Appendix M

Human Health Risk Assessment

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APPENDIX M

HUMAN HEALTH RISK ASSESSMENT

Remedial Investigation
Camp Hero, Montauk, New York

Revision: 0

Prepared for:

Department of the Army
U.S. Army Corps of Engineers
New York District
26 Federal Plaza
New York, NY 10278

and

U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742

Prepared By:

A Joint Venture of AECOM – Tidewater
3101 Wilson Boulevard
Suite 900
Arlington, VA 22201

Formerly Used Defense Site Project Number: C02NY002403
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ACRONYMS AND ABBREVIATIONS

ACWS	Aircraft Control and Warning Squadron
Al	aluminum
ALM	Adult Lead Methodology
AOC	Area of Concern
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
BaP	benzo(a)pyrene
BaP NC	benzo(a)pyrene, non-cancer
BaP TEQ	benzo(a)pyrene, toxicity equivalence
bgs	below ground surface
BTV	background threshold value
CAL EPA	California Environmental Protection Agency
CDC	Centers for Disease Control and Prevention
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COC	chemical of concern
COPC	chemical of potential concern
CSEM	conceptual site exposure model
CSF	cancer slope factor
CSM	conceptual site model
DER	Division of Environmental Remediation
DERP	Defense Environmental Restoration Program
DNA	deoxyribonucleic acid
DoD	Department of Defense
DSA	data sensitivity analysis
DU	decision unit
EC	exposure concentration
ELCR	excess lifetime cancer risk
EMCX	Environmental and Munitions Center of Expertise
EPC	exposure point concentration
Fe	iron
FS	Feasibility Study

ft	feet
FUDS	Formerly Used Defense Site
GIABS	gastrointestinal absorption
HEAST	Health Effects Assessment Summary Table
HHRA	human health risk assessment
HI	hazard index
HMW	high molecular weight
HQ	hazard quotient
ID	identification
IEUBK	Integrated Exposure-Uptake Biokinetic Model
IRIS	Integrated Risk Information System
IUR	inhalation unit risk
JV	Joint Venture
K_{ow}	octanol/water partition coefficient
kg	kilogram
KM	Kaplan Meier
L	liter
LMW	low molecular weight
LNAPL	light non-aqueous phase liquid
LOD	limit of detection
MDC	maximum detected concentration
mg	milligram
mL	milliliter
Mn	manganese
MRL	minimal risk level
ND	non-detect
NFA	no further action
NYCRR	New York Codes, Rules, and Regulations, Official Compilation
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYSOPRHP	New York State Office of Parks, Recreation and Historic Preservation

OLEM	Office of Land and Emergency Management
OSWER	Office of Solid Waste and Emergency Response
PAH	polycyclic aromatic hydrocarbon
PCB	Polychlorinated Biphenyl
PbB	blood lead concentration
PPRTV	Provisional Peer Reviewed Toxicity Value
PSE	preliminary screening evaluation
RAGS	Risk Assessment Guidance for Superfund
RfC	reference concentration
RfD	reference dose
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
RSL	regional screening level
QA/QC	quality assurance/quality control
SAP	Sampling and Analysis Plan
SEA	stream exposure area
STB	Suspected Tank B
SVOC	semivolatile organic compound
TCE	trichloroethene
TEF	toxicity equivalence factor
THQ	target hazard quotient
TMB	trimethylbenzene
TR	target risk
TSERAWG	Tri-Service Environmental Risk Assessment Working Group
UCL	upper confidence limit
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UST	underground storage tank
UU/UE	unlimited use and unrestricted exposure
VF	volatilization factor
VISL	vapor intrusion screening level
VOC	volatile organic compound

µg/dL	micrograms per deciliter
$\mu g/m^3$	micrograms per cubic meter

EXECUTIVE SUMMARY

The human health risk assessment (HHRA) was conducted under the contract W912DR-13-D-0016 with the United States Army Corps of Engineers (USACE) by the AECOM-Tidewater Joint Venture (JV) as part of the Remedial Investigation (RI) at Camp Hero (the site). The RI was completed under the Defense Environmental Restoration Program (DERP) for Formerly Used Defense Sites (FUDS) for Hazardous, Toxic, and Radioactive Waste, Project Number C02NY002403. The work was conducted under the DERP FUDS program and is compliant with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process, as amended by the Superfund Amendments and Reauthorization Act of 1986.

Camp Hero is located on the eastern tip of the south fork of Long Island, New York, approximately 5 miles east of the village of Montauk. The former Camp Hero was established in early 1942 as a Coastal Defense Installation and the facility changed ownership within the military multiple times over the course of the following decades. Site lands were transferred to state, local, and other federal agencies between 1974 and 1984, and the facility was permanently closed in 1982. The area is now used as Camp Hero State Park and owned by the New York State Parks Commission.

The primary objective of the HHRA is to evaluate whether chemicals of potential concern (COPCs) attributable to past site activities have the potential to cause unacceptable adverse health effects to human receptors within the area under investigation. Results of the HHRA are used to assess risk management options for each exposure area, including possible further actions to address impacted soils, groundwater, surface water, and sediment.

Three phases of field investigation and a preliminary screen evaluation (PSE) were conducted at Camp Hero in support of the RI and risk assessments, and are summarized below:

- The objective of the Phase I investigation was to determine the presence or absence of contamination at the 47 Camp Hero areas of concern (AOCs). Phase I activities included the collection of discrete, biased surface and subsurface soil samples for use in the PSE, and grab groundwater samples for use in refining the groundwater conceptual site model (CSM). Background surface and subsurface soil samples were also collected for the Camp Hero background evaluation. The Phase I RI field investigation was conducted between 16 May and 24 June 2016.

- The Phase II RI field investigation evaluated the extent of residual light non-aqueous phase liquid (LNAPL) and related constituents at the former Building 203 AOC (i.e., location of two former diesel underground storage tanks). The Phase II investigation also included the installation and sampling of 15 sitewide background monitoring wells. The Phase II RI field investigation was conducted between 28 November and 16 December 2016.

- A PSE was completed using the Phase I and II RI dataset to (1) determine which AOCs require further assessment as part of the Phase III RI field effort using risk-based screening levels and background threshold values (BTVs) and (2) refine the list of parameters for sample collection during the Phase III RI field effort with the intent of completing the RI phase of the CERCLA process. The PSE also determined that 21 AOCs, plus 6 segments of the sitewide waste disposal system AOC, warranted further assessment and were grouped into 18 geometric decision units (DUs) (roughly 0.5 or 1 acre in size) and 8 stream exposure areas (SEAs). The DUs and SEAs coincide with the anticipated exposure areas for the receptors evaluated in the HHRA. The PSE was conducted in May 2017 (Appendix G of the RI Report).

- Finally, Phase III RI field investigation included (1) collecting unbiased surface and subsurface soil samples at the individual DUs; (2) collecting unbiased samples for surface water and sediment on a sitewide basis for the SEAs, as well as background sample locations; (3) establishing a representative background groundwater monitoring network and collected samples on a sitewide basis; and (4) collecting additional physical and chemical data to support the groundwater CSM, risk assessments, and feasibility study. The Phase III RI field investigation was conducted between 30 May and 28 June 2017.

Only unbiased soil, groundwater, surface water and sediment samples were used in the HHRA. The COPC selection process included the following steps: (1) the most conservative of the federal and state risk-based screening levels; (2) Camp Hero-specific BTVs; (3) site and background mean comparison (i.e., hypothesis testing for centrality); and (4) a geochemical evaluation. The COPC selection results eliminated DU02, DU04, DU09, and DU17 from further evaluation. DU05/SEA05 and DU18/SEA01 were also eliminated from further evaluation because dermal exposure to polycyclic aromatic hydrocarbons (PAHs) in surface water could not be quantified due to limitations with the United States Environmental Protection Agency (USEPA) steady-state water exposure equations. The remaining DUs and SEAs were further evaluated in the HHRA risk calculations. **Table ES-1** documents the COPCs that were identified for each DU and SEA for surface soil, subsurface soil, surface water, sediment, and groundwater.

The HHRA evaluated the following current and future on-site exposure scenarios: a youth trespasser (current only; it was assumed that the park will open all areas following the investigation and remediation [if warranted] activities), park employee, outdoor maintenance worker, and recreational user (child, adult, and lifetime). Future on-site exposure scenarios that were addressed include a construction worker, indoor worker, and hypothetical resident (child, adult, and lifetime). The lifetime scenarios for the recreational user and the hypothetical resident represents the combined child and adult potential cancer risk estimates that are normalized over a lifetime of exposure (i.e., 70 years), assuming they continue to visit Camp Hero over the course of their lifetimes.

The current and expected future land use of the park is recreational. However, the inclusion of a hypothetical future resident in the HHRA was used to conservatively evaluate unlimited use and unrestricted exposure (UU/UE) for future risk management decision-making, should the land use change. The hypothetical on-site resident scenario was treated as the worst-case exposure scenario and was exposed to all media and exposure pathways that were quantified for the other on-site receptors. The drinking water exposure pathway, however unlikely, was also quantitatively evaluated for the hypothetical on-site resident. A potability analysis was conducted for Camp Hero which revealed that the shallow perched groundwater was not suitable as a potable water source. The potential excess lifetime cancer risk (ELCR) and non-cancer hazard results for the hypothetical on-site resident were provided in the HHRA for informational purposes only and were not used to identify chemicals of concern (COCs) requiring remediation based on unacceptable risk. Instead, the other current and future exposure scenarios were used as the basis for risk management determinations for the RI Report because they represent reasonable exposure scenarios (USEPA 1989).

The following exposure pathways were evaluated for each receptor:

- Soil-related exposure pathways include incidental ingestion, dermal contact, and inhalation of wind-blown particulates and vapors.
- Surface water-related exposure pathways include dermal contact while wading in the SEA. The surface water at Camp Hero is shallow and intermittent; therefore, full immersion (swimming) is not likely. Incidental ingestion of surface water was considered an insignificant exposure pathway.
- Sediment-related exposure pathways include incidental ingestion and dermal contact while wading in the SEA.
- Groundwater-related exposure pathways include incidental ingestion, dermal contact, and inhalation of vapors (if volatile groundwater COPCs were identified) from shallow groundwater that has seeped into an excavation trench for an on-site construction worker. Although no buildings are present at the DUs, inhalation of groundwater vapors that have migrated into a hypothetical building (i.e., vapor intrusion) was evaluated for a future on-site indoor worker and an on-site hypothetical resident. The potable use of groundwater exposure pathways (i.e., ingestion of tap water, dermal contact while bathing, and

inhalation of vapors while showering/bathing) was evaluated under the hypothetical on-site resident scenario, however unlikely, for informational purposes.

For the future scenarios, the surface soil (0 to 1 foot [ft] below ground surface [bgs]) and subsurface soil (greater than 1 ft bgs) COPC data were combined to create a total soil data set to evaluate possible future land redevelopment. Excavation activities may result in the subsurface soil being brought to the surface and mixed together. Soil data with depths ranging from 0 to 10 ft bgs (i.e., typical construction excavation depth) were used to derive total soil exposure point concentrations (EPCs) for the human health risk calculations. A ratio approach was used to weigh the soil concentrations before combining the surface and subsurface soil data sets (e.g., the surface soil concentration was multiplied by a 1/10 ratio and subsurface soil concentration was multiplied by a 9/10 ratio). The ratio was adjusted according to the range of sample soil depths collected at the DU; site conditions (e.g., encountering shallow groundwater) determined the depth of each soil boring.

For some DUs, no subsurface soil data were collected because the PSE did not identify subsurface soil COPCs. The HHRA did not conduct a total soil evaluation for the following DUs: DU02, DU04, DU08, DU09, DU10, DU11, DU13, DU17, and DU18. The HHRA examined the areas where the New York State Office of Parks, Recreation and Historic Preservation (NYSOPRHP) planned to develop future camping grounds in proximity to (but not directly within) DU04, DU06, DU16, and DU17. As noted above, DU04 (as well as DU02, DU09, and DU17) was eliminated from further evaluation in the HHRA COPC selection process. HHRA risk calculations were conducted for DU06 and DU16 where a future on-site recreational user scenario was evaluated using total soil EPCs.

Off-site exposure scenarios such as a current and future industrial worker and resident were considered. The perched groundwater conditions at Camp Hero prevent groundwater COPCs from flowing off-site in an underlying aquifer. Heavy vegetation and wetland conditions inhibit any wind-blown dust or vapors from migrating off-site. The streams are intermittent and do not feed into a surface water body or water bodies that supply drinking water for surrounding areas. Surface runoff to off-site areas was considered a minimal exposure pathway. Therefore, off-site exposure was eliminated from further evaluation in the HHRA.

The RI identified light non-aqueous phase liquid (LNAPL) in the shallow groundwater at DU01 that serves as a continuous source of petroleum-related chemical concentrations. The receptors most likely to have shallow groundwater exposure at DU01 are the future on-site construction worker via an excavation trench scenario and a future on-site indoor worker via inhalation of indoor vapors in a hypothetical on-site building. The HHRA evaluated petroleum-related chemicals (e.g., benzene, toluene, ethylbenzene, xylenes, and PAHs) at DU01 and found that the potential ELCR and non-cancer hazard results for the two workers were below the USEPA target thresholds, ELCR of 1×10^{-4} (one in 10,000; 1E-04) and target hazard index (HI) of 1 per target organ endpoint.

With the exception of DU11 and DU12, the estimated ELCR and non-cancer hazard results for the non-residential receptors evaluated at Camp Hero were below the USEPA target ELCR and non-cancer hazard thresholds (i.e., 1E-04 and 1, respectively). The HHRA risk drivers at DU11 and DU12 caused the cumulative ELCR and HI estimates to exceed 1E-04 and/or a target organ-specific HI greater than 1, and are as follows:

- Benzo(a)pyrene was identified as a non-cancer hazard driver via direct contact with surface soil (i.e., incidental ingestion, dermal contact, and inhalation of particulates) at DU11 for the future on-site construction worker. Exposure to benzo(a)pyrene in surface soil may produce adverse developmental health effects (i.e., target organ-specific HI of 2 exceeded the USEPA threshold of 1). Subsurface soil samples were not collected at DU11 because the PSE did not identify any COPCs in the subsurface soil; therefore, surface soil is the exposure medium of potential concern at DU11.

- Benzo(a)pyrene was identified as a non-cancer hazard driver via incidental ingestion and dermal contact with surface soil at DU12 for the current on-site child recreational user. Exposure to benzo(a)pyrene in surface soil may produce adverse developmental health effects (i.e., target organ-specific HI of 2 exceeded the USEPA threshold of 1). The non-cancer hazard results for the total soil evaluation for the future on-site recreational user were below 1; therefore, surface soil is the exposure medium of potential concern at DU12.

- Total benzo(a)pyrene PAHs (total BaP PAHs) was identified as cancer risk driver via incidental ingestion and dermal contact with surface soil for the current on-site recreational user (lifetime) with an ELCR of 3E-04, exceeding the USEPA threshold of 1E-04). The cancer risk results for the total soil evaluation for the future on-site recreational user were below 1E-04; therefore, surface soil is the exposure medium of potential concern at DU12.

A weight-of-evidence evaluation was conducted where the results of the risk characterization and uncertainty assessment were combined, to further weigh the HHRA risk results for the data sensitivity analysis (DSA), DU01, DU11, DU12, and hypothetical resident evaluations:

Data Sensitivity Analysis Risk Evaluation

- The limits of detection (LODs) were compared to screening levels when either 1) the chemical was 100% non-detect (ND) in the DU/medium; 2) detected results were below their respective screening levels; or 3) detected results were above their screening levels but below their BTVs. The second and third conditions were added because the "J"-flagged results (i.e., estimated values) were treated as detected results in the HHRA (USEPA 1989). This leaves uncertainty for data not detected (i.e., the chemical concentration could potentially be higher than the "J"-flagged estimated value but less than the LOD). If the chemical was identified as a COPC, it is unknown if the estimated risk was under- or overestimated because its true concentration is unknown.

The DSA ELCR estimates were in the 1E-06 range or lower. With the exception of the hypothetical on-site resident, the DSA HI estimates were roughly 1 to 2 orders of magnitude below 1.The results of the DSA evaluation indicate that the conclusions of the HHRA are not likely to change if the DSA HHRA results were added to the existing HHRA risk calculations.

DU01

- The HHRA risk results for exposure to petroleum-related COPCs at DU01 were below the USEPA cancer and non-cancer target thresholds for the on-site non-residential exposure scenarios; the level of uncertainty associated with human health exposure to DU01 is reduced.

- The hypothetical resident risk results at DU01 exceeded the USEPA cancer and non-cancer target thresholds due to exposure to shallow groundwater via drinking water, showering/bathing, and inhalation of vapors in indoor air in a hypothetical residence. The hypothetical residential scenario and his/her exposure to shallow groundwater at DU01 are considered to be incomplete (see hypothetical resident evaluation below).

- The LNAPL identified at DU01 remains as a potential continuing source of petroleum-related chemical concentrations in shallow groundwater. A New York State Department of Environmental Conservation (NYSDEC) Pollution Complaint Number (PC-1602757) has been opened and the LNAPL will be addressed under the NYSDEC Spills Response Program in accordance with Article Twelve of the New York State Navigation Law. The RI has evaluated the NAPL stability, lack of recoverability, and evidence of active source depletion; these results will be taken into consideration when evaluating whether further action is required under the NYSDEC program. The level of uncertainty associated with human health exposure to LNAPL is reduced.

DU01 was eliminated from further evaluation in the HHRA because the non-residential exposure scenarios were below USEPA cancer and non-cancer target thresholds. The LNAPL will be addressed under the NYSDEC Spills Response Program.

DU11

- The on-site construction worker is not a likely scenario at DU11 because NYSOPRHP has no plans for developing areas at or near DU11 for future camping grounds or hiking trails; DU11 is a wooded area with dense vegetation that is generally inaccessible to the public.

- The upper confidence limit (UCL) of the mean concentration of 123.3 milligrams per kilogram (mg/kg) that was used as the surface soil EPC for benzo(a)pyrene is influenced by the surface soil sample DU11-S003 concentration of 180 mg/kg. The remaining surface soil detections for benzo(a)pyrene ranged from 0.031 mg/kg to 1.7 mg/kg.

- Even though discrete samples were randomly distributed to capture enough information to derive an UCL of the mean concentration for surface soil, this information is likely not representative of soil exposure for a future on-site construction worker who is more apt to be exposed to total soil (0 to 10 ft bgs) while excavating the area for future land redevelopment. The surface soil EPC was used in the total soil evaluation of the construction worker scenario.

- The PSE results for the Phase I biased subsurface soil data did not identify any COPCs for DU11; therefore, subsurface soil was not evaluated in the Phase III investigation. The Phase I biased subsurface soil concentrations for benzo(a)pyrene ranged from 0.00071 to 7 mg/kg.

- As part of the uncertainty assessment, Phase I subsurface soil data were used to estimate cancer risk and non-cancer hazards for the future construction worker scenario. The data were not combined with the unbiased surface soil data because the Phase I and III soil boring samples were collected from different locations (i.e., not representative of a total soil column). The maximum subsurface soil concentration of 7 mg/kg was used to estimate risk to the on-site construction worker in combination with groundwater and sediment media at DU11; the cumulative HI was 0.3 which is below the USEPA HI threshold of 1.

- The likelihood of an on-site construction worker spending 125 days out of the year for 8 hours each day at the DU11-S003 sample location is quite low and so the level of exposure is likely overestimated. In addition, a review of the PAH ratios for the DU11-S003 sample indicated that the sample is pyrogenic and may represent creosote or coal tar which would not be associated with a CERCLA release[1].

[1] A CERCLA release can be defined broadly to include a situation where a hazardous substance escapes into the environment from its normal container. A CERCLA release, as used in the context of the RI, refers to DoD activities that may have resulted in "spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment (including the abandonment or discarding of barrels, containers, and other closed receptacles containing a hazardous substance or pollutant or contaminant) (CERCLA § 101(22)).

- Chronic toxicity values for benzo(a)pyrene were used to estimate non-cancer health effects because subchronic toxicity values were not available; the non-cancer hazard results for the construction worker are likely overestimated.

Following the weight-of-evidence evaluation outlined above, benzo(a)pyrene was eliminated as a potential surface soil COC at DU11 in the HHRA.

DU12

- NYSOPRHP has no plans for developing areas near or at DU12 for future camping grounds or hiking trails. The recreational user risk results for DU12 assume that the receptor spends 100 days per year for 26 years at DU12 for recreational activities (e.g., camping, hiking, wading in streams, etc.). The results are biased high because DU12 does not have a camping ground nearby and so the recreational user is less likely to spend much time at DU12 and instead seek out more attractive and accessible camping ground areas.

- Coast Artillery Road runs through the middle of DU12. The southern portion of DU12 has a concrete foundation and the northern portion of DU12 contains a park maintenance area with piled brush (partially fenced but usually open).

- Background soil evaluation results for DU12 (i.e., BTV screen and the background and site mean comparison via hypothesis testing) support that benzo(a)pyrene and total BaP PAH surface soil concentrations were not consistent with background conditions and may be site-related.

- An additional characterization of PAHs in surface soil was conducted for DU12 as part of the uncertainty assessment. PAH ratios were calculated for DU12 soil in accordance with the Navy guidance recommended by the USACE EMCX. The results indicated that the PAH sources were likely pyrogenic, for both the Camp Hero background data sets as well as the corresponding soil media at DU12. Also, the soil boring logs for DU12 (Appendix I of the RI Report) indicate evidence of demolished asphalt parking lot materials (black coloring, concrete fragments, tar, and pulverized brick).

- The risk results for the recreational user are likely overestimated due to the conservative level of exposure (100 days per year for 26 years) but the receptor still has access to the DU.

Following the weight-of-evidence evaluation, total benzo(a)pyrene and BaP PAHs were eliminated from further evaluation in the HHRA. The additional characterization of PAHs evaluation (Appendix C5 of the RI Report) indicated that the PAHs in surface soil may not be attributed to a CERCLA release.

Hypothetical Resident Evaluation

- The current and expected future land use of the park is recreational. Residential reuse of the park is not expected to occur in the future. A hypothetical on-site residential scenario was evaluated to assess the potential for UU/UE for future risk management decision-making, should the land use change.
- The well-by-well evaluation assessed each monitoring well at Camp Hero as a potential drinking water source. The evaluation identified monitoring wells near DU01, DU08, DU11, DU14, and Suspected Tank B (STB) as having potential ELCR and/or non-cancer hazards above the USEPA thresholds. Metals, PAHs, semivolatile organic compounds (SVOCs), and volatile organic compounds (VOCs) were the risk drivers, assuming the shallow groundwater is used as tap water source.
- The wells identified during the well-by-well evaluation as having cancer risk/non-cancer hazard estimates above the USEPA thresholds were carried forward and HHRA risk calculations were conducted for the hypothetical resident. The potential ELCR and non-cancer hazard results for the hypothetical resident were above USEPA target risk thresholds at DU01, DU11, DU14, STB, and sitewide groundwater. Metals, PAHs, and VOCs were identified as the primary risk drivers in shallow groundwater due to the ingestion of groundwater as drinking water as well as inhalation of vapors while showering/bathing and indoor air (vapor intrusion).
- Total PAHs was identified as a primary risk driver for the hypothetical resident via incidental ingestion and dermal contact with sediment at DU10/SEA03 and DU15/SEA07.

The hypothetical resident risk results were not used to identify COCs requiring remediation based on unacceptable risk. The potential cancer risk and on-cancer hazard drivers identified for the hypothetical resident are generally from using shallow groundwater for tap water; the shallow perched groundwater at Camp Hero is not suitable as a potable water source therefore the drinking water exposure pathway is considered an incomplete exposure pathway.

In conclusion, the HHRA results did not identify any chemicals that required further evaluation in the RI. Although the HHRA indicated potential risks could be posed to receptors from PAHs in surface soil at DU11 and DU12, the lines of evidence indicated that the risk results were overestimated and the PAHs in surface soil at DU11 and DU12 were not attributed to a CERCLA release. Therefore, no further assessment or response action is warranted for the investigation areas at Camp Hero under the CERCLA program.

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1.0 INTRODUCTION

The human health risk assessment (HHRA) was conducted under the contract W912DR-13-D-0016 with the United States Army Corps of Engineers (USACE) by the AECOM-Tidewater Joint Venture (JV) as part of the Remedial Investigation (RI) at Camp Hero (the site). The RI was completed under the Defense Environmental Restoration Program (DERP) for Formerly Used Defense Sites (FUDS) for Hazardous, Toxic, and Radioactive Waste, Project Number C02NY002403. The work was conducted under the DERP FUDS program and is compliant with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process, as amended by the Superfund Amendments and Reauthorization Act of 1986.

Camp Hero is located on the eastern tip of the south fork of Long Island, New York, approximately 5 miles east of the village of Montauk. The former Camp Hero was established in early 1942 as a Coastal Defense Installation and the facility changed ownership within the military multiple times over the course of the following decades. Site lands were transferred to state, local, and other federal agencies between 1974 and 1984, and the facility was permanently closed in 1982. The area is now used as Camp Hero State Park and owned by the New York State Parks Commission.

Figure 1-1 presents the general location of Camp Hero. **Figure 1-2** presents a site map.

1.1 Scope and Objectives of the Human Health Risk Assessment

The primary objectives of the Camp Hero RI are to determine the nature and extent of potential releases and impacts in site media from former military operations, and to subsequently quantify whether unacceptable risks are posed to human health or ecological receptors. The RI and risk assessments for Camp Hero are being conducted by the AECOM-Tidewater JV in coordination with the USACE, New England and New York Districts, as well as the Environmental and Munitions Center of Expertise (EMCX).

The primary objective of the HHRA is to evaluate whether chemicals of potential concern (COPCs) attributable to past site activities have the potential to cause unacceptable adverse health effects to human receptors within the area under investigation. Results of the HHRA were used to assess risk management options for each exposure area, including possible further actions to address impacted soils, groundwater, surface water, and sediment.

1.2 Regulatory Framework

The HHRA was conducted in accordance with the U.S. Environmental Protection Agency (USEPA) CERCLA. The following USEPA Risk Assessment Guidance for Superfund (RAGS) and subsequent guidance documents were used:

- *RAGS Volume I: Human Health Evaluation Manual* (Part A) (Interim Final) (USEPA 1989)

- *RAGS Volume I: Human Health Evaluation Manual: Supplemental Guidance*, Standard Default Exposure Factors (Interim Final) (USEPA 1991a)
- *RAGS Volume I: Human Health Evaluation Manual* (Part D, Standardized Planning, Reporting and Review of Superfund Risk Assessments) (USEPA 2001)
- *RAGS Volume I: Human Health Evaluation Manual* (Part E, Supplemental Guidance for Dermal Risk Assessment) (Final) (USEPA 2004)
- *RAGS Volume I: Human Health Evaluation Manual* (Part F, Supplemental Guidance for Inhalation Risk Assessment) (Final) (USEPA 2009a)

Other USEPA guidance documents, directives, and resources were used (not all inclusive):

- *Human Health Toxicity Values in Superfund Risk Assessment* (USEPA 2003)
- *Guidelines for Carcinogen Risk Assessment* (USEPA 2005a)
- *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (USEPA 2005b)
- *Exposure Factors Handbook: 2011 Edition* (USEPA 2011)
- *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors* (USEPA 2014a)
- ProUCL Version 5.1 Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations (USEPA 2016a)
- Regional Screening Level (RSL) Table and User's Guide (USEPA 2017a, 2018a)

The following USACE guidance documents were used:

- *Environmental Quality, Standard Scopes of Work for Environmental Risk Assessments* (USACE 2016)
- *Tri-Service Position Paper on Background Levels in Risk Assessment* (USACE 2011)

Finally, the following New York State Department of Environmental Conservation (NYSDEC) risk assessment guidance documents (NYSDEC 2010a, 2010b) were integrated into the HHRA where possible to satisfy both federal and state programs:

- *Commissioner Policy 51 (CP-51): Soil Cleanup Guidance* (NYSDEC 2010a)

- *DER-10/Technical Guidance for Site Investigation and Remediation* (NYSDEC 2010b)

The HHRA results are presented in USEPA RAGS Volume 1, Part D standard table formats (USEPA 2001).

1.3 Report Organization

The HHRA addresses the following CERCLA guidance steps for conducting an HHRA: Data Evaluation/Hazard Identification (Section 2.0), Identification of COPCs (Section 3.0), Exposure Assessment (Section 4.0), Toxicity Assessment (Section 5.0), Risk Characterization (Section 6.0), and Uncertainty Assessment (Section 7.0). The following attachments provide supporting information for these steps:

- **Attachment A: Sample Data for HHRA –** documents the sample locations that were used for each exposure medium in the HHRA.
- **Attachment B: Data Summary Statistics** – provides the summary statistics (e.g., minimum and maximum detections, minimum and maximum detection limits) for the data used in the HHRA.
- **Attachment C: Selected Screening Criteria** – presents the selected screening criteria used in the COPC selection process.
- **Attachment D: Data Sensitivity Analysis** – evaluates the sensitivity of the detection limits used for detecting chemicals in each exposure medium at Camp Hero.
- **Attachment E: Well-by-Well Evaluation** – evaluates each groundwater well as a possible source of drinking water for the hypothetical resident scenario evaluation.
- **Attachment F: Total Soil Weighting and Exposure Point Concentrations -** explains how total soil concentrations were derived to evaluate excavation of soils for the construction worker scenario and the calculation of exposure point concentrations (EPCs) used to estimate potential excess lifetime cancer risk (ELCR) and non-cancer hazard in the HHRA.
- **Attachment G: Lead Evaluation** – describes the modeling results that were used to estimate lead exposure in the HHRA.
- **Attachment H: Environmental Transport and Fate Models** – describes the modeling calculations that were conducted to estimate exposure in the HHRA.

- **Attachment I: RAGS Part D Tables** – provides the USEPA RAGS Part D Tables 1 through 10 used to document the HHRA process and results in tabular format.
- **Attachment J: Hypothetical Resident Cancer Risk and Non-Cancer Hazards Calculations** – provides the risk results for a hypothetical resident scenario for informational purposes only.

2.0 HAZARD IDENTIFICATION AND DATA EVALUATION

This section briefly describes Camp Hero's operational history and site investigations. This section also identifies the hazards at the site and describes the data handling procedures and datasets used for conducting the HHRA.

2.1 Operational History of Camp Hero

Camp Hero was established in early 1942 as a Coastal Defense Installation and continued to be used for military purposes throughout the Cold War period. Military development included a series of underground bunkers associated with the many gun batteries that were used as part of a coastal defense system installed during World War II. Other developments on the site included supporting facilities (barracks, mess halls, hospital facilities, a motor repair shop, a recreation facility, sentry boxes, and water supply and sewage facilities) and a radar tower that was the main component of an air defense system in operation during the Cold War.

In 1952, the Air Force property was renamed the Montauk Air Force Station and occupied by the Aircraft Control and Warning Squadron (ACWS). In 1974, when some of the on-site military uses were still active, portions of the property were transferred from Department of Defense (DoD) to the State of New York. With the departure of the last military personnel from the site in 1980, the DoD declared the remainder of the property to be surplus federal land. Over the next few years, the property was divided and deeded to the State of New York and Town of East Hampton. The ACWS facility was permanently closed in 1982 and the final land transfer to the State occurred in 1984.

2.2 Site Investigation Summary

This section describes the three phases of investigation that were conducted as part of the RI technical approach: Phase I, Phase II, and Phase III. The objective of the Phase I investigation was to determine the presence or absence of site-related chemicals in affected media (i.e., soil, groundwater, surface water, and sediment) at the 47 Camp Hero areas of concern (AOCs). Phase I activities included collection of discrete, biased surface, and subsurface soil samples for use in the preliminary screening evaluation (PSE), and grab groundwater samples for use in refining the groundwater conceptual site model (CSM). The Phase I RI field investigation was conducted between 16 May and 24 June 2016. The Phase I field report is provided in Appendix E of the RI Report (AECOM-Tidewater JV 2016). Because the Phase I samples were collected where contamination was suspected (i.e., biased sampling), they are not necessarily representative of human exposure areas; therefore, the Phase I data are not used in the HHRA.

The Phase II RI field investigation evaluated the extent of residual light non-aqueous phase liquid (LNAPL) and related chemicals at the former Building 203 AOC (i.e., location of two former diesel underground storage tanks [USTs]). The Phase II investigation also included the installation and sampling of 15 background groundwater monitoring wells. The Phase II RI field investigation was conducted between 28 November and 16 December 2016. The results are documented in the Phase II RI field report provided in Appendix F of the RI Report (AECOM-Tidewater JV 2018a).

A PSE was completed using the Phase I and II RI datasets to (1) determine which AOCs require further assessment as part of the Phase III RI field effort using risk-based screening levels and BTVs, and (2) refine the list of parameters for sample collection during the Phase III RI field effort with the intent of completing the RI phase of the CERCLA process. The PSE is available as Appendix E to the Phase III RI Sampling and Analysis Plan (SAP) (AECOM-Tidewater JV 2017b). Based on the PSE, 21 AOCs, plus 6 segments of the sitewide waste disposal system AOC, warranted further assessment and were grouped into 18 geometric DUs for the Phase III investigation (**Figure 2-1**).

The Phase III RI field investigation was conducted between 30 May and 28 June 2017. Results of the investigation are documented in the Phase III Field Investigation Field Report (AECOM-Tidewater JV 2018b). The objectives of the Phase III RI field effort were to:

- Collect an unbiased, representative dataset for potentially impacted surface and subsurface soil associated with each of the individual DUs;
- Collect a representative background dataset for surface water and sediment on a sitewide scale, as well as collect unbiased, representative surface water and sediment data in stream exposure areas (SEAs) in the vicinity of DUs that could potentially impact downgradient surface water and sediment;
- Establish a representative groundwater monitoring well network and collect groundwater samples on a sitewide and local scale in the vicinity of DUs that could potentially (or have been demonstrated to) have localized groundwater releases; and
- Collect additional physical and chemical data to support the CSM, risk assessments, and feasibility study (FS).

The Phase III field report is provided in Appendix H of the RI Report (AECOM-Tidewater JV 2018b). Subsurface soil samples were only collected from the following 9 DUs based on the PSE screen results: DU01, DU03, DU05, DU06, DU07, DU12, DU14, DU15, and DU16.

Data validation was conducted for the Camp Hero analytical data presented in the Phase I, II, and III reports. All analytical data packages were validated to ensure compliance with specified analytical, quality assurance/quality control (QA/QC) requirements, data reduction procedures, data reporting requirements, and required accuracy, precision, and completeness criteria. The quality of the data collected in support of the RI was considered acceptable.

2.3 Hazard Identification

The HHRA evaluated potential human health exposure to site media within 18 DUs and 8 SEAs at Camp Hero. The DUs are approximately 0.5-acre or 1.0-acre exposure areas, consistent with the extent of potential site-related releases from prior investigations as well as with potential human health and ecological receptor exposure areas. In general, the DUs were designed as geometric squares, but the sampling protocol within the DUs was adjusted where appropriate, to account for nearby fences, roads, steep slopes, drainage channels, or similar geographic features.

A sitewide network of surface water and sediment samples was grouped into linear SEAs for the assessment of potential DU contributions as well as broader drainage stream conditions along longer stretches of the channels. The SEAs included samples that were upstream, adjacent, or downstream of DUs or groups of DUs. The goal of SEAs was to create a robust dataset for surface water and sediment, and to establish representative EPCs from a realistic exposure area for potential human health and ecological receptors. Each SEA was grouped with nearby DU(s) to assess cumulative exposure to potential HHRA exposure scenarios (e.g., recreational user wading in a stream while picnicking in the area).

The primary drainages within Camp Hero are generally second-order streams. Streams ranged from less than 1 to 4 feet (ft) in width (maximum width of approximately 10 ft) with water depths ranging from 0 (dry conditions) to approximately 1 ft deep. Stream flow in primary drainages and intermittent streams varied from no apparent flow to approximately 2 ft per second.

Many of the primary and intermittent streams throughout the park are channelized with narrow, wooden stream revetments along the sides of the streambeds, which appear to have been installed to control surface water flow across the facility (i.e., revetted).

Figure 2-1 presents the site map with the DUs and SEAs. **Table 2-1** identifies the SEA paired with each DU as well as the revetted streams. **Table 2-2** summarizes the DUs and exposure media that are assessed in the HHRA.

2.4 Data Evaluation

Unbiased soil, groundwater, surface water, and sediment samples were collected during the 2017 RI Phase II and III field activities (AECOM-Tidewater JV 2018a, 2018b) for risk assessment purposes. Background samples were also collected for all media to derive BTVs and provide background datasets for conducting hypothesis testing for centrality where needed (USACE 2011). Appendix L1 of the RI Report presents the detailed background evaluation.

Attachment A provides sample data for each DU and SEA that was used in the HHRA. **Attachment B** presents the summary statistics for each exposure medium. With the exception of

"R"-flagged (rejected) data, all of the flagged data were carried forward for quantitative evaluation in the HHRA. Flagged results such as "J" flags (i.e., estimated values) were carried forward into the HHRA in all exposure media. A "J"-flagged result indicates that the analyte was positively identified and the associated numerical value is an estimated quantity with an unknown bias. Results that are biased high are flagged "J+" and results that are biased low are flagged "J-". The "J"-flagged result was treated as a detected concentration even though the chemical's true concentration is unknown (USEPA 1989). The uncertainties associated with the evaluation of the flagged data were also qualitatively discussed in the Uncertainty Assessment (Section 7.0).

For sample locations in which a duplicate sample was also collected, the duplicate sample results for each chemical/medium/area combination were processed prior to the calculation of summary statistics. Duplicates were resolved as follows: 1) when both the sample and duplicate are detected, the average of field and duplicate was used to calculate summary statistics; 2) when both the sample and duplicate are non-detects (NDs), the sample with the lower limit of detection (LOD) was used; and 3) when one of the pair is reported as not detected and the other is detected, the detected result was used.

2.5 Filtered and Unfiltered Data Evaluation

The surface water and groundwater media include filtered (dissolved phase) and unfiltered (total recoverable) results for metals. The risk assessments for Camp Hero have taken the following approach for evaluating dissolved and filtered results.

Surface water: Field-filtered (dissolved phase) surface water samples were only collected from a subset of sampling locations, so the total recoverable phase surface water samples served as the HHRA dataset for quantitative evaluation (Appendix C3 of the RI Report). The dissolved phase results were considered qualitatively in risk characterization and uncertainty assessment sections to provide context for exceedances based on the total recoverable phase results, if needed.

Groundwater: The dissolved phase results were used for the evaluation of the hypothetical resident potable use of groundwater scenario (i.e., the filtered results best represent water quality conditions for tap water). The total recoverable results were used for evaluating the construction worker scenario because direct contact with shallow groundwater seeping into a trench is unlikely to be treated or filtered.

2.6 Chemical-Specific Considerations

Some chemicals require additional handling or analysis before they can be evaluated in the HHRA. The additional steps taken to evaluate these chemicals are described below.

Speciated Chromium: As part of the Phase III sampling effort, speciated chromium data were collected in 10% of the metal samples in all media to ascertain what, if any, fraction of total chromium present in the medium is in the more toxic hexavalent chromium form. A ratio (hexavalent chromium to total chromium concentrations) was derived for each exposure medium to estimate hexavalent chromium concentrations where an analytical result for hexavalent chromium was not available for a given sample. Total chromium analytical results were available for all samples. A technical approach memorandum was prepared to document this process (Appendix C2 of the RI Report). The ratios of hexavalent chromium to total chromium established for this project are as follows:

- 0.073 for soil (surface and subsurface)
- 0.25 for sediment
- 0.3 for groundwater (filtered and unfiltered) and surface water (filtered and unfiltered)

The ratio established for soil was also applied directly to the total chromium BTVs to derive the hexavalent chromium BTVs in soil, as no hexavalent chromium background samples were collected in soil.

Carcinogenic Polycyclic Aromatic Hydrocarbons (PAHs): Carcinogenic PAHs exhibit toxicological properties similar to benzo(a)pyrene, but they differ in the degree of toxicity. The HHRA used toxicity equivalence factors (TEFs) to adjust measured concentrations of carcinogenic PAHs in relation to benzo(a)pyrene, which is the most toxic. **Table 2-3** presents the carcinogenic PAHs and their corresponding TEFs (USEPA 1993, 2017a).

The individual carcinogenic PAH concentrations were multiplied by the TEF and then summed for each sample. When one or more of the carcinogenic PAHs were ND, the laboratory LOD was used as the censoring limit and the TEF-multiplied concentrations were summed using the Kaplan Meier (KM) method (Helsel 2009). USEPA's statistical software, ProUCL Version 5.1, was used to conduct the KM calculations (USEPA 2016a). This sum, referred to as a benzo(a)pyrene toxicity equivalence (BaP TEQ) concentration, was derived for each sample. Appendix C1 of the RI Report provides the PAH sample summation results for all exposure media. BaP TEQ was screened using BaP's cancer risk-based screening levels to evaluate the potential carcinogenic health effects associated with carcinogenic PAHs identified in **Table 2-4**.

Total PAH Summations: Total PAH summations were calculated for each sample. For this summation, the carcinogenic PAHs were not multiplied by the TEF as described above. Again, ProUCL Version 5.1 was used to conduct the KM calculations where ND results were present in the sample (USEPA 2016a). The purpose of the total PAHs summation is to represent exposure to carcinogenic and noncarcinogenic PAHs because PAHs are typically found as a mixture in the environment (Agency for Toxic Substances and Disease Registry [ATSDR] 1996). Risk-based screening levels for benzo(a)pyrene were used for the risk-based screening of total PAHs calculated summations, as benzo(a)pyrene exhibits both carcinogenic and noncarcinogenic health effects and the levels are the most conservative. Some of the PAHs are volatile (as indicated in **Table 2-4**); naphthalene's vapor intrusion screening level was used as a surrogate for the other volatile PAHs to assess the vapor intrusion pathway.

Total Polychlorinated Biphenyl (PCB) Summations: The calculation of total PCB summations is similar to the total PAH summation procedure. ProUCL Version 5.1 was used to conduct the KM calculations where ND results were present in the sample (USEPA 2016a). The purpose of the total PCBs summations is to represent exposure to carcinogenic and noncarcinogenic aroclors. Aroclors are chlorinated compounds associated with dielectric and coolant fluids used in electrical equipment that tend to be pervasive in the environment if released. High-risk PCBs (cancer) and Aroclor 1254 (non-cancer) screening criteria and toxicity values were used to evaluate the total PCB summation results. Appendix C1 of the RI Report provides the PCB sample summation results for all exposure media. **Table 2-5** lists the aroclors used in the summations.

Essential Nutrients: The essential nutrients calcium, magnesium, potassium, and sodium were eliminated in all exposure media from evaluation in the HHRA. Essential nutrients are toxic only at very high doses (i.e., much higher than those that could be associated with contact at Camp Hero) (USEPA 1989). Arsenic and iron were carried forward for evaluation in the HHRA because their concentrations may be attributed to Camp Hero-related historical activities.

3.0 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

This section describes the identification of COPCs for each DU and exposure medium with regard to human health effects. **Figure 3-1** presents the Camp Hero screening and risk assessment process flow chart. Steps 1, 3, and 4 are described in this section. Step 2 (food web modeling) is applicable to the ecological risk assessment only, and is therefore not discussed in this HHRA.

3.1 Step 1: Selected Screening Criteria

A COPC selection process is implemented to identify a subset of chemicals detected in each exposure medium that could pose a potential risk to human receptors that come into contact with the affected medium. The COPC screening process is also predicated on identifying chemicals that are either present due to site-related releases or anthropogenic conditions, or are naturally occurring. Therefore, the selected screening criteria for use in selecting COPCs in the HHRA are equal to the higher of the background BTV and selected risk-based screening level. The criteria used to determine if a chemical is a COPC are as follows:

- If a chemical was not detected in any samples in a given medium, and DU and measurement quality objectives for sensitivity are met (Section 3.4), the chemical was not selected as a COPC.
- The maximum detected concentrations (MDCs) within each medium and DU were compared to screening criteria.
  - If a chemical's MDC is greater than the selected screening criteria, it was retained as a Step 1 COPC and then carried forward into Steps 3 and 4 of the COPC selection process.
  - If a chemical's MDC is less than the selected screening criteria, then the chemical was eliminated from consideration as a COPC and was not carried forward into the HHRA.

The following sections discuss the BTVs and selection of risk-based screening levels used in Step 1 of the COPC selection process. The selected screening criteria are documented in **Attachment C**.

<u>Background Threshold Values</u>

NYSDEC Division of Environmental Remediation Program Policy 10 recommends using site-specific background concentrations where possible (NYSDEC 2010b). Therefore, background datasets were for all media at Camp Hero to derive medium-specific BTVs after data validation for the risk assessments (AECOM-Tidewater JV 2017a, b). **Table 3-1** summarizes the selected BTVs for each exposure medium. Appendix L1 of the RI Report presents the detailed background evaluation for Camp Hero.

Risk-Based Screening Levels

Table 3-2 summarizes the risk-based screening levels used in the HHRA. The most conservative of the USEPA and New York screening levels was selected as the risk-based screening level. Generally, the NYSDEC screening levels are provided for informational purposes; however, if the NYSDEC screening level is more conservative than the USEPA screening level, then the NYSDEC screening level was selected as the risk-based screening level.

USEPA RSLs (USEPA 2017a) were used as a source of risk-based screening levels in the COPC selection process. After the COPC selection process was conducted, USEPA published its semi-annual update to the RSL table (USEPA 2018a). The chemicals that underwent toxicity value or chemical-specific parameter changes in the May 2018 update were not analyzed for at Camp Hero. Therefore, the USEPA RSL screening results presented in this HHRA are applicable and current as of the date this HHRA.

For screening purposes, a target hazard quotient (THQ) for non-cancer based RSLs of 0.1 was used to account for potential additive effects of multiple chemicals impacting similar target organ endpoints. A target risk (TR) of one in 1,000,000 (expressed as 1E-06) for cancer-based RSLs was used. In cases where a chemical has both cancer-based and non-cancer-based RSLs, the lower (i.e., more stringent) of the two values was used for screening (USEPA 2017a).

Chemical/Pathway-Specific Risk-Based Screening Levels

Vapor Intrusion: An additional set of screening levels was used to screen volatile chemicals detected in groundwater. In accordance with USEPA (2015a) vapor intrusion guidance, USEPA's vapor intrusion screening level (VISL) on-line calculator (USEPA 2018d) was used to identify DUs that may require further vapor intrusion evaluation. The VISL calculator identifies chemicals that are considered to be volatile and sufficiently toxic through the soil gas intrusion pathway and provides media-specific screening levels for groundwater, near-source soil gas, sub-slab soil gas, and indoor air (USEPA 2018d). **Attachment I** provides the risk-based screening results for the vapor intrusion pathway (indirect contact evaluation) in USEPA RAGS Part D Table 2 format (USEPA 2001).

For Camp Hero, volatiles detected in groundwater were screened against residential groundwater VISLs. The VISLs were derived using the same THQ and TR as the USEPA RSLs. A site-specific ambient groundwater temperature of 16 degrees Celsius was used to adjust the chemical-specific Henry's Law Constants to represent subsurface conditions. Although no buildings currently exist at the DUs, this screening step was used to evaluate the vapor intrusion exposure pathway under a potential future land use redevelopment scenario.

The following vapor intrusion COPCs were identified during the Step 1 COPC selection process:

- DU01: 1,1′-biphenyl, naphthalene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, benzene, ethylbenzene, and trichloroethene (TCE)
- Sitewide: 1,1′-biphenyl, naphthalene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, benzene, ethylbenzene, and TCE

Benzo(a)pyrene: The non-cancer benzo(a)pyrene RSLs were selected as the risk-based screening levels for benzo(a)pyrene since the cancer RSLs for benzo(a)pyrene were used to screen the total BaP PAHs summation results. This conservative step was taken to address the potential carcinogenic and noncarcinogenic health effects of benzo(a)pyrene, which is the most toxic of the PAHs.

Chromium: The chromium III RSLs were selected as the risk-based screening levels for total chromium. The hexavalent chromium RSLs were selected as the risk-based screening levels for hexavalent chromium.

PAH Summations: The cancer RSLs for benzo(a)pyrene were used to screen total BaP PAHs (carcinogenic PAHs) as well as total PAHs (carcinogenic and noncarcinogenic PAHs) summations. If the risk-based screening results identified individual carcinogenic PAHs and total BaP PAHs as exceeding the selected screening criteria, only total BaP PAHs was carried forward as the medium-specific COPC to address exposure to carcinogenic PAHs (ATSDR 1995; USEPA 1989). If the risk-based screening results identified one or more individual noncarcinogenic PAHs as exceeding the selected screening criteria, then the individual noncarcinogenic PAHs were carried forward as medium specific COPCs in the HHRA since USEPA has provided chemical-specific noncancer toxicity values to evaluate them. Total PAHs was carried forward as a COPC in the HHRA when it was the only PAH identified as a COPC in the exposure medium; noncancer toxicity values for benzo(a)pyrene were used to estimate exposure to total PAHs in the HHRA. The cancer toxicity values for benzo(a)pyrene were not used to evaluate total PAHs because carcinogenic exposure to PAHs are addressed through the risk-based screening and evaluation of total BaP PAHs.

Lead: USEPA residential soil and tap water RSLs for lead are protective of a blood lead threshold of 10 micrograms of chemical per deciliter (µg/dL). The lead RSLs are considered action levels because they were derived using USEPA's Integrated Exposure-Uptake Biokinetic (IEUBK) model (USEPA 2010). For risk-based screening, the residential soil RSL of 400 milligrams of chemical per kilogram (mg/kg) was used for soil and sediment. For water, the USEPA action level of 15 micrograms of chemical per liter (µg/L) was used (USEPA 2017a, 2018a). In cases where the

MDC of lead exceeds its RSL, a DU-specific mean concentration was calculated per USEPA guidance (USEPA 2007). The following steps were taken:

- If lead's MDC exceeded the RSL in one exposure medium for a DU, then a DU-specific mean concentration was calculated and compared to the residential soil (400 mg/kg) or tap water (15 µg/L) RSL. The 0.5-acre to 1.0-acre DU represents a reasonable exposure area for potential receptors likely to visit or spend time in the area; the DU-specific mean is considered a representative concentration to estimate exposure per USEPA guidance (USEPA 2007). Lead was carried forward as a Step 1 COPC if the DU-specific mean concentration was above the residential soil or tap water RSL.

- If lead's MDC exceeded the RSL in more than one exposure medium for a DU, then the USEPA (2017a) User's Guide recommends comparing the mean concentration to lower screening levels (e.g., 250 mg/kg for soil and 5 µg/L for water) so that cumulative exposure to multiple exposure media does not result in more than 5% of a population from exceeding a 10 µg/dL blood-lead threshold. Lead was carried forward as a Step 1 COPC if the DU-specific mean concentration was above the alternate lead screening criteria.

Table 3-3 presents the Step 1 COPC screening results for lead when the mean concentration was used. Lead was identified as a total and dissolved phase groundwater COPC at DU14. The mean concentrations of 30.7 µg/L (dissolved phase) and 24.5 µg/L (total phase) were above 15 µg/L. Lead is further assessed for DU14 in the Exposure Assessment (Section 4.0) and **Attachment G**.

3.2 Step 3: Site and Background Population Mean Comparison

Step 1 identified soil, groundwater, surface water, and sediment COPCs detected above both background BTVs and risk-based screening levels. For chemicals with available background data, hypothesis testing for centrality was conducted to compare the mean background concentration with site-related DU or SEA concentrations (AECOM-Tidewater JV 2017a; USACE 2011). As shown on **Figure 3-1**, this analysis was conducted prior to the selection of final COPCs to focus the HHRA on site-related COPCs (AECOM-Tidewater 2017b; USACE 2011). **Tables 3-4 through 3-8** identify the chemicals that were eliminated as COPCs due to the hypothesis testing results (indicated with "BE"). Appendix L1 of the RI Report provides the detailed background evaluation conducted for Camp Hero.

3.3 Step 4: Geochemical Evaluation

A geochemical analysis was conducted to distinguish whether metals concentrations at Camp Hero are either present due to site/anthropogenic activities, or are naturally occurring. The premise of conducting a geochemical evaluation is to identify metals concentrations that are originally derived from minerals (rocks) that, when exposed, break down and result in the release of metals. The metals will form new minerals (secondary minerals) via new processes, including absorption and precipitation. The primary metals that absorb to other metals are aluminum (Al), iron (Fe), and manganese (Mn) (i.e., Al as mostly clays, Fe and Mn as primarily oxyhydroxides). If the metals detected at the site are naturally occurring, a relationship can be observed via regression. A regression graph is utilized, plotting the concentrations of major/reference metals (Al, Fe, and Mn) on the x-axis against other metals on the y-axis. If the metals form a good regression (line) from the lower left corner to upper right corner of the graph, then these metals are most likely to be naturally occurring. If there is not a good regression, their presence is most likely is due to site/anthropogenic activities. **Tables 3-4 through 3-8** identify what chemicals were eliminated as COPCs due to the geochemical evaluation (indicated with "GC"). Appendix L2 of the RI Report presents the detailed geochemical analysis.

A geochemical evaluation was not conducted for total or dissolved phase groundwater because of the variability of the acidic conditions, reducing conditions or elevated turbidity of the Camp Hero groundwater data. Combining the data to conduct correlation and regression analysis could lead to erroneous conclusions. Also, groundwater used as drinking water is considered an incomplete exposure pathway for Camp Hero; a potability analysis was conducted (Appendix K of the RI Report) and the conclusions indicated that the shallow perched groundwater at Camp Hero is not suitable as a potable water source (i.e., unsuitable for drinking based on the groundwater characteristics and New York State and Suffolk County drinking well standards). A well-by-well groundwater evaluation was conducted in the highly unlikely event that the groundwater is used for potable purposes for the hypothetical future resident.

3.4 Well-by-Well Evaluation

A screening level cumulative risk assessment was conducted for each Camp Hero monitoring well to conservatively assess the potential cancer risk and non-cancer hazard associated with exposure to shallow groundwater as a tap water source (i.e., ingestion of drinking water, dermal contact while bathing or showering, and inhalation of shower vapors). The assessment assumed that any monitoring well at Camp Hero may be used as a tap water source as part of the hypothetical on-site resident evaluation.

The DUs with monitoring wells that have cumulative screen risk results below the cancer risk threshold of 1E-04 and a non-cancer hazard threshold of 1 are DU06, DU07, DU12, DU13, and DU15; these monitoring wells were eliminated from further evaluation. The DUs that have one or more monitoring wells with risk results above the cancer or non-cancer thresholds were DU01, DU08, DU11, DU14, and Suspected Tank B (STB). The exceedances were attributed to metals, PAHs, semivolatile organic compounds (SVOCs), and volatile organic compounds (VOCs) in the groundwater. The well-by-well screen results are presented in **Attachment E** and are provided for informational purposes only.

3.5 Management of Data Sensitivity

As part of the identification of COPCs, certain chemicals were selected for further evaluation in a data sensitivity analysis (DSA) and not carried forward into the risk calculations of the HHRA. The results of the DSA are provided in **Attachment D**. These chemicals were captured during the risk-based screening provided in **Attachment I**. For chemicals not selected as COPCs, the maximum LOD within each exposure media and DU was compared to risk-based screening levels and BTVs identified in Section 3.1 to determine whether analytical quantitation limits were adequate for risk assessment purposes. The DSA addressed soil, surface water, sediment, and groundwater media. If a chemical was not selected as a COPC and did not meet the measurement quality objectives for sensitivity (see bullets below), the chemical was evaluated in the DSA. The following steps were taken:

- If a chemical is all ND and has a maximum LOD lower than the screening level, then it was eliminated from further evaluation in the HHRA.
- If a chemical is both detected and ND, with a maximum LOD lower than the screening level, it was evaluated following the standard risk assessment procedures.
- If a chemical is all ND but the maximum LOD is higher than the screening level, then it was selected as a LOD-COPC for further evaluation in the DSA and addressed in the Uncertainty Assessment (Section 7.0).
- If a chemical has some "J"-flagged detections (estimated values) and NDs, but the LOD is higher than the screening level, it was selected as a LOD-COPC for further quantitative evaluation. In these cases, the chemical may be present in the medium at a concentration that exceeds the screening level, but its true concentration is unknown. This means that the risk may be underestimated for such chemicals. Again, if the estimated concentration was above its risk-based screening level and BTV, it would have been selected as a COPC in the HHRA and not evaluated for the DSA, because "J"-flagged results (i.e., values between the LOD and the limit of quantitation) were treated as detected values in the HHRA but discussed as a source of uncertainty in the Uncertainty Assessment (USEPA 1989).
- LOD-COPCs selected for the DSA underwent additional screening documented in **Attachment D**. Steps to the secondary screening included:

- If the LOD was elevated due to dilution, then the intended LOD (prior to the sample being diluted) was used as the reference point for whether the LOD is greater than the screening level.

- If the chemical was not detected in any sample across all media and DUs (all RI sample results), the LOD was reported as zero, removed from further evaluation, and was qualitatively discussed in the Uncertainty Assessment (Section 7.0).

For the selected LOD-COPCs, separate risk uncertainty calculations were conducted in the DSA to quantify the associated potential risk. A qualitative weight-of-evidence analysis was incorporated into the Uncertainty Assessment section addressing how the range of risk results affects the HHRA conclusions.

3.6 Final COPC Selection Results

Tables 3-4 through 3-8 summarize the COPCs identified for each exposure medium and DU in accordance with the Camp Hero screening process (i.e., Steps 1, 3, and 4). Many metals, SVOCs, and VOCs were eliminated during Step 1 for all DUs or SEAs and the LODs were protective of the selected screening criteria. Therefore, these chemicals are not presented in these tables; instead, the tables focus on chemicals that were either retained or eliminated via later steps of the COPC screening process or were evaluated in the DSA screening for one or more DUs or SEAs. **Attachment I** provides the risk-based screening results for each DU and SEA in USEPA RAGS Part D Table 2 format (USEPA 2001).

The COPC selection process eliminated the following DUs from further evaluation in the HHRA: DU02, DU04, DU09, and DU17. Total BaP PAHs in surface water was identified as the only COPC for DU05 (SEA05) and DU18 (SEA01). Exposure to total BaP PAHs in surface water is a minimal exposure pathway because the carcinogenic PAHs have log octanol/water partition coefficient (K_{ow}) values greater than 3.5. Chemicals having large K_{ow} values have high lipophilicity (i.e., are insoluble in water) and will tend to move slowly through the stratum corneum, which is the layer of skin cells that provides a barrier to movement of chemicals through the skin. USEPA (2004) recommends not evaluating dermal exposure to surface water for highly lipophilic chemicals. Therefore, DU05 and DU18 are not quantitatively evaluated in the HHRA, but the uncertainty associated with dermal exposure to surface water is qualitatively addressed in the Uncertainty Assessment (Section 7.0).

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4.0 EXPOSURE ASSESSMENT

This section identifies human receptors that may be exposed to site-related human health COPCs in affected media and addresses the potential extent of their exposure under site-specific exposure scenarios. **Figures 4-1 and 4-2** present the human health conceptual site exposure model (CSEM) for assessing current and future receptors at Camp Hero, respectively. The CSEMs present the current understanding of the site conditions with respect to known and suspected chemical sources, potential transport mechanisms and migration pathways, and human receptors. **Table 1-1 in Attachment I** provides the rationale for the selection or exclusion of receptors and exposure pathways in RAGS Part D Table 1 format (USEPA 2001).

In the absence of site-specific information, the USEPA (2014a) recommends using standard default exposure parameters where possible to characterize exposure to Camp Hero receptors. Use of these default parameters is considered to represent a conservative assessment of potential health risk/hazard. Site-specific assumptions, such as the exposure frequency, are identified in the scenario descriptions below (Section 4.2). **Attachment I** presents the intake and exposure concentration equations and exposure parameters for each Camp Hero receptor in RAGS Part D standard Table 4 format (USEPA 2001).

4.1 Camp Hero State Park Environmental Setting and Land Use

The environmental setting of Camp Hero State Park includes wooded areas, freshwater wetlands, and sea-side bluffs to the east of the park. The park contains hiking trails, roadways, picnic areas, and recreational areas. The expected future land use of the park is recreational. Residential reuse of the park is not expected to occur in the future.

Table 2-2 describes the potential site accessibility for each DU. **Figure 4-3** shows the current and future hiking trails and camping areas in relation to the DUs and SEAs. A camping area is currently located near DU06. The NYSOPRHP plans to develop future camping grounds in proximity to (but not directly within) DU04, DU06, DU16, and DU17 (**Figure 4-3**). As described in **Table 2-2**, the other DUs are not as attractive to a young child and adult recreational user due to their steep terrain, heavy vegetation, or wetland conditions.

The streams are intermittent at Camp Hero, so surface water and sediment exposure for the SEAs were addressed using a wading scenario (i.e., no full immersion swimming); the water depths of the streams range from 0 (dry conditions) to approximately 1 ft deep. Dermal contact with surface water was the only exposure pathway evaluated in the HHRA. Incidental ingestion of surface water is assumed to be infrequent and is therefore an insignificant pathway. Also, the consumption of fish was not evaluated in the HHRA because consumable fish communities are not expected to be present in the intermittent streams. The Camp Hero State Park is not used for recreational hunting; therefore, consumption of wild game is an incomplete exposure pathway.

Camp Hero employs three on-site maintenance workers that reside at the Park Maintenance building (Motor Pool building) located directly west of DU11. The workers use golf carts to go where they are needed to repair park equipment and perform general grounds maintenance at the park.

The HHRA assumed that the on-site youth trespasser (ages 6 to 16 years old) spends his/her time climbing fences into areas where current access is restricted, secluded, or not easily accessible. **Table 2-2** identifies the DUs that are attractive to the trespasser scenario.

DU08 is inundated with water because it is a wetlands area. The HHRA assumed that the recreational user would not venture into this DU, but the youth trespasser and park employee (e.g., naturalist) may visit the area. If the DU was redeveloped, then the future construction worker and hypothetical resident would have access to DU08.

A potability analysis was conducted for Camp Hero (Appendix K of the RI Report). The analysis revealed that the shallow perched groundwater at Camp Hero was not suitable as a potable water source. However, the drinking water exposure pathway was quantitatively evaluated, however unlikely, in the HHRA to assess the potential for UU/UE for future risk management decision-making should the land use change.

The hypothetical on-site resident risk results are not used to identify chemicals of concern (COCs) requiring remediation based on unacceptable risk. The other current and future exposure scenarios are intended as the basis for risk management determinations because they represent likely, reasonable scenarios for Camp Hero (USEPA 1989).

A New York State Park Police building on the park is utilized as a residence for a park officer, but is not located within the investigation area. The residence is currently being provided potable water by municipal water supply. Any chemical concentrations identified within the investigation area are highly unlikely to migrate or impact this residence.

Off-site scenarios such as a current and future industrial worker and resident were considered. The perched groundwater conditions at the site prevent groundwater COPCs from flowing off-site in an underlying aquifer. Heavy vegetation and wetland conditions inhibit any wind-blown dust or vapors from migrating off-site. The streams are intermittent and do not feed into a surface water body or water bodies that supply drinking water for surrounding areas. Surface runoff to off-site areas was considered a minimal exposure pathway. Off-site exposure was eliminated from further evaluation in the HHRA.

4.2 Current and Future Land Use Scenarios

The HHRA addresses current and future on-site exposure scenario timeframes. The primary difference between the current and future scenario evaluations for Camp Hero receptors is soil exposure. The current scenario timeframe represents exposure to existing site conditions (i.e., no land redevelopment, so only surface soil exposure is evaluated). Subsurface soil (greater than 1 ft bgs) is not disturbed unless future land redevelopment occurs. The future evaluation for these scenarios addresses exposure to total soil (i.e., mixed surface and subsurface soil).

On-Site Outdoor Maintenance Worker: The on-site maintenance worker periodically visits DUs to repair park equipment and perform grounds maintenance for 40 days per year for 25 years. The outdoor worker is assumed to be exposed to surface soil (current) and total soil (future), assuming the land is redeveloped. Soil-related exposure pathways include incidental ingestion, dermal contact, and inhalation of wind-blown particulates or vapors from soil. Surface water and sediment exposure for this receptor was qualitatively evaluated; the surface water and sediment exposure for the on-site park employee is more conservative (i.e., higher exposure frequency) and therefore protective of any site-related worker exposure.

On-Site Park Employee: The on-site park employee (e.g., park police or naturalist) is assumed to spend 225 days per year for 25 years visiting the DUs as part of routine patrols, to check fences, or to conduct environmental studies. The on-site park employee is assumed to be exposed to surface soil (current) and total soil (future), assuming the land is redeveloped. Soil-related exposure pathways include incidental ingestion, dermal contact, and inhalation of wind-blown particulates or vapors from soil. Water-related exposure pathways include dermal contact with surface water (i.e., wading in SEAs); as stated in Section 4.1, the surface water streams are intermittent and shallow, so no full immersion (swimming) is likely. The on-site park employee may incidentally ingest and come into dermal contact with sediment during wading activities.

On-Site Recreational User: The on-site recreational user is assumed to be an adult and a young child (0 to 6 years) that visits the park for 100 days per year (2 days per week for 50 weeks out of the year) for 26 years. Recreational activities include walking on trails, picnicking, and camping. The future on-site recreational user is assumed to be exposed to total soil (i.e., where surface and subsurface soil are mixed) to evaluate potential exposure to subsurface soil where nearby future camping grounds or trails are planned. Due to the intermittent nature of the streams, it is assumed that one-half of the total exposure frequency (50 days per year) is spent wading in streambeds. The on-site recreational user is assumed to be exposed to surface soil (current) and total soil (future), assuming the land is redeveloped. Soil-related exposure pathways include incidental ingestion, dermal contact, and inhalation of wind-blown particulates or vapors from soil. Water-related exposure pathways include dermal contact with surface water (i.e., wading in the SEAs); as stated in Section 4.1, the surface water streams are intermittent and shallow so no full immersion (swimming) is likely. The on-site recreational user may incidentally ingest and come into dermal contact with sediment during wading activities. Potential cancer risk and non-cancer hazard estimates are calculated for the child, adult, and lifetime recreational user. The lifetime recreational user represents the combined child and adult cancer risk estimates that are normalized over a lifetime of exposure (i.e., USEPA default assumption of 70 years), assuming that the child and adult continue to visit Camp Hero over the course of their lifetime.

On-Site Trespasser: The on-site trespasser is a youth age 6 to 16 years old that spends 88 days per year in the park climbing fences into restricted areas of a DU where current access is either restricted or secluded. Due to the intermittent nature of the streams, it is assumed that one-half of the total exposure frequency (44 days per year) is spent wading in streambeds. It is assumed that fencing will be removed in the future to make the park more accessible. The NYSOPRHP has identified future camping and trail areas (**Figure 4-3**); however, it is assumed that the on-site trespasser would avoid more public areas and spend more time exploring areas that are either secured or secluded. The on-site trespasser is exposed to surface soil (current) only. Soil-related exposure pathways include incidental ingestion, dermal contact, and inhalation of wind-blown particulates or vapors from soil. Water-related exposure pathways include dermal contact with surface water (i.e., wading in SEAs); as stated in Section 4.1, the surface water streams are intermittent and shallow, so no full immersion (swimming) is likely. The trespasser may incidentally ingest and come into dermal contact with sediment during wading activities.

4.3 Future Only Land Use Scenarios

The future scenario timeframe addresses site soil conditions that will change due to land redevelopment. It is assumed that excavation activities will bring subsurface soil to the surface, thus mixing the soil strata. Total soil EPCs were derived that addresses the entire soil column (Section 4.5).

On-Site Indoor Worker: Currently, no buildings exist at the DUs. This receptor was used to assess a hypothetical future exposure scenario in which one or more buildings are constructed, which may result in a potentially complete vapor intrusion exposure pathway. This exposure pathway may be complete if non-petroleum-related COPCs were identified within 100 ft horizontally and vertically of a source area, or if petroleum-related COPCs were identified within 30 ft horizontally and vertically of a source area (USEPA 2015a,b). USEPA standard indoor worker exposure parameters (i.e., 250 days per year for 25 years) were used (USEPA 2014a).

On-Site Construction Worker: The construction worker is assumed to be involved in a 6-month-long construction project (i.e., exposure frequency of 125 days per year). Soil-related exposure pathways include incidental ingestion, dermal contact, and inhalation of wind-blown particulates or vapors from total soil (0 to 10 ft bgs). Also, shallow groundwater may migrate into an excavation trench, so incidental ingestion and direct contact exposure pathways were addressed. Inhalation of groundwater vapors that migrate from the shallow groundwater into trench air were also evaluated if volatile groundwater COPCs were identified. It was assumed that the construction worker may need to redirect drainage areas (i.e., SEAs) during construction activities. Therefore, dermal contact with the surface water as well as incidental ingestion and dermal contact with sediment were evaluated.

On-Site Hypothetical Resident: The expected future land use of the park is recreational. However, the inclusion of a hypothetical future resident was used to conservatively evaluate UU/UE for future risk management decision-making should the land use change. The hypothetical resident scenario addresses all exposure media and exposure pathways that were quantified for the other current and future Camp Hero receptors, thus representing the worst-case scenario. USEPA standard default residential exposure parameters (i.e., 350 days per year for 26 years) were used (USEPA 2014a). Similar to the recreational user, the potential cancer risk and non-cancer hazard estimates are calculated for the child, adult, and lifetime residents. The lifetime resident represents the combined child and adult cancer risk estimates that are normalized over a lifetime of exposure (i.e., USEPA default assumption of 70 years), assuming that the child and adult continue to live at Camp Hero throughout the course of their lifetime. The hypothetical resident risk calculations are provided in **Attachment J**.

4.4 Chemical Intake and Exposure Concentrations

Exposure is defined as the contact rate of an organism with a chemical or physical agent. Intake is exposure normalized for time and body weight and is expressed in units of mg/kg body weight-day (USEPA 1989).

The measure of chronic exposure is the chronic daily intake (CDI). The CDI for each COPC was estimated by combining the EPC with exposure parameters, such as ingestion rate, contact rate, duration, and frequency of exposure. In addition, intake parameters were selected so the combination of intake variables resulted in an individual estimate of the reasonable maximum exposure (RME) for that pathway and receptor (USEPA 1989). The CDI was calculated for ingestion and dermal exposure pathways and for long-term exposures.

Consistent with USEPA RAGS Part F guidance (USEPA 2009a), inhalation exposure was evaluated by calculating an adjusted exposure concentration (EC) of air in micrograms of chemical per cubic meter ($\mu g/m^3$).

Attachments I and J present the CDI and EC equations in RAGS Part D Table 4 format for each receptor (USEPA 2001). Where possible, the HHRA used the most current exposure parameters from the USEPA Exposure Factors Handbook and the USEPA standard default exposure parameters (USEPA 2011, 2014a). **Attachment I** includes the calculation of non-standard exposure parameters, such as skin surface areas and body weights, for the recreational user and trespasser scenarios (USEPA 2011). Some chemicals such as mutagens and TCE require specialized intake and EC equations (USEPA 2005b, 2014c, 2017a). The specialized equations are also documented in **Attachments I and J**.

4.5 Exposure Point Concentrations

Attachment F provides the EPCs that were derived for each DU and SEA in USEPA RAGS Part D Table 3 format (USEPA 2001). The concentrations of COPCs that a receptor may come into contact with are referred to as EPCs. USEPA (1989) recommends using the lower of the MDC and the 95% UCL of the mean as the EPC in cases where the DU is reasonably defined. For lead, the mean concentration is used as the EPC (USEPA 2007).

The EPCs were derived using approved statistical methodologies for calculating the 95% UCL of the mean. USEPA's ProUCL Version 5.1 software was used, which was developed for USEPA, to test the distribution of the datasets (USEPA 2016a). After testing, the program computes a conservative 95% UCL based on the appropriate distribution of the data. For those datasets that do not fit the normal, lognormal, or gamma distributions, several parametric and distribution-free non-parametric methods are available to calculate an appropriate 95% UCL (e.g., bootstrap methods). The ProUCL Version 5.1 program uses several statistical methods to handle datasets with ND results (USEPA 2016a). **Attachment F** provides the ProUCL input and output information.

Table 4-1 provides a description of the fate and transport models that were used to estimate the indirect exposure pathway EPCs in the HHRA.

Total Soil Exposure Point Concentrations: Future excavation activities may result in the subsurface soil being brought to the surface and mixed together. Therefore, a total soil EPC was derived for the surface soil and subsurface soil COPCs, assuming future land redevelopment occurs. For DUs that have 0 to 1 ft bgs surface soil and 1 to 10 ft bgs subsurface soil datasets, a ratio approach was used to weigh the soil concentrations before combining the surface and subsurface soil to calculate a total soil EPC:

- Surface soil (1/10 ratio multiplication factor)
- Subsurface soil (9/10 ratio multiplication factor)

For DUs where 0 to 1 ft bgs and 1 to 2 ft bgs samples were collected, the 1 to 2 ft bgs sample result was considered representative of the 1 to 10 ft bgs subsurface soil. Deeper subsurface soil samples were not collected at these locations because conditions at the site did not allow for deeper borings (e.g., shallow groundwater was encountered) or the Phase I risk-based screening evaluation did not identify subsurface soil COPCs at the DU (AECOM-Tidewater JV 2016). A weighting factor of 0.5 was applied to the 0 to 1 ft bgs and 1 to 2 ft bgs data to calculate a total soil EPC. In other words, the weighting factors were adjusted accordingly to represent the available surface and subsurface soil depth ranges. **Attachment F** provides the total soil weighting calculations that were conducted for the total soil exposure medium.

For DUs where only surface soil data (0 to 1 ft bgs) are available (i.e., DU11, DU13, and DU18), the surface soil COPC data (i.e., no weighting) were used to evaluate the future construction worker excavation trench scenario. The NYSOPRHP does not have any plans to develop camping grounds at these DUs and the Phase I risk-based screening evaluation did not identify subsurface soil COPCs. The likelihood of exposure to subsurface soil COPCs at these DUs is minimal.

4.6 Lead Modeling

Attachment G presents the lead modeling exposure parameters and results. The USEPA adult lead methodology (ALM) model (version dated 14 June 2017) does not evaluate potential exposures to lead in water. However, a model for evaluating adult exposure to elevated levels of lead in multiple environmental media (air, soil, and water) is available from peer reviewed literature (Bowers et al. 1994). The Bowers model is based on a biokinetic slope factor approach conceptually similar to the ALM model. Therefore, the Bowers model was used to evaluate potential groundwater exposure for the future construction worker at DU14.

The USEPA IEUBK Model for Lead in Children (Windows version 1.1, Build 11) was used to evaluate groundwater exposure to the hypothetical child resident (USEPA 2010). As recommended by USEPA (2017c), the child age range of 12 to 72 months was used in the evaluation. Because children are the most sensitive receptors, the IEUBK model is protective of the adult residential receptor.

Lead was identified as a dissolved and total phase groundwater COPC at DU14. Because the dissolved phase lead concentration (30.7 µg/L) was greater than the total phase lead concentration (24.5 µg/L), the dissolved concentration of 30.7 µg/L was used as the EPC in the lead modeling. The lead modeling results are presented in the Risk Characterization (Section 6.0).

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5.0 TOXICITY ASSESSMENT

This section describes the relationship between the magnitude of exposure (dose or exposure concentration) and the incidence of adverse health effects associated with the human health COPCs.

5.1 Selection of Toxicity Values

The selection of toxicity values for the HHRA follows USEPA (2003), guidance which recommends the following hierarchy for selecting toxicity values for the HHRA:

- Tier 1 – USEPA's Integrated Risk Information System (IRIS) (USEPA 2018b).
- Tier 2 – USEPA's Provisional Peer Reviewed Toxicity Values (PPRTVs) (USEPA 2018c).
- Tier 3 – Other Toxicity Values – Tier 3 includes additional USEPA and non-USEPA sources of toxicity information. Priority was given to those sources of information that are the most current, the basis for which is transparent and publicly available, and that have been peer reviewed. Some examples of Tier 3 sources include the following:
    - The California Environmental Protection Agency (Cal EPA) (Cal EPA 2018).
    - The Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels (MRLs) (ATSDR 2017).
    - Health Effects Assessment Summary Tables (HEAST) (USEPA 1997).

Attachment I presents the non-cancer and cancer toxicity values for each COPC in USEPA RAGS Part D Tables 5.1, 5.2, 6.1, and 6.2 format (USEPA 2001).

Dermal toxicity values are not available in USEPA's IRIS or other sources listed above. To evaluate potential cancer risk and non-cancer hazards from dermal routes of exposure, USEPA's RAGS Part E dermal guidance was used (USEPA 2004). USEPA (2004) recommends adjusting oral toxicity values using gastrointestinal absorption factors (GIABS) to evaluate dermal exposure routes for some chemicals. The oral-to-dermal adjustment is not required for chemicals where 100 percent (i.e., GIABS=1) absorption is assumed (USEPA 2004). The GIABS values used to derive the dermal toxicity values are documented in the RAGS Part D Tables 5.1 and 6.1 in **Attachment I.**

5.2 Noncarcinogenic Health Effects

RAGS Part D Tables 5.1 and 6.1 in **Attachment I** present the non-cancer toxicity values used in the HHRA. Evaluation of noncarcinogenic effects is based on the assumption that noncarcinogenic toxicological effects of chemicals occur only after a threshold dose is achieved. The reference dose

(RfD) was used to evaluate ingestion and dermal exposure pathways. The reference concentration (RfC) was used to evaluate the inhalation pathway and the estimates of the threshold dose (or concentration) at which the most sensitive human population may experience an observed adverse effect for that compound.

USEPA defines a chronic RfD/RfC as an estimate of a daily exposure level for the human population that is unlikely to result in deleterious effects during a lifetime (i.e., 70 years). A chronic RfD/RfC was used to evaluate the potential noncarcinogenic hazards associated with long-term chemical exposures. Chronic toxicity values were used for the following Camp Hero receptors: on-site outdoor maintenance worker, on-site park employee, on-site trespasser, on-site recreational user (adult/child), on-site indoor worker, and on-site hypothetical resident (adult/child).

Subchronic RfDs and RfCs have been developed for a few chemicals to characterize potential noncarcinogenic hazards associated with shorter term chemical exposures. USEPA defines subchronic exposure as periods ranging from 2 weeks to 7 years (USEPA 1989); this timeframe is applicable for the future on-site construction worker scenario. Therefore, subchronic toxicity values were used where available to estimate non-cancer hazards for the construction worker scenario.

5.3 Carcinogenic Health Effects

USEPA (1989) requires that potential carcinogens be evaluated as if minimum threshold doses do not exist. USEPA has established a weight-of-evidence approach to evaluate whether a particular chemical is a carcinogen (USEPA 1986). This weight-of-evidence classification is as follows:

- Group A chemicals are known carcinogens for which there are sufficient evidence to support a causal association between exposure to the agents in humans and cancer.
- Group B1 chemicals are probable human carcinogens for which there is limited evidence of carcinogenicity in humans.
- Group B2 chemicals are probable human carcinogens for which there is sufficient evidence of carcinogenicity in animals but inadequate or no human data.
- Group C chemicals are possible human carcinogens for which there is limited evidence of carcinogenicity in animals and inadequate or no human data.
- Group D chemicals are not classifiable as to human carcinogenicity as there is inadequate human and animal evidence of carcinogenicity or no data are available.
- Group E chemicals show evidence of noncarcinogenicity in humans as no evidence of carcinogenicity is shown in either human or animal studies.

In 2005, USEPA published new guidelines for carcinogenic risk assessment (USEPA 2005a). The 2005 guidelines recognize the growing sophistication of research methods; therefore, USEPA is revising the weight-of-evidence classification system. Weighing of the evidence includes addressing both the likelihood of human carcinogenic effects of the agent and the conditions under which such effects may be expressed, to the extent that these are revealed in the toxicological and other biologically important features of the agent. Five standard hazard descriptors are recommended under the 2005 cancer guidance:

- Carcinogenic to Humans
- Likely to be Carcinogenic to Humans
- Suggestive Evidence of Carcinogenic Potential
- Inadequate Information to Assess Carcinogenic Potential
- Not Likely to be Carcinogenic to Humans

USEPA is currently re-examining the carcinogenic classification for numerous chemicals. Where available, the new classification is provided in RAGS Part D Tables 6.1 and 6.2 in **Attachment I** for the carcinogenic COPCs evaluated in this HHRA.

RAGS Part D Tables 6.1 and 6.2 in **Attachment I** present the cancer toxicity values used in the HHRA. The cancer slope factor (CSF) was used to estimate the incremental potential risk from exposure to carcinogenic COPCs. CSFs are developed based on a dose response curve for the carcinogenicity of the specific chemical. In estimating risks posed by potential carcinogens, USEPA generally assumes that any exposure level is associated with a finite probability, however minute, of producing a carcinogenic response. This mechanism for carcinogenicity is referred to as non-threshold, because there is theoretically no level of exposure for such a substance that does not pose a small, though finite, probability of producing a carcinogenic response.

The CSF, expressed in units of 1/milligrams per kilogram-day $(mg/kg\text{-}day)^{-1}$, is used to convert the CDI of a chemical from ingestion and dermal exposures, normalized over a lifetime, directly to a potential cancer risk estimate. To evaluate inhalation exposure, the CSF is expressed as an inhalation unit risk (IUR) in units of $(\mu g/m^3)^{-1}$ and is used to convert the adjusted EC in units of $\mu g/m^3$ directly to a potential cancer risk estimate.

Some chemicals are identified as mutagens. A mutagen adversely affects the deoxyribonucleic acid (DNA) of a receptor; the mutated DNA causes malfunctioning or loss of function for a particular gene(s), and the accumulation of mutations may lead to cancer. USEPA has developed equations to address mutagenic health effects, especially for age-sensitive or developmental stages (e.g., on-site hypothetical child resident and youth trespasser) where mutagenic health effects are likely to occur (USEPA 2005b). Mutagenic COPCs evaluated in the HHRA include hexavalent chromium, total BaP PAHs, and TCE.

6.0 RISK CHARACTERIZATION

This section integrates the information developed in the exposure assessment and the toxicity assessment into an evaluation of the potential risks associated with exposure to COPCs at each DU. Both the potential cancer risk and non-cancer health hazard were evaluated

This section also addresses the nature and magnitude of potential human health risks in comparison to state and federal target risk levels for making risk management decisions.

6.1 Target Risk Levels

USEPA (1991c) states that where the cumulative incremental current or future potential ELCR to an individual is less than 10^{-4} (one in 10,000; 1E-04), action generally is not warranted unless there are adverse environmental impacts. The target risk range that USEPA uses to manage site risks as part of a Superfund Cleanup is 1×10^{-6} (one in 1,000,000; 1E-06) to 1×10^{-4} (one in 10,000; 1E-04). In effect, estimated risks that are less than 1E-06 are generally considered negligible, while risks that are greater than 1E-04 are usually considered sufficient justification for undertaking remedial action. Risks in the intermediate range between these two values can be considered acceptable on a case-by-case basis.

For non-cancer hazards, potential adverse health effects cannot be ruled out if the target HI is greater than 1 per target organ endpoint. If the total HI for all target organ endpoints combined exceeds 1, chemicals are segregated based on the target organ endpoint, and separate target organ-specific HIs are calculated. Only chemicals that act on the same target organ are expected to be additive (USEPA 1989).

Lead exposure was evaluated by comparing the estimated blood lead concentration (PbB) to the USEPA's target PbB of 10 micrograms per deciliter (µg/dL) for the receptor population (USEPA 2016b). This is sometimes referred to as the P10 statistic. The target PbB is based on potentially adverse neurological effects in children (Centers for Disease Control and Prevention [CDC] 1991). The CDC Advisory Committee on Childhood Lead Poisoning Prevention has revised its recommended target blood lead level to 5 µg/dL (CDC 2012). At the present time, USEPA has not formally adopted this blood lead level and continues to use a target level of 10 µg/dL. However, a sensitivity analysis was performed as part of the lead evaluation to determine how the lead modeling results would change if a target blood lead level of 5 µg/dL were used.

In addition, the threshold for lead is to limit the risk to no more than a 5% probability for a young child's or a fetus of a pregnant female worker PbB concentration to exceed the target PbB level in the IEUBK and Bowers models, respectively (USEPA, 2010). If the probability of 5% is exceeded, then adverse health effects from exposure to lead are possible for the hypothetical child resident or fetus of the adult female worker.

The potential risks are only estimates and are based on intentionally conservative exposure and toxicity assumptions. Exceedance of any particular risk level does not imply that adverse health effects have already occurred or will occur. The estimates are an indication that additional evaluation or action may be warranted.

For each exposure scenario (i.e., receptor and DU) with a potential ELCR/HI above USEPA target levels, COCs were defined as COPCs that caused the cumulative ELCR to exceed 1E-04 and/or the target organ endpoint HI to exceed 1, at one significant figure. Lead was identified as a COC if the target PbB of 10 µg/dL for the receptor population was exceeded.

6.2 Carcinogenic Risks

The potential ELCR, which is unitless, represents an estimation of an upper bound incremental lifetime probability that an individual may develop cancer as a result of exposure to a potential carcinogen.

The potential ELCR is calculated for each chemical and exposure pathway (ingestion and dermal) by multiplying the estimated CDI by the CSF, as follows:

Equation 1:

$$\text{ELCR (unitless)} = \text{CDI (mg/kg-day)} \times \text{CSF (mg/kg-day)}^{-1}$$

For the inhalation pathway, a similar calculation is made using the IUR and the adjusted EC (in units of concentration in air):

Equation 2:

$$\text{ELCR (unitless)} = \text{EC } (\mu g/m^3) \times \text{IUR } (\mu g/m^3)^{-1}$$

Potential chemical-specific risks for all chemicals associated with a specific pathway are summed to assess exposure to multiple chemicals. The pathway-specific risks for all pathways are then summed to determine the estimated total cumulative risk for the exposure scenario. The total cumulative risk estimate assumes that different carcinogens affect the same target organ to produce a cancer response, ignoring potential antagonistic or synergistic effects or disparate effects on different target organs.

The potential ELCR calculations are provided in **Attachment I** in USEPA RAGS Part D Tables 7 and 9 format (USEPA 2001). **Table 6-1** summarizes the potential ELCR results for each DU. The potential cancer risk estimates for all receptors and DUs are below the target ELCR threshold of 1E-04 with the exception of the lifetime on-site recreational user at DU12. The lifetime recreational user potential ELCR at DU12 (3E-4) is attributed to incidental ingestion and dermal contact with total BaP PAHs in surface soil.

6.3 Noncarcinogenic Risks

To characterize potential noncarcinogenic effects, comparisons were made between projected intakes of substances over a specified time period and toxicity values, primarily RfDs and RfCs. The ratio of exposure to toxicity value is the hazard quotient (HQ). The HQ is calculated for each chemical and exposure pathway (ingestion and dermal) by dividing the CDI by the RfD as follows:

Equation 3:

Non-cancer HQ (unitless) = CDI (mg/kg-day)/RfD (mg/kg-day)

For inhalation exposures, a similar comparison is made using the RfC and the adjusted EC:

Equation 4:

Non-cancer HQ = EC ($\mu g/m^3$)/(RfC [mg/m^3] × 1000 µg/mg)

Estimated HQs for noncarcinogenic effects are generated on a chemical-by-chemical basis for each relevant pathway of exposure. The chemical-specific HQs are summed for all chemicals associated with a specific pathway to determine the pathway-specific HI. The HIs for all pathways are then summed to determine the total cumulative HI for the exposure scenario.

The HQ is not a statistical probability of a noncarcinogenic effect occurring. If the exposure level is less than the appropriate toxicity value (i.e., the HQ is less than 1), adverse health effects are not likely, even with a lifetime of exposure. Given the uncertainty of factors used in deriving RfDs and RfCs, a HQ greater than 1 may not indicate a higher risk of adverse effect than a HQ of 1 or less.

If the cumulative HI for an exposure scenario is greater than 1, the HI is segregated by critical effect and mechanism of action (USEPA 1989). HQs for chemicals that affect the same target organ endpoint are summed to derive target organ-specific HIs.

The non-cancer hazard calculations are provided in **Attachment I** in USEPA RAGS Part D Tables 7 and 9 format (USEPA 2001). **Table 6-1** summarizes the potential non-cancer hazard results for each DU. The cumulative HI results are below 1 with the exception of the future on-site construction worker at DU11 and the current on-site child recreational user at DU12. For the future construction worker at DU11, the cumulative HI is attributed to benzo(a)pyrene (target organ-specific HI of 2 associated with developmental effects) via incidental ingestion, dermal contact, and inhalation of soil particulates in surface soil. For the child recreational user at DU12, the cumulative

HI is attributed to the incidental ingestion and dermal contact with benzo(a)pyrene in surface soil (target organ-specific HI of 2 associated with developmental effects).

6.4 On-Site Hypothetical Resident Results

The current and expected future land use is non-residential (recreational) and therefore the hypothetical on-site resident is not a likely scenario for Camp Hero. The estimated cancer risks and non-cancer hazards were derived for a hypothetical resident scenario to conservatively evaluate UU/UE for future risk management decision-making should land use change. Any chemicals that are driving the residential risk were not identified as COCs in this HHRA unless these chemicals are identified as contributing to an unacceptable risk to one or more of the other potentially complete Camp Hero on-site non-residential exposure scenarios (e.g., recreational user, park employee, outdoor maintenance worker). The hypothetical on-site resident potential ELCR and non-cancer calculations are provided in **Attachment J**. **Table 6-2** summarizes the hypothetical resident potential ELCR and non-cancer hazard results.

6.5 Lead Modeling Results

The Bowers model predicted that the PbB for a future on-site construction worker associated with the mean groundwater concentration at DU14 was below the USEPA target level of 10 µg/dL (0.81 µg/dL). Therefore, the results of the lead evaluation indicate that lead concentrations in DU14 groundwater (through incidental ingestion) do not result in adverse health effects for the future on-site construction worker scenario.

The IEUBK model results indicate that there is a 7.6% probability that children exposed to lead in the groundwater of DU14 will have a PbB greater than 10 µg/dL (i.e., 92% of children potentially exposed to lead are predicted to exhibit PbB concentrations lower than the current USEPA target PbB level of 10 µg/dL). There is a 52% probability that children exposed to lead in the groundwater of DU14 will have a PbB greater than 5 µg/dL (i.e., 48% of children potentially exposed to lead are predicted to exhibit PbB concentrations lower than the proposed PbB level of 5 µg/dL).

The threshold for lead is to limit the risk to no more than a 5% probability that a child's (or a population of children's) PbB concentration will not exceed a 10 µg/dL PbB target level (USEPA, 2010). If the probability of 5% is exceeded, then adverse health effects from exposure to lead in groundwater are possible for the hypothetical child resident, assuming that the groundwater is used for drinking water. Therefore, these results indicate that exposure to DU14 groundwater as drinking water exceeds the target PbBs of concern (i.e., 10 µg/dL and 5 µg/dL) and 5% probability threshold for the hypothetical on-site child resident.

7.0 UNCERTAINTY ASSESSMENT

This section qualitatively assesses the uncertainties associated with each step of the HHRA. It provides information about the key assumptions, their inherent uncertainty and variability, and the impact of this uncertainty and variability on the estimates of potential risk.

7.1 Hazard Identification and Data Evaluation

Source of Uncertainty: Unbiased samples were collected from soil, surface water, sediment, and groundwater at each DU and SEA in a manner that is representative of exposure at the site.

- **Effect on Risk/Hazard Estimates:** Representative.
- **Potential Magnitude:** Low.
- **Rationale for Assumptions:** Unbiased samples provide better data to derive representative EPCs for evaluating ELCR and/or non-cancer hazards.

Source of Uncertainty: If the analytical methods used do not apply to some chemicals that are present at the site, risk could be underestimated.

- **Effect on Risk/Hazard Estimates:** Underestimate.
- **Potential Magnitude:** Low.
- **Rationale for Assumptions:** The Phase I, II, and III investigations were designed to address potential chemical exposure from historical site-related DoD activities at Camp Hero. Data gap analysis was conducted following Phase I and II field events to determine what additional sampling was needed to conduct the RI and risk assessment.

Source of Uncertainty: With the exception of "R"-flagged (rejected data), flagged results such as "J" flags (i.e., estimated values) were carried forward into the HHRA.

- **Effect on Risk/Hazard Estimates:** Under- or overestimate.
- **Potential Magnitude:** Low.
- **Rationale for Assumptions:** USEPA (1989) guidance recommends treating "J"-flagged results as detected concentrations. A comprehensive QA/QC program was implemented with each phase of investigation (see the field reports in Appendices E, F, and H of the RI Report) to ensure that data quality objectives were met during sample collection, preparation, analysis, and data reporting. The results from the QC samples were assessed to ensure that samples were processed while laboratory systems were in control. In

addition, QC data were evaluated to provide an assessment of potential data quality issues arising from uncontrollable parameters such as matrix interferences.

The statistical calculations of EPCs takes into account detect and ND results to derive representative concentrations. A "J"-flagged result indicates that the analyte was positively identified and the associated numerical value is an estimated quantity with an unknown bias. Results that are biased high are flagged "J+" and results that are biased low are flagged "J-". The "J"-flagged result was treated as a detected concentration even though the chemical's true concentration is unknown (USEPA 1989). Therefore, if the J-flagged chemical was identified as a COPC, it is unknown if the estimated risk was under- or overestimated because its true concentration is unknown. While the concentration is still unknown with chemicals flagged J+ or J-, the estimated risk can be identified as an under or overestimate.

Source of Uncertainty: Identify whether LODs are low enough (i.e., below screening criteria) to capture detected concentrations in the affected media.

- **Effect on Risk/Hazard Estimates:** Underestimate
- **Potential Magnitude:** Moderate
- **Rationale for Assumptions:** A DSA was conducted to identify chemicals that may not have been evaluated in the COPC screening process because the LOD is higher than the selected screening criteria. Separate risk calculations were conducted for the LOD COPCs and presented in **Attachment D**. The DSA potential ELCR estimates are in the 1E-06 range or lower. With the exception of the hypothetical on-site resident, the HI estimates are roughly 1 to 2 orders of magnitude below 1. A chemical was eliminated from further evaluation in the HHRA if the LOD was reported as zero and it was not detected in any sample across all media and DUs. **Table 7-1** presents the chemicals that were eliminated from further evaluation.

Source of Uncertainty: Total phase surface water data were used in the HHRA risk calculations.

- **Effect on Risk/Hazard Estimates:** Overestimate.
- **Potential Magnitude:** Low.
- **Rationale for Assumptions:** Total phase results were used in the HHRA calculations because limited dissolved phase data were available. Surface water samples were not field-filtered if the turbidity was low (i.e., below 10 nephelometric turbidity units). The low

turbidity conditions of the SEAs helped to lower the level of uncertainty associated with using total phase concentrations to represent dissolved phase concentrations.

Source of Uncertainty: Hexavalent chromium concentrations were estimated using a ratio method (as discussed in Section 2.6).

- **Effect on Risk/Hazard Estimates:** Under- or overestimate.
- **Potential Magnitude:** Low-Moderate
- **Rationale for Assumptions:** Speciated chromium data were collected in 10% of the metal samples in all media to ascertain what, if any, fraction of total chromium present in the medium is in the more toxic hexavalent chromium form. It is unknown if derived hexavalent chromium concentrations are representative of site conditions. The background and geochemical evaluations eliminated hexavalent chromium as a COPC in multiple exposure media; however, these results are based on the estimated hexavalent chromium concentrations for the background and DU-specific datasets. Hexavalent chromium is often associated with specialized industrial processes (e.g., plating operations and rust inhibitors in cooling towers) that are not known to occur at Camp Hero (USEPA 2018b). The level of uncertainty is reduced for identifying hexavalent chromium as a site-related COPC.

7.2 Identification of COPCs

Source of Uncertainty: Background and geochemical evaluations were incorporated into the COPC selection process.

- **Effect on Risk/Hazard Estimates:** Representative.
- **Potential Magnitude:** Moderate.
- **Rationale for Assumptions:** The purpose of conducting these evaluations is to distinguish whether concentrations of metals and PAHs at Camp Hero are attributed to background/anthropogenic conditions or site-related activities. Assuming regulatory approval of these evaluations, these steps help to streamline the risk assessment process and focus the risk results on site-related COPCs.

Source of Uncertainty: Surrogates were used if a risk-based screening level was not available for a particular chemical.

- **Effect on Risk/Hazard Estimates:** Under- or overestimate.

- **Potential Magnitude:** Low
- **Rationale for Assumptions:** Surrogates with similar molecular structures were selected to represent chemicals without toxicity information to derive risk-based screening levels. The use of surrogates reduces the level of uncertainty for chemicals that are not quantified in the COPC screening and HHRA risk calculations. **Attachment I** documents the surrogates that were used.

Source of Uncertainty: The USEPA RSLs were updated during the course of the HHRA.

- **Effect on Risk/Hazard Estimates:** None.
- **Potential Magnitude:** Negligible.
- **Rationale for Assumptions:** The May 2018 update did not affect the chemicals that were evaluated at Camp Hero. The level of uncertainty is minimal regarding the COPC screen and DSA screen results.

Source of Uncertainty: MDCs and generic screening levels were used to identify COPCs for Camp Hero.

- **Effect on Risk/Hazard Estimates:** Overestimate.
- **Potential Magnitude:** Moderate.
- **Rationale for Assumptions:** USEPA (1989, 2017a) guidance recommends using conservative generic screening levels and MDCs for initial COPC screening. Although the park is likely to remain recreational into the future, residential screening levels were used to identify COPCs to be protective of the general public. Also, lower LODs were selected to be protective of risk-based screening levels where possible; the laboratory was better able to detect potential concentrations of chemicals that may be COPCs at the site.

Source of Uncertainty: High detection of lead of 677 mg/kg in surface soil (sample DU07-S004-01) was identified at DU07.

- **Effect on Risk/Hazard Estimates:** Underestimate.
- **Potential Magnitude:** Low.
- **Rationale for Assumptions**: With the exception of the soil detection of 677 mg/kg, the detected surface soil concentrations ranged from 4.71 mg/kg to 23 mg/kg at DU07. The

EPC derived for lead was 52 mg/kg, which is below the residential action level of 400 mg/kg. The terrain of DU07 is generally inaccessible to the public due to woods, steep inclines, and a wetland area. It is unlikely that potential receptors may spend time at DU07; therefore, the level of uncertainty is minimal.

7.3 Exposure Assessment

Source of Uncertainty: The lower of the 95% UCL of the mean concentration and the MDC were selected as the EPC. The mean concentration was used as the EPC for lead.

- **Effect on Risk/Hazard Estimates:** Overestimate.
- **Potential Magnitude:** Low.
- **Rationale for Assumptions:** The unbiased sample datasets generally contained 15 or more data points so that 95% UCLs of the mean concentration were derived. The exception to this was the DU-specific groundwater evaluation where only 1 to 2 rounds of groundwater sampling data were available. The groundwater results for DUs with only 1 or 2 groundwater monitoring wells (**Table 2-2**) tend to have overestimated risk results for the future construction worker and hypothetical resident. The mean concentration as the EPC for lead is consistent with USEPA guidance (USEPA 2007).

Source of Uncertainty: The surface soil EPC for benzo(a)pyrene at DU11 was influenced by elevated concentrations in a single surface soil sample DU11-S003; benzo(a)pyrene was identified as a non-cancer hazard driver for the on-site construction worker.

- **Effect on Risk/Hazard Estimates:** Overestimate.
- **Potential Magnitude:** Moderate.
- **Rationale for Assumptions:** The benzo(a)pyrene concentration in the surface soil sample from DU11-S003 is 180 mg/kg and the remaining surface soil detections for benzo(a)pyrene ranged from 0.031 mg/kg to 1.7 mg/kg. The benzo(a)pyrene EPC of 123.3 mg/kg is well above the majority of the measured concentrations. The future on-site construction worker is more apt to be exposed to total soil (0 to 10 feet below ground surface) while excavating the area for future land redevelopment. The Phase I biased subsurface soil sample concentrations of benzo(a)pyrene at DU11 ranged from 0.00071 mg/kg to 7 mg/kg. The maximum subsurface soil concentration of 7 mg/kg benzo(a)pyrene was used to estimate risk to the on-site construction worker in combination with groundwater and sediment media at DU11; the cumulative non-cancer hazard index (HI) was 0.3 which was below the

USEPA threshold of 1. Therefore, the non-cancer hazard results for the on-site construction worker at DU11 are likely overestimated.

Source of Uncertainty: Concentrations of chemicals in the exposure media may decrease over time as chemicals migrate or degrade. The risk estimates for current scenarios do not necessarily represent future risk.

- **Effect on Risk/Hazard Estimates:** Overestimate.
- **Potential Magnitude:** Moderate.
- **Rationale for Assumptions:** For many organic COPCs, the measured concentrations represent the worst-case scenario for future exposure scenarios. Over time, estimated ELCR and/or non-cancer hazards can be expected to decline. This is especially true for the petroleum-related DUs such as DU01 where LNAPL is present. The RI has delineated the LNAPL at DU01 and the test results indicate that it is biodegrading.

Source of Uncertainty: The wooden revetments used to channelize surface water flow within streams may also contribute to the total PAH concentrations in SEA03 and SEA08 sediment. The number of revetted stations in SEA03 and SEA08 was higher than originally designated in the risk assessments; therefore, it is likely that the PAH sediment concentrations found in these SEAs were associated with the presence of the revetments rather than attributed to a CERCLA release[2].

- **Effect on Risk/Hazard Estimates:** Overestimate.
- **Potential Magnitude:** Moderate.
- **Rationale for Assumptions:** SEA03 and SEA08 included revetted and non-revetted portions. Field notes indicated that the majority of SEA03 and SEA08 did not have revetments visible at the time of sampling; therefore, SEA03 and SEA08 were classified as non-revetted SEAs during the risk assessments. However, an additional review of maps and site photographs (Appendix H of the RI Report) was conducted; the review showed evidence of revetments for some locations not originally classified as revetted by the field team; two additional SEA03 stations (CH-SWSD071 and CH-SWSD072) and four additional SEA08 stations (CH-SWSD146 through CH-SWSD149) could be classified as revetted. The updated revetment determinations were considered in the statistical background

[2] A CERCLA release can be defined broadly to include a situation where a hazardous substance escapes into the environment from its normal container. A CERCLA release, as used in the context of the RI, refers to DoD activities that may have resulted in "spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment (including the abandonment or discarding of barrels, containers, and other closed receptacles containing a hazardous substance or pollutant or contaminant) (CERCLA § 101(22)).

comparisons conducted in the additional PAH characterization evaluation (Appendix C5 of the RI Report). The statistical background comparison confirmed that the PAH concentrations in sediment in the revetted portions of SEA03 and SEA08 were not significantly higher than the background revetted dataset. Total PAHs was identified as a primary risk driver for the hypothetical resident via incidental ingestion and dermal contact with sediment at DU10/SEA03; these results are likely attributed to the revetments rather than a CERCLA release.

Source of Uncertainty: Total soil EPCs were derived using weighted soil concentrations where surface and subsurface soil data were available.

- **Effect on Risk/Hazard Estimates:** Under- or overestimate.
- **Potential Magnitude:** Low
- **Rationale for Assumptions:** The weighting of soil concentrations provides a more representative total soil EPC because the weighting was adjusted to represent the available surface and subsurface soil depth ranges. Deeper subsurface soil samples were not collected at some locations because either the site conditions did not allow for deeper borings (e.g., shallow groundwater was encountered), or the Phase I risk-based screening evaluation did not identify subsurface soil COPCs at the DU (AECOM-Tidewater JV 2016).

Source of Uncertainty: Modeled concentrations were used to estimate concentrations in outdoor air, indoor air, and PbBs. Generally, a higher level of uncertainty is associated with the modeled concentrations rather than the use of measured concentrations.

- **Effect on Risk/Hazard Estimates:** Under- or overestimate.
- **Potential Magnitude:** Low.
- **Rationale for Assumptions:** Conservative model assumptions were used to estimate outdoor air concentrations using a site-specific PEF and chemical-specific VFs, indoor air concentrations using the J&E model, and PbBs using lead models. The conservative parameters tend to reduce the likelihood of underestimating the ELCR/non-cancer hazard results. The risk drivers identified in **Table 6-1** are attributed more to the incidental ingestion and dermal contact with soil exposure pathways. Vapor intrusion was eliminated as a potential pathway of concern for the future indoor worker but not for the hypothetical resident. The modeled indoor air concentrations were derived assuming sandy soil conditions when the soil types at Camp Hero are predominantly sandy, but not 100% sand. Lead was eliminated as a groundwater COC for the future construction worker, but not for

the hypothetical resident. However, the hypothetical resident lead modeling results assume that the groundwater is used for potable purposes; the Camp Hero potability analysis indicates that this pathway is incomplete.

Source of Uncertainty: USEPA steady-state equations were used to estimate ELCR/non-cancer hazard results for the dermal contact with water exposure pathways; however the equations are limited when dealing with chemicals that have large K_{ow} values and are highly lipophilic (USEPA 2004 and 2016d).

- **Effect on Risk/Hazard Estimates:** Overestimate.
- **Potential Magnitude:** Moderate.
- **Rationale for Assumptions:** Chemicals having large K_{ow} values (i.e., greater than 3.5) tend to move slowly through the stratum corneum, which is the layer of skin cells that provides a barrier to the movement of chemicals through the skin. These chemicals tend to remain within the cells of the stratum corneum; the human body regularly sloughs skin cells (every 14 days), making them unavailable for entry into the body. Although the steady-state equations have an FA component that addresses the loss of chemicals through skin sloughing, USEPA made no FA adjustment for a number of the carcinogenic PAHs (USEPA 2004 and 2016d). For example, a default FA of 1 was assumed for benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene despite their log K_{ow} values being 5.66, 6.10, and 6.12, respectively. A few carcinogenic PAHs such as dibenz(a,h)anthracene and indeno(1,2,3-cd)pyrene have lower FA adjustments (0.6) to account for their log K_{ow} values of 6.84 and 6.58, respectively. Since the HHRA evaluates PAHs using summation results, the dermal exposure to groundwater and/or surface water pathways were not evaluated for PAHs in the HHRA. Surface water risk calculations were not conducted for DU05/SEA05 and DU18/SEA01 because total BaP PAHs and benzo(a)pyrene in surface water were the only COPCs.

Source of Uncertainty: Potable use of groundwater was evaluated for a hypothetical resident, despite the potability analysis indicating that the exposure pathway is incomplete.

- **Effect on Risk/Hazard Estimates:** Overestimate.
- **Potential Magnitude:** High.
- **Rationale for Assumptions:** The Camp Hero potability analysis revealed that the shallow perched groundwater at Camp Hero was not suitable as a potable water source. However, the drinking water exposure pathway was quantitatively evaluated to assess the potential

for UU/UE for future risk management decision-making should the land use change. The hypothetical on-site resident risk results will not be used to identify COCs requiring remediation based on unacceptable risk. The hypothetical resident potential ELCR/non-cancer hazard results are provided separately (**Attachment J**). The other current and future exposure scenarios are intended as the basis for risk management determinations.

Source of Uncertainty: The NYSOPRHP plans to develop future camping grounds in proximity to (but not directly within) DU04, DU06, DU16, and DU17. However, the level of development to occur in these areas is unknown (e.g., depth of excavations, installation of drinking fountains or bathing facilities).

- **Effect on Risk/Hazard Estimates:** Under- or overestimate.
- **Potential Magnitude:** Low.
- **Rationale for Assumptions:** The COPC screening did not identify any COPCs for DU04 and DU17. Surface and subsurface soil data are available for DU06 and DU16, so a total soil evaluation was completed for the future construction worker to address potential land redevelopment. The future construction worker and recreational user risk results were below USEPA ELCR and non-cancer thresholds. Assuming NYSOPRHP would provide city-supplied water, the risk results support using these DUs as future camping grounds.

Source of Uncertainty: LNAPL is present in DU01 shallow groundwater and is therefore a continuous source for groundwater concentrations.

- **Effect on Risk/Hazard Estimates:** Under- or overestimate.
- **Potential Magnitude:** Moderate.
- **Rationale for Assumptions:** The HHRA recognizes that the LNAPL is present at DU01. Organic COPCs were quantitatively addressed in the groundwater risk calculations, but it is unknown how the LNAPL will affect future groundwater concentrations. However, the RI has evaluated the NAPL stability, lack of recoverability, and evidence of active source depletion; these results will be taken into consideration when evaluating whether further action is required under the NYSDEC program. The level of uncertainty associated with human health exposure to LNAPL is reduced.

7.4 Toxicity Assessment

Source of Uncertainty: USEPA cancer slope factors are considered to be plausible upper bounds of risk at a 95% confidence limit. Therefore, there is a 95% probability that the true cancer risks do not exceed these levels, and that the estimated cancer risks are likely to be much lower (USEPA 2018b).

- **Effect on Risk/Hazard Estimates:** Overestimate.
- **Potential Magnitude:** Moderate.
- **Rationale for Assumptions:** Cancer guidelines state that the use of linearized multistage models and upper bound risk estimates are appropriate, but the lower limit of risk may be as low as zero (USEPA 2018b).

Source of Uncertainty: Reference doses are frequently derived from animal studies that have little quantitative bearing on potential adverse health effects in humans.

- **Effect on Risk/Hazard Estimates:** Overestimate.
- **Potential Magnitude:** Moderate.
- **Rationale for Assumptions:** Since the fate and mechanism of action of a chemical may differ in animals and humans, the effects observed in animals may not be observed in humans, resulting in an overestimation of potential adverse health effects.

Source of Uncertainty: Provisional toxicity data (e.g., PPRTV and Cal EPA toxicity values) were used to estimate cancer risk and/or non-cancer hazards for acetone, aluminum, antimony arsenic, barium, 1,1'-biphenyl, bis(2-ethylhexyl)phthalate, hexavalent chromium, cobalt, ethylbenzene, iron, thallium, dibenzofuran, 1-methylnaphthalene, naphthalene, n-propylbenzene, and vanadium.

- **Effect on Risk/Hazard Estimates:** Under- or overestimate.
- **Potential Magnitude:** Unknown.
- **Rationale for Assumptions:** Provisional toxicity values are still undergoing intensive scientific review and have not been verified by IRIS. It is unknown if the ELCR and/or non-cancer hazards are under- or overestimated. As noted in **Table 6-2**, aluminum, arsenic, hexavalent chromium, and cobalt are risk drivers for the hypothetical resident.

Source of Uncertainty: Some chronic toxicity data were used to calculate non-cancer hazards for the construction worker scenario, which is a subchronic exposure scenario (6 months of exposure).

- **Effect on Risk/Hazard Estimates:** Overestimate.
- **Potential Magnitude:** Low.
- **Rationale for Assumptions:** Where possible, subchronic RfDs and RfCs were used in the HHRA when evaluating the future construction worker. The level of uncertainty associated with the receptor's non-cancer hazards is reduced. For example, benzo(a)pyrene is a non-cancer hazard driver for the future construction worker at DU11; chronic RfD and RfC toxicity values were used to estimate the non-cancer hazards. The non-cancer hazard results are likely overestimated.

7.5 Risk Characterization

Source of Uncertainty: PAHs were eliminated as surface soil COCs in DU11 surface soil because the source of PAHs was likely pyrogenic for soil sample DU11-S003 and would not be attributed to a CERCLA release.

- **Effect on Risk/Hazard Estimates:** Overestimate.
- **Potential Magnitude:** High.
- **Rationale for Assumptions:** The surface soil EPC for benzo(a)pyrene was influenced by elevated concentrations in a single surface soil sample DU11-S003. As an example, the benzo(a)pyrene concentration in the surface soil sample from DU11-S003 is 180 mg/kg and the remaining surface soil detections for benzo(a)pyrene ranged from 0.031 mg/kg to 1.7 mg/kg. The benzo(a)pyrene EPC (95% UCL) was 123.3 mg/kg, which is well above the majority of the measured concentrations. A review of PAH ratios can be useful for differentiating between PAH assemblages containing primarily pyrogenic (formed as a result of incomplete combustion) or petrogenic (often associated with petroleum spills) PAHs (Battelle Memorial Institute et al. 2003). PAH ratios of 2.8 for phenanthrene to anthracene (PH/AN) and 1.4 for fluoranthene to pyrene (FL/PY) were calculated for the DU11-S003 sample using DU11 PAH surface soil results from Attachment A of the HHRA. The ratio results indicate that the sample is pyrogenic (i.e., creosote or coal tar source) (Battelle Memorial Institute et al. 2003) which would not be associated with a CERCLA release.

Source of Uncertainty: PAHs were eliminated as surface soil COCs in DU12 surface soil because additional characterization of PAHs was conducted. However, the statistical evaluation (Appendix C5 of the RI Report) indicated the PAHs at DU12 were likely pyrogenic in source, which indicates the source is likely not related to a fuel spill from former Building 36.

- **Effect on Risk/Hazard Estimates:** Overestimate.

- **Potential Magnitude:** High.

- **Rationale for Assumptions:** Three of the 16 surface soil benzo(a)pyrene concentrations at DU12 were above 100 mg/kg (ranging from 110 mg/kg to 150 mg/kg) at sample locations DU12-S001, DU12-S004, and DU12-S008. The remaining surface soil sample results ranged from 0.043 mg/kg to 77 mg/kg. Another possible source of PAHs is Coast Artillery Road which runs through the middle of DU12. Also, a former Fueling Station (former Building 36) was previously located to the northwest of DU12. The USTs associated with the former Building 36 (USTs 24A, 24B, and 25) had an associated NYSDEC spill report, 93-09098, dated 25 October 1993. The spill report was closed later in 1993 with a NYSDEC-Region 1 Tank Removal Report. The USTs/the former fueling station was not investigated during the Phase I RI field program as an AOC because NFA was required by NYSDEC (there were no COCs above regulatory action levels). Although the fueling station was not specifically investigated in the RI, a potential fuel release from the station was considered as a possible source for the high concentrations of PAHs detected within DU12 near the former fueling station. Given the lack of other potential point-sources within DU12 and the proximity of the roadway to the most elevated PAH concentrations, the most likely sources of PAHs in surface soil at DU12 are expected to be vehicle exhaust and emissions, weathering of asphalt roads and tires, and ongoing asphalt road maintenance. Also, the soil boring logs for DU12 (Appendix I of the RI Report) indicate evidence of demolished asphalt parking lot materials (black coloring, concrete fragments, tar, and pulverized brick).

  Finally, the HHRA results are likely biased high because NYSOPRHP has no plans for developing areas near or at DU12 for future camping grounds or hiking trails and no camping grounds are nearby DU12, so the recreational user is less likely to spend much time there.

Source of Uncertainty: Risk characterization uncertainties include possible synergistic or antagonistic effects of exposure to multiple chemicals and applicability of cancer risk estimation methodology to less than lifetime exposure durations.

- **Effect on Risk/Hazard Estimates:** Under- or overestimate.

- **Potential Magnitude:** Low.

- **Rationale for Assumptions:** These uncertainties are generic to the risk assessment process and not specific to Camp Hero.

Source of Uncertainty: The COPC screening process may not have captured all potential COPCs due to LODs being higher than selected screening criteria.

- **Effect on Risk/Hazard Estimates:** Underestimate.
- **Potential Magnitude:** Low.
- **Rationale for Assumptions:** As noted in Section 7.1, separate risk calculations were conducted as part of the DSA. The DSA ELCR estimates were in the 1×10^{-6} range or lower. With the exception of the hypothetical resident, the HI estimates were roughly 1 to 2 orders of magnitude below 1. The conclusions of the HHRA are not likely to change if the DSA results were added to the existing HHRA risk calculations.

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8.0 HHRA CONCLUSIONS

The HHRA has fulfilled the objective discussed in Section 1.0, which was to evaluate whether COPCs attributable to past site activities have the potential to cause unacceptable adverse health effects to human receptors within the area under investigation. The HHRA addressed current and future land use scenarios. Results of the HHRA are used to develop risk management options for each exposure area, including possible further actions to address impacted soils, groundwater, surface water, and sediment where needed. The results are summarized below.

The COPC selection results eliminated DU02, DU04, DU09, and DU17 from further evaluation. DU05/SEA05 and DU18/SEA01 were also eliminated from further evaluation because dermal exposure to PAHs in surface water could not be quantified due to limitations with the USEPA steady-state equations (USEPA 2004 and 2016d). The remaining DUs and SEAs were further evaluated in the HHRA risk calculations.

Off-site exposure scenarios such as a current and future industrial worker and resident were considered. The perched groundwater conditions at Camp Hero prevent groundwater COPCs from flowing off-site in an underlying aquifer. Heavy vegetation and wetland conditions inhibit any wind-blown dust or vapors from migrating off-site. The streams are intermittent and do not feed into a surface water body or water bodies that supply drinking water for surrounding areas. Surface runoff to off-site areas was considered a minimal exposure pathway. Therefore, off-site exposure was eliminated from further evaluation in the HHRA.

The RI identified LNAPL in the shallow groundwater at DU01 that serves as a continuous source of petroleum-related chemical concentrations. The receptors most likely to have shallow groundwater exposure at DU01 are the future on-site construction worker via direct contact and inhalation of vapors from groundwater seeping into a trench, and a future on-site indoor worker via inhalation of indoor vapors in a hypothetical on-site building. The site investigation area does not have any existing buildings. The HHRA evaluated petroleum-related chemicals (e.g., benzene, toluene, ethylbenzene, xylenes, and PAHs) at DU01 and found that the potential ELCR and non-cancer hazard results for the two workers were below the USEPA target ELCR level of 1E-04 and target HI of 1 per target organ endpoint.

With the exception of DU11 and DU12, the estimated ELCR and non-cancer hazard results for the non-residential receptors evaluated at Camp Hero were below the USEPA target ELCR and non-cancer hazard thresholds (i.e., 1E-04 and 1, respectively). The HHRA preliminary COCs at DU11 and DU12 caused the cumulative ELCR and HI estimates to exceed 1E-04 and/or a target organ-specific HI greater than 1, and are as follows:

- Benzo(a)pyrene was identified as a noncarcinogenic risk driver in surface soil at DU11 and the potential pathway of concern is direct contact with surface soil (i.e., incidental ingestion, dermal contact, and inhalation of particulates) for the future on-site construction worker. Exposure to benzo(a)pyrene in surface soil may produce adverse developmental health effects (i.e., target organ-specific HI of 2 exceeded the USEPA threshold of 1). Subsurface soil samples were not collected at DU11 because the PSE did not identify any COPCs in the subsurface soil; therefore, surface soil is the exposure medium of concern at DU11.

- Benzo(a)pyrene was identified as a noncarcinogenic risk driver in surface soil at DU12 and the potential pathways of concern are incidental ingestion and dermal contact with surface soil for the current on-site child recreational user. Exposure to benzo(a)pyrene in surface soil may produce adverse developmental health effects (i.e., target organ-specific HI of 2 exceeded the USEPA threshold of 1). The non-cancer hazard results for the total soil evaluation for the future on-site recreational user were below 1; therefore, surface soil is the exposure medium of concern at DU12.

- Total benzo(a)pyrene PAHs (total BaP PAHs) was identified as a carcinogenic risk driver in surface soil. The potential pathways of concern are incidental ingestion and dermal contact with surface soil for the current on-site recreational user (lifetime) with an ELCR of 3E-04, exceeding the USEPA threshold of 1E-04). The cancer risk results for the total soil evaluation for the future on-site recreational user were below 1E-04; therefore, surface soil is the exposure medium of concern at DU12.

The current and expected future land use of the park is recreational. However, the inclusion of a hypothetical future resident in the HHRA was used to conservatively evaluate UU/UE for future risk management decision-making should the land use change. The hypothetical on-site resident scenario was treated as the worst-case exposure scenario that may be exposed to all media and exposure pathways that were quantified for the other on-site receptors. The drinking water exposure pathway, however unlikely, was also quantitatively evaluated for the hypothetical on-site resident. A potability analysis was conducted for Camp Hero which revealed that the shallow perched groundwater was not suitable as a potable water source. The potential ELCR and non-cancer hazard results for the hypothetical on-site resident were provided in the HHRA for informational purposes only, and were not used to identify COCs requiring remediation based on unacceptable risk. Instead, the other current and future exposure scenarios were used as the basis for risk management determinations for the RI Report because they represent reasonable exposure scenarios (USEPA 1989). The hypothetical resident risk results are summarized below for informational purposes only:

- The well-by-well groundwater evaluation evaluated each monitoring well at Camp Hero as a potential drinking water source. The evaluation identified monitoring wells near DU01, DU08, DU11, DU14, and STB as having potential ELCR and/or non-cancer hazards above the USEPA thresholds. Metals, PAHs, SVOCs, and VOCs were the risk drivers for the drinking water exposure pathway.

- Separate HHRA risk calculations were conducted for the hypothetical resident. The potential ELCR and non-cancer hazard results for the hypothetical resident were above USEPA target risk thresholds at DU01, DU11, DU12, DU14, STB, and sitewide groundwater. Metals, PAHs, and VOCs were identified as the primary risk drivers in shallow groundwater due to the ingestion of groundwater as drinking water and vapor intrusion (inhalation of indoor vapors in a hypothetical residence) exposure pathways.

- Lead modeling results indicate that adverse health effects from exposure to lead in shallow groundwater at DU14 are possible for a hypothetical child resident, assuming the perched groundwater is used for drinking water.

- Total PAHs was identified as a primary risk driver for the hypothetical resident via incidental ingestion and dermal contact with sediment at DU10/SEA03 and DU15/SEA07. However, an additional statistical evaluation of sediment data was conducted to assess whether total PAHs from revetted/non-revetted locations were consistent with the revetted/non-revetted background datasets. The evaluation concluded that the PAH concentrations in sediment are not likely attributed to a CERCLA release.

A weight-of-evidence evaluation was conducted where the results of the risk characterization and uncertainty assessment were combined, to further weigh the HHRA risk results for the DSA risk evaluation, DU01, DU11, and DU12:

Data Sensitivity Analysis Risk Evaluation

The DSA ELCR estimates were in the 1E-06 range or lower. With the exception of the hypothetical on-site resident, the DSA HI estimates were roughly 1 to 2 orders of magnitude below 1. The results of the DSA evaluation indicate that the conclusions of the HHRA are not likely to change if the DSA HHRA results were added to the existing HHRA risk calculations.

DU01

The HHRA results for exposure to petroleum-related COPCs at DU01 were below the USEPA cancer and non-cancer target thresholds for the on-site non-residential exposure scenarios; the level of uncertainty associated with human health exposure to DU01 is reduced.

The hypothetical resident risk results at DU01 exceeded the USEPA cancer and non-cancer target thresholds due to exposure to shallow groundwater via drinking water, showering/bathing, and inhalation of vapors in indoor air in a hypothetical residence. The hypothetical residential scenario and his/her exposure to shallow groundwater at DU01 are considered to be incomplete.

The LNAPL identified at DU01 remains as a potential continuing source of petroleum-related chemical concentrations in shallow groundwater. A NYSDEC Pollution Complaint Number (PC-1602757) has been opened and the LNAPL will be addressed under the NYSDEC Spills Response Program in accordance with Article Twelve of the New York State Navigation Law. The RI has evaluated the NAPL stability, lack of recoverability, and evidence of active source depletion; these results will be taken into consideration when evaluating whether further action is required under the NYSDEC program. The level of uncertainty associated with human health exposure to LNAPL at DU01 is reduced.

DU01 was eliminated from further evaluation because the non-residential exposure scenarios were below USEPA cancer and non-cancer target thresholds and because there is an open NYSDEC Pollution Complaint Number (PC-1602757) for LNAPL at Building 203. DU01 will be addressed under the NYSDEC Spill Response Program in accordance with Article Twelve of the New York State Navigation Law.

DU11

Benzo(a)pyrene in surface soil was identified as a risk driver for the future on-site construction worker at DU11. The on-site construction worker is not a likely scenario at DU11 because NYSOPRHP has no plans for developing areas at or near DU11 for future camping grounds or hiking trails; DU11 is a wooded area with dense vegetation that is generally inaccessible to the public.

The surface soil EPC for benzo(a)pyrene was influenced by elevated concentrations in a single surface soil sample DU11-S003. For example, the benzo(a)pyrene concentration in the surface soil sample from DU11-S003 is 180 mg/kg and the remaining surface soil detections for benzo(a)pyrene ranged from 0.031 mg/kg to 1.7 mg/kg. The benzo(a)pyrene EPC (based on the UCL of the mean concentration) was 123.3 mg/kg, which is well above the majority of the measured concentrations.

The likelihood of an on-site construction worker spending 125 days out of the year for 8 hours each day at the DU11-S003 sample location would be quite low. Since NYSOPRHP has no plans for future development at DU11, the future on-site construction worker scenario is unlikely.

The Phase I biased subsurface soil data was examined because the future on-site construction worker is more apt to be exposed to total soil (0 to 10 feet below ground surface) while excavating the area for future land redevelopment. The Phase I biased subsurface soil sample concentrations of benzo(a)pyrene ranged from 0.00071 mg/kg to 7 mg/kg. The PSE did not identify any subsurface soil COPCs for DU11 and therefore subsurface soil was not evaluated in the Phase III investigation.

The maximum subsurface soil concentration of 7 mg/kg benzo(a)pyrene was used to estimate risk to the on-site construction worker in combination with groundwater and sediment media at DU11; the cumulative non-cancer hazard index (HI) was 0.3 which was below the USEPA threshold of 1.

Also, chronic toxicity values for benzo(a)pyrene were used to estimate non-cancer health effects because subchronic toxicity values were not available.

The HHRA uncertainty assessment concluded that the non-cancer cumulative HI of 3 for the future on-site construction worker at DU11 was likely overestimated.

The HHRA uncertainty assessment concluded, based on the lines of evidence presented above, that the non-cancer cumulative HI of 3 for the future on-site construction worker at DU11 was likely overestimated. In addition, a review of the PAH ratios for the DU11-S003 sample indicated that the sample is pyrogenic and may represent creosote or coal tar which would not be associated with a CERCLA release (Appendix C5 of the RI Report).

Following the weight-of-evidence evaluation outlined above, benzo(a)pyrene was eliminated as a potential surface soil COC at DU11.

DU12

Benzo(a)pyrene and total BaP PAHs in surface soil were identified as the primary risk drivers for the current on-site recreational user scenario. The HHRA assumed that the recreational user would spend 100 days per year for 26 years at DU12 for recreational activities (e.g., camping, hiking, wading in streams, etc.). The results are likely biased high because NYSOPRHP has no plans for developing areas near or at DU12 for future camping grounds or hiking trails and no camping grounds are nearby DU12, so the recreational user is less likely to spend much time there.

The Camp Hero background evaluation (Appendix L1 of the RI Report) identified concentrations of benzo(a)pyrene and total BaP PAHs in surface soil as being above background concentration.

Three of the 16 surface soil benzo(a)pyrene concentrations at DU12 were above 100 mg/kg (ranging from 110 mg/kg to 150 mg/kg) at sample locations DU12-S001, DU12-S004, and DU12-S008. The remaining surface soil sample results ranged from 0.043 mg/kg to 77 mg/kg.

Coast Artillery Road runs through the middle of DU12. The southern portion of DU12 has a concrete foundation and the northern portion of DU12 contains a park maintenance area with piled brush (partially fenced but usually open).

A former Fueling Station (former Building 36) was previously located to the northwest of DU12. The historical records associated with the former Fueling Station were reviewed during the records review phase of the RI. The USTs associated with the former Building 36 (USTs 24A, 24B, and 25) had an associated NYSDEC spill report, 93-09098, dated 25 October 1993. The spill report was closed later in 1993 with a NYSDEC-Region 1 Tank Removal Report. The USTs/the former fueling station was not investigated during the Phase I RI field program as an AOC because NFA was required by NYSDEC (there were no COCs above regulatory action levels). Although the fueling station was not specifically investigated in this RI, a potential fuel release from the station was considered as a possible source for the high concentrations of PAHs detected within DU12 near the former fueling station. However, the PAH source evaluation conducted as part of this additional characterization of PAHs (refer to Section 6.0) indicated the PAHs at DU12 were likely pyrogenic in source, which indicates the source is likely not related to a fuel spill from former Building 36.

Given the lack of other potential point-sources within DU12 and the proximity of the roadway to the most elevated PAH concentrations, the most likely sources of PAHs in surface soil at DU12 are expected to be vehicle exhaust and emissions, weathering of asphalt roads and tires, coal tar (potentially used as roadway seal coating), and ongoing asphalt road maintenance. Also, the soil boring logs for DU12 (Appendix I of the RI Report) indicate evidence of demolished asphalt parking lot materials (black coloring, concrete fragments, tar, and pulverized brick).

Following the weight-of-evidence evaluation, total benzo(a)pyrene and BaP PAHs were eliminated potential surface soil COCs in the HHRA. The additional characterization of PAHs evaluation (Appendix C5 of the RI Report) indicated that the PAHs in surface soil at DU12 could not be attributed to CERCLA release.

In conclusion, the HHRA results did not identify any chemicals that required further evaluation in the RI. **Table 8-1** summarizes the recommended path forward for each DU and SEA. Although the HHRA indicated potential risks could be posed to receptors from PAHs in surface soil at DU11 and DU12, the lines of evidence indicated that the risk results for both DUs were likely overestimated. Also, the DU11 surface soil results were driven by one elevated concentration which may represent creosote or coal tar and therefore not attributed to a CERCLA release. Further characterization of PAHs in surface soil at DU12 indicate that the concentrations were not likely attributed to a CERCLA release. Therefore, no further assessment or response action is warranted for the investigation areas at Camp Hero under the CERCLA program.

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