RANGE ENVIRONMENTAL GROUP

DOCUMENT 850-08

IDENTIFICATION AND RANKING OF EMERGING CONTAMINANTS IMPORTANT TO DEPARTMENT OF DEFENSE (DoD) OPERATIONAL RANGES

WHITE SANDS MISSILE RANGE
REAGAN TEST SITE
YUMA PROVING GROUND
DUGWAY PROVING GROUND
ABERDEEN TEST CENTER
NATIONAL TRAINING CENTER
ELECTRONIC PROVING GROUND
HIGH ENERGY SYSTEMS TEST FACILITY

NAVAL AIR WARFARE CENTER WEAPONS DIVISION, PT. MUGU
NAVAL AIR WARFARE CENTER WEAPONS DIVISION, CHINA LAKE
NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION, PATUXENT RIVER
NAVAL UNDERSEA WARFARE CENTER DIVISION, NEWPORT
PACIFIC MISSILE RANGE FACILITY
NAVAL UNDERSEA WARFARE CENTER DIVISION, KEYPORT

30TH SPACE WING
45TH SPACE WING
AIR FORCE FLIGHT TEST CENTER
AIR ARMAMENT CENTER
ARNOLD ENGINEERING DEVELOPMENT CENTER
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NATIONAL NUCLEAR SECURITY ADMINISTRATION (NEVADA)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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IDENTIFICATION AND RANKING OF EMERGING CONTAMINANTS IMPORTANT TO DEPARTMENT OF DEFENSE OPERATIONAL RANGES

September 2008

Prepared by

RANGE ENVIRONMENTAL GROUP

IN COLLABORATION WITH

THE OFFICE OF THE ASSISTANT DEPUTY UNDER SECRETARY OF DEFENSE (OADUSD) FOR INSTALLATIONS AND ENVIRONMENT
(EMERGING CONTAMINANTS DIRECTORATE)

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APPENDIX A DATA SOURCES EVALUATION MATRIX

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APPENDIX B COMPLETE LIST OF RANKED CHEMICALS UNDER BASELINE SCENARIO

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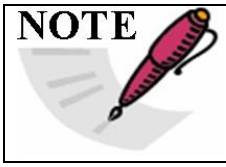

Appendix E has a restricted access level of Distribution C: U.S. Government Agencies and their contractors. Appendix E is available as a separate document in the RCC private portal in file folder https://www.trmc.osd.mil/wiki/display/RCC/850+Emerging+Contaminants.

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PREFACE

The Office of the Assistant Deputy Under Secretary of Defense (OADUSD) for Installations and Environment (Emerging Contaminants Directorate) and the Range Commanders Council (RCC) jointly funded a project to assess the risks of emerging contaminants (ECs) to Department of Defense (DoD) test and training ranges and to assist with identifying and recommending risk management options (RMO) for Range Commanders. The joint effort was aimed at developing a process that the ranges could use to identify and evaluate emerging contaminants (EC). The objectives of the REG efforts were to:

a. Survey representative operational test and training ranges and create a database of potential sources of EC including munitions, propellants, pyrotechnics, fuels, lubricants, coolants, herbicides, pesticides, and other relevant materials (past, current, and future use).
b. To compare that data base to lists of EC for exact matches and relevant chemical families.
c. To establish a process which will provide range managers with situational awareness of these ECs.
d. To establish a process to inform all concerned of new products and ingredients (e.g., CL-20) which will be transitioning into munitions.

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ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
AEC	Army Environmental Center
AL	Action List (EC Directorate)
BMGR	Barry M. Goldwater Range
BzBP	butyl benzyl phthalate
CAA	Clean Air Act
CalEPA	California Environmental Protection Agency
CAS	Chemical Abstracts Service (division of the American Chemical Society)
CCL	Candidate Contaminant List
CD	compact disc
CDC	Centers for Disease Control and Prevention
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHPPM	Center for Health Promotion and Preventive Medicine (U.S. Army)
CWA	Clean Water Act
DBP	di-n-butyl phthalate
DEHP	di(2-ethylhexyl)phthalate
DoD	Department of Defense
EC	emerging contaminant
EPCRA	Emergency Planning and Community Right-to-Know Act
ESTCP	Environmental Security Technology Certification Program HAP hazardous air pollutant
HCH	hexachlorocyclohexane
HLC	Henry's Law constant
IARC	International Agency for Research on Cancer
IRIS	Integrated Risk Information System (USEPA)
kg	kilogram(s)
K_{ow}	octanol-water partition coefficient
L	liter
mg	milligram
MIDAS	Munitions Items Disposition Action System (U.S. Army)
NAAQS	National Ambient Air Quality Standards
NAVSEA	Naval Sea Systems Command
NBP	National Biomonitoring Program (CDC)
NTP	National Toxicology Program
ODS	ozone depleting substance
ODUSD(I&E)	Office of the Deputy Under Secretary of Defense, Installations and Environment
ORAP	Operational Range Assessment Plan
OSD	Office of the Secretary of Defense
OSHA	Occupational Safety and Health Administration
PBT	Persistent Bioaccumulative and Toxic
PCB	polychlorinated biphenyl

PEL	Permissible Exposure Limit
POP	persistent organic pollutant
PPRTV	Provisional Peer Reviewed Toxicity Value
RAGS	Risk Assessment Guidance for Superfund
RAIS	Risk Assessment Information System (U.S. Department of Energy)
RCC	Range Commanders Council
RCRA	Resource Conservation and Recovery Act
RDT&E	Research, Development, Test, and Evaluation
RDX	cyclotrimethylene-trinitramine
REG	Range Environmental Group
RFMSS	Range Facility Management Support System
SARA	Superfund Amendment and Reauthorization Act
SDWA	Safe Drinking Water Act
SERDP	Strategic Environmental Research and Development Program
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCE	trichloroethylene
TCL	Target Chemicals List (NAVSEA)
TNT	2,4,6-trinitrotoluene
TRI	Toxic Release Inventory
TRV	Toxicity Reference Value
TSCA	Toxic Substance Control Act
U.S.	United States
UCMR	Unregulated Contaminant Monitoring Rule
USEPA	U.S. Environmental Protection Agency
USMC	U.S. Marine Corps
USMR	Unregulated Contaminant Monitoring Rule
UXO	Unexploded ordnance
VOC	volatile organic compound
WL	Watch List (EC Directorate)
YPG	Yuma Proving Ground

CHAPTER 1

INTRODUCTION

1.1 Project Overview

The Office of the Deputy Under Secretary of Defense for Installations and Environment (ODUSD (I&E)) and the Range Environmental Group (REG) of the Range Commanders Council (RCC), jointly funded a project to assess the risks to Department of Defense (DoD) operational test and training ranges from chemicals released/used on ranges. Specifically, emerging contaminants (ECs) are of interest. Emerging contaminants are chemicals or materials that meet the following two conditions:

a. They have either a real or perceived threat to human health or the environment.
b. They have neither a peer-reviewed health standard nor an evolving standard.

1.2 Approach (Part 1): Identification of ECs

The early identification of ECs which are important to ranges is the first step towards controlling the potential for adverse impacts on range operations. Some ECs are already the focus of regulatory action based on a significant body of scientific studies while others are just coming over the regulatory horizon and may be associated with less scientific rigor. In general, ECs are not an immediate cause of concern for operational ranges but may become important drivers for operational consideration in the future.

The analysis in this document examines a broad scope of relevant data sources to identify and rank chemicals that could be of specific concern to ranges. Consistent with the definition of an EC, the analysis focused on indicators of future regulatory action, current regulatory status, the likelihood that exposure might be of concern, and the likelihood of finding the chemical on an operational range. Once a set of chemicals was identified, an analytic framework was developed to assign scores based on a set of decision rules. The scores were then weighted based on stakeholder input and the ECs were ranked according to the weighted scores. Three different ranking scenarios were calculated to represent a wide range of stakeholder priorities.

1.3 Approach (Part 2): Data Analysis

The data analysis is the second part of the project to identify and rank ECs that would be important to operational ranges. In the first part of this project, the RCC requested that a survey of its REG member ranges be conducted to help define the scope of the risks from ECs both now and in the future. The RCC membership is comprised mostly of ranges with a Research, Development, Test, and Evaluation (RDT&E) mission. In addition, the ODUSD(I&E) requested inclusion of a limited number of non-RCC ranges in the survey to capture activities on large training ranges. The survey was an important step leading to the identification of sources, pathways, and potential receptors for ECs on ranges. The results of the survey were used in the data analysis.

The process described in this report is to identify and then rank chemicals of importance to operational ranges. This process is different from the process used by the ODUSD(I&E) to identify and then prioritize ECs across the entire DoD complex. The differences are in large part due to the narrow and specific focus of this effort on operational ranges as compared to the broad focus necessitated by the ODUSD(I&E) examination of ECs across all DoD operational functions.

CHAPTER 2

APPROACH TO IDENTIFICATION OF THE RANGE-RELATED EMERGING CONTAMINANTS (ECs)

The identification, assessment, scoring, and ranking process began with the development of a list of attributes that would help define a chemical as emerging and make it of interest to operational test and training ranges. These attributes about what makes a chemical emerging and of interest to the range community were developed through discussions with the ODUSD(I&E) and the RCC.

After EC attributes were defined, research was conducted and a number of data sources, or lists, were identified. The presence of a chemical on a specific list would show relevance to the level of importance of that EC and how changes in its use might affect range activities and contribute to the overall assessment and ranking process. For example, a chemical appearing on the Candidate Contaminant List Number 3 (CCL3) would indicate that the chemical may have the potential for future regulatory change. The CCL3 list identifies a broad universe of potential drinking water contaminants and then applies screening criteria to those contaminants that should be further evaluated based on a contaminant's potential to occur in public water systems and for public health concern. For the CCL3 and each of the other lists, a weighting and scoring value was assigned, and a rationale or justification was used to form the basis of the assigned value(s). In determining the list weightings and scores, considerable emphasis was placed on areas of concern. Examples of concerns include the toxicity of the EC, the presence of the EC on the list, and the risk that may be imposed on range personnel and the environment.

Chemicals listed on the EC Directorate's Watch List (WL) and Action List (AL) were included in the assessment since those ECs have already been identified by the DoD as being present at military test ranges, as ECs of importance to the DoD (listed on the WL) or as ECs of significant importance to the DoD (listed on the AL). Secondly, since managers at the ranges are best suited to know what chemicals are being used at the facilities and in what capacity they are being used, a survey[1] of relevant questions was developed and distributed to representative ranges for input. While the ECs from the WL and AL were included as part of the survey, the survey respondents were directed to not limit their responses to only those ECs listed on the survey. The respondents were also asked to consider the unique circumstances and operational conditions of their range and identify any additional ECs that should be considered in the assessment. The reasoning behind the added guidance was because the ECs applicable to a specific range may differ from those already on the AL and WL.

2.1 Attributes of Chemicals Identified

Through discussions with the ODUSD(I&E) and the RCC, attributes that would be useful for the identification of chemicals used on ranges that would qualify as ECs were developed.

[1] [1] NTR-2007-029, Survey of Emerging Contaminants on Department of Defense Ranges, Summary and Analysis of Survey Responses, Noblis Organization, September 2007, referred to in this document as the "survey" or "range survey."

For defining when a chemical was an EC, the existing ODUSD(I&E) definition of an EC was used. The attributes that would make a chemical of interest to the operational training and testing community were developed by reviewing conceptual site models for multiple range types and considering the types of activities at test and training ranges. The attributes determined to be important for identifying ECs at operational test and training ranges were divided into the five categories shown in Table 2-1. These attributes were used to guide data collection efforts for lists of chemicals. Later in the analysis, these same attributes were used to categorize the data sources for scoring and ranking.

TABLE 2-1. ATTRIBUTE CATEGORIES FOR IDENTIFYING ECs

Category	Description
I - Evaluation of potential for regulatory change	The potential for a chemical to be subject to a regulatory change
II - Current Regulatory Status	The current regulatory status of the chemical
III - Degree of Toxicity	The chemical's degree of toxicity
IV - Exposure and Mobility	The potential for exposure and therefore a chemical's mobility in the environment
V - ECs Identified by Others/Chemicals on ranges	The fact that a chemical has already been identified as an EC and that it is likely to be used on a range

2.2 Data Sources

2.2.1 Data Sources Reviewed and Considered

Using the five categories of attributes, multiple data sources were reviewed and considered for inclusion in the analysis. Data sources were identified through literature and internet searches as well as discussions with the RCC and other range community members. A complete listing of the data sources considered for this assessment, along with their attribute assignments, can be found in the Data Sources Evaluation Matrix at Appendix A.

a. Data sources in Category I. Evaluation of Potential for Regulatory Change consisted mostly of lists of chemicals from multiple United States Environmental Protection Agency (USEPA) regulatory programs including those for drinking water, air quality, toxicity, and waste management/disposal. Many of the lists of chemicals in this category are precursors to regulation. Therefore, this attribute is critical to the identification of chemicals that, consistent with the definition of an EC, have an evolving regulatory standard. The presence of a chemical on a list shows that the USEPA is in the early data collection stages for potential regulation. Only regulatory change data from state and federal sources were obtained.

b. Data sources in Category II. Current Regulatory Status consisted mostly of lists of chemicals from current regulatory programs enforced by the USEPA and the Occupational Safety and Health Administration (OSHA). The term "regulatory" was broadly interpreted to include toxicity benchmarks which, while not strictly regulatory in nature, serve as the basis for many formal regulations. In addition, international treaties signed by the U.S. that control specific chemicals on the list were also considered. The assignment of a list to this category indicates that the chemicals are already regulated. Experience shows that chemicals with regulations are somewhat more likely to be re-regulated further than chemicals that are currently unregulated. In addition, chemicals with a provisional or non-federal toxicity value (an indication that a health standard is evolving) were also placed into this category. While regulatory data from state and federal sources were sought, data from federal sources were more readily obtainable.

c. Data sources in Category III. Degree of Toxicity consisted of lists of chemicals and databases of a chemical's relative toxicity. The data sources captured information related to cancer and non-cancer (i.e., reproductive) health effects. Health effects data was obtained for humans and ecological (i.e., birds, reptiles) receptors. Health effects data for aquatic ecological receptors was not obtained. Health effects data from state, federal, and international sources was obtained.

d. Data sources in Category IV. Exposure and Mobility were identified to capture the fate and transport of the chemicals in the environment. Chemical parameters such as the octanol-water partition coefficient (K_{ow}) were identified. The K_{ow} is the ratio of the concentration of a chemical in octanol and in water at equilibrium and a specified temperature. Octanol is an organic solvent that is used as a surrogate for natural organic matter. This parameter is used in many environmental studies to help determine the fate of chemicals in the environment. An example would be using the coefficient to predict the extent a contaminant will bioaccumulate in animals.

e. Data sources in Category V. ECs Identified by Others/Chemicals on ranges were identified to capture chemicals already identified as ECs, chemicals identified as ECs by the RCC members through the range survey, and chemicals identified by others that are expected at operational ranges.

2.2.2 Data Sources Selected

The data sources selected to support the EC ranking are shown in Table 2-2. Along with each data source is a brief explanation of the purpose the data source served in the analysis and the category into which the data source was placed. Data sources were reviewed and selected to reflect availability as of the fall 2007 with only minor exceptions. Updates or changes to the underlying data sources would likely effect the conclusions of this report. The 34 data sources identified in this analysis listed more than 6,100 records. While most sources listed individual chemicals, some provided a single entry for an entire class of chemicals (e.g., polychlorinated biphenyls (PCBs)).

TABLE 2-2. DATA SOURCES SELECTED TO IDENTIFY AND RANK CHEMICALS ON RANGES SORTED BY DATA CATEGORY

Item	Data Source	Purpose	Category[1]
1.	Safe Drinking Water Act (SDWA) National Primary Drinking Water Regulations	Presence on this list shows that the chemical is already regulated; however, under the SDWA rules, chemicals already regulated are reviewed every six years for updates as required by law. Thus, the potential for future change exists by statute.	I
2.	CCL3	The CCL3 is a 2008 update to CCL2 and is a precursor to regulation under the SDWA. While not all chemicals on the CCL3 will be regulated under the SDWA, the presence of a chemical on the list indicates that the USEPA is moving in that direction.	I
3.	Unregulated Contaminant Monitoring Rule, 2nd Phase (UCMR 2)	The UCMR 2 is a precursor to regulation under the SDWA. The presence of a chemical on the list shows that the USEPA is in the early data collection stages for potential regulation.	I
4.	National Ambient Air Quality Standards (NAAQS)	Presence on this list shows that a chemical is already regulated; however, chemicals for which NAAQS were established are reviewed every five years for possible update as required by law, thus the potential for future change exists by statute.	I
5.	Integrated Risk Information System (IRIS) Update List 2008	Presence on this list shows that the chemical is undergoing an initial or reevaluation for potential toxic effects.	I
6.	Clean Water Act (CWA) (Hazardous Substance, Priority Pollutant or Toxic Pollutant)	Presence on this list shows that the chemical is already regulated. Experience shows that chemicals with regulations are more likely to be regulated further.	II
7.	Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) /Superfund Amendments and Reauthorization Act (SARA)/Emergency Planning and Community Right-to-Know Act (EPCRA)	Presence on this list shows that the chemical is already regulated. Experience shows that chemicals with regulations are more likely to be regulated further.	II
8.	Resource Conservation and Recovery Act (RCRA) Listed Waste	Presence on this list shows that the chemical is already regulated. Experience shows that chemicals with regulations are more likely to be regulated further.	II
9.	Clean Air Act (CAA) Hazardous Air Pollutants (HAPs)	Presence on this list shows that the chemical is already regulated. Experience shows that chemicals with regulations are more likely to be regulated further.	II
10.	Ozone Depleting Substances (ODSs) Class I or II	Presence on this list shows that the chemical is already regulated. Experience shows that chemicals with regulations are more likely to be regulated further.	II

Table 2-2 Continued (Page 2 of 4)

Item	Data Source	Purpose	Category
11.	OSHA Permissible Exposure Limits (PELs)	Presence on this list shows that the chemical is already regulated. Experience shows that chemicals with regulations are more likely to be regulated further; however, OSHA is typically very slow in regulatory rule makings.	II
12.	Stockholm Convention Persistent Organic Pollutants (POPs)	Presence on this list shows a commitment by signatory nations to eliminate or reduce the release of these chemicals into the environment. Experience shows that chemical with international attention are more likely to be regulated further.	II
13.	IRIS	Presence on this list shows that the chemical has already been evaluated for potential toxicity and that toxicity benchmarks have been established where possible. Experience shows that chemicals with IRIS values are more like to be regulated further than chemicals without IRIS values. Changes in IRIS values are often precursors to movement in other risk-based regulations.	II
14.	National Toxicology Program (NTP) Testing Program, Report on Carcinogens 11th Edition	Presence on this list shows that the chemical is (or was) being evaluated for potential toxicity. For chemicals nominated to the NTP, there is an existing case for hazard identification. Classification of a substance as a carcinogen can influence the direction of other regulations.	II
15.	California Environmental Protection Agency (CalEPA), Proposition 65	Presence on this list shows that the chemical was evaluated for potential toxicity. This may lead to further regulation within the state of California. In this case, the chemical's presence on the list rather than the classification of the chemical's toxicity was used (see also item 21).	II
16.	USEPA Persistent Bioaccumulative and Toxic (PBT) Chemicals List	Presence on this list shows that the chemical underwent an evaluation of toxicity and was determined to be associated with a range of adverse human health effects including effects on the nervous system, reproductive and developmental problems, cancer, and genetic impacts.	II
17.	USEPA Provisional Peer Reviewed Toxicity Values (PPRTVs)	Presence of a provisional toxicity value indicates that the USEPA has no official agency position, but the chemical has been found to be a potential risk driver at a Superfund site. In this case, the chemical's presence on the list was used as an indicator of current regulatory status rather than the relative toxicity of the chemical (see also item 24).	II
18.	USEPA Cancer Classifications	This data will be used to identify chemicals that are known or suspected carcinogens.	III

Table 2-2 Continued (Page 3 of 4)

Item	Data Source	Purpose	Category
19.	USEPA Region III Risk-Based Concentrations Table	The data are used to examine the relative toxicity of chemicals to one another.	III
20.	California Toxicity Criteria Database	The data are used to examine the relative toxicity of chemicals to one another. This table will supplement the IRIS.	III
21.	CalEPA, Proposition 65	This list is used to identify the chemicals that are considered by the state of California to cause cancer, developmental, or reproductive effects. In this case, the classification of the chemical's toxicity was used rather than simply the chemical's presence on the list (also see item 15).	III
22.	Center for Disease Control and Prevention (CDC) National Biomonitoring Program (NBP), National Report on Human Exposure to Environmental Chemicals, 2nd Report	Presence on this list shows that the chemical is being evaluated for its presence in the national population. Since chemicals are nominated to the CDC's NBP, there is an existing case for hazard identification.	III
23.	International Agency for Research on Cancer (IARC) (Confirmed and Suspected Carcinogens List)	Presence on this list shows that the chemical was evaluated for potential toxicity and found to have a significant potential for being a carcinogen.	III
24.	USEPA PPRTVs	The data are used to examine the relative toxicity of chemicals to one another. In this case the relative toxicity of the chemical was used rather than simply the chemical's presence on the list (also see item 17).	III
25.	U.S. Army's Center for Health Promotion and Preventive Medicine (CHPPM) Terrestrial Toxicity Database	Data will be used to gauge toxicity to non-human receptors.	III
26.	Water solubility	High water solubility may indicate that the material can easily be transported from the range via soil, groundwater, or surface water to a potential receptor.	IV
27.	Log K_{ow}	A high K_{ow} indicates that the chemical may bioaccumulate in the tissues of animals or humans and may move through the food chain.	IV
28.	Volatility	Highly volatile chemicals are unlikely to remain in soil or water. In accordance with the Risk Assessment Guidance for Superfund (RAGS) Part B, chemicals with a Henry's Law constant (HLC) > 1E-5 and molecular weight < 200 are marked as volatile organic compounds (VOCs).	IV
29.	DoD EC WL	Presence on this list shows that the chemical has been identified as an EC of importance to the DoD.	V

Table 2-2 Continued (Page 4of 4)

Item	Data Source	Purpose	Category
30.	DoD EC AL	Presence on this list shows that the chemical has been identified as an EC of significant importance to the DoD.	V
31.	REG survey, Table 2-1	Presence on this list shows that the chemical has been identified as a potential EC with demonstrated regulatory significance to ranges.	V
32.	REG survey, Table 2-2	Presence on this list shows that the chemical has been identified by range managers as a potential EC with significance to ranges.	V
33.	Munitions Items Disposition Action System (MIDAS) Database	Chemicals listed in MIDAS are known to be present in one or more munitions items. The presence of the chemical in a munitions item is a reasonable link to its potential for use on a range.	V
34.	Army Range Testing List	The U.S. Army Environmental Center (AEC) has a test program to identify and quantify the emissions that result from weapons firing and from the use of pyrotechnic devices. The presence of the chemical on this list is a reasonable link to its potential for use on a range.	V

[1] Notes
Category I - Evaluation of Potential for Regulatory Change Category II - Current Regulatory Status
Category III - Degree of Toxicity Category IV - Exposure and Mobility
Category V - EC Identified by Others/Chemicals on ranges

2.3 Scoring Procedures

The scores assigned to each chemical were dependent on the characteristics (e.g., mobility or toxicity) of a chemical or its presence or absence on a list. The specific scoring assignments are provided in Table 2-3. Scores were assigned within a range from 0-20 points with score assignments given when specific criteria were met. For example, under Category I, a chemical's presence on a specific list was assigned a value of 20 points whereas a chemical's absence from the list was assigned a value of 0 points.

TABLE 2-3. PROCEDURES USED TO SCORE CHEMICALS ON RANGES

Item	Data Source Name	Score Points
1.	SDWA National Primary Drinking Water Regulations	Yes = 20 No = 0
2.	CCL2	Yes = 20 No = 0
3.	UCMR 2	Yes = 20 No = 0
4.	NAAQS	Yes = 20 No = 0
5.	IRIS Update List 2008	Yes = 20 No = 0
6.	CWA (Hazardous Substance, Priority Pollutant or Toxic Pollutant)	Yes = 20 No = 0
7.	CERCLA/SARA/EPCRA	Yes = 20 No = 0
8.	RCRA Listed Waste	Yes = 20 No = 0
9.	CAA HAPs	Yes = 20 No = 0
10.	ODSs Class I or II	Yes = 20 No = 0
11.	OSHA PELs	Yes = 20 No = 0
12.	Stockholm Convention POPs	Yes = 20 No = 0
13.	IRIS	Yes = 20 No = 0
14.	NTP Testing Program, Report on Carcinogens 11th Edition	Yes = 20 No = 0
15.	CalEPA, Proposition 65	Yes = 20 No = 0
16.	USEPA PBT Chemicals List	Yes = 20 No = 0
17.	USEPA PPRTVs	Yes = 20 No = 0
18.	USEPA Cancer Classifications	Type A or "carcinogen" = 20 Type B1, B2 or any “B” classification, or "likely to" = 18 Type C or “suggestive” = 10 Type D or blank = 5 Type E = 0
19.	USEPA Region III Risk-Based Concentrations Table	Residential < 0.5 mg/kg = 20 Residential > 0.5 mg/kg = 5 No value = 10

Table 2-3 Continued (Page 2 of 2)

Item	Data Source Name	Score Points
20.	California Toxicity Criteria Database	Oral Slope Factor > 9.45 (mg/kg-d)-1 = 20 Oral Slope Factor < 9.45 (mg/kg-d)-1 = 5 No value/blank = 10
21.	CalEPA, Proposition 65	Cancer = 20 Development or reproductive effects = 15 No value/blank = 5
22.	CDC NBP, National Report on Human Exposure to Environmental Chemicals, 2nd Report	Yes = 20 No = 0
23.	IARC (Confirmed and Suspected Carcinogens List)	Confirmed = 20 Suspected = 10 No value/blank = 5
24.	USEPA PPRTVs	Oral Slope Factor ≥ 9.45 (mg/kg-d)-1 = 20 Oral Slope Factor < 9.45 (mg/kg-d)-1 = 5 No value/blank = 10
25.	CHPPM Terrestrial Toxicity Database	Toxicity Reference Value (TRV) for birds or mammals < 1 mg/kg-day = 20 TRV for birds or mammals ≥ 1 mg/kg-day = 5 No value/blank = 10
26.	Water solubility	> 1.0 mg/L = 20 ≤ 1.0 mg/L = 5 No value/blank = 10
27.	log K_{ow}	log KOW ≥ 4.0 = 20 log KOW < 4.0 = 5 No value/blank = 10
28.	Volatility	All other combinations of HLC and molecular weight = 20 HLC > 1E-5 and molecular weight < 200 = 5 No value/blank = 10
29.	DoD EC WL	Yes = 20 No = 0
30.	DoD EC AL	Yes = 20 No = 0
31.	REG survey, Table 2-1	Yes = 20 No = 0
32.	REG survey, Table 2-2	Yes = 20 No = 0
33.	MIDAS Database	Yes = 20 No = 0
34.	Army Range Testing List	Yes = 20 No = 0

2.4 Weighting Procedure

The following weighting procedure was developed in order to place emphasis on the potential for a chemical to be:

a. Subject to regulatory change, and
b. Present on an operational range.

Therefore, higher weights (35 percent) were assigned to Category I and Category V. Equal weights of 11.25 percent were assigned to Category III and Category IV. The remaining weight of 7.5 percent was assigned Category II. Placing a high relative emphasis on the first and last categories was determined to be consistent with the definition of an EC and the purpose of the project. However, the analytical process used can easily be revised to allow for a multitude of weights to reflect different stakeholder interests.

2.5 Ranking Process

As described previously, each of the five categories was assigned a weighting based on its relative importance and the potential for affecting range activities both now and in the future. The Baseline Scenario included a weighting assignment of 35 percent of the total score for Categories I and V, 11.25 percent for Categories III and IV and 7.5 percent for Category II. If a chemical was determined to be on one of the lists under Category I, II, or V, a score of 20 was assigned to that chemical and an applicable list-weighting assigned each time it was found on the individual lists under those three categories. If the chemical was not listed, it received a score of zero (0). Unlike the other categories, the lists under Categories III and IV characterized the chemical with specific data, such as the information that is provided in the USEPA Region III Risk-Based Concentrations Table, where the relative level of toxicity on each of the chemicals being assessed is provided. For these two categories, scores were assigned based on the EC meeting a specific threshold value or characteristic. For example, if a chemical listed in the USEPA Region III table showed a residential value of < 0.5 mg/kg, it would receive a score of 20; however, if the residential soil value was > 0.5 mg/kg, a score of 5 was assigned. If no residential soil value was shown, then the score would be 10. This approach was used to score each of the chemicals on a relative basis to the entire list of chemicals.

Table 2-4 illustrates how the scoring process would be carried out for each individual chemical. First, the chemical is checked against the lists and then assigned a score based on the criteria specified in the matrix. This value would then be multiplied first by the percentage weighting assigned to that particular list and then by the percentage weighting of the category. A total score is then calculated and then the chemical is ranked as follows: the chemical with the highest score is ranked number 1, the chemical with the second highest score ranked number 2.

This process continues until all of the chemical have been scored and ranked. In the example shown below, the total score for the chemical is calculated as being 2.86.

TABLE 2-4. EXAMPLE CHEMICAL SCORING PROCESS

List	Score	List Weight	Category	Category Weight	Weighted Score
SDWA National Primary Drinking Water Regulations	20	20%	I	35.00%	1.40
RCRA Listed Waste	0[1]	15%	II	7.50%	0.00
USEPA Cancer Classification	18[2]	25%	III	11.25%	0.51
Water Solubility	5[3]	45%	IV	11.25%	0.25
DoD EC AL	20	10%	V	35.00%	0.70
Total Score for this chemical					2.86

Notes
1. EC was not listed as RCRA waste, and so a score of 0 is assigned.
2. EC was listed as Type B1, and so a score of 18 is assigned.
3. EC was listed as having a water solubility of ≤ 1.0 mg/L, and so a score of 5 is assigned.

2.6 Sensitivity Analysis

In addition to the Baseline Scenario described in paragraph 2.4, two additional scenarios were completed to demonstrate the effect on the EC rankings through varying the weightings of the five categories. The two additional scenarios created for the sensitivity analysis were:

a. Alternative Scenario 1: Designed to reflect an equal emphasis across all attribute categories.
b. Alternative Scenario 2: Designed to increase emphasis on the potential for exposure and toxicity.

The category weightings applied for each of the three scenarios are shown in Table 2-5.

TABLE 2-5. SCENARIOS AND ASSIGNED WEIGHTINGS

Scenario	CATEGORY				
	I	II	III	IV	V
Baseline Scenario (See Appendix B)	35.00%	7.50%	11.25%	11.25%	35.00%
Alternative Scenario 1 (See Appendix C)	20.00%	20.00%	20.00%	20.00%	20.00%
Alternative Scenario 2 (See Appendix D)	11.25%	7.50%	35.00%	35.00%	11.25%

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CHAPTER 3

RESULTS

A summary of the top 20 chemicals identified as chemicals of importance to operational test and training ranges for the three scenarios described in Chapter 2 is provided in Table 3-1. A complete listing of the ranking for all of the chemicals examined is provided in the appendixes. The results of the analysis are remarkably consistent across the three scenarios, with nine of the top 20 chemicals being consistently present in each scenario.

NOTE	The following paragraphs discuss the attribute categories for identifying ECs. For ease of reference, the categories were defined in Table 2-1 were: I Evaluation of potential for regulatory change II Current Regulatory Status III Degree of Toxicity IV Exposure and Mobility V ECs Identified by Others/Chemicals on ranges

Under the Baseline Scenario, which weighted Category I and Category V most heavily, three of the top ten chemicals identified are not normally associated with range operations; in other words, they are not associated with munitions or range maintenance activities. While this may seem surprising, this finding is consistent with the results of the range managers survey, which indicated that the chemicals driving environmental response actions at ranges were the result of historical waste disposal actions. Only two of the chemicals listed in the top ten are normally associated with munitions (see Appendix E); the two chemicals are cyclotrimethylene-trinitramine (RDX) and 2, 4, 6-trinitrotoluene (TNT).

NOTE	Appendix E has a restricted access level of Distribution C: U.S. Government Agencies and their contractors. Appendix E is available as a separate document in the RCC private portal in file folder https://www.trmc.osd.mil/wiki/display/RCC/850+Emerging+Contaminants

Under Alternative Scenario 1, which weighted all categories equally, none of the top ten chemicals is typically associated with munitions use. While some of these chemicals are present in munitions items (see Appendix E), they are not typically present in significant amounts.

Under Alternative Scenario 2, which weighted Category III and Category IV most heavily, the results indicated that pesticides were a significant issue. Six of the top ten chemicals under Alternative Scenario 2 (Appendix D) are pesticides. The remaining chemicals are by-products of combustion (e.g. dioxins) or were previously used as dielectrics.

TABLE 3-1. TOP 20 RANKED EMERGING CONTAMINANTS FOR THE THREE SCENARIOS

Rank	Baseline Scenario	Alternative Scenario 1	Alternative Scenario 2
1	trichloroethylene (TCE)	2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)*	TCDD*
2	Beryllium*	Hexachlorobenzene*	Hexachlorobenzene*
3	Naphthalene*	Beryllium*	hexachlorocyclohexane (HCH), technical grade
4	tetrachloroethylene	di(2-ethylhexyl)phthalate (DEHP)*	HCH, gamma-
5	RDX	Naphthalene*	heptachlor
6	TNT	PCBs*	PCBs*
7	DEHP*	HCH, gamma-	pentachlorophenol
8	TCDD*	di-n-butyl phthalate (DBP)*	DEHP*
9	DBP*	TCE	Mirex
10	arsenic	butyl benzyl phthalate (BzBP)*	hexachlorodibenzo-p-dioxin, mixture
11	cadmium*	Pentachlorophenol	BzBP*
12	m-Dinitrobenzene	Cadmium*	HCH, beta-
13	hexachlorobenzene*	heptachlor	DBP*
14	Hexachloroethane	mirex	benzo(a)anthracene
15	PCBs*	HCH, technical grade	Naphthalene*
16	Lead	tetrachloroethylene	Alachlor
17	formaldehyde	hexachloroethane	Cadmium*
18	BzBP*	benzo(a)anthracene	diethylstilbestrol
19	copper	1,4-dichlorobenzene	Chrysene
20	chromium	RDX	Beryllium*

Note: Chemicals with an * are present in all three scenarios.

CHAPTER 4

DATA GAPS

While efforts were made to fill data gaps by extracting relevant information from multiple data sources, there are still many gaps in the knowledge about the chemicals released on ranges. The existence of these gaps limited the ability to score all the chemicals for the criteria under Categories II and III. To address this limitation, the scoring process was designed to not assign chemicals too few points due to the lack of information. For example, the lack of a USEPA cancer classification for a chemical limited the ability to assign a score for many of the chemicals and thus could have led to artificially inflated scores for chemicals across Category III. Likewise, the lack of a published K_{ow} could have led to artificially inflated scores for chemicals across Category II. To limit the impact of data gaps on the scores, the scoring process assigned 10 points, or 5 points in some cases, depending on the specific criteria, when a chemical lacked specific data elements, rather than assign 0 points. Therefore, chemicals with an unknown K_{ow} received a higher score than a chemical with a known K_{ow} when the log K_{ow} was < 4.0.

Some of the data gaps could be filled through additional efforts by the ODUSD and/or the RCC; however, efforts to fill other data gaps are outside the control of the DoD and would depend on the efforts of regulatory agencies. Additional literature research, especially for those chemicals lacking physical constants such as K_{ow}, could be completed by the DoD to allow for a more accurate ranking of chemical for which the physical constants are not reported here. However, the lack of an oral reference dose or cancer classification in IRIS is likely to be addressed only by the USEPA. Filling the data gaps would result in changes to the scores and thus the final rank for each chemical.

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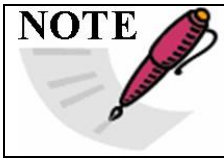
CHAPTER 5

CONCLUSIONS

Many of the chemicals identified under the Baseline Scenario (as being of potential concern to ranges) have already been identified as ECs. Only four of the top ten chemicals identified under the Baseline Scenario are not currently being monitoring by the ODUSD(I&E) due to placement on the DoD's AL or WL. Using the Baseline Scenario as a guide, a focus should be placed on examining phthalates, arsenic, and TNT because these chemicals are not already being monitored as ECs. Additional investigations should be made to assess the amount of these chemicals deposited on ranges, especially with regard to the concentration of arsenic that is likely already present from natural processes.

Many of the chemicals identified are associated with munition items currently or previously used at testing and training ranges. The specific munition items associated with the top 50 chemicals identified under each scenario are listed in Appendix E. Efforts to examine different means to reduce the release of the chemicals listed in Appendix E may be warranted to minimize future liabilities.

NOTE 	Appendix E has a restricted access level of Distribution C: U.S. Government Agencies and their contractors. Appendix E is available as a separate document in the RCC private portal in file folder https://www.trmc.osd.mil/wiki/display/RCC/850+Emerging+Contaminants

Some of the chemicals identified as being of possible concern are typically not associated with range operations and represent only a very minor amount of the chemicals (by weight) in a wide range of munition items; this is documented by a comparison to data contained in the Army MIDAS database. These chlorinated chemicals, TCE and tetrachloroethylene, normally associated with parts cleaning were identified in the Baseline Scenario and Alternative Scenario 1. Concerns about chlorinated solvents were also raised by range managers in the survey. Therefore, chemicals of concern to ranges should not be confined to those associated with munitions or target related chemicals.

The data sources reviewed and selected for this analysis reflect availability, as of the fall of 2007, with minor exceptions. Some of the data sources are subject to change and revision. For example, the analysis used the proposed CCL3 list published by the USEPA in the Federal Register at the start of 2008. The final CCL3 list, expected in late spring 2008, may contain changes in the number of chemicals included. Updates or changes to the underlying data sources would likely affect the conclusions of this report.

Execution of this project included numerous activities to collect appropriate data for identification and subsequent scoring and ranking of chemicals that might be of concern to ranges. The activities identified the need for a service-wide effort to capture data for munitions and thus chemical loading on operational test and training ranges. While some data is collected on specific ranges, a system to examine munitions loading across all services does not exist. In addition, the project included activities to increase awareness of the potential liabilities posed by

chemicals on operational ranges. These research and outreach activities are documented in Appendix F.

CHAPTER 6

RECOMMENDATIONS FOR FURTHER ANALYSIS

Recommendations for further analysis of the emerging contaminants (ECs) and their impact on DoD test and training ranges are contained in Table 6-1.

TABLE 6-1. EMERGING CONTAMINANTS (ECs): RECOMMENDATIONS FOR FURTHER STUDY

No.	Subject Area	Description
1	Automated management systems	Use systems such as the Army's Range Facility Management Support System (RFMSS), which is used to log data on expended munitions and other range data (such as the rate of dud munitions encountered by soldiers using ranges) to gather better estimates of expenditures on ranges. These expenditure data should then be tied to data from MIDAS to estimate the emissions of specific chemicals on ranges.
2	Loading factors for munitions	Identify a valid cross-section of DoD operational ranges and then use the site-specific data from the DoD Toxic Release Inventory (TRI) reporting system to develop range-specific loading factors for different munition types.
3	Correlation of firing data and air emission factors	Couple firing data from a cross-section of test and training ranges with the air emissions factors developed by the Army as part of the USEPA's Air Pollutant Emission Factors (AP-42).
4	Data gaps: Additional sources.	Explore additional sources of physical/chemical data for the chemicals identified in this report to address data gaps that limit the scoring process.
	Data Gaps: Filling data gaps through additional research, modeling, etc.	Fill data gaps which can be addressed though additional research, literature searches, or modeling. Communicate to the regulatory agencies the need for them to fill data gaps in cancer classifications and toxicity benchmarks so the risks to operational ranges can more accurately be defined.
5	Periodic updates to analyses and rankings contained in this report	The data sources that were reviewed and selected for this analysis reflect the availability of data in the fall of 2007, with only minor exceptions. Given that updates or changes to the underlying data sources would likely affect the conclusions of this report, the analysis and rankings should be recalculated after significant updates or changes are observed in any of the data sources. For example, after the release of the CDC's next update to the National Report on Human Exposure to Environmental Chemicals in the fall, 2008.