2-Diphenylhydrazine[C]	9.6[T2]	6/22/99	1.1[T2]	6/22/99	0.36 (D)[T1] 2.1 (ND)	4/18/00	ID	4/18/00		
115297	Endosulfan	0.10[T1]	5/16/01	0.05[T1]	5/16/01			85 (D)[T2] 170 (ND)	9/15/99		
72208	Endrin[BCC]	0.086[R]	8/26/98	0.036[R]	8/26/98			0.187 (D)[T2] 0.193 (ND)	4/18/00		
100414	Ethylbenzene	1,000[T2]	5/16/01	110[T2]	5/16/01			2,100 (D)[T1] 9,100 (ND)	4/19/00		
106934	Ethylene Dibromide[C]	ID	7/27/99	ID	7/27/99	0.004 (D)[T1] 0.17 (ND)	4/19/00	ID	4/19/00		
107211	Ethylene Glycol	2,200,000[T2]	5/16/01	240,000[T2]	5/16/01			56,000 (D)[T1] 4,500,000 (ND)	4/19/00	73,000[T2]	3/15/99
206440	Fluoranthene	17[T2]	4/11/01	3.6[T2]	4/11/01			9.4 (D)[T2] 9.5 (ND)	4/19/00		
86737	Fluorene	22[T2]	5/16/01	2.4[T2]	5/16/01			250 (D)[T2] 320 (ND)	4/19/00		
16984488	Fluoride	12,000[T2]	5/18/00	3,400[T2]	5/18/00						
50000	Formaldehyde[C]	660[T2]	5/16/01	74[T2]	5/16/01	ID	4/20/00	3,200 (D)[T1] 320,000 (ND)	4/20/00		
1071836	Glyphosate	ID	2/19/99	ID	2/19/99						
76448	Heptachlor[C,BCC]					0.0016 (D)[T2] 0.0016 (ND)	3/7/00	0.29 (D)[T2] 0.29 (ND)	9/18/00		

118741	Hexachlorobenzene[C,BCC]					0.00045 (D)[R] 0.00045 (ND)	8/26/98	0.046 (D)[R] 0.046 (ND)	8/26/98		
87683	Hexachlorobutadiene[C,BCC]	ID	12/8/99	ID	12/8/99	0.22 (D)[T2] 0.24 (ND)	12/8/99	ID	12/8/99		
319-84-6	Alpha-Hexachloro-cyclohexane[C,BCC]					0.027 (D)[T2] 0.051 (ND)	3/8/00	ID	3/8/00		
319-85-7	beta-Hexachloro cyclohexane[C,BCC]	ID	2/10/00	ID	2/10/00	0.093 (D)[T2] 0.18 (ND)	3/9/00	ID	2/10/00		
608-73-1	Hexachloro-cyclohexane[C,BCC]					0.093 (D)[T2] 0.18 (ND)	3/9/00	ID	2/10/00		
77-47-4	Hexachlorocyclopentadiene							170 (D)[T1] 1,500 (ND)	3/15/00		
67721	Hexachloroethane[C]					5.3 (D)[R] 6.7 (ND)	8/26/98	6 (D)[R] 7.6 (ND)	8/26/98		
193395	Indeno[1,2,3-cd]pyrene[C]	ID	8/11/99	ID	8/11/99	ID	4/20/00	ID	4/20/00		
12040572	Iron(III)	ID	3/15/98	ID	3/15/98						
78591	Isophorone	7,500[T2]	5/17/01	830[T2]	5/17/01			4,100 (D)[T1] 110,000 (ND)	4/20/00		
7439921	Lead[T1, C]	$e^{1.273(\ln(hardness))-1.055}$	11/13/96	$e^{1.273(\ln(hardness))-4.003}$	11/13/96	ID	4/20/00	ID	4/20/00		
58899	Lindane[BCC]	0.95[T1]	8/24/99	0.11[T2]	8/24/99			0.47 (D)[R] 0.5 (ND)	8/26/98		
7439965	Manganese	$e^{0.8784(\ln(hardness))+2.992}$ [T2]	4/06/01	$e^{0.8784(\ln(hardness))+2.226}$ [T2]	4/06/01			ID	4/20/00		
7439976	Mercury[BCC]	1.694[R]	8/26/98	0.9081[R]	8/26/98			0.0018 (D)[R] 0.0018 (ND)	8/26/98	0.0013 [R]	10/1/98
67561	Methanol	3,000[T2]	7/17/01	330[T2]	7/17/01			14,000 (D)[T1] 1,100,000 (ND)	4/27/00		
72435	Methoxychlor							6.3 (D)[T2] 6.6 (ND)	4/28/00		
74895	Methylamine	7,700[T2]	4/12/99	860[T2]	4/12/99			ID	4/28/00		
75092	Methylene chloride[C]	14,000[T2]	7/17/01	1,500[T2]	7/17/01	47 (D)[R] 2,600 (ND)	8/26/98	1,600 (D)[R] 90,000 (ND)	8/26/98		

91576	2-Methylnaphthalene	ID	2/3/97	ID	2/3/97			ID	4/28/00		
95487	2-Methylphenol	600[T2]	5/15/01	67[T2]	5/15/01			1,400 (D)[T1] 44,000 (ND)	4/28/00		
106445	4-Methylphenol	480[T2]	5/15/01	53[T2]	5/15/01			ID	4/28/00		
108101	Methyl isobutyl ketone	ID	8/30/99	ID	8/30/99			ID	4/28/00		
1634044	Methyl *tert*-butyl ether	6500[T2]	9/18/01	730[T2]	9/18/01			ID	4/28/00		
51218452	Metolachlor	ID	2/15/99	ID	2/15/99			3,000 (D)[T1] 11,000 (ND)	7/26/00		
2385855	Mirex[BCC]							7.3×10^{-4} (D)[T1] 7.3×10^{-4} (ND)	7/26/00		
7439987	Molybdenum	1200[T2]	9/18/01	800[T2]	9/18/01						
91203	Naphthalene	200[T2]	9/18/01	26[T2]	9/18/01			490 (D)[T1] 1,900 (ND)	7/26/00		
1338245	Naphthenic Acid	ID	7/20/99	ID	7/20/99			ID	7/26/00		
7440020	Nickel	$e^{0.846(\ln(hardness))+2.255}$ [R]	8/26/98	$e^{0.846(\ln(hardness))+0.0584}$ [R]	8/26/98			460 (D)[T1] 42,000 (ND)	7/26/00		
98953	Nitrobenzene	1,000[T2]	9/18/01	220[T2]	9/18/01			13 (D)[T1] 28,000 (ND)	7/26/00		
88755	2-Nitrophenol	650[T2]	5/15/01	73[T2]	5/15/01			ID	7/26/00		
100027	4-Nitrophenol	530[T2]	4/14/99	58[T2]	4/14/99			ID	7/26/00		
55185	*N*-Nitrosodiethylamine[C]	ID	7/15/99	ID	7/15/99	0.0023 (D)[T1] 0.18 (ND)	8/23/00	ID	8/23/00		
62759	*N*-Nitrosodimethylamine[C]	ID	7/20/99	ID	7/20/99	0.0068 (D)[T1] 0.55 (ND)	7/20/99	ID	7/20/99		
924163	*N*-Nitrosodi-n-butylamine[C]	ID	7/21/99	ID	7/21/99	0.06 (D)[T1] 0.73 (ND)	8/24/00	ID	8/24/00		
621647	*N*-Nitrosodipropylamine[C]	ID	2/15/00	ID	2/15/00	0.049 (D)[T1] 2.9 (ND)	3/9/00	ID	8/24/00		
86306	*N*-Nitrosodiphenylamine[C]	220[T2]	9/19/01	25[T2]	9/19/01	36 (D)[T1] 74 (ND)	8/24/00	ID	8/24/00		

993552	*N*-Nitrosopyrrolidine[C]	ID	7/22/99	ID	7/22/99	0.16 (D)[T1] 13 (ND)	9/15/00	ID	8/24/00		
25154523	Nonylphenol	25[T1]	9/29/99	6.6[T1]	9/29/99						
29082-74-4	Octachlorostyrene[BCC]	ID	2/9/00	ID	2/9/00			ID	2/9/00		
56382	Parathion	0.065[R]	8/26/98	0.013[R]	8/26/98			ID	9/14/00		
608935	Pentachlorobenzene[BCC]	16[T2]	12/7/99	3.1[T2]	12/7/99			0.18 (D)[T1] 0.18 (ND)	12/8/99		
87865	Pentachlorophenol[C]	$e^{1.005(pH)-4.869}$ [R]	8/26/98	$e^{1.005(pH)-5.134}$ [R]	8/26/98	2.8 (D)[T1] 84 (ND)	9/14/00	820 (D)[T1] 24,000 (ND)	9/14/00		
85018	Phenanthrene	8.4[T2]	9/19/01	0.93[T2]	9/19/01			ID	9/14/00		
108952	Phenol	1,300[T1]	5/22/02	180[T2]	5/22/02			2,000 (D)[T2] 2,300 (ND)	9/14/00		
57556	Propylene glycol	700,000[T2]	9/19/01	78,000[T2]	9/19/01			700,000 (D)[T1] 56,000,000 (ND)	9/15/00	900,000[T2]	3/15/99
1336363	PCBs[C,BCC]					$6.8x10^{-6}$ (D)[R] $6.8x10^{-6}$ (ND)	8/26/98			$1.2x10^{-4}$ [R]	10/1/98
129000	Pyrene	ID	4/1/99	ID	4/1/99			15 (D)[T2] 15 (ND)	9/15/00		
7782492	Selenium	ID***		5[R]	8/26/98			140 (D)[T1] 3,400 (ND)	9/15/00		
7440224	Silver	UR	8/24/98	UR	8/24/98			130 (D)[T1] 26,000 (ND)	9/18/00		
122349	Simazine	80[T2]	9/19/01	9[T2]	9/19/01			140 (D)[T1] 3,800 (ND)	9/18/00		
7440246	Strontium	7,700[T2]	9/19/01	860[T2]	9/19/01			ID	7/21/99		
100425	Styrene							5,000 (D)[T1] 32,000 (ND)	9/18/00		
1746016	2,3,7,8-TCDD[C,BCC]					$8.6x10^{-9}$ (D)[R] $8.6x10^{-9}$ (ND)	8/26/98	$6.7x10^{-8}$ (D)[R] $6.7x10^{-8}$ (ND)	8/26/98	$3.1x10^{-9}$ [R]	10/1/98
95943	1,2,4,5-Tetrachlorobenzene[BCC]	75 [T2]	12/16/99	8.3 [T2]	12/16/99			0.35 (D)[T1] 0.36 (ND)	2/24/00		

127184	Tetrachloroethylene[C]	480[T2]	9/19/01	60[T2]	9/19/01	11 (D)[T1] 60 (ND)	9/20/00	320 (D)[T1] 1,700 (ND)	9/20/00		
7440280	Thallium	54[T2]	9/20/01	6[T2]	9/20/01			2 (D)[T1] 5 (ND)	9/20/00		
7440315	Tin	ID	3/23/99	ID	3/23/99			ID	9/20/00		
7440326	Titanium	ID	3/31/99	ID	3/31/99			ID	9/20/00		
108883	Toluene	840[T2]	9/20/01	94[T2]	9/20/01			5,600 (D)[R] 51,000 (ND)	8/26/98		
8001352	Toxaphene[C,BCC]					6.8×10^{-5} (D)[R] 6.8×10^{-5} (ND)	8/26/98	ID	9/18/00	1.7×10^{-4} [T1]	10/5/98
56359	Tributyltin oxide	0.46[T1]	9/14/98	0.063[T1]	9/14/98			3.3 (D)[T2] 5.4 (ND)	9/27/00		
71556	1,1,1-Trichloroethane	3,700[T2]	1/17/97	410[T2]	1/17/97			ID	9/18/00		
79005	1,1,2-Trichloroethane	490[T2]	7/17/01	87[T2]	7/17/01			110 (D)[T1] 3,000 (ND)	9/27/00		
79345	1,1,2,2-Tetrachloroethane[C]	900[T2]	10/27/98	100[T2]	10/27/98	1.6 (D)[T2] 17 (ND)	9/29/00	ID	9/29/00		
79016	Trichloroethylene[C]	2,300[T2]	9/21/01	260[T2]	9/21/01	29 (D)[R] 370 (ND)	8/26/98	ID	9/18/00		
95954	2,4,5-trichlorophenol	17[T2]	9/25/01	1.9[T2]	9/25/01			1,300 (D)[T2] 2,500 (ND)	2/25/00		
95954	2,4,6-trichlorophenol[C]	12[T2]	9/25/01	1.4[T2]	9/25/01	27 (D)[T1] 200 (ND)	2/24/00	ID	2/24/00		
108678	1,3,5-Trimethylbenzene	ID	1/31/97	ID	1/31/97			ID	9/27/00		
95636	1,2,4-Trimethylbenzene	ID	1/31/97	ID	1/31/97			ID	9/27/00		
7440622	Vanadium	110[T2]	9/21/01	12[T2]	9/21/01			230 (D)[T1] 2,300 (ND)	9/28/00		
75014	Vinyl Chloride[C]	8,400[T2]	6/26/01	930[T2]	6/26/01	0.25 (D)[T1] 14 (ND)	9/28/00	83 (D)[T1] 4,900 (ND)	9/28/00		
1330207	Xylene	310[T2]	9/21/01	35[T2]	9/21/01			38,000 (D)[T1] 150,000 (ND)	9/29/00		

7440666	Zinc	$e^{0.8473(\ln(hardness))+0.884}$ R	8/26/98	$e^{0.8473(\ln(hardness))+0.884}$ R	8/26/98			9,000 (D)[T1] 250,000 (ND)	9/29/00		

Where:
ID = insufficient data for Tier I criteria or Tier II value calculation.
UR = currently under review
(D) = for drinking water sources
(ND) = for nondrinking water sources
T1 = criterion was calculated using Tier I methodology
T2 = value calculated using Tier II methodology
R = adopted into the rules during the Great Lakes Initiative rulemaking. (Note that metals criteria adopted into the rules have conversion factors not printed here.)
C = substance is considered to be carcinogenic
BCC = Bioaccumulative Chemical of Concern (listed in 327 IAC 2-1.5-6(b))

***EPA is currently conducting toxicity tests in order to calculate criteria for selenium. When EPA releases the results of their tests, we will calculate selenium criteria for the state.

Tier I criteria that have not been adopted into the rules and all Tier II values are subject to change as more data become available.

Metals criteria are for total metals. Conversion factors are in the rules to convert the total to dissolved form. Metals without conversion factors are assumed to have a conversion factor of 1.0.

Last modified:
December 12, 2002

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Acenaphthene	83-32-9		**38**[a]	6.71[r]	6.82 e+5
Acenaphthylene	208-96-8		4.84 e+3[b]	5.87[r]	6.82 e+5
Acetone	67-64-1	959	**1700**[a, c, z]	**9.9**[z]	2500[w]
Acetonitrile	75-05-8	17.1	**12 e+3**[d, z]	**56**[z]	1370[w]
Acetophenone	98-86-2		-----	-----	3 e+5
Acetylaminofluorene [2-]	53-96-3		535[b]	15.3	596
Acrolein	107-02-8	0.578	**0.19**[c, z]	**1.52 e-3**[z]	5270[w]
Acrylonitrile	107-13-1	0.797	**66**[a]	**1.2**	23.9[w]
Aldrin	309-00-2		**1.7 e-2**[a, z]	2[t]	3.32[x]
Allyl chloride	107-05-1	1.22		-----	13.4
Aminobiphenyl [4-]	92-67-1			-----	3.05
Aniline	62-53-3		**4.1**[d]	**0.31**	56.8[w]
Anthracene	120-12-7		**0.035**[f]	**57.2**[u]	1.48 e+6
Antimony (Total)	7440-36-0		**80**[c]		142
Aramite	140-57-8		3.09[g]	1.11 e-3	1.66 e+5
Arsenic (Total)	7440-38-2		**148**[f]	**9790**[u]	5700
Azobenzene [p-(dimethylamino)]	60-11-7		1.65[b]	318	40
Barium (Total)	7440-39-3		**220**[d, z]		1040
Benzene	71-43-2	9.76	114[f]	142	255
Benzo[a]anthracene	56-55-3		**0.025**[c, z]	**108**[u]	5210

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Benzo[a]pyrene	50-32-8		0.014[h]	**150[u]**	1520
Benzo[b]fluoranthene	205-99-2		9.07[b]	1.04 e+4	5.98 e+4
Benzo[ghi]perylene	191-24-2		7.64[b]	170[t]	1.19 e+5
Benzo[k]fluoranthene	207-8-9		-----	240[t]	1.48 e+5
Benzyl alcohol	100-51-6		**8.6[h, z]**	**1.04[z]**	6.58 e+4
Beryllium (Total)	7440-41-7		**3.6[d, k, z]**		1060
BHC [alpha-]	319-84-6		12.4[b]	6[t]	99.4
BHC [beta-]	319-85-7		0.495[b]	5[t]	3.98[x]
BHC [delta-]	319-86-8		667[g]	7.15 e+4	9940
BHC [gamma-]	58-89-9		**0.026[a]**	**2.37[u]**	5[x]
Bromodichloromethane	75-27-4			-----	540
Bromoform	75-25-2	9.11	**230[d, z]**	**492[z]**	1.59 e+4
Bromophenyl phenyl ether [4-]	101-55-3		1.5[h]	1550	
Butylamine [N-Nitrosodi-n-]	924-16-3		-----	-----	267
Butylbenzyl phthalate	85-68-7		**23[d, z]**	**1970[z]**	239
Cadmium (Total)	7440-43-9		**0.15[i, j, k]**	**990[u]**	2.22
Carbon disulfide	75-15-0	3.67	**15[d, z]**	**23.9[z]**	94.1
Carbon tetrachloride	56-23-5	1.41	**240[d]**	**1450**	2980
Chlordane	57-74-9		**4.3 e-3[j]**	**3.24[u, z]**	224[x]
Chlorethyl ether [bis(2-]	111-44-4		**19 e+3[l]**	**3520**	2.37 e+4[w]

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Chloro-1-methylethyl)ether [bis(2-]	108-60-1		-----	-----	1.99 e+4
Chloroaniline [p-]	106-47-8		232[g]	146	1100
Chlorobenzene	108-90-7	120	**47**[a]	**291**	1.31 e+4
Chlorobenzilate	510-15-6		7.16[g]	860	5050
Chloroethane	75-0-3	20	-----	-----	
Chloroform	67-66-3	1.34	**140**[d]	**121**	1190
Chloronaphthalene [2-]	91-58-7		0.396[b]	417	12.2
Chlorophenol [2-]	95-57-8		**24**[a]	**31.9**	243
Chlorophenyl phenyl ether [4-]	7005-72-3			-----	
Chloroprene	126-99-8	4.16 E-2		-----	2.9
Chromium^{+3} (Total)	7440-47-3		42[j, k]	**4.34 e+4**[u]	400[y]
Chrysene	218-1-9		-----	**166**[u]	4730
Cobalt (Total)	7440-48-4		**24**[d]	5.00 e+4[t]	140
Copper (Total)	7440-50-8		**1.58**[j, k, z]	**3.16 e+4**[u]	**5400**
Cresol [4,6-dinitro-o-]	534-52-1		**23**[m]	**104**	144
Cresol [m-]	108-39-4		**62**[d]	**52.4**	3490
Cresol [o-]	95-48-7		**67**[c]	**55.4**	4.04 e+4
Cresol [p-chloro-m-]	59-50-7		34.8[g]	388	7950
Cresol [p-]	106-44-5		**25**[a]	**20.2**	1.63 e+5
Cyanide	57-12-5		5.2[a]	0.1[t]	1330[w]

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
DDD [4,4'-]	72-54-8		-----	**4.88[u, z]**	758
DDE [4,4'-]	72-55-9		4.51 e-9[e]	**3.16[u]**	596
DDT [4,4'-]	50-29-3		**1.1 e-5[a, z]**	**4.16[u]**	**3.5[z]**
Di-n-butyl phthalate	84-74-2		**9.7[a]**	**1114**	150
Di-n-octyl phthalate	117-84-0		30[f]	4.06 e+4	7.09 e+5
Diallate	2303-16-4		-----	-----	452[w]
Dibenzofuran	132-64-9		**4[a, z]**	**449[z]**	
Dibenz[a,h]anthracene	53-70-3		-----	**33[u]**	1.84 e+4
Dibromo-3-chloropropane [1,2-]	96-12-8	0.32	-----	-----	35.2
Dibromochloromethane	124-48-1		-----	-----	2050
Dibromoethane [1,2-]	106-93-4	176	-----	-----	1230
Dichloro-2-butene [trans-1,4-]	110-57-6	4.03		-----	
Dichlorobenzene [m-]	541-73-1	273	**38[a, z]**	**1315[z]**	3.77 e+4
Dichlorobenzene [o-]	95-50-1	270	**14[h]**	**294**	2960
Dichlorobenzene [p-]	106-46-7	275	**9.4[d, z]**	**318[z]**	546
Dichlorobenzidine [3,3'-]	91-94-1		**4.5[a, z]**	**127**	646
Dichlorodifluoromethane	75-71-8	1550		-----	3.95 e+4
Dichloroethane [1,1-]	75-34-3	1240	47[h]	0.575	2.01 e+4
Dichloroethane [1,2-]	107-6-2	29.7	**910[h]**	**260**	2.12 e+4
Dichloroethene [1,1-]	75-35-4	0.303	**65[a, z]**	**19.4[z]**	8280

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Dichloroethylene [trans-1,2-]	156-60-5	29.1	**970**[d]	**654**	784
Dichlorophenol [2,4-]	120-83-2		**11**[d, z]	**81.7**[z]	8.75 e+4
Dichlorophenol [2,6-]	87-65-0			-----	1170
Dichloropropane [1,2-]	78-87-5	70.6	**360**[a, z]	**333**[z]	3.27 e+4
Dichloropropene [cis-1,3-]	10061-1-5	5.89	-----	-----	398
Dichloropropene [trans-1,3-]	10061-2-6	5.89	-----	-----	398
Dieldrin	60-57-1		**7.1 e-5**[a]	**1.9**[u, z]	2.38
Diethyl O-2-pyrazinyl phosphorothioate [O,O-]	297-97-2			-----	799
Diethyl phthalate	84-66-2		**110**[a]	**295**	2.48 e+4
Dimethoate	60-51-5		-----	-----	218
Dimethyl phthalate	131-11-3		-----	-----	7.34 e+5
Dimethylbenzidine [3,3'-]	119-93-7			-----	104
Dimethylbenz[a]anthracene [7,12-]	57-97-6		0.548[b]	6.64 e+4	1.63 e+4
Dimethylphenethylamine [alpha,alpha-]	122-9-8			-----	300
Dimethylphenol [2,4-]	105-67-9		100[b]	304	10[x]
Dinitrobenzene [m-]	99-65-0		**22**[d]	**8.61**	655
Dinitrophenol [2,4-]	51-28-5		**19**[a]	**6.21**	60.9
Dinitrotoluene [2,4-]	121-14-2		**44**[d, z]	**14.4**[z]	1280
Dinitrotoluene [2,6-]	606-20-2		**81**[d]	**39.8**	32.8

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Dinoseb	88-85-7		**0.48[a]**	**14.5**	21.8
Dioxane [1,4-]	123-91-1	367	**22 e+3[a]**	**119**	2050[w]
Diphenylamine	122-39-4		412[b]	34.6	1010
Disulfoton	298-4-4		4.02 e-2[e]	324	19.9
D [2,4-]	94-75-7		**220[a]**	**1273**	27.2
Endosulfan I	959-98-8		**0.056[j]**	**3.26**	119
Endosulfan II	33213-65-9		**0.056[j]**	**1.94**	119
Endosulfan sulfate	1031-7-8		2.22[b]	34.6	35.8
Endrin	72-20-8		**0.036[a]**	**2.22[u, z]**	10.1
Endrin aldehyde	7421-93-4		0.15[b]	**480[z]**	10.5
Ethyl methacrylate	97-63-2	356		-----	3 e+4
Ethyl methane sulfonate	62-50-0			-----	
Ethylbenzene	100-41-4	304	**14[o, z]**	**175**	5160
Famphur	52-85-7			-----	49.7
Fluoranthene	206-44-0		**1.9[f, z]**	**423[u]**	1.22 e+5
Fluorene	86-73-7		**19[d]**	**77.4[u]**	1.22 e+5
Heptachlor	76-44-8		**3.8 e-3[j]**	0.6[r]	5.98
Heptachlor epoxide	1024-57-3		**3.8 e-3[j]**	**2.47[u]**	152
Hexachlorobenzene	118-74-1		**3 e-4[a]**	20[t]	199
Hexachlorobutadiene	87-68-3		**0.053[a, z]**	**26.5[z]**	39.8

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Hexachlorocyclopentadiene	77-47-4		77[b]	901	755
Hexachloroethane	67-72-1		**8**[a, z]	**584**[z]	596
Hexachlorophene	70-30-4		0.228[e]	2.31 e+5	199
Hexachloropropene	1888-71-7		-----	-----	
Hexanone [2-]	591-78-6	105	**99**[h, z]	**58.2**[z]	1.26 e+4
Indeno (1,2,3-cd) pyrene	193-39-5		4.31[b]	200[t]	1.09 e+5
Isobutyl alcohol	78-83-1	32.8	-----	-----	2.08 e+4[w]
Isodrin	465-73-6		3.09 e-2[e]	55.2	3.32[x]
Isophorone	78-59-1		**920**[d]	**432**	1.39 e+5
Isosafrole	120-58-1			-----	9940
Kepone	143-50-0		0.132[e]	3.31	32.7
Lead (Total)	7439-92-1		**1.17**[j, k, z]	**3.58 e+4**[u]	53.7
Mercury (Total)	7439-97-6		1.3 e-3[a]	174[r]	100[y]
Methacrylonitrile	126-98-7	3.38		-----	57[w]
Methane [bis(2-chloroethoxy)]	111-91-1		-----	-----	302[w]
Methapyrilene	91-80-5			-----	2780[w]
Methoxychlor	72-43-5		**0.019**[h]	**13.6**	19.9
Methyl bromide	74-83-9	26.5	**16**[d]	**1.37**	235[w]
Methyl chloride	74-87-3	2.63		-----	1.04 e+4[w]
Methyl ethyl ketone	78-93-3	642	**2200**[a, z]	**42.4**[z]	8.96 e+4[w]

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Methyl iodide	74-88-4	11.7		-----	1230
Methyl mercury	22967-92-6		2.46 e-3[e]	0.01	1.58
Methyl methacrylate	80-62-6	87.1	2800[g]	168	9.84 e+5[w]
Methyl methanesulfanate	66-27-3			-----	315[w]
Methyl parathion	298-0-0			-----	0.292
Methyl-2-pentanone [4-]	108-10-1	45.9	**170**[h, z]	**25.1**[z]	4.43 e+5
Methylcholanthrene [3-]	56-49-5		8.91 e-2[b]	8.19 e+6	77.9
Methylene bromide	74-95-3	344		-----	6.5 e+4[w]
Methylene chloride	75-9-2	4780	**940**[a]	**159**[z]	4050[w]
Methylnaphthalene [2-]	91-57-6		330[b]	20.2[r]	3240
Naphthalene	91-20-3	80.1	**13**[a, z]	**176**[u]	99.4
Naphthoquinone [1,4-]	130-15-4		-----	-----	1670
Naphthylamine [1-]	134-32-7		-----	-----	9340
Naphthylamine [2-]	91-59-8			-----	3030
Nickel (Total)	7440-2-0		**28.9**[j, k, z]	**2.27 e+4**[u]	1.36 e+4
Nitroaniline [m-]	99-9-2			-----	3160
Nitroaniline [o-]	88-74-4			-----	7.41 e+4
Nitroaniline [p-]	100-1-6			-----	2.19 e+4
Nitrobenzene	98-95-3		**220**[a, z]	**145**[z]	1310
Nitrophenol [o-]	88-75-5		-----	-----	1600

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Nitrophenol [p-]	100-2-7		**60[a]**	**13.3**	5120
Nitroquinoline-1-oxide [4-]	56-57-5			-----	122
Nitrosodiethylamine [N-]	55-18-5		768[g]	22.8	69.3[w]
Nitrosodimethylamine [N-]	62-75-9			-----	0.0321[w]
Nitrosodiphenylamine [N-]	86-30-6		-----	-----	545
Nitrosomethylethylamine [N-]	10595-95-6			-----	1.66[w]
Nitrosomorpholine [N-]	59-89-2			-----	70.6[w]
Nitrosopiperidine [N-]	100-75-4			-----	6.65[w]
Nitrosopyrrolidine [N-]	930-55-2			-----	12.6[w]
Parathion	56-38-2		**0.013[a, d]**	**0.757**	0.34[y]
Pentachlorobenzene	608-93-5		**0.019[a, z]**	**24[z]**	497
Pentachloroethane	76-1-7	0.68	56.4[g]	689	1.07 e+4
Pentachloronitrobenzene	82-68-8		-----	-----	7090
Pentachlorophenol	87-86-5		**4.0[j, p, z]**	**2.3 e+4[z]**	119
Phenacetin	62-44-2		-----	-----	1.17 e+4
Phenanthrene	85-1-8		**3.6[f]**	**204[u]**	4.57 e+4
Phenol	108-95-2	4.31	**180[c]**	**49.1**	1.2 e+5
Phenylenediamine [p-]	106-50-3			-----	6160[w]
Phorate	298-02-2		3.62[g]	0.861	0.496
Phthalate [bis(2-ethylhexyl)]	117-81-7		**0.3[q, z]**	182[r]	925

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Picoline [2-]	109-6-8	140	-----	-----	9900[w]
Polychlorinated biphenyls	1336-36-3		**1.2 e-4**[a, z]	**59.8**[u]	0.332
Polychlorinated dibenzo-p-dioxins	PCDD-S		2.78 e-7[b]	**0.011**	1.99 e-4
Polychlorinated dibenzofurans	51207-31-9		-----	-----	0.0386
Pronamide	23950-58-5		-----	-----	13.6[x]
Propionitrile	107-12-0	1.87	-----	-----	49.8[w]
Propylamine [N-nitrosodi-n-]	621-64-7			-----	544
Pyrene	129-0-0		0.3[g]	**195**[u]	7.85 e+4
Pyridine	110-86-1	13.7	2380[g]	106	1030[w]
Safrole	94-59-7		-----	-----	404
Selenium (Total)	7782-49-2		5[j]		27.6
Silver (Total)	7440-22-4		**0.12**[f, z]	500[t]	4040
Silvex	93-72-1		**30**[a, z]	**675**[z]	109[x]
Styrene	100-42-5	0.946	**32**[d, z]	**254**[z]	4690
Sulfide	18496-25-8				3.58
Tetrachlorobenzene [1,2,4,5-]	95-94-3		**3**[a, z]	**1252**[z]	2020
Tetrachlorodibenzo-p-dioxin [2,3,7,8-]	1746-1-6		**3 e-9**[a, z]	**1.2 e-4**[z]	1.99 e-4
Tetrachloroethane [1,1,1,2-]	630-20-6	22.5	-----	-----	2.25 e+5
Tetrachloroethane [1,1,2,2-]	79-34-5	353	**380**[a]	**850**	127
Tetrachloroethene	127-18-4	69	**45**[a]	**990**	9920

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Tetrachlorophenol [2,3,4,6-]	58-90-2		**1.2**[a, z]	**129**[z]	199
Tetraethyl dithiopyrophosphate	3689-24-5		13.9[b]	560	596
Thallium (Total)	7440-28-0		**10**[a]		56.9
Tin (Total)	7440-31-5		**180**[d]		7620
Toluene	108-88-3	1040	253[f]	**1220**[z]	5450
Toluidine [5-nitro-o-]	99-55-8			-----	8730
Toluidine [o-]	95-53-4			-----	2970[w]
Toxaphene	8001-35-2		**1.4 e-4**[a, z]	**0.077**[z]	119
Trichlorobenzene [1,2,4-]	120-82-1		**30**[a, z]	**5062**[z]	1.11 e+4
Trichloroethane [1,1,1-]	71-55-6	4170	**76**[d, z]	**213**[z]	2.98 e+4
Trichloroethane [1,1,2-]	79-0-5	11.6	**500**[a, z]	**518**[z]	2.86 e+4
Trichloroethylene	79-1-6	1220	**47**[h, z]	**112**[z]	1.24 e+4
Trichlorofluoromethane	75-69-4	5150		-----	1.64 e+4
Trichlorophenol [2,4,5-]	95-95-4			-----	1.41 e+4
Trichlorophenol [2,4,6-]	88-6-2		**4.9**[d]	**208**	9940
Trichloropropane [1,2,3-]	96-18-4	3.32	-----	-----	3360
Trichlorphenoxyacetic acid [2,4,5-]	93-76-5		686[g]	5.87 e+4	596
Triethyl phosphorothioate [O,O,O-]	126-68-1		58.2[b]	189	818
Trinitrobenzene [Sym-]	99-35-4			-----	376[w]
Vanadium (Total)	7440-62-2		**12**[a, z]		1590

Chemical	CAS No.	Air mg/m^3	Water ug/l	Sediment[s] ug/kg	Soil[v] ug/kg
Vinyl acetate	108-5-4	359	248[g]	13	1.27 e+4[w]
Vinyl chloride	75-1-4	0.221	**930**[a]	**202**	646
Xylenes (total)	1330-20-7	135	**27**[d, z]	**433**[z]	1 e+4[x]
Zinc (Total)	7440-66-6		**65.7**[j, k, z]	**1.21 e+5**[u]	6620[y]

[a] = Michigan water quality standards, Rule 57 water quality values, July 23, 2003. Available at: http://www.michigan.gov/deq/0,1607,7-135-3313_3686_3728-11383--,00.html. The water ESL data for acenaphthene, BHC (gamma), cyanide and parathion are Michigan (final chronic value or FCV) Tier I criteria. Likewise, water ESL data for dieldrin, dioxin, DDT, endrin, hexachlorobenzene, hexachlorobutadiene, mercury, PCB's and toxaphene represent wildlife values (see Notes at end of these footnotes for dioxin, DDT, mercury and PCB's). All of the remaining data are Tier II values.

[b] = Water Ecological Screening Level (ESL) based on exposure to a mink (*Mustela vison*).

[c] = Indiana water quality standards, Title 327, Article 2, of the Indiana Administrative Code, Feb. 4, 2002. Available at: http://www.ai.org/legislative/iac/t03270/a00020.pdf The water ESL for toxaphene is from the Indiana chronic aquatic criterion for all waters outside of mixing zones (see Table 1 under Rule 1 of 327 IAC 2-1-6 Minimum Surface Water Quality Standards at the above Internet site). The remaining water ESL data are either wildlife values (for dioxin, DDT, mercury and PCB's) or Tier II values for the Indiana Great Lakes Basin (see Great Lakes Basin Criteria and Values Table as developed under Rule 1.5 of 327 IAC Article 2 as referenced above).

[d] = Ohio water quality standards, Chapter 3745-1 of the Ohio Administrative Code, Dec. 30, 2002. Available at: http://www.epa.state.oh.us/dsw/rules/3745-1.html The water ESL data for endrin and parathion are Ohio aquatic life Tier I criteria from the Outside Mixing Zone Average (OMZA). Wildlife values are available for dioxin, DDT, mercury and PCB's. All of the remaining data are Ohio aquatic life Tier II values from the OMZA. See Ohio summary tables for water quality criteria and values along with reference on the development of Tier I criteria and Tier II values.

[e] = Water ESL based on exposure to a belted kingfisher (*Ceryle alcyon*).

[f] = Minnesota water quality standards, Rule 7052.0100, Subpart 2 (water ESL data for arsenic & benzene represents aquatic life chronic standards and dioxin, DDT, mercury and PCB's represents wildlife values), April 13, 2000. Rule 7050.0222, Subpart 2, Feb. 12, 2003. Available at: http://www.revisor.leg.state.mn.us/arule/7050/0100.html and http://www.revisor.leg.state.mn.us/arule/7052/0222.html

[g] = Region 5, RCRA Interim Criteria, based on Aquire database with acceptable review codes and endpoints (life cycle). Must have eight or more acceptable studies (i.e., chronic and/or acute).

[h] = GLWQI Tier II value as presented in: Suter, G.W. II and Tsao, C.L. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota, 1996 Revision. ES/ER/TM-96/R2. Available at: http://www.esd.ornl.gov/programs/ecorisk/ecorisk.html

[i] = U.S. EPA 2001 Update of Ambient Water Quality Criteria for Cadmium (EPA 822-R-01-001).
[j] = U.S. EPA National Recommended Water Quality Criteria: 2002 (EPA 822-R-02-047)
[k] = For hardness-dependent metals (beryllium, cadmium, chromium^{+3}, copper, lead, nickel and zinc), freshwater chronic criteria are based on soft water with a total hardness of 50 mg/L as $CaCO_3$. Soft water is common within Region 5 and this water ESL may be recalculated when site specific water hardness is less than 50 mg/L.
[l] = U.S. EPA Ambient Water Quality for Chloroalkyl Ethers (EPA 440/5-80-030). No definitive data available concerning chronic toxicity. The water ESL is based on no adverse effects for a chronic toxicity embryo-larval test of the fathead minnow.
[m] = U.S. EPA Ambient Water Quality for Nitrophenols (EPA 440/5-80-063). The acute value of 230 ug/l was adjusted with an uncertainty factor of ten for 2,4-dinitrophenol and 4,6-dinitro-o-cresol since no chronic criteria are available.
[n] = Wisconsin Surface Water Quality Criteria and Secondary Values for Toxic Substances, NR 105.07(1)(b), Sept.1, 1997. Available at: http://www.legis.state.wi.us/rsb/code/nr/nr100.html
[o] = Illinois water quality standards, Title 35, Part 302.208, Dec. 20, 2002. Available at: http://www.ipcb.state.il.us/SLR/IPCBandIEPAEnvironmentalRegulations-Title35.asp
[p] = The criterion for pentachlorophenol is pH dependent and is based on a pH of 6.5.
[q] = U.S. EPA Ambient Water Quality for Phthalate Esters (EPA 440/5-80-067). A chronic value of 3 ug/L that resulted in significant reproductive impairment was adjusted with an uncertainity factor of ten.
[r] = Environment Canada. September 1994. Interim Sediment Quality Assessment Values. Ecosystem Conservation Directorate. Evaluation and Interpretation Branch.
[s] = Unless noted otherwise, all Sediment ESLs were derived using equilibrium partitioning (EqP) equation and the corresponding water ESL. Note: Sediment ESL = K_{oc} x Water ESL x 0.01.
[t] = Ontario Ministry of the Environment. August 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario.
[u] = Consensus based threshold effect concentrations (TEC) as presented in MacDonald et. al. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch Environ Contam Toxicol 39:20-31 (see Table 2). The TEC for mercury had a high incidence of toxicity and was not used. These values do not consider bioaccumulation nor biomagnification.
[v] = Unless noted otherwise, all Soil ESLs are based on exposure to a masked shrew (*Sorex cinerus*).
[w] = Soil ESL is based on exposure to a meadow vole (*Microtus pennsylvanicus*).
[x] = Soil ESL is based on exposure to a plant.
[y] = Soil ESL is based on exposure to soil invertebrates (e.g., earthworms).
[z] = New ESL data is lower than the previous table.

Notes: New ESL data are displayed in bold font and a dashed line (e.g., -----) is used to show when data was deleted from the previous table (i.e., supporting data was inadequate). All six states in EPA Region 5 have the same water ESL's for dioxin, DDT, mercury and PCB's which are based on a wildlife value. A summary report will be created on the development of soil benchmarks including equations, criteria and references. Likewise, a report will be prepared on the development of water benchmarks that are based on mink and belted kingfisher exposure.

APPENDIX B

ALTERNATIVE COST ESTIMATES

APPENDIX B-1

COST ESTIMATE
ALTERNATIVE S-2: LIMITED ACTION – LAND USE CONTROLS

NAVAL SURFACE WARFARE CENTER CRANE
Crane, Indiana
SWMU 5
Alternative S-2: Limited Action - Land Use Controls
Capital Cost

Item		Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Labor	Subtotal
1 PROJECT PLANNING & INSTITUTION CONTROLS									
1.1 Prepare Site - Specific LUC		40	hr			$35.00		$1,400	$1,400
Subtotal								$1,400	$1,400
Local Area Adjustments								82.9%	
								$1,161	$1,161
Overhead on Labor Cost @	30%							$348	$348
G & A on Labor Cost @	10%							$116	$116
G & A on Material Cost @	10%								$0
G & A on Subcontract Cost @	10%								$0
Total Direct Cost								$1,625	$1,625
Indirects on Total Direct Cost @	35%								$569
Profit on Total Direct Cost @	10%								$162
Subtotal									$2,356
Health & Safety Monitoring @	1%								$24
Total Field Cost									$2,380
Contingency on Total Field Costs @	0%								$0
Engineering on Total Field Cost @	10%								$238
TOTAL CAPITAL COST									**$2,618**

NAVAL SURFACE WARFARE CENTER CRANE
Crane, Indiana
SWMU 5
Alternative S-2: Limited Action - Land Use Controls
Operation and Maintenance Cost

	Item	Quantity	Unit	Unit Cost	Subtotal	Notes
1	System Maintenance		ls	$0	$131	5% of Installation Cost; replacement signs, etc.
2	Annual Report	1	ea	$1,000	$1,000	
				O & M per year	**$1,131**	

NAVAL SURFACE WARFARE CENTER CRANE
Crane, Indiana
SWMU 5
Alternative S-2: Limited Action - Land Use Controls
Annual Cost

Item	Item Cost Year 1	Item Cost Years 2 - 3	Item Cost Years 4 - 30	Item Cost Every 5 Years Through 30 Years	Notes
Annual Report	$1,000	$2,000	$1,000		Document sampling events and results, $1,000 per report.
Site Inspection	$500	$500	$500		To verify continued implementation of the LUC
Site Review				$1,000	Site review every 5 years for 30 years.
TOTALS	**$1,500**	**$2,500**	**$1,500**	**$1,000**	

NAVAL SURFACE WARFARE CENTER CRANE
Crane, Indiana
SWMU 5
Alternative S-2: Limited Action - Land Use Controls
Present Worth Analysis

Year	Capital Cost	Operation & Maintenance Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$2,618			$2,618	1.000	$2,618
1		$1,131	$1,500	$2,631	0.935	$2,460
2		$1,131	$2,500	$3,631	0.873	$3,170
3		$1,131	$2,500	$3,631	0.816	$2,963
4		$1,131	$1,500	$2,631	0.763	$2,007
5		$1,131	$2,500	$3,631	0.713	$2,589
6		$1,131	$1,500	$2,631	0.666	$1,752
7		$1,131	$1,500	$2,631	0.623	$1,639
8		$1,131	$1,500	$2,631	0.582	$1,531
9		$1,131	$1,500	$2,631	0.544	$1,431
10		$1,131	$2,500	$3,631	0.508	$1,844
11		$1,131	$1,500	$2,631	0.475	$1,250
12		$1,131	$1,500	$2,631	0.444	$1,168
13		$1,131	$1,500	$2,631	0.415	$1,092
14		$1,131	$1,500	$2,631	0.388	$1,021
15		$1,131	$2,500	$3,631	0.362	$1,314
16		$1,131	$1,500	$2,631	0.339	$ 892
17		$1,131	$1,500	$2,631	0.317	$ 834
18		$1,131	$1,500	$2,631	0.296	$ 779
19		$1,131	$1,500	$2,631	0.277	$ 729
20		$1,131	$2,500	$3,631	0.258	$ 937
21		$1,131	$1,500	$2,631	0.242	$ 637
22		$1,131	$1,500	$2,631	0.226	$ 595
23		$1,131	$1,500	$2,631	0.211	$ 555
24		$1,131	$1,500	$2,631	0.197	$ 518
25		$1,131	$2,500	$3,631	0.184	$ 668
26		$1,131	$1,500	$2,631	0.172	$ 453
27		$1,131	$1,500	$2,631	0.161	$ 424
28		$1,131	$1,500	$2,631	0.150	$ 395
29		$1,131	$1,500	$2,631	0.141	$ 371
30		$1,131	$2,500	$3,631	0.131	$ 476
					TOTAL PRESENT WORTH	**$39,109**

APPENDIX B-2

COST ESTIMATE
ALTERNATIVE S-3: LIMITED REMOVAL ACTION – LAND USE CONTROLS, SURFACE DEBRIS REMOVAL, AND LEAD HOTSPOT REMOVAL

NAVAL SURFACE WARFARE CENTER CRANE
CRANE, INDIANA
SWMU 5
Alternative S-3: Land Use Controls, Surface Debris Removal, and Lead Hotspot Removal
Capital Cost

	Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost
Plans, Permits, Reports												
1	Health & Safety Plan	40	hr			$35.00		$0	$0	$1,400	$0	$1,400
2	Environmental Protection Plan	16	hr			$35.00		$0	$0	$560	$0	$560
3	Work Plan	60	hr			$35.00		$0	$0	$2,100	$0	$2,100
4	Waste Management Plan	8	hr			$35.00		$0	$0	$280	$0	$280
5	Meetings	24	hr			$35.00		$0	$0	$840	$0	$840
6	Prepare LUC RD Documents	80	hr			$35.00		$0	$0	$2,800	$0	$2,800
Site Support												
1	Site Superintendent	30	day			$400.00		$0	$0	$12,000	$0	$12,000
2	H & S; QA/QC Site Support	30	day			$350.00		$0	$0	$10,500	$0	$10,500
3	Labor, Common (3 laborers for 30 days)	90	day				$232.16	$0	$0	$0	$20,894	$20,894
4	Pick-up Truck (2 trucks for 30 days)	60	day				$100.00	$0	$0	$0	$6,000	$6,000
5	Sanitary Facilities	2	mo				$180.00	$0	$0	$0	$360	$360
6	Utilities (phones, water, etc.)	30	day				$30.00	$0	$0	$0	$900	$900
7	Decon Facilities - Materials	1	ls		$400.00			$0	$400	$0	$0	$400
8	Decon Facilities - Equipment (duration x number of pads)	30	day				$80.00	$0	$0	$0	$2,400	$2,400
9	Dewatering Facilities - Materials	1	ls		$7,000.00			$0	$7,000	$0	$0	$7,000
10	Survey Support	2	day	$975.00				$1,950	$0	$0	$0	$1,950
Site Preparation												
1	Utility Survey	1	ls	$3,500.00				$3,500	$0	$0	$0	$3,500
2	Backhoe/Loader	3	day			$289.20	$410.00	$0	$0	$868	$1,230	$2,098
3	Temporary Access Road Surface, mulch & straw	444	sy		$1.86			$0	$826	$0	$0	$826
4	Stone Construction Entrance	1	ea		$1,100.00			$0	$1,100	$0	$0	$1,100
5	E&S Silt Fence	900	lf		$0.34			$0	$306	$0	$0	$306
6	Clear Site, cut & chip trees	2	day				$252.40	$0	$0	$0	$505	$505
7	Mob/demob Equipment	3	ea			$118.00	$248.00	$0	$0	$354	$744	$1,098
Excavation												
1	Backhoe/Loader	10	day			$289.20	$410.00	$0	$0	$2,892	$4,100	$6,992
2	Verification Sampling	1	ea	$500.00	$50.00	$40.00	$20.00	$500	$50	$40	$20	$610
3	Common Fill	29	cy		$21.00			$0	$609	$0	$0	$609
4	Top Dress Top Soil	6	cy		$21.00			$0	$126	$0	$0	$126
5	Seed	5	msf		$17.80			$0	$89	$0	$0	$89
Debris Removal												
1	Skid Steer	10	day				$222.20	$0	$0	$0	$2,222	$2,222
2	Cutoff Saw	10	day				$53.00	$0	$0	$0	$530	$530
3	Install Signs	38	ea		$146.50			$0	$5,567	$0	$0	$5,567
Transportation & Disposal												
1	T & D of Site Debris	50	cy	$53.80				$2,690	$0	$0	$0	$2,690
2	Waste Disposal Characterization / Analytical	1	ea	$1,050.00				$1,050	$0	$0	$0	$1,050
3	T & D of Lead Contaminated Soil	53	ton	$105.00				$5,565	$0	$0	$0	$5,565
4	Box Rental per Month	5	ea	$262.50				$1,313	$0	$0	$0	$1,313

NAVAL SURFACE WARFARE CENTER CRANE
CRANE, INDIANA
SWMU 5
Alternative S-3: Land Use Controls, Surface Debris Removal, and Lead Hotspot Removal
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Total Cost Subcontract	Total Cost Material	Total Cost Labor	Total Cost Equipment	Total Direct Cost
Subtotal							$16,568	$16,073	$34,634	$39,905	$107,179
Overhead on Labor Cost @	30%								$10,390		$10,390
G & A on All Cost @	10%						$1,657	$1,607	$3,463	$3,991	$10,718
Taxes on Materials & Equipment @	6%							$964		$2,394	$3,359
Total Direct Cost							$18,224	$18,644	$48,487	$46,290	$131,646
Indirects on Total Direct Cost @	10%										$13,165
Profit on Total Direct Cost @	8%										$10,532
TOTAL COST											**$155,342**

NAVAL SURFACE WARFARE CENTER CRANE
CRANE, INDIANA
SWMU 5
Alternative S-3: Land Use Controls, Surface Debris Removal, and Lead Hotspot Removal
Annual Cost

Item	Item Cost Years 1 - 30	Item Cost Every 5 Years Through 30 Years	Notes
Site Inspection	$1,000		To verify continued implementation of institutional controls.
Report	$500		Document sampling events and results, $1,000 per report.
Site Review		$7,500	Site review every 5 years for 30 years.
TOTALS	**$1,500**	**$7,500**	

NAVAL SURFACE WARFARE CENTER CRANE
CRANE, INDIANA
SWMU 5
Alternative S-3: Land Use Controls, Surface Debris Removal, and Lead Hotspot Removal
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$155,342		$155,342	1.000	$155,342
1		$1,500	$1,500	0.935	$1,403
2		$1,500	$1,500	0.873	$1,310
3		$1,500	$1,500	0.816	$1,224
4		$1,500	$1,500	0.763	$1,145
5		$9,000	$9,000	0.713	$6,417
6		$1,500	$1,500	0.666	$999
7		$1,500	$1,500	0.623	$935
8		$1,500	$1,500	0.582	$873
9		$1,500	$1,500	0.544	$816
10		$9,000	$9,000	0.508	$4,572
11		$1,500	$1,500	0.475	$713
12		$1,500	$1,500	0.444	$666
13		$1,500	$1,500	0.415	$623
14		$1,500	$1,500	0.388	$582
15		$9,000	$9,000	0.362	$3,258
16		$1,500	$1,500	0.339	$509
17		$1,500	$1,500	0.317	$476
18		$1,500	$1,500	0.296	$444
19		$1,500	$1,500	0.277	$416
20		$9,000	$9,000	0.258	$2,322
21		$1,500	$1,500	0.242	$363
22		$1,500	$1,500	0.226	$339
23		$1,500	$1,500	0.211	$317
24		$1,500	$1,500	0.197	$296
25		$9,000	$9,000	0.184	$1,656
26		$1,500	$1,500	0.172	$258
27		$1,500	$1,500	0.161	$242
28		$1,500	$1,500	0.150	$225
29		$1,500	$1,500	0.141	$212
30		$9,000	$9,000	0.131	$1,179
				TOTAL PRESENT WORTH	**$190,126**

APPENDIX B-3

COST ESTIMATE

ALTERNATIVE GW-2: LIMITED ACTION – LAND USE CONTROLS

NAVAL SURFACE WARFARE CENTER CRANE
Crane, Indiana
SWMU 5
Alternative GW-2-Exp: Limited Action - Land Use Controls
Capital Cost

Item	Quantity	Unit	Unit Cost: Subcontract	Unit Cost: Material	Unit Cost: Labor	Unit Cost: Equipment	Labor	Subtotal
1 PROJECT PLANNING & INSTITUTION CONTROLS								
1.1 Prepare Site - Specific LUC	40	hr			$35.00		$1,400	$1,400
Subtotal							$1,400	$1,400
Local Area Adjustments							82.9%	
							$1,161	$1,161
Overhead on Labor Cost @ 30%							$348	$348
G & A on Labor Cost @ 10%							$116	$116
G & A on Material Cost @ 10%								$0
G & A on Subcontract Cost @ 10%								$0
Total Direct Cost							$1,625	$1,625
Indirects on Total Direct Cost @ 35%								$569
Profit on Total Direct Cost @ 10%								$162
Subtotal								$2,356
Health & Safety Monitoring @ 1%								$24
Total Field Cost								$2,380
Contingency on Total Field Costs @ 0%								$0
Engineering on Total Field Cost @ 10%								$238
TOTAL CAPITAL COST								**$2,618**

NAVAL SURFACE WARFARE CENTER CRANE
Crane, Indiana
SWMU 5
Alternative GW-2-Exp: Limited Action - Land Use Controls
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate 1.9%	Present Worth
0	$2,618		$2,618	1.000	$2,618
1		$29,000	$29,000	0.981	$28,459
2		$1,500	$1,500	0.963	$1,445
3		$29,000	$29,000	0.945	$27,408
4		$1,500	$1,500	0.927	$1,391
5		$29,000	$29,000	0.910	$26,395
6		$1,500	$1,500	0.893	$1,340
7		$48,000	$48,000	0.877	$42,075
8		$1,500	$1,500	0.860	$1,290
9		$19,000	$19,000	0.844	$16,039
10		$1,500	$1,500	0.828	$1,243
11		$19,000	$19,000	0.813	$15,447
12		$1,500	$1,500	0.798	$1,197
13		$19,000	$19,000	0.783	$14,876
14		$21,000	$21,000	0.768	$16,135
15		$19,000	$19,000	0.754	$14,327
16		$1,500	$1,500	0.740	$1,110
17		$19,000	$19,000	0.726	$13,797
18		$1,500	$1,500	0.713	$1,069
19		$19,000	$19,000	0.699	$13,288
20		$1,500	$1,500	0.686	$1,029
21		$38,000	$38,000	0.674	$25,593
22		$1,500	$1,500	0.661	$991
23		$19,000	$19,000	0.649	$12,324
24		$1,500	$1,500	0.637	$955
25		$19,000	$19,000	0.625	$11,869
26		$1,500	$1,500	0.613	$920
27		$19,000	$19,000	0.602	$11,430
28		$21,000	$21,000	0.590	$12,398
29		$19,000	$19,000	0.579	$11,008
30		$1,500	$1,500	0.569	$853
				TOTAL PRESENT WORTH	**$330,318**