DECOMMISSIONING PLAN

Revision 4

Former Carnotite Reduction Company Site
434 East 26th Street
Chicago, Illinois 60616

Prepared by

Tetra Tech, Inc.
1 South Wacker Drive, 37th Floor
Chicago, IL 60606

Prepared for

City of Chicago,
Department of Assets, Information and Services
30 North LaSalle, Suite 300
Chicago, IL 60602

April 2020

TABLE OF CONTENTS

Section **Page**

TABLES

FIGURES

ATTACHMENT

ACRONYMS AND ABBREVIATIONS

μCi/ml	MicroCuries per milliliter
2FM	Chicago Department of Fleet and Facility Management
AIS	Chicago Department of Assets, Information and Services
ALARA	As low as reasonably achievable
bgs	Below ground surface
BOC	Biochemical oxygen demand
CDOT	Chicago Department of Transportation
CFR	Code of Federal Regulations
COC	Contaminant of concern
cpm	Counts per minute
cps	Counts per second
DOE	Department of Environment
EMP	Environmental monitoring plan
EOX	Extractable organic halides
EPA	U.S. Environmental Protection Agency
ESA	Environmental site assessment
FAL	Field action level
FIDLER	Field Instrument for Detecting Low Energy Radiation
gpm	Gallons per minute
GPS	Global positioning system
HASP/RPP	Health and safety plan and radiation protection plan
IAC	Illinois Administrative Code
IDPH	Illinois Department of Public Health
IDW	Investigation-derived waste
IEMA	Illinois Emergency Management Agency
MG	Million gallons
micro-rem/hr	Microrems per hour
mL	Milliliter
mrad/hr	Millirad per hour
MSL	Mean seal level
MWRDGC	Metropolitan Water Reclamation District of Greater Chicago
NaI	Sodium iodide
NRC	U.S. Nuclear Regulatory Commission
OFSM	Office of State Fire Marshal

OSL	Optically stimulated luminescence
PBC	Public Building Commission
PCB	Polychlorinated biphenyl
PCC	Portland cement concrete
pCI/g	PicoCuries per gram
pCi/L	PicoCuries per liter
PPE	Personal protective equipment
ppm	Parts per million
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality Control
Ra-226	Radium 226
Ra-228	Radium 228
RCA	Radiological control area
REC	Recognized environmental condition
RESRAD	RESidual RADioactivity
RSO	Radiation safety officer
SVOC	Semivolatile organic compound
TACO	Tiered approach to corrective action objectives
TCLP	Toxicity characteristic leaching procedure
TENORM	Technologically enhanced naturally occurring radioactive material
Th-230	Thorium 230
UST	Underground storage tank
U-234	Uranium-234
U-235	Uranium-235
U-238	Uranium-238
VOC	Volatile organic compound

1.0 INTRODUCTION

Tetra Tech, Inc. (Tetra Tech) has prepared this decommissioning plan on behalf of the City of Chicago, Department of Assets, Information and Services (AIS) (formerly the Department of Fleet and Facility Management [2FM]) for the former Carnotite Reduction Company (Carnotite) site in Chicago, Illinois. This report was prepared under Task Order Request 14-2FMEHS-00018 (2FM 2015a) in accordance with radioactive materials license number IL-02467-01 issued by the Illinois Emergency Management Agency (IEMA) (IEMA 2016). This revision of the decommissioning plan addresses IEMA's comments on the previous versions of the plan, includes additional investigations conducted since the previous submittal in February 2020, and reflects the current remediation plans and specifications (IEMA 2018c, 2019a, and 2020).

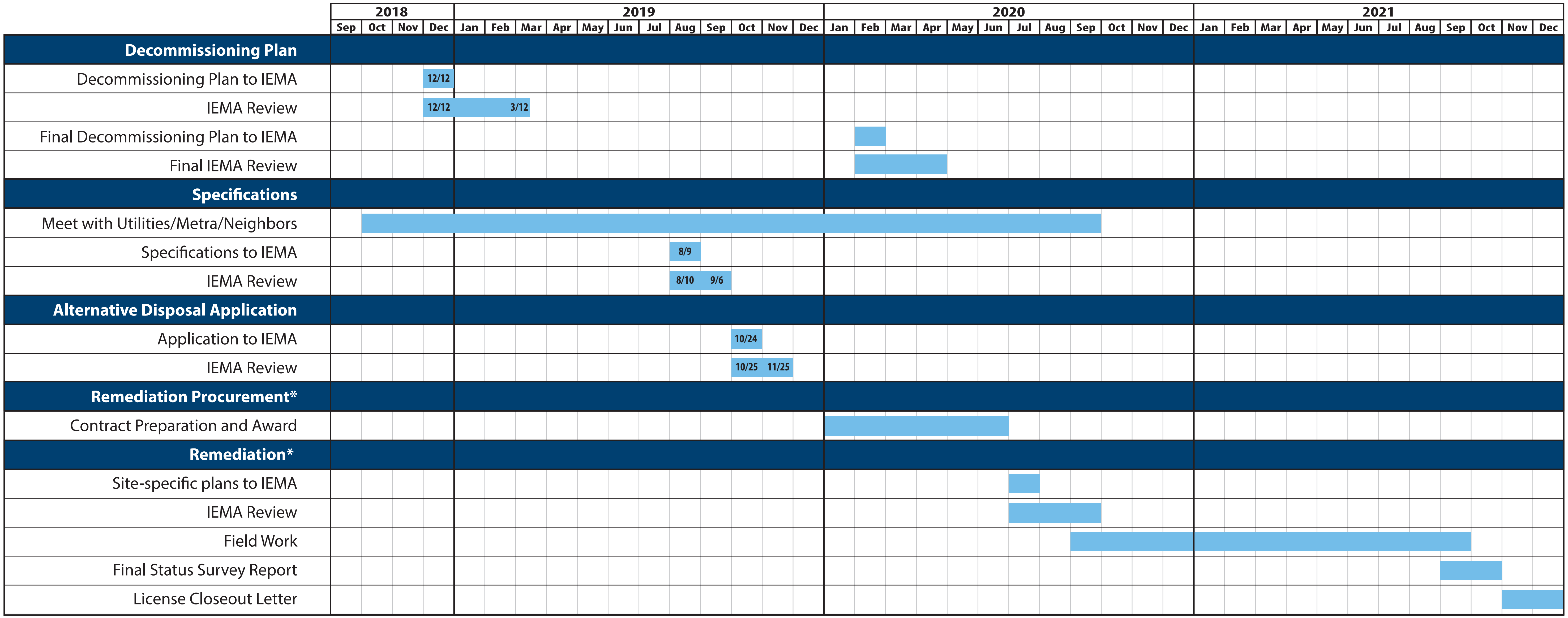
The decommissioning plan's primary purpose is to define procedures required to meet license termination requirements outlined in the Carnotite radioactive materials license, 32 *Illinois Administrative Code* (IAC) 330.325, and IEMA's "Decommissioning Guidance for Radioactive Materials Licensees" (IEMA 2007). The decommissioning activities at the Carnotite site require a decommissioning plan because loose form radioactive material (radium, uranium, and thorium) that is not listed in 32 IAC 330 Appendix B, Exempt Quantities exists at the site (IEMA 2007). Radioactive material at the site consists of soil contamination resulting from former radium separation and refining operations, which processed carnotite uranium ore at the site. Site-specific contaminants of concern (COC) include radium-226 (Ra-226), uranium (U-234, -235, and -238), and thorium (Th-230), a long-lived daughter of U-234 and -238. As a result, soil remediation is required for license termination. Soil remediation criteria are outlined by IEMA in the current Carnotite radioactive materials license. The site-specific soil remediation criteria are:

- Radium-226 - 5.9 picocuries per gram (pCi/g)
- Total uranium (U-234, U-235, and U-238) – 22 pCi/g to 5 meters and 52 pCi/g below 5 meters
- Thorium-230 – 5.5 pCi/g

COCs have not been detected above site-specific screening levels in other media including groundwater, sewer water, or sewer sediment. Therefore, this remediation planning document focuses on soil remediation and presents a framework for decommissioning.

AIS will prepare remedial design plans and specifications in accordance with this decommissioning plan for bidding. After project bidding and award, the remediation oversight contractor will submit relevant project plans, such as a field sampling plan, quality assurance project plan, and health and safety and radiation protection plan, among others, to IEMA for review and approval. Also, the excavation, transportation, and disposal contractor will submit plans and documentation as required in the bid specifications for IEMA approval, including but not limited to a work plan, construction quality control plan, traffic control plan, transportation and disposal plan, environmental protection plan, and site-specific health and safety and radiation protection plan. These plans will include site remediation details, including those regarding stockpile management, haul road management, and dust control. Upon IEMA's approval, remediation construction and subsequent reporting will be conducted. An approximate decommissioning timeline is presented in Table 1. The timeline may be revised as bidding and construction timing is dependent on the City's budget appropriation.

This decommissioning plan includes a description of site background (Section 2), nature and extent of contamination (Section 3), project objective (Section 4), project management and organization (Section 5), remediation strategy and estimated costs (Section 6), field sampling activities (Section 7), laboratory analytical methods (Section 8), decontamination procedures (Section 9), disposal of investigation-derived waste (Section 10), health and safety procedures (Section 11), quality assurance and quality control requirements (Section 12), site coordination (Section 13), and references (Section 14). Table 3 and Figures appear following Section 14.



***Notes:** Contracting and construction timing is dependent on the City's procurement process and budget appropriation. Draft Decommissioning Plan submitted to IEMA on June 29, 2018 and Pre-Design Investigation completed in July 2018 (see Draft Decommissioning Plan for detailed schedule).

FORMER CARNOTITE REDUCTION COMPANY SITE
434 E. 26th STREET
CHICAGO, ILLINOIS

TABLE 1
DECOMMISSIONING TIMELINE

TETRA TECH

2.0 SITE BACKGROUND

From about 1916 to 1921, Carnotite operated an elemental radium separation and refining facility on the site at 2600 S. Inglehart Place, a street that no longer exists (HBK Engineering, LLC [HBK] 2012). Carnotite operations were near what is now 434 E. 26th Street, Chicago, Illinois. This property later became part of the land occupied by the former Michael Reese Hospital. In 1979, the State of Illinois Department of Health, Division of Radiological Health, in cooperation with the U.S. Environmental Protection Agency (EPA), conducted a radiological surface survey of part of the Michael Reese property and identified several areas of elevated radioactivity. State personnel concluded that the contamination did not pose an immediate health hazard but should be considered prior to any future construction. In September 2008, the owner of Michael Reese filed a petition for bankruptcy protection in the U.S. Bankruptcy Court for the Northern District of Illinois. Anticipating selection of Chicago as host of the 2016 Olympic Games, the City of Chicago purchased the 37-acre former Michael Reese property in June 2009. The city planned to develop the property as the site of the Olympic Village. In August 2009, IEMA conducted a gamma surface survey, observed gamma activity, and recommended to the City of Chicago further investigation of gamma activity prior to invasive construction work (AECOM Technical Services, Inc. [AECOM] 2011a). In December 2009, U.S. Environmental Protection Agency (EPA) conducted a surface gamma survey at the site and confirmed elevated surficial gamma activity (EPA 2009). In June 2012, subsurface investigations confirmed elevated levels of radium and uranium in subsurface soil (AECOM 2012a). In October 2013, at the City of Chicago’s request, the IEMA Division of Nuclear Safety was determined to be the lead regulatory agency for the site (former Michael Reese Site) (2FM 2013); pursuant to this determination, AIS obtained a radioactive material storage license from IEMA in 2015 (see Section 2.4).

2.1 SITE DESCRIPTION

The site is located at 434 East 26th Street on the northern portion of the former Michael Reese Hospital campus in Chicago, Cook County, Illinois and is 0.25 mile west of Lake Michigan and 1.20 miles southeast of the Chicago River (see Figure 1). The site is currently owned by the City of Chicago. The site boundary is defined by the radioactive material license and is based on property boundaries to the north, east, southwest, and west. The southernmost site boundary is based on results of prior investigations that did not identify radioactive contamination above background levels south of the current boundary (AECOM 2013 and 2014; Tetra Tech 2018a). The 7-acre site is bordered to the north by the former Advocate Health Center (currently vacant), east by the Metra South Shore rail line, south by vacant property and residential property, and west by Dr. Martin Luther King, Jr. Drive and residential property across South Dr. Martin Luther King Jr. Drive (Figure 2). Ra-226, uranium, and Th-230 contamination is present within the central and western portions of the site, believed to have resulted from Carnotite’s refining operations in the early 1900s. Based on results of previous investigations at the site, including surficial gamma surveys, down-hole gamma logging, and analyses of soil samples, the estimated extent of radiological contamination is limited to the central, western, and southern portions of the site (see Figure 3). Most impacted material is limited to the top 5 feet below ground surface (bgs). However, contamination extends to at least 14 feet bgs within the northwest portion of the site (AECOM 2012a; Tetra Tech 2019a).

Most of the western portion of the site is vegetated and consists of an open field (formerly a baseball field) with some trees. The south-central portion of the site is paved and consists of a former basketball court and tennis courts. The eastern and northern portions of the site are paved with a concrete slab and asphalt parking lot remaining from former Michael Reese Hospital campus Building No. 1. The site is split into northwestern and southeastern sections by East 26th Street and South Ellis Avenue. East 26th Street enters the site near the northwestern corner of the site. East 26th Street then traverses the site, eventually becoming South Ellis Avenue. South Ellis Avenue exits the south-central portion of the site and extends south to the intersection of South Ellis Avenue and 27th Street (see Figure 2). A fence surrounds both the northeastern and southwestern portions of the site. East 26th Street and South Ellis Avenue remain open to public pedestrian traffic as access to the Metra Electric District line 27th Street station.

Borings advanced by AECOM during a subsurface investigation identified three distinct soil/fill types underlying the Carnotite site. The first type was demolition debris apparently used to fill historical foundations that predate construction of Michael Reese Hospital. This demolition material consisted of sand, gravel, and concrete with traces of brick and cinders. The second type was brown to black fill soil that ranged from a fine to medium sand to silty clay and contained minor amounts of gravel and cinders. The third soil type, a native tan to brown fine sand, was encountered in most of the borings. The native sand was typically encountered at a depth of 4 to 6 feet bgs but at deeper depths where historical foundations were present. An exception is in the vicinity of the tennis courts where native sand was not encountered within the first 12 feet, the maximum depth of the borings. Subsequent investigation of other areas of the former Michael Reese Hospital complex, mostly outside the Carnotite site boundary, found the same three soil/fill types at similar depths (AECOM 2012a and 2014). During the 2018 pre-design investigation, subsurface observations were consistent with previous investigations. However, in the tennis court area, native sand was observed between 10 and 14 feet bgs (Tetra Tech 2018a).

Regional geology generally consists of unconsolidated glacial deposits about 50 feet thick overlying Silurian bedrock. Unconsolidated glacial deposits include the Chicago Lake Plain sediments and the Wadsworth Till Member—a clayey gray till. The Wadsworth Till Member is a glacial till and a part of the Wedron Formation. In the Chicago area, the upper alluvium consists of undisturbed Chicago Lake Plain sediments that are primarily fine-grained silt and clay. At the site, urban fill and lake-bottom sand was observed to approximately 30 feet bgs. Underlying clay was identified at a depth of between 25 and 30 feet bgs, which may be the Wadsworth Till Member (CH2MHILL 2008).

Four major groundwater aquifers are recognized in northeastern Illinois. From uppermost to lowermost, aquifers include the Pleistocene glacial drift (shallow) aquifer, Silurian dolomite aquifer, Cambro-Ordovician aquifer, and Cambrian Mt. Simon sandstone aquifer. Historical site information indicates that shallow groundwater generally flows northeast toward Lake Michigan. Unless disturbed or breached, the native clay underlying the shallow fill and sandy lake deposits forms an effective aquitard that inhibits vertical migration of shallow groundwater into units below the clay. Monitoring well water levels measured during May 5 to 7, 2008, indicate an easterly flow direction toward Lake Michigan in the shallow aquifer. Saturated conditions in the Phase II borings were generally encountered between 6 and 12 feet bgs across the site, indicating presence of a continuous groundwater unit within the sandy geologic material (CH2MHILL 2008).

Well records from the Illinois State Geological Survey identify 28 registered groundwater wells within a 1-mile radius of the site. Most of these wells are screened in Silurian bedrock from 70 to 1,937 feet bgs (EDI 2009). However, these wells are believed to be inactive because the City of Chicago Department of Water Management supplies drinking water from Lake Michigan to the City of Chicago and City of Chicago municipal code Chapter 11-8 prohibits installation of potable water supply wells.

Natural surface drainage patterns at the site have been altered by construction and demolition activities. Ground surface elevations range from 591 feet above mean sea level (MSL) near the southeast corner of the site to 600 feet above MSL near the center of the site. Overland flow is minimal because of the relatively flat topography and water will flow into existing sewers. Flooding is not expected at the site, as the site is not within 100-year or 500-year floodplains (EDI 2009).

2.2 SITE HISTORY

From about 1916 to 1921, Carnotite operated an elemental radium separation and refining facility at the site. Based on a 1911 Sanborn map, Conrad Seipp Brewing Company occupied the site area prior to Carnotite operations (EDI 2008). The time-period of Carnotite's operation was apparently not covered by available historical records; therefore, the Carnotite site was not identified during previous Phase I and II environmental site assessments (ESAs) (EDI 2008 and 2009; CH2MHILL 2008).

During Carnotite operations, uranium ore "carnotite" was likely the primary raw material from which radium was extracted and concentrated. Although the carnotite was relatively rich in uranium, large amounts of ore were required to produce relatively small amounts of radium. Most radium production sites in the early 1900s produced only a few grams of radium each year. However, production of a few grams would have required processing hundreds of tons of uranium ore. The separation methods used to isolate radium also concentrated uranium from the origin ore during the radium recovery process. Based on historical U.S. Patent Office documents, Carnotite radium recovery operations included rotating the carnotite ore in drums or barrels to gravity-separate the heavier radioactive constituents, followed by treatment of concentrated (separated) ore with an aqueous solution of sulfuric and hydrochloric acids. Addition of sulfuric acid facilitated formation of barium and radium sulfates, which remained insoluble during the treatment process, further concentrated radium as precipitates. The mixture was dried and baked at 250 degrees Celsius to drive off the water. The resultant “green slime” was further treated with a dilute solution of hydrofluoric acid and water to further concentrate the radium sulfate. An estimated 20 pounds of material containing radium, which was further refined, was produced from 1 ton of carnotite ore (U.S. Patent Office 1916 and 1919). Because radium was the primary product, the extracted uranium would likely have become a waste. As a result, COCs include both residual radium and uranium, as well as Th-230, a long-lived daughter product of U-238.

2.3 FORMER SITE INVESTIGATIONS

Previous Phase I and Phase II ESAs documented non-radiological contamination at the site; however, this decommissioning plan focuses on the radioactive COCs in environmental media. Previous radiological site investigations discussed below have documented elevated gamma readings in surface and subsurface soil, as well as elevated levels of radium and uranium in subsurface soil. Previous investigations have also been conducted to delineate the extent of contamination at the site.

Phase I and II ESAs

On August 8, 2008, Environmental Design International, Inc. (EDI) submitted a Phase I ESA Update Report to CH2M HILL regarding the facility described as the Michael Reese Hospital and Medical Center, which included the site. This assessment revealed evidence of recognized environmental conditions (REC) on the former Michael Reese Hospital facility. EDI also identified data gaps in historical information regarding the facility, particularly during the period of 1912 through 1949, and during the 1950s, 1960s, and early 1970s (EDI 2008).

On August 8, 2008, CH2M HILL prepared a Phase II ESA Report regarding the facility described as the Michael Reese Hospital site, which included the site. Field work occurred in two phases—from May 5 to 14, 2008 (Phase IIa), and from June 12 to 13, 2008 (Phase IIb). A total of 127 soil samples and 53 groundwater samples were collected for laboratory analysis during the two field efforts. Broad spectrum chemical analyses of the soil and groundwater samples occurred for volatile organic compounds (VOC), semivolatile organic compounds (SVOC), pesticides, polychlorinated biphenyls (PCB), and metals. Approximately 58 percent of the soil samples collected at the site and nearby areas contained contaminant concentrations exceeding one or more Tiered Approach to Cleanup Objectives (TACO) Tier 1 residential criteria. An evaluation of the groundwater data acquired at the site documented TACO Tier 1, Class I groundwater criteria exceedances by concentrations of lead, arsenic, chromium, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, indeno(123-cd)pyrene, and chloroform. Approximately 75 percent of the groundwater samples collected at the site contained contaminant concentrations exceeding one or more TACO Tier 1 residential criteria, principally lead concentrations (C2HM HILL 2008).

On June 26, 2009, EDI submitted a Phase I ESA Update Report regarding the facility described as the Michael Reese Hospital and Medical Center, which included the site. The updated Phase I ESA Report included addition of recognized environmental conditions (RECs) per conclusions and results from the Phase II ESA completed by C2HM HILL on August 8, 2008, and information obtained from the Office of the Illinois State Fire Marshal (OSFM) indicating that OSFM had issued a notice of violation to the facility regarding eight underground storage tanks (USTs) associated with the facility (EDI 2009).

Radiological Site Investigations

IEMA visited the former Michael Reese Hospital to close out radiological licenses at the former hospital and to scan the former hospital buildings. Through a records review, IEMA discovered a letter regarding a 1979 gamma survey related to the former Carnotite site. On August 12, 2009, IEMA conducted a gamma surface survey of the site area. On August 18, 2009, in a letter to the City of Chicago Department of Environment (DOE), IEMA indicated that the observed gamma readings did not pose an immediate health risk, but recommended additional characterization prior to invasive construction activities at the site (AECOM 2011a and 2014).

On December 11, 2009, EPA conducted a gamma surface survey of the site and confirmed presence of elevated surficial gamma activity. EPA provided DOE an aerial image depicting a color-coded data point overlay of the surface gamma readings, but gamma reading values were not provided (EPA 2009).

DOE evaluated historical documents to assess development of the site that took place during the early 1900s. DOE determined that Carnotite had operated on site from about 1916 until 1921. It was purchased by Tungsten Products Company (Boulder, Colorado) when Carnotite went out of business in 1920. Tungsten Products Company had recently merged with the Radium Company of Colorado. Information on Tungsten Products or the Radium Company after 1926 could not be found. On March 14, 1979, the Illinois Department of Public Health (IDPH), Division of Radiological Health (a predecessor organization to IEMA), in cooperation with EPA, surveyed the area of what was thought to be the site. Most of the site at that time was part of the Michael Reese Medical Center. Radiation levels were found relatively low, and because of the depth of the radioactive material and the geographical location, IDPH determined that no immediate health hazard was apparent (IDPH 1979).

On January 26, 2011, AECOM completed an interior radiological survey of Building No. 1 and provided a letter report to the Chicago Public Building Commission (PBC) titled “Interior Radiological Survey Results for Building No. 1 – Former Carnotite Reduction Company Investigation.” The investigation area consisted of a large building within the northeast portion of the site (former Building No. 1) that was part of the former Michael Reese Hospital complex. AECOM had conducted the gamma surface survey using Ludlum Model 2221 meters and unshielded 2- x 2-inch sodium iodide (NaI) probes (Model 44-10). Field instrumentation background for the interior slab of approximately 5,150 counts per minute (cpm) was established based on six readings taken within the building and away from the exterior walls. Maximum readings from the floor slab survey grids ranged from 4,800 to 9,300 cpm. The southwest corner of the building was not surveyed because of debris/conditions limited access. In addition to the main building area, the concrete slab within the covered walkway extending south from the southeast corner of the building was also surveyed on December 13, 2010. Gamma readings did not indicate elevated conditions, and results (grid maximums) ranged from 6,100 to 7,200 cpm. Thus, the interior floor surveys did not indicate elevated gamma readings of radiologically-impacted soil beneath the concrete slabs. Based on the survey results, AECOM determined that a radiological exposure issue for the public and construction workers did not exist, if the pavement remained appreciably intact and soil beneath the slab was not exposed. The recommendation was based on several similar projects where known radiological impacts had existed beneath paved surfaces in public areas (parking lots), but EPA had allowed continued use of the areas if the paved surface was maintained (AECOM 2011a).

On February 8, 2011, AECOM completed a radiological surface gamma survey and provided a letter report to the PBC titled “Radiological Surface Gamma Survey Results – Former Carnotite Reduction Company Investigation.” The investigation area included grassy areas and paved surfaces, as well as Building No. 1 that was part of the former Michael Reese Hospital complex but based on its year of construction (1948), was not associated with Carnotite. The surface gamma survey utilized a Ludlum 2221 rater-scaler with an unshielded 2- x 2-inch NaI probe. Surface readings were recorded continuously and logged at a minimum of every 2 seconds along with Global Positioning System (GPS) coordinates as the operator traversed the investigation area. The individual traverses were spaced approximately 3 feet apart and generally parallel to the boundaries of the screening area. The field instrumentation surface gamma background value was calculated to be approximately 4,050 cpm for paved surfaces and 6,815 cpm for soil or grassed areas. Because cleanup criteria and an equivalent field instrumentation threshold had not been established for the site, elevated gamma readings were defined as readings exceeding twice background. Based on the benchmark of twice the paved background value (8,100 cpm), the results indicated that much of the investigation area (predominantly the southern and eastern portions) was not radiologically impacted. The surface gamma survey encountered elevated gamma readings in the northwest portion of the investigation area adjacent to and likely beneath East 26th Street (see Figure 3). Peak gamma responses exceeded 90,000 cpm within an area west of the former Building No. 1 and near the East 26th Street curb line. The results indicated that the paved road surface was likely providing significant shielding, and the radiologically impacted soil likely extended into or was contiguous beneath the street. The areas of elevated gamma response were generally consistent with results of previous smaller scale surface gamma studies by IEMA and EPA (AECOM 2011b).

In June 2012, EPA conducted a radiological surface gamma survey of the site and of properties near the site (readings were in counts per second [cps] instead of cpm). Three figures were provided—aerial images of the site and the site area. The figures included color-coded point data overlays of the surface gamma readings. The highest total gamma cps survey readings were encountered along 26th Street, particularly in the northwest portion of the site and at the northern edge of the tennis courts (EPA 2012a).

On June 11, 2012, AECOM completed a down-hole gamma survey of the site and submitted a final report titled “Subsurface Gamma Screening Results (Final) – Former Carnotite Reduction Company” to the PBC. The down-hole surveys utilized a Ludlum 2221 rater-scaler with a 0.5- by 1-inch NaI probe Model 44-62 that was equipped with a 1-inch lead end-cap. The purpose of the lead end-cap was to shield gamma radiation from below the probe so that depth-specific results could be obtained. A Geoprobe rig was utilized to advance the boreholes and collect samples for radioisotope analyses. A total of 215 borings were advanced, logged, and position-located by use of GPS instrumentation. Down-hole gamma readings ranged from below 1,000 cpm to over 230,000 cpm. In general, native sand was encountered at about 6 feet bgs, but at greater depths where historical foundations were present. A total of 58 soil samples were selected for gamma spectroscopy analysis. A balance of clean and impacted surface samples (0 to 2 feet bgs) were selected, as well as a group of subsurface samples that had exhibited a range of gamma counts. In the 58 samples analyzed at the laboratory via gamma spectroscopy, total uranium activity ranged from non-detect to 3,670 pCi/g, and total radium activity ranged from 0.85 to 1,181 pCi/g (AECOM 2012a).

On October 22, 2012, AECOM completed a radiological surface surveillance for demolition operations of Building No. 1, and provided a letter report to the PBC titled “Radiological Surface Surveillance of Demolition Operations for Building No. 1 – Former Carnotite Reduction Company Investigation.” AECOM applied the same methods described in the “Radiological Surface Gamma Survey Results – Former Carnotite Reduction Company Investigation” letter report to conduct ground surface gamma surveys. Field gamma measurements reported during radiological surveying prior to and during demolition of Building No. 1 did not exceed the “twice-background” threshold limits previously cited, and ranged from 7,800 to 13,700 cpm unshielded. Thus, no radiologically contaminated material was indicated (AECOM 2012b).

On October 31, 2012, AECOM completed a surface gamma survey and provided a letter report to the PBC titled “Draft-Radiological Surface Gamma Survey Results - Former Michael Reese Hospital site.” The September 2012 investigation area included South Vernon and South Ellis Avenues north of East 29th Street, as well as a flat, grass-covered area west of South Ellis Avenue, which is south of the site. AECOM applied the same methods as prior investigations to conduct ground surface gamma surveys. Results of the September 2012 survey within the paved areas did not indicate gamma readings greater than twice background. Gamma readings within the vegetated or soil covered surfaces were all less than 13,000 cpm— less than twice the background value for these surfaces. Thus, gamma readings taken during the September 2012 survey did not indicate surface or near-surface radiological contamination (AECOM 2012c).

On February 1, 2013, Prairie Shores Apartments (Prairie Shores) submitted a letter to IEMA regarding radiological surveys of the apartment buildings and grounds. Prairie Shores is south/southwest of the site. At Prairie Shores, RSSI had conducted short- and long-term radon monitoring utilizing alpha track radon monitors, surface radiation surveys by use of a Ludlum Model 44-10 side-shielded probes connected to Ludlum 193 alarming rate meters, and dose rate surveys utilizing Health Physics Instrument Model 1010 tissue-equivalent dose-rate meters. Short-term radon monitoring detected radon from below 0.3 to 1.7 pCi/L (picocuries per liter). Long-term radon monitoring detected radon from 0.8 to 2.9 pCi/L. Surface radium survey readings did not exceed 2,000 cpm except for a range from 6,000 to 8,000 cpm within a localized area adjacent to the base of a freestanding brick wall at the east edge of the parking lot east of Vernon Avenue and opposite Prairie Shores Building 3. The background dose rate at Prairie Shores was measured at approximately 0.006 millirad per hour (mrad/hr). Dose rates exceeded background only at the east and west base of the brick wall (ranging from 0.014 to 0.026 mrad/hr), with surface radium survey readings of 6,000 to 8,000 cpm. Dose rates ranged from 0.008 to 0.014 mrad/hr at three other locations, including a green space between the west side of Prairie Shores building and South Dr. Martin Luther King Jr. Drive, a localized area on unpaved land north of Prairie Shores Building 5 parking lot, and two localized areas of the paved circular drive north of Prairie Shores Building 4. Based on the results and health-based standards applied by IEMA, Prairie Shores concluded that no actionable public health risk existed on the Prairie Shores property due to radiological contamination associated with the site. Prairie Shores requested a review of the results by IEMA to confirm absence of actionable public health risk to determine if IEMA would recommend remediation of two discrete areas of contamination and if IEMA would consider release of the Prairie Shores property for unrestricted use (Prairie Shores 2013).

On March 4, 2013, IEMA responded to the Prairie Shores “Prairie Shores Apartments – Radiological Investigations” letter report. IEMA concurred with the methodology utilized by RSSI to conduct the cursory site investigation. IEMA suggested both near surface and subsurface soil sampling investigations, combined with down-hole gamma surveys, to fully characterize and delineate the lateral and vertical extent of possible contamination. IEMA recommended analyses of samples for total radium and total uranium. IEMA stated that without data further characterizing the Prairie Shores property, a public health risk related to possibly present radiological contamination at the Prairie Shores property could not be confirmed or refuted (IEMA 2013).

On May 23, 2013, EPA submitted a letter to the City of Chicago Department of Law, Aviation, Environmental, Regulatory & Contracts Division that conveyed a cost estimate for cleanup of the site to the City of Chicago. EPA had prepared a rough draft, order of magnitude cost estimate for cleanup of certain environmental contamination on the property. EPA based the estimate on cleanup of likely COCs including arsenic, lead, radium, and uranium, and cleanup criteria of 13.1 parts per million (ppm), 400 ppm, 7.1 pCi/g, and 20 pCi/g, respectively. EPA also incorporated boring data acquired by AECOM, and assumed GPS positions of elevated areas, programmable heavy equipment using GPS readings to direct work, and transport radioactively contaminated material to properly licensed disposal facilities in compliance with EPA off-site policies. Without an exact volume of contaminated soils determined, EPA's preliminary estimate indicated a cost of approximately $23 million to conduct cleanup work (EPA 2013).

On June 28, 2013, AECOM submitted a letter report to AIS titled "Radiological Surface Gamma and Dose Rate Survey Results – Former Michael Reese Hospital Site." At the time of the report, the former Michael Reese Hospital facility, which included the site, was covered primarily by vegetation/soil, gravel/crushed concrete surfaces, and paved surfaces (streets and sidewalks). In April 2013, AIS authorized AECOM to conduct a similar surface gamma survey east of S. Vernon and S. Ellis Avenues, north of E. 29th Street, south of E.27th Street, and west of the Metra rail corridor. AECOM applied the same methods described in the "Radiological Surface Gamma Survey Results – Former Carnotite Reduction Company Investigation" letter report to conduct ground surface gamma surveys. The twice background value for the paved areas slightly exceeded 10,068 cpm. Results from both the September 2012 and April 2013 surveys of the paved areas did not indicate gamma readings greater than twice background. Gamma readings from the vegetated or soil-covered surfaces were less than 13,000 cpm and substantially less than twice the background value for these surfaces. Thus, gamma readings taken during the September 2012 and April 2013 surveys did not indicate surface or near-surface radiological contamination. A primary goal of the September 2012 and April 2013 surface surveys was to determine if radiological contamination could result in potential human health exposure issue. Survey results did not indicate radiological contamination at or in the near surface soil of the investigation area. Therefore, no radiological concern with surface soil in the survey areas was indicated. This report noted that limitations of Ludlum instrumentation surveys, especially shielding effects, restrict the surface gamma screening technique to the upper 1.5 feet of soil and 1 foot or less of paved areas. Thus, conclusions regarding absence of radiological contamination should not be extrapolated to soil beneath pavement or to depths exceeding 1.5 feet below unpaved surfaces. Dose rates were measured by use of a Bicron MicroRem meter. Dose rate results within areas outside of the area of known contamination ranged from 3 to 7 micro rems per hour (micro-rem/hr) at the surface and appeared to be at background levels for the surveyed areas. These areas include the former park and playground area, and the former building and parking lot areas north of E. 29th Street. Within the area of known contamination, the dose rates measured at the surface ranged from 3 to 55 micro-rem/hr, with an average of 13 micro-rem/hr. The relatively small areas with the highest measured dose rates were consistent with areas of high surface gamma activity indicated in data acquired during the original December 2010 and January 2011 surface surveys. Because the areas with highest dose rates were small, AECOM determined that exceedance of the Nuclear Regulatory Commission's (NRC) annual dose limit was not a realistic expectation (AECOM 2013).

On December 4, 2013, IDPH provided a Letter Health Consultation regarding the site. The health consultation determined the dose to public commuters traversing the accessible portions of the site for 20 minutes each day to and from the train station, for 250 days per year, would be 21.6 millirems per year (mrem/yr). IDPH considered this to be a maximum likely exposure situation under current conditions. IDPH further concluded that a dose of 21.6 mrem/yr is considerably less than the 310 mrem/yr annual average total radiation dose from all natural sources and less than the 100 mrem/yr of exposure greater than normal background permitted for the general public by the EPA and NRC (IDPH 2013).

On May 22, 2014, AECOM submitted a report to AIS titled "Subsurface Gamma Screening Report – Former Michael Reese Hospital Campus." As previous surface and subsurface studies focused on the delineation of radiological contamination near the northern boundary of the former Michael Reese Hospital campus, the purpose of the investigations discussed in this report was to collect data to substantiate that radiological contamination was not present on other portions of the former campus. The subsurface investigation included down-hole gamma surveys at 29 soil borings. The investigation also included collection and analysis of select soil samples from several of the soil borings. The 29 borings were advanced at locations predetermined by AIS. Two of the borings, B-27 and B-29, were advanced at locations within the current radioactive material license area, near the eastern boundary of the area. AECOM applied a method for the down-hole gamma survey and soil sample collection using the methodology described in "Subsurface Gamma Screening Results (Final) – Former Carnotite Reduction Company" report. Down-hole gamma survey measurements were taken from each of the 29 soil borings. Down-hole gamma readings from the fill soil ranged from 260 to 2,078 cpm—less than twice the field instrument background value of 2,500 cpm. Therefore, no elevated subsurface gamma readings were encountered at the 29 boring locations. Fill soil samples were collected from select borings and submitted for gamma spectroscopy. The samples were selected to represent a range of gamma readings encountered, as well as spatial distribution across the investigation area. (AECOM 2014).

In October 2016, Tetra Tech prepared a dose assessment report for uranium soil cleanup objective determination. The dose assessment report's primary purposes were to establish a uranium soil cleanup objective consistent with standards in 32 IAC 340.310 and to determine if additional groundwater sampling was needed at the Carnotite site. A proposed uranium soil cleanup objective of 187 pCi/g was calculated based on a set of soil-based exposure pathways assuming a conservative residential scenario and using the RESidual RADioactivity (RESRAD)-ONSITE modeling program. Subsequently, the RESRAD-OFFSITE modeling program was used to evaluate whether soil at the Carnotite site may adversely impact receptors exposed via surface water from Lake Michigan, about 0.25 mile east and downgradient of the Carnotite site. Based on a total uranium soil concentration of 3,670 pCi/g (the maximum detected concentration of total uranium in site soil), the maximum dose to receptors potentially exposed via ingestion of surface water and fish tissue from Lake Michigan downgradient of the Carnotite site was established at 5.859E-07 mrem/yr. This dose is well below the allowable annual dose of 25 mrem/yr. Finally, the RESRAD-OFFSITE modeling program was used to evaluate hypothetical use of groundwater as drinking water and resulting dose estimates. Based on a total uranium soil concentration of 3,670 pCi/g, the maximum dose is 6E-01 mrem/yr for a drinking water well located at the Carnotite site boundary; again, well below the allowable annual dose (Tetra Tech 2016a). Ultimately, IEMA established the uranium soil remediation criteria, which were not based on this dose assessment, as listed in the radioactive material license for the site (IEMA 2018a).

On April 3, 2017, Tetra Tech collected two soil samples for remediation planning. The soil samples were collected from areas along 26th Street known to be contaminated. One sample was collected from 2.5 feet bgs and another from the surface. Ra-226 was detected at 57.9 and 592 pCi/g, Th-230 at 106 and 445 pCi/g, and total uranium was detected at 36.5 and 48 pCi/g (Tetra Tech 2017a).

In July 2018, Tetra Tech conducted a pre-design investigation to further delineate Ra-226, Th-230, and uranium contamination in soil; confirm depth to a confining clay layer for evaluating shoring requirements; and acquire groundwater data for design of dewatering and pre-treatment systems. Existing groundwater monitoring wells were sampled; a new groundwater monitoring well (MW-1) was installed and sampled; and 18 investigative, seven background, and three waste characterization soil borings were advanced. Also, XRF screening was conducted for select soil samples. Of 65 investigative soil samples collected within 0 and 30 feet bgs, nine contained Ra-226, uranium, or thorium-230 above site-specific soil remediation criteria at depths between 0 and 6 feet bgs. These exceedances were detected only within previously identified contaminated areas. No Ra-226, uranium, or Th-230 soil concentrations exceeded soil remediation criteria outside of the horizontal or vertical footprint of the established contamination area. In addition, no soil remediation criteria were exceeded in the 33 soil samples collected below the water table. No borings could be installed west of the plume area along 26th Street and east of Dr. Martin Luther King Jr. Drive due to access issues and the presence of utilities. However, the extent of contamination in these areas was defined during the 2012 subsurface investigation.

XRF data collected during the investigation were compared with laboratory results. XRF and laboratory analytical results were similar for uranium concentrations detected by the XRF analyzer above 50 ppm (*i.e.*, relative percent differences [RPD] of less than 5 percent). For uranium concentrations near the XRF detection limit range of 15 to 25 ppm, the difference between XRF and laboratory analytical results was greater (*i.e.*, RPDs of 24 to 45 percent) but remained within the acceptable range of difference between soil duplicate samples (*i.e.*, RPD of 50 percent). However, because the uranium remediation criteria of 22 pCi/g at depths to

5 meters is is within the XRF detection range,, uranium concentrations near the remediation criteria may not be detected by the XRF. Accurate determination of Th-230 concentrations in soil by use of field screening with an XRF was found to be impractical because XRF results were not consistent with analytical results. Other study objectives achieved included: (1) confirmation of the depth to clay at 31 to 33 feet bgs; (2) establishment of thorium-230 background concentration of 0.842 pCi/g and, as a result, a thorium-230 remediation objective of 5.5 pCi/g; (3) acquisition of groundwater analytical results for wastewater treatment design and discharge purposes; and (4) confirmation that groundwater analytical results do not exceed site-specific groundwater concentrations of concern (Tetra Tech 2018a).

In December 2018, GSG Consultants, Inc. (GSG) conducted a geotechnical investigation in the north contaminated area where deep excavation to 14 to 15 feet bgs is planned during site remediation activities. Three soil borings were advanced at the northwest, east, and southwest boundary of the expected deep excavation area to explore the subsurface conditions, to determine engineering properties of the subsurface soil, and develop sheet piling design and construction recommendations. Representative soil samples were tested for moisture content, Atterberg Limits, and dry unit weight. Soil borings were advanced to between 61 and 71 feet bgs. In the borings, fill material was observed from the surface to between 3.5 and 6.5 feet bgs. Beneath the fill, loose to medium dense sand was observed to depths of between 26 and 31 feet bgs. Clay and silty clay was encountered below the sand to boring depths of between 61 and 63.5 feet bgs. Two borings were terminated at 61 and 61.5 feet upon encountering auger refusal on hard silty clay soils. The third boring noted dense to very dense silt with traces of clay and limestone fragments between 63.5 and 71 feet bgs. Groundwater was encountered at depths ranging from 8.5 to 18.5 feet bgs (GSG 2019a). GSG also determined minimum excavation slope requirements for the site remediation activities based on the results of the geotechnical investigation. The following side slopes were recommended (GSG 2019b):

- For excavations up to 15 feet bgs - 2.5H:1V
- For excavations 7.5 feet bgs or less - 2H:1V
- For excavations 5 feet bgs or less - 1.5H:1V

In December 2018, Tetra Tech conducted a hydrogeologic assessment at the site. The assessment was performed to support the remedial design. Slug tests and surveying of existing monitoring wells ASC-2A, ASC-5, and MW-1 were conducted to determine groundwater flow rate. Groundwater flow rate was used to facilitate design of excavation dewatering and groundwater treatment remediation activities. Hydraulic conductivity in the on-site wells ranged from 1.69×10^{-3} centimeters per second (cm/sec) in MW-1 to 7.17×10^{-3} cm/sec in ASC-5 (Tetra Tech 2019a).

In January 2019, Tetra Tech conducted a soil boring investigation to determine the maximum depth of contamination located beneath the northern portion of 26th Street and along the north property boundary. The maximum depth of contamination above site-specific soil remediation criteria was determined to be 14 feet bgs. Total uranium was detected in soil up to 41 pCi/g and to depths of up to 14 feet. Ra-226 was detected in soil up to 26.9 pCi/g and Th-230 was detected up to 89 pCi/g, both within previous maximum depth ranges of 7 feet bgs or less. Soil boring logs confirmed subsurface conditions consistent with previous investigations. In March 2019, Tetra Tech advanced a hand boring to confirm the eastern extent of surficial Th-230 contamination along the northern portion of 26th Street. Ra-226, uranium, or Th-230 were not detected at concentrations above the site-specific soil remediation criteria (Tetra Tech 2019b).

In July 2019, at the request of the City's Department of Water Management, AIS conducted a sewer investigation in planned excavation areas to determine if any unknown connections to the combined sewers exist prior to removal of the sewers during remediation activities. During the investigation, the sewers were cleaned by hydro-jetting, if possible, and televised. Two previously unknown sewer connections to the north 26th Street sewer from the adjacent property to the north were discovered. In addition, the sewer along north 26th Street was observed to be in poor condition in some locations (Tetra Tech 2019c).

In February 2020, Tetra Tech advanced soil borings to a maximum depth of 2 feet bgs using hand auger methods to determine the presence of thorium-230 within shallow soil immediately outside of the proposed excavation area. Nine near-surface soil samples from 0 to 2 feet bgs were collected for onsite screening and subsequently shipped for analysis to TestAmerica Laboratories, Inc. (TestAmerica) of Earth City, Missouri. Eight of the nine samples were analyzed for thorium-230. No thorium-230 concentrations were detected above the site-specific Th-230 soil remediation criterion of 5.5 pCi/g (Tetra Tech 2020a).

In summary, investigations at the site since 2009 have identified the presence of gamma activity. A subsurface investigation in June 2012 confirmed the presence of elevated levels of radium and uranium in subsurface soil. Soil sampling in 2017 and the pre-design investigation in 2018 confirmed the presence of Th-230. The 2018 pre-design investigation also delineated the extent of Ra-226, uranium and Th-230 soil contamination. Soil analytical results for site-specific COCs from the 2012, 2017, 2018, 2019, and 2020 investigations are summarized in Table 3. Soil analytical results from these site investigations exceeding the soil remediation criteria are presented on Figure 4. Soil analytical results within the north contaminated area, where deep excavation is anticipated, are presented on Figure 5. The discovery of radionuclide contamination associated with the former Carnotite site and the need to address the contamination in accordance with state and federal requirements required the City (AIS) to obtain a radioactive facility license with the IEMA. IEMA is the lead regulatory agency that oversees the proper management and remediation of radionuclide-contaminated sites in Illinois.

Ongoing environmental monitoring activities and associated reporting are discussed in Section 2.5.

2.4 LICENSE HISTORY

On May 13, 2015, AIS submitted a radioactive facility license application for the former operations of the Carnotite Reduction Company site to the IEMA (2FM 2015b). IEMA then issued radioactive materials license IL-02467-07 for the Carnotite site on July 10, 2015, with subsequent Amendments 1, 2, and 3 on July 18, 2016; November 27, 2017; and October 1, 2018, respectively. The license allows possession and storage of radium, uranium and thorium, and their daughters (1) as contamination from previous operations and (2) as environmental samples. Possession and storage of radioactive materials is allowed pending development of a site decommissioning plan. With the submittal of this final decommissioning plan, AIS is requesting IEMA approval of a license revision to include decommissioning activities. The license also requires an environmental monitoring program (IEMA 2015, 2016, 2017a, and 2018a), which has been implemented by AIS and is further described in Section 2.5. On March 20, 2017, IEMA modified the license requirements to provide temporary relief until remediation activities begin from environmental monitoring program Conditions 8A, air particulate sampling; 8D, water sampling; and 8E, sewer sediment sampling. In addition, license Condition 8F was amended to require only annual reporting (IEMA 2017b).

2.5 ENVIRONMENTAL MONITORING ACTIVITIES

Beginning in October 2015, Tetra Tech has conducted quarterly monitoring of air particulates, groundwater, sewer sediment, and sewer water at the site and passive quarterly monitoring of gamma radiation and radon in air for AIS. Figure 2 shows the locations of air monitoring and groundwater and sewer sampling. Quarterly monitoring activities were conducted in accordance with the Carnotite radioactive material license, environmental monitoring plan (EMP), quality assurance project plan (QAPP), health and safety and radiation protection plan (HASP/RPP), and subsequent addenda (IEMA 2015 and 2016; Tetra Tech 2015a, b, c, d and 2016b). The purpose of environmental monitoring at the site is to document that concentrations of Ra-226 and total uranium (U-234, -235, and -238) in air particulates, groundwater, sewer water, and sewer sediment, as well as radon concentrations and gamma radiation in air do not exceed concentrations of concern and dose limits documented in the QAPP and subsequent addenda (Tetra Tech 2015b, 2015c, and 2016b).

The Year 1 quarterly monitoring activities (Q4 2015 through Q3 2016) were conducted between October 1, 2015, and September 30, 2016, and are documented in the annual environmental monitoring report submitted on January 10, 2017, pursuant to Condition 8F of the radioactive material license. These activities included the following:

- Continuous low-volume air particulate sampling at four locations. Filter media was exchanged weekly at each location. At the end of each quarter, all weekly filter media collected at a given sampling location were submitted to Eberline Services, Inc. (Eberline) in Oak Ridge, Tennessee, for composite analyses for total radium (Ra-226 and Ra-228) and total uranium (U-234, U-235, and U-238).

- Continuous passive gamma radiation monitoring at 10 locations using dosimeters with optically stimulated luminescence (OSL) technology. At the end of each quarter, the OSL dosimeters collected at each monitoring location, as well as the transit and deploy control dosimeters located southeast of the intersection of Vernon and Ellis Avenues (see Figure 2), were submitted to Landauer, Inc. (Landauer) in Glenwood, Illinois, for analysis. The two control badges (transit and deploy) are used to determine net dose that would be incurred at each monitoring location excluding shipping and placement.
- Continuous passive radon monitoring at 10 locations using Landauer Radtrak Type M (Q4 2015 – Q2 2016) or Radiation Safety Services, Inc. (RSSI) alpha-track radon detectors (Q3 2016). At the end of each quarter, the radon detectors were submitted to Landauer or RSSI in Morton Grove, Illinois, for analysis.
- Quarterly groundwater sampling of three existing monitoring wells, ASC-2A, ASC-4, and ASC-5. Groundwater samples were submitted to TestAmerica in Earth City, Missouri, for radium (Ra-226 and Ra-228) and uranium (U-233, U-234, U-235, U-236, and U-238) analysis.
- Quarterly sewer water sampling of up to two locations, SM-01 and SM-03. Groundwater samples were submitted to TestAmerica in Earth City, Missouri, for radium (Ra-226 and Ra-228) and uranium (U-233, U-234, U-235, U-236, and U-238) analysis.
- Quarterly sewer sediment sampling of up to three locations, SM-01, SM-02, and SM-03. Sewer sediment samples were submitted to TestAmerica in Earth City, Missouri, for radium (Ra-226 and Ra-228) and uranium (U-235 and U-238) analyses.

No results exceeding COC or dose limits were observed in any sample media during this annual monitoring. Radioactive material license Condition 8.E. requires four quarters of sewer sediment sample collection. This requirement was fulfilled during this first of the two annual monitoring periods and no additional sewer sediment monitoring has been conducted to date (Tetra Tech 2017b).

Year 2 quarterly environmental monitoring activities (Q4 2016 through Q3 2017) were conducted between October 1, 2016, and September 30, 2017, and are documented in the annual environmental monitoring report submitted on January 12, 2018. These activities included the following:

- Air Monitoring: Air monitoring included air particulate sampling and passive air monitoring. Tetra Tech conducted continuous low volume air particulate sampling for the first two quarters (Q4 2016 and Q1 2017) at four locations before IEMA granted AIS temporary relief from air particulate sampling requirements. Passive gamma detection monitoring and passive radon monitoring were conducted for each quarterly event through Q3 2017. Passive gamma detection and radon monitoring were continuous at 10 locations, including the four air particulate monitoring stations.
- Groundwater Sampling: During Q4 2016, Tetra Tech collected quarterly groundwater samples at three existing monitoring wells, ASC-2A, ASC-4, and ASC-5. IEMA granted AIS temporary relief from groundwater monitoring requirements prior to the Q1 2017 environmental sampling event; therefore, groundwater sampling was completed for only Q4 2016. No groundwater sample results exceeded concentrations of concern during prior sampling activities.
- Sewer Water: During Q4 2016, Tetra Tech collected one sewer water sample. IEMA granted AIS temporary relief from further sewer water monitoring requirements prior to the Q1 2017 environmental sampling event. No sewer water sample results exceeded concentrations of concern during previous sampling activities.

- Sewer Sediment: No sampling was required during this monitoring period as license Condition 8.E requires quarterly sampling of two locations for four quarters and this was completed prior to this annual reporting period. No sewer sediment sample results exceeded concentrations of concern.

Other than one likely anomalous radon result at location PM-06, no concentrations of concern or dose limits exceeded were recorded in any sample media during this annual monitoring period. The anomalous radon result of 6.1 pCi/g was detected during Q3 2017. Previous radon concentrations detected at PM-06 and throughout the remainder of the site have been generally consistent with background. The Q4 2017 radon result for PM-06 was 0.3 pCi/L, which was identical to the radon result from the site-specific radon background location collected during Q4 2017. Therefore, based on these results, the Q3 2017 PM-06 radon result was not representative of site conditions.

IEMA has granted temporary relief from air particulate, water, and sewer sediment sampling (IEMA 2017b). Therefore, no additional air particulate, water, and sewer sediment sampling is anticipated until remediation begins, site conditions change, or if specifically requested by IEMA. However, Tetra Tech continues quarterly passive radon and gamma monitoring activities (Tetra Tech 2018b).

On September 8, 2017, Tetra Tech prepared a public dose evaluation report to demonstrate compliance with 32 IAC 340.320 as requested by IEMA. The public dose evaluation period covered environmental monitoring activities conducted over one year beginning in the fourth quarter of calendar year 2015 (Q4 2015) through the third quarter of calendar year 2016 (Q3 2016). Additional gamma dose rate surveys were conducted on September 5, 2017, to provide supplemental data for this evaluation. Based on the monitoring data, the sum of the potential doses to the individual members of the public, excluding background, from air particulates—(0.371 mrem/yr), radon (0 mrem/yr), and external gamma (18.98 mrem/yr) — is 19.35 mrem/yr, which is less than the annual dose limit of 100 mrem/yr from 32 Illinois Administrative Code 340.310. In addition, the net hourly maximum dose measured in publicly accessible areas at the site was 0.026 mrem/hr, which is less than the hourly dose limit of 2 mrem in any one hour from 32 Illinois Administrative Code 340.320. Also, the radon COC presented in the QAPP, 1E-08 microcuries per milliliter (µCi/ml) (10 picocuries per liter [pCi/L]), was revised downward to 1E-10 µCi/ml (0.1 pCi/L) (Tetra Tech 2017c). On October 31, 2017, IEMA approved the public dose evaluation report and requested (1) the establishment of a site-specific background concentration for radon, and (2) collection of dose rates at each environmental dosimeter location in addition to a fence line dose rate survey (IEMA 2017c).

On August 27, 2018, Tetra Tech prepared a public dose evaluation report for the fourth quarter of calendar year 2016 (Q4 2016) through the third quarter of calendar year 2017 (Q3 2017). One elevated radon concentration occurred during Q3 2017 at the PM-06 sampling location. A concentration of 6.1E-09 µCi/mL was observed for this sample. However, the average gross concentration observed over the previous 7 quarters for this sampling location was 4.4E-10 µCi/mL. The cause of this anomaly has not been determined and no known site conditions have changed which could have resulted in this single elevated measurement. Duplicate radon samples collected at each sampling location beginning in Q3 2018 will facilitate evaluation of any future elevated results. Using conservative assumptions, the sum of the potential doses to the individual members of the public, excluding background, from air particulates (0.479 mrem/yr), radon (74.55 mrem/yr or 10.7 mrem/yr without the radon anomaly), and external gamma (18.98 mrem/yr) is 94.01 mrem/yr or 30.16 mrem/yr without the radon anomaly, both of which are less than the annual dose limit of 100 mrem/yr from 32 Illinois Administrative Code 340.310. Also, the net hourly maximum dose measured in publicly accessible areas at the site is 0.026 mrem/hr, which is less than the hourly dose limit of 2 mrem/hr from 32 Illinois Administrative Code 340.320 (Tetra Tech 2018c).

Year 3 quarterly environmental monitoring activities (Q4 2017 through Q3 2018) were conducted between October 1, 2017, and September 30, 2018, and are documented in the annual environmental monitoring report submitted on January 24, 2019. These activities included the following:

- Air Monitoring: Continuous passive radon monitoring and passive gamma radiation monitoring was conducted throughout the monitoring period. Monitoring was conducted at 10 locations, including the four air monitoring stations previously used for sampling particulates. No air particulate sampling was conducted because IEMA granted approval to suspend these monitoring activities as no previous air particulate analytical results exceeded site-specific concentrations of concern.

- Groundwater Sampling: As discussed above, IEMA granted AIS temporary relief from quarterly groundwater monitoring requirements prior to the monitoring period; however, as part of pre-design investigation activities, groundwater sampling was conducted only in Q3 2018 (Tetra Tech 2018a). During the Q3 2018 sampling event, Tetra Tech collected samples at three existing monitoring wells, ASC-2A, ASC-4, and ASC-5, as well as one newly installed monitoring well, MW-1. No groundwater analytical results exceeded concentrations of concern during the current or prior monitoring periods.

- Sewer Water: Sewer water sampling activities were suspended for the duration of the monitoring period. IEMA granted AIS temporary relief from further sewer water monitoring requirements prior to the Q1 2017 environmental sampling event. No sewer water analytical results exceeded COC.

- Sewer Sediment: No sampling was required during this monitoring period as license Condition 8E requires quarterly sampling of two locations for four quarters and this was completed prior to this annual reporting period. Sewer sediment monitoring results are documented in the previous annual EMR dated January 10, 2017 (Tetra Tech 2017b). No sewer sediment sample results exceeded concentrations of concern.

Excluding one anomalous radon result at location AM-01, no exceedances of concentrations of concern or dose limits were recorded in any sample media during this annual monitoring period. The anomalous radon result of 7.2 pCi/L at AM-01 was detected during Q1 2018. Previous radon concentrations detected at AM-01 and throughout the remainder of the site have been generally consistent with background. The Q2 and Q3 2018 radon results for AM-01 were at or below site-specific radon background location concentrations. Therefore, the Q1 2018 AM-01 radon result was not believed to be representative of site conditions.

The Q4 2017 through Q3 2018 annual environmental monitoring report also included the annual public dose evaluation for this period. The cumulative exposure of potential doses to the individual members of the public, excluding background, from radon, and external gamma was determined to be 92.3 mrem/yr (including the anomalous radon concentration) or 22.6 mrem/yr (without the anomalous concentration), which were both below the annual dose limit to members of the general public of 100 mrem/yr defined in 32 IAC 340.310. The net hourly maximum dose measured in publicly accessible areas at the site during the September 5, 2017, fence line survey was 0.026 mrem/hr, which is less than the hourly dose limit of 2 mrem/hr to members of the general public defined in 32 IAC 340.310 (Tetra Tech 2019d).

Year 4 quarterly environmental monitoring activities (Q4 2018 through Q3 2019) were conducted between October 1, 2018, and September 30, 2019, and are documented in the annual environmental monitoring report submitted to IEMA on January 23, 2020. These activities included the following:

- Air Monitoring: Continuous passive radon monitoring and passive gamma radiation monitoring was conducted throughout the monitoring period. Monitoring was conducted at 10 locations, including the four air monitoring stations previously used for sampling particulates. No air particulate sampling was conducted because IEMA granted approval to suspend these monitoring activities as no previous air particulate analytical results exceeded site-specific COCs.
- Groundwater Sampling: Groundwater sampling activities were suspended for the duration of this monitoring period. IEMA granted 2FM temporary relief from further groundwater monitoring requirements until remediation activities begin. No groundwater analytical results exceeded COCs during the prior monitoring periods.
- Sewer Water: Sewer water sampling activities were suspended for the duration of the monitoring period. IEMA granted 2FM temporary relief from further sewer water monitoring requirements prior to the Q1 2017 environmental sampling event. No sewer water analytical results exceeded COC.
- Sewer Sediment: No sampling was required during this monitoring period as results from prior monitoring did not exceed COCs.

The annual public dose evaluation conducted based on the Q4 2018 through Q3 2019 environmental monitoring results concluded that the cumulative exposure of potential doses to the individual members of the public, excluding background, from radon, and external gamma is 38.4 mrem/yr, which is below the annual dose limit to members of the general public of 100 mrem/yr defined in 32 IAC 340.310. The net hourly maximum dose measured in publicly accessible areas at the site during the July 1, 2019, fence line survey was 0.026 mrem/hr, which is less than the hourly dose limit of 2 mrem/hr to members of the general public defined in 32 IAC 340.310 (Tetra Tech 2020b).

During ongoing monitoring activities, groundwater depths in on-site monitoring wells have ranged from 9 to 12 feet bgs. Ongoing environmental monitoring activities conducted after September 30, 2018, and associated results and public dose evaluation will be documented in the next annual environmental monitoring report, which will be completed before January 28, 2020, in accordance with radioactive material license Condition 8.E.

3.0 NATURE AND EXTENT OF CONTAMINATION

Investigation activities have been conducted in 2012, 2017, 2018, and 2019 to evaluate the extent of contamination in shallow and deep soil, sewer sediment and water, or groundwater as described below. The investigations were conducted by AECOM and Tetra Tech on behalf of AIS. The investigations included both field screening activities and the collection of samples that were then laboratory-analyzed for site-specific COCs. In addition, Tetra Tech conducted additional activities to collect data to accurately portray the extent of contamination which included verifying site elevation and using 3D visualization modeling.

In 2012, the nature and extent of contamination at the site was evaluated through a down-hole gamma survey of the site and associated soil sampling. A total of 215 borings were advanced and down-hole gamma logged. Down-hole gamma readings ranged from below 1,000 cpm to over 230,000 cpm. A total of 58 soil samples were selected for off-site laboratory gamma spectroscopy analysis. A balance of clean and impacted surface samples (0 to 2 feet bgs) were selected, as well as a group of subsurface samples that had exhibited a range of gamma counts. In the 58 samples analyzed at the laboratory via gamma spectroscopy, total uranium activity ranged from non-detect to 3,670 pCi/g, and total radium activity ranged from 0.85 to 1,181 pCi/g (AECOM 2012a). Based on this 2012 investigation, radium contamination was not found to extend below 9 feet bgs, with the deepest contamination present beneath 26th Street along the north/northwestern site boundary. However, the extent of uranium was not identified during this investigation because uranium at over 3,000 pCi/g was detected in the deepest soil sample at 11 feet bgs. Th-230, later determined to be a site compound of concern, was not evaluated in this initial investigation.

In 2017, Tetra Tech collected surface soil samples from two locations to determine if Th-230 was present at elevated concentrations in soil at the site. Ra-226 was detected from 57.9 to 592 pCi/g, Th-230 was detected from 106 to 445 pCi/g, and total uranium was detected from 36.5 to 48 pCi/g (Tetra Tech 2017a).

In 2018, Tetra Tech conducted a pre-design investigation to further delineate nature and extent of contamination. A total of 65 investigative soil samples were collected from 18 soil borings and soil samples were analyzed for Ra-226, isotopic uranium, and Th-230. Ra-226 was detected at concentrations ranging from non-detect to 135 pCi/g, total uranium was detected from 0.229 to 116 pCi/g, and Th-230 was detected from 0.129 to 361 pCi/g (Tetra Tech 2018a).

In 2019, Tetra Tech conducted a soil boring investigation to determine the maximum depth of contamination located beneath the northern portion of 26th Street and along the north property boundary. The maximum depth of contamination above site-specific soil remediation criteria was determined to be 14 feet bgs. Total uranium was detected in soil up to 41 pCi/g and to depths of up to 14 feet. Ra-226 was detected in soil up to 26.9 pCi/g and Th-230 was detected up to 89 pCi/g, both within previous maximum depth ranges of 7 feet bgs or less. Soil boring logs confirmed subsurface conditions consistent with previous investigations. Tetra Tech advanced a hand boring to confirm the eastern extent of surficial Th-230 contamination along the northern portion of 26th Street. Ra-226, uranium, or Th-230 were not detected at concentrations above the site-specific soil remediation criteria (Tetra Tech 2019b).

Based on results of the 2012, 2017, 2018, and 2019 subsurface investigations, Tetra Tech utilized the 3D visualization software Earth Volumetric Studio (Studio), created by CTech, to estimate and visualize the extent of soil contamination. The software also estimated the volume of contaminated soil containing Ra-226, uranium, and Th-230 exceeding soil remediation criteria outlined in the Carnotite radioactive materials license and background concentrations provided by IEMA (5.9 pCi/g Ra-226; 22 pCi/g total uranium above 5 meters bgs and 52 pCi/g total uranium below 5 meters bgs; and 5.5 pCi/g Th-230) (See Section 4.2).

As initial inputs to the model, the ground surface elevations assigned to the soil sample and down-hole gamma counts locations were estimated from topographic survey documents (HBK 2012; EDI 2019a). Tetra Tech developed a database using the 2012, 2017, 2018, and 2019 soil sample analytical results and assigned elevation data to be used in the 3D visualization and analysis (3DVA). The CTech software defined a three-dimensional 2.8- by 2.9- by 1-foot (X by Y by Z) grid, and applied a kriging method to interpolate the value of each node in the grid from all samples within the dataset. The initial 3DVA indicated a contaminant plume that was unbounded in many areas, which was not consistent with down-hole gamma count results. Therefore, the down-hole gamma readings below background were added to the dataset used in the initial 3DVA to more accurately depict the extent of the contaminated areas by more accurately defining the boundary of contamination in areas where down-hole gamma count data showed no contamination. Downhole gamma readings above background were also added in the area between the north and south contaminated areas where gamma screening results suggest the presence of contamination that was not reflected in available soil sample results. Based on these assumptions, the volume of contaminated soil is estimated to be approximately 16,250 cubic yards (CY) and contamination is estimated to extend up to 14 feet bgs. The estimated nature and extent of contamination of each contaminant of concern is presented in 3D on Figure 3.

4.0 PROJECT OBJECTIVE

Project objectives include meeting regulatory requirements, soil remediation criteria, and goals for removing radionuclides to levels that are as low as reasonably achievable (ALARA) as defined in 32 IAC 310.20.

4.1 REGULATORY REQUIREMENTS

Site decommissioning is required in accordance with radioactive materials license number IL-02467-01 issued by IEMA for the site (IEMA 2016). License termination requirements outlined in 32 IAC 330.325 and IEMA's "Decommissioning Guidance for Radioactive Materials Licensees" must also be met. In addition, the decommissioning activities at the Carnotite site require a decommissioning plan because loose form radioactive material including radium, uranium, and thorium associated with the former Carnotite operations, that is not listed in 32 IAC 330 Appendix B, Exempt Quantities, exists at the site.

IEMA license termination requirements include:

- Cease use of radioactive material
- Remove radioactive contamination
- Properly transfer and dispose of radioactive material
- Submit a completed Agency Form KLM.007, Certificate Termination and Disposition of Radioactive Material, or provide equivalent information
- Submit a final status survey report

IEMA will also conduct verification surveys and sampling before placement of backfill to verify removal of radioactive contamination, including at the end of each phase of excavation. However, excavation backfill decisions may be made, in coordination with IEMA, based on preliminary AIS and/or IEMA radium-226 results (*i.e.*, without 21-day ingrowth period).

The final status survey report must include at least the following information: (1) site description, (2) license history, (3) impacted areas and systems, (4) applicable maps and detailed drawings, (5) equipment and instrumentation used, (6) release criteria including ALARA goals, (7) remedial actions, (8) waste management and disposal, (9) verification survey and sampling protocol, (10) sample analysis and measurement results, and (11) data validation procedures and results.

After successful decommissioning and cleanup, AIS or the current licensee will notify IEMA in writing that license termination requirements have been met in accordance with 32 IAC 330.325 and other license requirements (IEMA 2007).

4.2 SOIL REMEDIATION CRITERIA

The primary radionuclides of concern in soil at the Carnotite site are total uranium (predominantly U-238, with small fractions of U-234 and U-235), Ra-226, and Th-230. Soil remediation criteria are outlined by IEMA in the current Carnotite radioactive materials license. Remediation criteria are defined below for Ra-226, total uranium (U-234, U-235, and U-238), and Th-230.

Ra-226: The license specifies that the concentration of residual Ra-226 in dry soil, after removal of soil or other materials that are being relocated, shall not exceed 5 pCi/g above background. Concentrations of radium in such residual soil shall be averaged over areas of 100 square meters and averaged over layers of 15-centimeter thickness consistent with requirements in 32 IAC 340 Appendix A (IEMA 2018a). The Ra-226 soil remediation criteria is **5.9 pCi/g**, based on the methodology described above and the site-specific background Ra-226 concentration of 0.9 pCi/g. The site-specific Ra-226 concentrations was determined based on 2014 soil analytical results from on-property areas located outside the licensed area. The Ra-226 concentrations ranged from 0.7 to 1.4 with an average value of 0.9 pCi/g (AECOM 2014). Prior to radioactive material license Amendment 2, site-specific radium concentrations of concern were based on total radium (Ra-226 and Ra-228). However, Ra-228 has not been detected above background concentrations at the site and therefore does not have a separate cleanup threshold.

Total Uranium (U-234, U-235, and U-238): The license also specifies that the concentration of total residual uranium in dry soil, after removal of soil or other materials that are being relocated, shall not exceed 20 pCi/g above background to a depth of 5 meters and 50 pCi/g above background for all other depths. Concentrations of uranium in such residual soil shall be averaged over areas of 100 square meters and averaged over layers of 15-centimeter thickness (IEMA 2018a). The total uranium soil remediation criteria are **22.0 pCi/g** to a depth of 5 meters and **52.0 pCi/g** below 5 meters, based on the methodology described above and a site-specific uranium background concentration of 2.0 pCi/g. The uranium background concentration was determined in 2014 based on soil analytical results from on-property areas located outside the licensed area. The total uranium activities were reported from below reporting limits to 4.37 pCi/g. The detected values ranged from 0.295 to 4.37 pCi/g with a median value of 2.00 pCi/g (AECOM 2014).

Th-230: The license specifies that the concentration of residual thorium (Th-230) in dry soil, after removal of soil or other materials that are being relocated, shall not exceed 5 pCi/g above background. Concentrations of Th-230 in such residual soil shall be averaged over areas of 100 square meters and averaged over layers of 15-centimeter thickness (IEMA 2018a). During the 2018 pre-design investigation, background soil samples were collected from approximately the same locations where background soil samples were collected during the 2014 investigation (AECOM 2014; Tetra Tech 2018a). The Th-230 concentrations ranged from 0.4 to 1.1 pCi/g with an average value of 0.8 pCi/g (Tetra Tech 2018a). However, IEMA proposed a background concentration of 0.5 pCi/g. IEMA expects this value will provide reasonable assurance that post remedial doses are maintained ALARA (IEMA 2018b). Therefore, the Th-230 soil remediation criteria is **5.5 pCi/g**.

IEMA concluded that the soil remediation criteria were deemed necessary to ensure that the requirements of 32 IAC 340.110(b) and 330.325 are met and to maintain acceptable doses to the public and releases to the general environment ALARA.

Radon is a decay product of U-238 and Ra-226. However, evaluation of residual radioactivity associated with radon and its progeny is not required based on license termination requirements presented in 32 IAC 330.325(b)(1)(B)(ii). Uranium and radium in air, groundwater, sewer water, and sewer sediment were not further evaluated and remediation criteria were not developed because quarterly monitoring results were consistently below COC thresholds.

4.3 ALARA GOALS

IEMA has deemed the soil remediation criteria assigned in the radioactive materials license as ALARA. Additional ALARA goals will include minimizing potential for public exposure during remediation activities to ALARA by conducting dust monitoring and suppression activities during excavation, blending, and loading of contaminated soil and by conducting perimeter air monitoring. Worker radiation doses will be maintained ALARA through appropriate radiation worker training and procedures designed to prevent the spread of contamination such as surveys and use of personal protective equipment where appropriate, as described in the HASP/RPP.

5.0 PROJECT MANAGEMENT AND ORGANIZATION

The City of Chicago is the current property owner and AIS's Bureau of Environmental, Health and Safety Management is managing the overall decommissioning process as the licensee. IEMA has overall regulatory authority for site decommissioning under the site-specific radioactive material license held by AIS. The radioactive material license identifies Glenn Huber, Stan A. Huber Consultants, Inc., or designee, as the radiation safety officer for the site. The radiation safety officer (RSO) has overall authority for radiation safety and license related activities at the site, including but not limited to providing site-specific radiation training to on-site personnel, radiation field screening surveys, conducting perimeter air monitoring, collecting samples for and conducting analyses in the on-site field laboratory, and conducting a final status survey. The RSO will have the authority to direct all onsite personnel to follow procedures pertaining to licensed activities. Tetra Tech project manager and project engineer are responsible for planning site decommissioning on behalf of AIS in accordance with the existing site radioactive material license and other relevant requirements. At this time, AIS, with Tetra Tech acting as the remediation oversight contractor, is expected to also manage the remediation contracting and construction; however, other entities, such as future property owners or developers could become involved.

The remediation oversight project manager is responsible for implementing the remediation oversight project scope and has the authority to commit the resources necessary to meet the project objectives and requirements (within the approved budget). The project manager will report to the AIS project manager and will serve as the primary point of contact for matters concerning the project. The remediation oversight field team leader directs day-to-day field activities conducted as part of remediation oversight, verifies that field sampling procedures follow the field sampling plan and QAPP, and provides the project manager with regular reports on the status of field activities. The remediation oversight site safety coordinator is responsible for implementing the HASP/RPP and for determining appropriate site control measures and personal protection levels for remediation oversight contractor personnel. The site safety coordinator also conducts safety briefings for remediation oversight personnel and site visitors and can suspend remediation oversight contractor operations that threaten health and safety. The site safety coordinator will also alert the project manager and the relevant contractor's site safety coordinator if unsafe conditions caused by other on-site contractors are observed. The analytical coordinator is responsible for working with the project team to define analytical requirements, assists in selecting laboratories to complete required analyses, and coordinates with the laboratory project managers on analytical requirements, delivery schedules, and logistics. The data validation lead is responsible for validating data in accordance with applicable guidelines and preparing data validation reports. The excavation, transportation, and disposal contractor will be contracted by AIS and is responsible for implementing the site remediation plan in accordance with site-specific specifications and plans, conducting soil excavation, managing waste transportation activities, and providing excavation and transportation progress reports to AIS. Figure 6 shows the anticipated project organization for site remediation activities.

6.0 REMEDIATION STRATEGY AND ESTIMATED COSTS

This section includes estimated disposal volumes, general remediation strategy, and estimated costs. The general remediation strategy presented below includes assumptions regarding specific equipment and procedures, as necessary, to estimate costs. Alternate means and methods may be implemented by the excavation, transportation, and disposal contractor, if approved by AIS and IEMA. Figure 7 depicts a general site layout during remediation activities.

6.1 ESTIMATED DISPOSAL VOLUMES

As discussed in Section 3.0, Tetra Tech estimated the volume of contaminated soil containing radium, uranium, and thorium at concentrations above the site-specific cleanup objectives using the Studio 3DVA software and the 2012, 2017, 2018, and 2019 subsurface investigation results (AECOM 2012a; Tetra Tech 2017a, 2018a, and 2019b). Based on the assumptions presented in Section 3.0, the volume of contaminated soil is estimated to be 16,250 CY, and contamination is estimated to extend to 14 feet bgs beneath the northern portion of 26th Street (see Figure 3). This volume estimate includes safe excavation sloping within excavation areas above the water table (10 feet bgs). Sheet piling will also be installed around the perimeter of the excavation in certain locations due to the anticipated depth of the excavation, presence of shallow groundwater and the non-cohesive soils at the site. Therefore, excavation sloping will be limited to areas where necessary and will likely not be necessary in the deeper portion of the plume as sheet piling will be used to maintain a stable excavation and limit groundwater management.

6.2 SOIL EXCAVATION

Before excavation begins, the remediation oversight contractor will develop a 10-meter by 10-meter (33-foot by 33-foot) grid system for the site based on surface radiation surveys and the results of the delineation assessments (see Figure 3). In addition, approximately 36,000 square feet of asphalt and concrete will be demolished from both East 26th Street and the tennis courts prior to excavation.

During excavation, soil will be screened with field screening equipment to separate clean from contaminated material to minimize the volume of contaminated soil to be shipped off site. Furthermore, soil screening will assist in the separation of radiological waste into disposal categories based on landfill acceptance criteria. During excavation, visible spray paint markers will allow the excavator operator to distinguish clean from contaminated material based on the screening results. Potentially clean overburden (*i.e.*, radium, uranium, and thorium concentrations below soil remediation criteria) will be stockpiled separate from the remediation work area to prevent cross contamination. Clean overburden, if present, will be removed in 6-inch lifts until contaminated soil is encountered. Based on subsurface conditions observed during the pre-design investigation, the presence of clean overburden is expected to be limited to the former park area located south and west of 26th

Street. The clean overburden stockpile material will be sampled in accordance with procedures identified in Section 7.6 to determine if the material may be reused on site or must be disposed off site. The excavator will remove up to 18-inch lifts of contaminated material that will be placed or transported by on-site dump trucks (about 8 CY capacity) or other appropriate means into approximately 20 CY piles in the stockpile management area for further characterization. Temporary stockpiles will be managed in designated stockpile management areas, with separate areas for contaminated and non-contaminated stockpiles, including clean overburden and construction debris. The contaminated stockpile areas will be lined, and bottom sloped with a water collection sump or sloped toward the open excavation to allow water to flow into the excavation. When not actively working with stockpiles, each pile will be covered completely with a minimum 10 mil plastic liner in minimum 20-foot long rolls that will be secured with sandbags or equivalent. Also, the plastic cover may be upgraded to fiber reinforced or heavier plastic sheeting, if warranted. Additional details regarding soil screening and characterization techniques are presented in Section 7.0.

The total depth of the excavation is estimated to be 14 to 15 feet bgs, with the deepest excavation located beneath the northern portion of 26th Street (see Figure 3). To reach this depth, the sides of the excavation should be sloped or shored to prevent collapse of the sidewalls during excavation. Dewatering will be necessary as the groundwater table is located at approximately 10 feet bgs in the area of deep contamination. Based on the high hydraulic conductivity expected for the fill and sandy units, groundwater flow rates may be as high as 5,000 gallons per minute (gpm), indicating that excessive volumes of groundwater would be generated on a continuous basis to dewater the excavation area. The groundwater would require treatment for radium, uranium, and thorium as well as any other compounds that may be present that exceed the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) pre-treatment standards prior to discharge to a nearby sanitary sewer. These radiological compounds will require specialty treatment equipment and appropriate monitoring of the discharge.

Steel sheet piling will be installed at the north boundary of the deep excavation area in the north contaminated area to provide slope stability because excavation to 14 to 15 feet bgs is required at the north property boundary. The sheet piling is to be installed to a depth of 37 to 66 feet bgs to allow it to key into the clay layer. Prior to installing the sheet piling, the sewer pipe draining the parking lot of the north property may be exposed a cut to prevent damage to the pipe during sheet piling installation. Any soil removed must be screened, sampled, managed, and disposed consistent with on-site soil. The deep excavation area would be dewatered using down-hole pumps installed in temporary sumps, or equivalent. The water would be pumped through a mobile treatment unit to achieve the MWRDGC pre-treatment criteria prior to discharge to the sanitary sewer. Refer to Section 6.4 for details on the dewatering and treatment.

Soil will be excavated from the deep portion of the contaminated areas and loaded into on-site dump trucks (8 CY capacity) or other appropriate means for transportation to the screening area to identify the appropriate disposition of the excavated material. Stone will be used to construct a ramp for the equipment to enter and exit the excavation area. The ramp will be constructed with a 0.75:1 slope and will be approximately 15 feet wide. The stone will be screened for radionuclides at the completion of use and, if deemed acceptable, may be used as backfill at the completion of excavation.

Miscellaneous debris such as concrete rubble is anticipated to be encountered during excavation. The concrete will be broken into manageable pieces using the excavator or a concrete breaker attachment. Concrete will be screened in accordance with established field screening procedures, and the material will be managed based on the screening results. A topographic survey will be performed once excavation is complete to document the extent of the excavation.

6.3 SOIL MIXING

After the stockpiled soil has been screened and categorized, soil containing lower concentrations of radium, uranium, or thorium may be blended with soil containing higher concentrations of radionuclides to reduce overall soil concentrations. The purpose of soil blending or mixing is to increase disposal options by decreasing soil concentrations to below landfill waste acceptance criteria for Subtitle C landfills permitted to accept certain concentrations of soil containing radium, uranium, and thorium, if possible. However, clean soil (radionuclide concentrations below site-specific soil remediation criteria) will not be blended with contaminated soil. An excavator will be used to blend material; the health physics contractor will screen and document the blending process and estimated soil concentrations for disposal. Soil designated for disposal will be loaded into dump trucks or IP bags (*i.e.*, super sacks) depending on the disposal requirements of the receiving disposal facility.

6.4 DEWATERING AND WATER MANAGEMENT

After the sheet piling system has been installed, and as the excavation work progresses, temporary sumps, dewatering well points, or equivalent, will be installed in the excavation and the soil will be dewatered. It is assumed that six temporary sumps or well points with submersible pumps of 50 gpm or other appropriate capacity will be used. Based on laboratory analytical data of a groundwater sample collected from the north excavation area, the concentration of uranium exceeded MWRDGC pre-treatment criteria. Thus, water will require treatment for uranium. The water will be pumped to a treatment system that includes bag filters to remove sediment, then further filtration to reduce sediment as needed. The water will then be processed through an ion exchange system. The treatment system will be designed to allow backflushing, as needed. In addition, the system will be designed to provide treatment trains in parallel, so that filters and resins can be replaced while providing continuous operations of the system. It is assumed that the volume of water to be removed will entail initial dewatering of the excavation area and continuous removal of groundwater. The treated water will be sampled daily, or as required, for analysis of site COCs, radium, uranium, Th-230, and

MWRDGC criteria prior to discharge. It is assumed that the resin will be changed up to 10 times during the project. The spent resin will be screened for radionuclides and will be disposed of along with the excavated soil at the appropriate landfill based on the concentrations detected.

Additional groundwater treatment steps, such as pH adjustment or additional filtration, may be necessary to treat extracted groundwater to applicable discharge limits.

The treated water will be discharged to the MWRDGC sewer system, pending approval and permitting. It was assumed that pre-treatment standards for radioactivity will be consistent with EPA maximum contaminant levels. MWRDGC pre-treatment standards will be confirmed prior to remediation.

6.5 SOIL AND DEBRIS TRANSPORTATION AND DISPOSAL

The excavation, transportation, and disposal contractor will collect waste characterization samples, as necessary, complete a waste profile for approval by the landfills receiving the Carnotite waste, and obtain approval from relevant radioactive waste compacts or other necessary regulatory approvals. The excavation, transportation, and disposal contractor will also be responsible for all necessary transportation permits and approvals. The Carnotite site waste is licensed radioactive material in accordance with the site-specific radioactive materials license issued by IEMA. Subpart K of 32 IAC 340 sets forth the regulations for waste disposal of licensed radioactive material. However, IEMA approved AIS's alternative disposal methodology, as authorized in 32 IAC 340.1020, to allow disposal of certain waste as non-licensed material at disposal facilities authorized to accept the material subject to the submittal of specific disposal facilities for IEMA's approval prior to shipping any waste offsite for disposal. Therefore, soil containing radium-226 and meeting the definition of by-product material in 32 IAC 310.20 and soil containing less than 0.05% by weight of total uranium and thorium-230 as defined in 32 IAC 330.30(a) is expected to be disposed at Resource Conservation and Recovery Act (RCRA) Subtitle C landfills or other disposal facilities as non-licensed material in accordance with facility-specific permit requirements, waste acceptance criteria and IEMA's approval (2FM 2019a and IEMA 2019b). Waste not meeting the alternative disposal conditions will be disposed as licensed waste at radioactive material landfills. Waste soil and debris will be shipped to the Subtitle C or radioactive material landfills in accordance with 49 Code of Federal Regulations (CFR) 173.436.

Once landfill approval is obtained, soil exceeding remediation criteria will be transferred to the disposal facility. Soil will be loaded directly into lined dump trucks or placed in IP bags before it is loaded into dump trucks and will be in accordance with 49 CFR 173.436. If rail transportation is used, flatbed trucks will transport the IP bags to a rented operating space at an intermodal facility. A crane, operator, laborer, screening technician, and shipping coordinator will be stationed at the intermodal facility to load material from the flatbed trucks and into rail cars. The screening technician will verify successful decontamination of rail cars and trucks exiting the intermodal facility. A shipping coordinator will be required to schedule transportation and disposal, obtain waste manifests, landfill weight tickets, and landfill screening documentation. Several intermodal facilities in the Chicago area exist that extend west to radioactive material landfill locations. However, the current cost estimate does not include rail transportation because costs are expected to be higher for rail transportation.

Class 7 shipping requirements outlined in 49 CFR 173.441 and 173.443, as well as other relevant U.S. Department of Transportation requirements, will be used as guidelines for all disposal facility shipments. Before it leaves the exclusion zone, each truck and dump trailer will be screened for exterior contamination and documented.

Radiation levels will be measured on the sides and underside of each conveyance by the construction or remediation oversight contractor using a Ludlum Model 19 microR meter, or equivalent. Disposal container screening will occur at a sufficient distance from active excavation areas, stockpiles, or other potential sources of contamination to prevent interference with screening equipment. A maximum contact screening level on the conveyance will be established, depending on the disposal facility requirements. Any readings above the maximum contact screening level will be further evaluated, which may include removing hot-spot material from the load before it is rescreened. Screenings will follow standard operating procedures and readings will be recorded. Screening of beta/gamma and alpha radiation levels on the exterior of the conveyance container will involve large area wipe samples counted on a Ludlum M2360 count rate meter with a 43-93 scintillation probe, or equivalent. Wipes will be counted for beta/gamma and alpha contamination. The excavation, transportation, and disposal contractor will update and document the soil transportation log with manifest numbers and soil quantities.

Any clean overburden removed from the excavation that is not suitable for backfill will be shipped to a Subtitle D or Special Waste landfill, as appropriate. Concrete and asphalt removed from the site will be screened and recycled to the extent possible.

6.6 BACKFILL OF EXCAVATION AREAS AND SITE RESTORATION

A post-excavation surface gamma survey and verification sampling will be performed by the remediation oversight contractor and IEMA to ensure the site-specific soil remediation criteria are met. Virgin stone will be used to backfill the excavation area to the ground surface, except in the stormwater basin and adjacent green space. In the stormwater basin and greenspace areas, virgin stone will be used as backfill to within 6 inches of final grade. Geotextile fabric, 6 inches of top soil, and hydroseeded grass will overlay the virgin stone in these areas. Virgin stone backfill material will be comprised of CA-6 or similar clean granular material and may also include clean overburden. Excavated soil and stone utilized for onsite roadways and ramps may be used as additional backfill material, above the groundwater table, if field screening levels and analytical results do not exceed remediation objectives. This material will be compacted.

The steel sheet piling will be left in place and cut to a depth of 3 feet bgs or below the existing sewer piping from the north property that will be reconnected to replacement sewers beneath 26th Street, as appropriate.

The Chicago Department of Transportation (CDOT) has provided a waiver indicating that restoration of the 26th Street roadway is not required after remediation, as the future developer will realign the road. Therefore, 26th Street will be temporarily closed to both vehicle and pedestrian traffic east of South Dr. Martin Luther King Jr. Drive during and after site remediation until development occurs (CDOT 2019). To comply with the requirements of the Chicago Stormwater Management Ordinance, Chapter 11-18 of the Municipal Code, for temporary stormwater management until final development, a stormwater detention basin must be installed to meet rate and volume control requirements. The 13,793-square foot stormwater basin and greenspace area will be constructed along the western portion of the excavation area. The basin will be 2 feet deep and the outlet will be connected to the City's existing sewer on 26th Street with a new proposed manhole, in accordance with the site-specific stormwater management plan (Tetra Tech 2019e).

Although a restoration waiver has been granted, the sewer beneath the northern portion of 26th Street (parallel to the northern site boundary) will be replaced after site remediation is complete. The 26th Street sewer must be replaced to maintain flow from two sewer pipes currently entering the 26th Street sewer from the property to the north. One sewer connection drains the adjacent north property parking lot and a second sewer connection appears to flow from the adjacent vacant building. The 26th Street sewer will be replaced in-kind with 18-inch and 12-inch extra strength vitrified clay pipe, or equivalent, in accordance with City of Chicago requirements. Sewer pipe elevations will maintain flow toward South Dr. Martin Luther King Jr. Drive. North property and 26th Street sewer pipe invert elevations were documented to facilitate sewer design (EDI 2019b).

A post-construction topographic survey will be performed when site restoration has been completed.

6.7 ESTIMATED COSTS AND DESIGN ASSUMPTIONS

Estimated costs range from [redacted] based on design assumptions below. The most significant variable in the range of costs is transportation and disposal options. The highest cost is associated with truck transportation to a radioactive waste landfill in the western U.S. The lowest cost assumes much of the contaminated soil is disposed at a RCRA Subtitle C landfills permitted to accept certain quantities of radioactive waste, in addition to disposal of soil exceeding the Subtitle C landfill's permitted limits at a radioactive waste landfill. Additional design assumptions are detailed below. Detailed cost estimates are presented in Attachment 1. These costs represent a planning-level estimate based on assumptions presented below. Actual costs and means and methods may vary.

Pre-Remediation Activities: Clearing and grubbing will consist of removing brush and trees in the excavation footprint in addition to surrounding staging areas. Utility locate services will be conducted by DIGGER and a private utility subcontractor to mark the underground utilities including water, sanitary sewers, stormwater sewers, gas lines, single connections, and telecommunications. 26th Street will be closed to vehicle and pedestrian traffic east of South Dr. Martin Luther King Jr. Drive. Prior to street closure, pedestrian wayfinding signage will be installed to direct Metra riders to the 27th Street station from the south via 29th Street, Vernon Avenue, and Ellis Avenue. Two power poles located along the north side of the site will be removed. These power poles will be replaced after remediation is complete. A temporary power source will be installed to supply electricity to four perimeter air monitoring stations, groundwater pumping and treatment system, office trailers, and any other required remediation equipment and facilities. Approximately 36,000 square feet of concrete, asphalt, and curb will be demolished prior to excavation because portions of the excavation footprint include sections of 26th Street, a former loading dock area and the tennis courts. A concrete thickness of 6 inches is assumed. Based on the depth of the proposed excavation area, two sewer lines beneath 26th Street will be plugged and then removed during excavation. However, flow must be maintained from two sewer pipes entering the 26th Street sewer from the north property. Both sewer lines are believed to be combined sewers that currently receive only storm water but formerly received sanitary discharge from the demolished former Michael Reese Hospital buildings or the currently vacant Advocate Medical Center on the north property. Two manholes located at the south side of the project site and on the corner of South Dr. Martin Luther King Jr. Drive and East 26th Street will be plugged and may be decommissioned or relocated so remedial activities will not affect the sewer system and to prevent storm water discharges to the site. Gas and water service lines, as well as CDOT electric, run along 26th Street and through the excavation area; these lines will be decommissioned and relocated by Peoples Gas, CDOT, or the City of Chicago Department of Water Management prior to excavation.

UST Removal Activities: One known and two suspect USTs may be located within the licensed area (Carnow, Conibear & Associates 2012). Prior to any excavation, the known UST located within the expected excavation area UST 2, as shown on Figure 7 will be removed under the supervision of the City of Chicago and in accordance with the city's agreement with, and the requirements of, OSFM. Approximately 40 square yards of 6-inch concrete will be removed to reach the USTs. UST 2 is registered with OSFM as a 1,000-gallon tank used to hold diesel fuel and was abandoned in place in 2012 (OSFM 2012). It is assumed UST 2 contains a flowable fill and will require proper disposal. UST 2 will be removed, rendered unusable, and cleaned. The UST will be hauled to a certified salvage yard for recycling; a 100-mile round trip to the nearest salvage yard is assumed. It is also assumed that one dump truck load of non-radiological petroleum contaminated soil will require disposal at a Special Waste landfill. Suspect USTs 1 and 3, if present, are suspected to hold 200 and 550 gallons, respectively, with unknown contents. They are located outside the excavation area and removal is not included in this work.

Installation of Sheet Pile: As discussed in Section 6.2, shoring will be installed on the north wall of the deep excavation area, at the north property boundary to ensure structural stability throughout the project. For the purposes of the cost estimate, cantilevered sheet piling was assumed to be installed to 37 to 66 feet bgs. The sheet pile will be left in place and cut to a depth of 3 feet below grade or below the existing north property sewer when the project is completed, as appropriate.

Excavation Area Access Ramp: A 15-foot-wide stone ramp with the slope of 0.75:1 is proposed to allow accessibility to the excavation area. A 15-foot-wide ramp is anticipated to accommodate dimensions of a 1 CY hydraulic excavator. Approximately 74 CY of stone is anticipated to construct the ramp for a 14 to 15-foot excavation.

Excavation and Soil Blending: A 1 CY hydraulic excavator is assumed to perform excavations to a depth of 14 to 15 feet bgs. An overall daily production rate of 150 CY is anticipated considering expected difficulties for excavation beyond 10 feet bgs. An approximately 8-CY dump truck or other appropriate equipment will use the stone ramp to transport material from the bottom of the excavation area to the surface. Approximately 108 days of excavation is anticipated based on the excavation daily production of 150 CY. A crew of laborers and one foreman will be expected to assist in sheet piling, rigging, setting up IP bags, and dewatering activities. A screening technician will be assigned to screen the footprint of the excavator. Blending is assumed to take 5 days.

Dust Control: Dust control measures will be implemented as needed during excavation, stockpiling, loading, and any on-site operations that may generate dust to minimize dust generation and prevent off-site dust migration. General dust control may include water sprinkling, covers, crusting agent, or equivalent. Dust control may also include regulating equipment speeds, limiting traffic volume, and minimizing dust-generating activities during periods of high wind.

Water Management: An approximately 300 gpm water treatment system will be on site to address the removal, treatment, and disposal of water entering the excavation area. Each resin adsorber is anticipated to require replacement up to 10 times during the project. A total of 10 million gallons (MG) of water is expected to be treated and discharged during the project. The water treatment system is expected to be used throughout the length of excavation. It is also anticipated that a laborer will monitor the dewatering pump for 12 hours a day, 6 days a week. However, continuous operation of the system may be required while excavating below the water table. One water disposal sample will be collected each day of water treatment operation, or as required, in addition to a 30 percent increase on the number of samples to include duplicate samples, matrix spike and matrix spike duplicate (MS/MSD) samples, and contingencies. The water discharge sample will be laboratory analyzed for MWRDGC discharge parameters, as well as radium, uranium and thorium, prior to discharge. Rush laboratory analysis may be required. For the purposes of this cost estimate, it is assumed that the water will be treated by ion exchange. If other parameters are present in the groundwater at concentrations exceeding MWRDGC discharge standards, then additional treatment technologies may be needed. Based on the water treatment analytical results from the pre-design investigation, no contaminants above the MWRDGC sewer system discharge standards are expected other than radium, uranium, and thorium.

Transportation and Disposal: Soil containing COCs above the site-specific soil remediation criteria will be shipped to a Subtitle C or radioactive material landfill by truck or rail. If rail transportation is used, three 25-ton flatbed trucks will be used to transport loaded IP bags to an intermodal facility. A shipping coordinator will be stationed at the intermodal facility to organize the railcar disposal schedule and ensure manifests are properly documented. However, the current cost estimate does not include rail transportation because costs are expected to be higher for rail transportation. For cost estimation purposes, the cost of transporting material per ton via 25-ton dump truck considers the truck rental, gas mileage, hourly truck driver wages, and a buffer time to allow for resting time and contingencies. Soil transported offsite is assumed to be placed in IP super sack bags; however, bags may not be required for disposal at Subtitle C landfills.

Dump trucks will be utilized to transport concrete and masonry to a Subtitle D landfill for disposal or will be recycled, assuming it is below the radionuclide screening criteria. Special waste will be transported in dump trucks and disposed of at a Subtitle D landfill in northern Illinois. In total, 10 percent of the total excavated soil is anticipated to be disposed of as special waste. A compaction factor of 1.2 is applied to the fill material. A minimal amount of overburden material or material removed for excavation sloping purposes may be tested and used as clean backfill material if results meet clean backfill criteria. Demobilization will entail removal of staging areas including the water treatment equipment, support facilities, and loading area.

Restoration and Backfill: Since a waiver for site reconstruction was approved by CDOT, 26th Street will remain closed temporarily during and after site remediation until site development is completed. Restoration of 26th Street and associated gas, water, and electric utilities is not required because street realignment is expected during site development. However, the sewer beneath the northern portion of 26th Street , parallel to the northern site boundary, will be replaced after site remediation is complete. The 26th Street sewer must be replaced to maintain flow from two sewer pipes currently entering the 26th Street sewer from the property to the north. The 26th Street sewer will be replaced in-kind with 18-inch and 12-inch extra strength vitrified clay pipe, or equivalent, and reconnected to the existing sewer pipe leading to the South Dr. Martin Luther King Jr. Drive combined sewer.

Virgin stone will be used to backfill the excavation area to the ground surface, except in the stormwater basin and adjacent green space. In the stormwater basin and greenspace areas, virgin stone will be used as backfill to within 6 inches of final grade. Geotextile fabric, 6 inches of topsoil, and hydroseeded grass will overlay the virgin stone in these areas. Virgin stone backfill material will be comprised of CA-6 or similar clean granular material and may also include clean overburden. Excavated soil and stone utilized for onsite roadways and ramps may be used as additional backfill material, above the groundwater table, if field screening levels and analytical results do not exceed remediation objectives. This material will be compacted.

The steel sheet piling will be left in place and cut to a depth of 3 feet bgs or below the existing sewer piping from the north property (8 feet bgs) that will be reconnected to replacement sewers beneath 26th Street, as appropriate.

For temporary stormwater management until final development, a stormwater detention basin must be installed to meet rate and volume control requirements. The 13,793-square foot stormwater basin and greenspace area will be constructed along the western portion of the excavation area. The basin will be 2 feet deep and the outlet will be connected to the City's existing sewer on 26th Street with a new proposed manhole, in accordance with the site-specific stormwater management plan. Seeding and fertilization of basin and green space areas will be completed by either hydroseeding or air seeding, depending on the site conditions at the time.

Monitoring Activities: In addition to the on-site health physicist technicians, a health physicist supervisor and associated equipment will be on site to provide field screening, laboratory analysis, air monitoring, dosimetry data, and other data collected during the project. Costs include two G-M pancake detectors, 2x2 NaI/GPS combination, 2x2 NaI detector, Micro-R meter, alpha tray counter, lapel air samplers, high volume air samplers, NIST traceable check sources, external dosimetry for personnel, and field gamma spectroscopy system for onsite analysis. Particulate air monitoring will also be performed for the length of the project. Additional information regarding field sampling activities is provided in Section 7.0.

7.0 FIELD SCREENING SURVEYS AND SAMPLING ACTIVITIES

This section describes the procedures to be used to collect samples. Specifically, this section details the procedures and methods that will be used to collect soil, air, water, construction debris, radiological waste transportation, and backfill samples and to conduct radiological surveys. These field sampling activities will likely be conducted by the remediation oversight contractor and RSO except the waste transportation and water discharge sampling, which will likely be conducted by the excavation, transportation and disposal contractor.

7.1 FIELD SCREENING SURVEYS

The purposes of the soil radiation screening are (1) to assist in locating the limits of excavation before a final surface radiation survey is conducted and verification samples are collected, (2) to assist in separation of non-radiological material from radiological waste with contamination greater than the soil remediation criteria, and (3) to assist in separation of radiological waste into categories for appropriate disposal. These activities will be conducted with all or a subset of the following instruments: a 2x2 NaI detector, Ludlum Model 44-213 Field Instrument for Detecting Low Energy Radiation (FIDLER), and portable X-ray fluorescence (XRF) analyzer capable of detecting uranium. Each of these field screening instruments, and associated field screening survey activities are presented below.

Gamma Field Screening (Radium)

On-site soil radiation screening will be conducted during remediation using a 2x2 NaI detector. The survey meter will be calibrated in cpm using a traceable standard to establish a count rate correlation for 5.9 pCi/g of Ra-226. High-energy gamma rays from the decay of radium daughters are detectable by NaI detectors and other radiation monitoring instruments. Because of the wide range of radium concentrations on site, each detector used for soil screening must be equipped with a 6-inch lead collimator shield to reduce the effects of gamma "shine." The 2x2 NaI detector will detect primarily radium and daughters and is not effective for lower concentrations of uranium or thorium. However, sampling data shows that uranium and thorium at shallow depths is generally comingled with radium and will be excavated during the initial stages of removal. The purposes of the soil radiation screening are (1) to assist in locating the limits of excavation before a final surface radiation survey is conducted and verification samples are collected, (2) to assist in separation of non-radiological material from radiological waste with contamination greater than the soil remediation criteria, and (3) to assist in separation of radiological waste into categories for appropriate disposal. Relevant field action levels (FAL) for each NaI detector will be established before remediation begins by regression analysis of screening data from calibration blocks of known radium concentrations against actual instrument readings. Background radium concentrations will also be determined for each NaI detector before remediation begins.

Low-Energy Gamma Screening (Uranium)

A Ludlum 2221 Scaler/Ratemeter with attached Ludlum Model 44-213 Field Instrument for Detecting Low Energy Radiation (FIDLER) low energy gamma detector, or equivalent, may be used for gamma scans for uranium after areas have been cleaned of radium to background levels. FIDLER gamma scans are performed using the same scanning techniques as the 2x2 NaI scans. The FIDLER detector is capable of detecting uranium concentrations below the cleanup criteria of 22 pCi/g. Because of its high efficiency to low energy gamma radiation, any radium present above background concentrations will cause an overresponse, leading to potential false positive readings. However, radium contamination is anticipated to be limited to approximately 10 feet bgs.

XRF Screening (Uranium)

Although laboratory analytical results will provide the basis for remedial decisions; portable X-ray fluorescence (XRF) analyzers may be used to screen for uranium in soil above the existing water table. XRF analysis requires no signs of visible moisture. Guidance for using portable XRF analyzers in the field is provided by EPA SW-846 Method 6200, with relevant refinements to this method provided by the EPA Region 4 Superfund XRF Field Operations Guide (EPA 2017). Although the XRF may have difficulty accurately quantifying low concentrations of uranium, XRF screening may be used as a tool to guide excavation.

Field screening methods will depend on site conditions. If the excavation area is safe to enter, personnel will screen the soil in place by walking over the surface with a 2×2 NaI detector. Soil will be removed in vertical lifts no more than 18 inches thick, and the new surface again will be screened. If the area is unsafe to enter, each bucket of excavated soil will be screened with a handheld 2×2 NaI detector. If the excavated soil is too wet for immediate screening, then it may be placed temporarily on a sloped surface adjacent to the excavation to allow liquids to drain into the excavation before the material is processed further. Alternatively, the wet material may be spread in a layer no more than 18 inches thick on polyethylene sheeting or a dewatering pad to dry. When the soil is dry, personnel will screen it by traversing the surface with a 2x2 NaI detector and FIDLER, if appropriate. If the soil pile is more than 18 inches thick, soil will be removed from the pile in 18-inch lifts to allow for effective screening.

After the soil is segregated based on field screening with the 2x2 NaI and, if applicable, FIDLER detectors, each 20 CY soil pile will be sampled and analyzed for total radium using the on-site field gamma spectroscopy system and, if applicable, XRF analysis. Split samples will be collected as one composite sample per every 10 piles designated for off-site disposal. Samples will be submitted to approved laboratories for radium, uranium, and thorium analysis. Radium analytical results will be received within 30 days, after the required 21-day ingrowth period. However, preliminary radium results may be requested and received within 7 days. Thorium and uranium analytical results do not require ingrowth and can be received on an expedited basis if requested.

Radiological waste will be separated into categories for disposal at the appropriate facility based on average radionuclide concentrations measured by on-site field gamma spectroscopy, off-site laboratory data, or the corresponding average FAL, as appropriate.

Several soil samples analyzed on-site will be sent to an off-site laboratory for analysis. The on-site gamma spectroscopy, off-site laboratory, and, if appropriate, XRF samples will be collected and homogenized as a single sample before each sample is divided into appropriate aliquots (40 milliliter [mL] for on-site, 1,000 mL for off-site laboratory samples, and 8 ounces for XRF).

Soils with initial screening results no greater than the FAL will be moved to either (1) an on-site stockpile for potential use as site backfill subject to analytical testing, or (2) if non-radiological contamination is observed or material is not suitable fill, a separate on-site stockpile for temporary storage pending transport to an off-site facility for disposal as non-radiological special waste.

If field screening results indicate that soil at the bottom or on the side wall of the excavation exceeds the FALs, then the soil will be either (1) excavated in vertical or horizontal lifts no more than 18 inches thick until levels are below the FAL, or (2) further evaluated by collecting samples for field screening laboratory analysis to assess the actual concentration of areas with elevated count rates. This process will continue until screening results indicate that levels in the floor and sidewall soil are below the FAL or field screening laboratory results are below the soil remediation criteria and verification sampling can be conducted, or until the sidewall reaches the site boundary and cannot be extended farther.

7.2 PERIMETER AIR MONITORING

The RSO will use the existing four stationary low-volume air sampling stations along the north, south, east, and west site boundaries to determine if nearby populations are being exposed to airborne radionuclides at levels above acceptable limits. During the various phases of the remedial action, the air particulate monitoring stations may be moved, as appropriate to evaluate exposure, to the boundaries of the remedial action area rather than the boundaries of the entire site. Specifically, air samples will be collected continuously during operations that involve disturbance of potentially contaminated soils from sampling stations located to provide unobstructed airflow from the source to the stations. Air particulate samples will be collected weekly and analyzed as described below. The results will be evaluated in accordance with the site-specific EMP and QAPP (Tetra Tech 2015a and b).

The weekly air particulate samples will be composited and shipped quarterly for off-site analysis by a laboratory for radium, uranium, and thorium. Weekly samples will also be analyzed onsite using a Ludlum Model 2200 scaler with attached Model 43-10 alpha scintillation detector the day after they are collected for gross alpha radiation concentration. It is expected that naturally occurring radon and thorium daughters will interfere with analysis; therefore, the sample must be reanalyzed 4 days after collection if the "day after" sample exceeds background concentrations. Thoron (Rn-220), if present in significant amounts, will require up to 4 days to allow for the decay of its lead-212 daughter (10.6-hour half-life). The count, after 4 days decay, will serve as the official measurement of gross alpha radiation and will be compared with the natural uranium Class Y air effluent limit of 9 x 10^{-14} microcuries per milliliter, as specified in Table 2 of Appendix B to 10 CFR 20.

Background air quality has been established by previously conducted monitoring activities as described in Section 2.5. However, background gross-alpha radiation concentrations will be established by collecting one downwind perimeter air sample for a minimum of 24 hours before excavation begins. This sample will be analyzed using the same on-site methods described above, including a "day after" analysis as well as reanalysis after 4 days. Perimeter air monitoring results from on-site analysis will be reported to AIS, or designee, on a weekly basis.

Currently ongoing gamma radiation and radon passive air monitoring will continue throughout remediation in accordance with the existing EMP, QAPP, and relevant addenda (Tetra Tech 2015a, 2015b, and 2016b; 2FM 2019b).

7.3 DISPOSAL PARAMETER SAMPLING

Disposal parameter samples will be collected from the site. Samples of soil and construction debris will be collected and analyzed for special waste disposal parameters, as appropriate. Water samples will be collected and analyzed for compliance with MWRDGC discharge criteria. Samples will be analyzed for these analytical groups using appropriate EPA methods, as identified in Section 8.0. In addition, field conditions may warrant the analysis of radium in soil or construction debris samples by gamma spectroscopy in the on-site screening laboratory. Quality control (QC) samples (field duplicate and MS/MSD) will be collected for disposal parameter samples, as described in Section 12.0.

7.3.1 Soil

Radiological waste samples may be collected for off-site analysis at a rate of one composite sample per 10 loads transported for off-site disposal, or other appropriate frequency. This sampling plan will apply to each category of radiological waste based on the requirements of the radiological waste disposal facilities.

The radiological waste composite samples will consist of aliquots of soil obtained from several different excavator buckets or locations within the area to be excavated or from the 20-CY soil piles removed from the excavation area to provide a representative concentration of radium, uranium, and thorium in each approximately 22-ton load of soil to be disposed of offsite. The number of aliquots will depend on how well the soil is homogenized as it is being excavated, but a minimum of one aliquot will be collected per load. More aliquots may be collected, if needed, to obtain accurate average concentrations. The data from the radiological waste samples analyzed on-site and, if necessary, by the off-site laboratory will be used for waste manifesting and classification.

In addition to the radiological waste samples discussed above, representative samples will be collected from the site for soil designated for disposal as special waste and will be submitted for analysis of the disposal parameters listed in Table 2. These parameters include radium, uranium, thorium, toxicity characteristic leaching procedure (TCLP) VOCs, TCLP SVOCs, TCLP pesticides, TCLP herbicides, TCLP metals, total cyanide, reactive sulfide, paint filter liquids test, pH, ignitability, total PCBs, extractable organic halides (EOX), and total phenol.

Additional soil samples may be collected on an as-needed basis based on observed changes in soil conditions or to verify contaminant concentrations. The results will verify the constituents of concern before the soil is delivered to the off-site landfill. If rapid turnaround is needed based on field conditions, the on-site field laboratory may perform a screening analysis for radium to identify preliminary disposal options based on radium concentrations.

As needed before wet soils are transported, the remediation oversight contractor will perform the paint filter liquids test to evaluate whether free liquids are present. The test will be conducted on site according to EPA Solid Waste Test Method 9095b.

7.3.2 Water

Water — including rain water and groundwater from the excavation area, as well as decontamination water — will be collected in holding tanks or otherwise, as appropriate, during remediation. Samples for analysis of water disposal parameters will be collected by holding sample jars directly up to a sampling port located on the effluent piping of the treatment system or the associated effluent holding tank. These samples will be collected before the water is discharged to the MWRDGC or before off-site disposal. One sample will be collected for every 10,000 gallons of water discharged, or as required. The water disposal parameter samples will be analyzed for radium, uranium, thorium, VOCs, biochemical oxygen demand, fluoride, hexavalent chromium, total metals, total cyanide, sulfide, oil (hexane soluble), phenolics, total suspended solids, and pH.

7.3.3 Construction Debris

Construction debris, including metal fencing, concrete, asphalt, and trees, will be removed from the site during site preparation or prior to excavation activities. Subsurface debris may also be encountered during excavation. The debris will be screened for both fixed and removable contamination prior to disposal using a

Ludlum Model 3 Survey Meter with attached Model 44-9 pancake G-M probe, or equivalent, and wipe samples may be collected and analyzed using a Ludlum 2929 Scaler with attached Model 43-10-1 Alpha/Beta Scintillation Counter, or equivalent. If the debris exhibits contamination above field action levels (FAL) or soil remediation criteria, the debris will be disposed of as radioactive waste, as appropriate. If the ground surface directly beneath removed asphalt or concrete is found to be below the FALs or soil remediation criteria, the asphalt and concrete will be assumed to be clean and only bulk gamma surface screening surveys shall be performed. Asphalt and concrete that has not been in direct contact with contaminated soils are unlikely to be contaminated. If the debris does not exhibit contamination above FALs or soil remediation criteria, the remediation oversight contractor may collect solid samples from these materials to be tested for contamination to document that the debris meets special waste disposal or recycling requirements. Samples will be collected as needed, but will not likely exceed a frequency of one per type of material (such as metal, concrete, or wood). Additional samples may be collected if it is determined in the field that a similar type of debris may be subject to different levels of contamination (if, for example, it is in close proximity to hot spots). Samples will be analyzed for radium, uranium, thorium, total cyanide; reactive sulfide; TCLP VOCs; TCLP SVOCs; TCLP metals; TCLP pesticides; TCLP herbicides; EOX; total PCBs; total phenol; ignitability; pH; and paint filter liquids test. If rapid turnaround is needed based on field conditions, the on-site field laboratory may perform a screening analysis for radium to identify preliminary disposal options based on radium concentrations.

Sample material types (metal, concrete, wood, or other) will be described in the field notebook. Sample locations will be photographed and noted in the field notebook, to be surveyed later as needed by professional surveyors.

Grab samples will be collected using stainless steel spades, shovels, or scoops, or disposable sampling equipment, where possible. Other tools, such as hammers, chisels, saws, or other cutting tools, may be used, depending on the construction debris to be sampled. All tools will be either dedicated or have been pre-cleaned with a non-phosphate cleanser and deionized water rinse.

7.4 RADIOLOGICAL WASTE TRANSPORTATION SAMPLES

Each radiological waste transportation container will be screened to measure exposure rate and surface contamination. The transportation and disposal contractor will collect removable contamination wipe samples of each transportation container (dump trucks or intermodal containers) to measure transferable alpha and beta contamination. Wipe samples will be collected from each side of the transportation container over an area of 300 square centimeters for each surface of concern with an absorbent material, using moderate pressure. The radioactivity of the wipe sample will be measured at the on-site field laboratory using a Ludlum Model 2200 Scaler with attached Model 43-10 Alpha Scintillation Detector. Sufficient measurements will be taken in the most appropriate locations to yield a representative assessment of the non-fixed contamination levels. The wipe samples will document that external surface contamination requirements listed in 49 CFR 173, Subpart I, Section 173.443, are met.

Each container will also be screened using a Bicron MicroREM meter, or equivalent, to assess the dose rate of the container. The point with the highest dose rate for each container will be further screened at a distance of 1 meter from the container surface. External radiation dose rates of the shipping containers must comply with 49 CFR Section 173.441 and any landfill-specific requirements. The appropriate information will be documented and provided on the radioactive waste manifest paperwork, as required.

7.5 FINAL STATUS SURVEY

After excavation is complete, a final status survey will be conducted to document radiological conditions of the site in preparation for free release. The final status survey will consist of a surface radiation survey conducted using a NaI detector and, if applicable, a XRF or FIDLER survey will also be conducted. The NaI detector will measure the gamma radiation levels at the near surface of the excavation floor and sidewalls. The XRF or FIDLER will measure uranium concentrations. For grids or portions of grids that are below the water table and saturated, the saturated soil from the floor of the excavation may be brought to the surface in 6- to 18-inch lifts and recreated at the surface on polyethylene sheeting or a dewatering pad and allowed to dry. When the soil is dry, personnel will conduct the radiation survey by traversing the surface with a 2x2 NaI detector, FIDLER, and XRF, if appropriate. Grids that do not exhibit evidence of contamination at the surface, or at depth in adjacent grids, may be surveyed without excavation.

If the FAL count rate for either radium or uranium is exceeded in all or portions of a 100-square-meter area, then the elevated count rate areas will be either (1) additionally excavated in vertical or horizontal lifts no more than 18 inches thick until gamma radiation levels are below the FAL, or (2) further evaluated by collecting samples for on-site or off-site laboratory analysis (or both) to determine actual concentration of areas with elevated count rates. If results continue to exceed the FAL or soil remediation criteria, additional excavation will continue as indicated in item 1 above. If the results do not exceed the FAL or soil remediation criteria, then excavation will be considered complete and verification samples will be collected in accordance with verification sample collection procedures described below.

Readings will be collected from the floor of the excavation and the sidewalls. However, remediation oversight contractor personnel will mark any portion of the sidewall that exhibits gamma radiation at levels above the FAL, since GPS data may not be recorded for sidewall readings. When the final surface radiation survey does not identify any areas exceeding the FAL, verification samples will be collected to evaluate whether the soil remediation criteria have been achieved.

One verification grab sample of about 600 mg will be collected from each 100-square-meter grid section of the excavation bottom and, where applicable, sidewalls. Based on the proposed verification sampling grids presented in Figure 3, approximately 75 verification soil samples, including duplicates, will be collected. Verification samples may be collected directly by the field crew from the excavation floor (shallow excavations), or an excavator or backhoe may facilitate sample collection (deeper excavations). The sample will be collected over a depth profile of 15 centimeters below the surface, as required by Title 32, IAC, Part 340, Appendix A: Decontamination Guidelines. The samples will be collected using scoops, aluminum pans, or similar sampling devices.

The verification sample for each 100-square-meter area will be composed of five sample aliquots, with one sample aliquot from each 20-square-meter portion of the grid. For grid sections of less than 100 square meters, one sample aliquot will be collected per 20 square meters (the same ratio as for the 100-square-meter sections). At least two aliquots will be collected from any grid section.

The sample aliquots will be composited and homogenized into a single verification sample. The homogenized verification sample will be split into two separate aliquots; 100 mg of the verification sample will be submitted to the on-site field laboratory for preliminary gamma spectroscopy analysis of radium, and the remaining soil collected will be submitted to an off-site laboratory for analysis of radium, uranium, and Th-230 to confirm the removal of concentrations exceeding soil remediation criteria. The off-site laboratory will provide preliminary radium results after seven days, and final results will be provided after a 21-day in-growth period. Verification samples will be analyzed for radium, uranium, and thorium, as well as chemical parameters using appropriate methods, as identified in Section 8.0 of this decommissioning plan. Non-radiological results will be compared to residential criteria set forth in Title 35, IAC, Part 742, Appendix B, Table A, Tier 1 Soil Remediation Objectives for Residential Properties. QC samples (field duplicate) will be collected for verification samples, as described in Section 12.0.

The verification sample aliquots for analysis in the on-site laboratory will be placed in plastic resealable bags for transport to the field laboratory. Each sample will be noted on a field laboratory chain-of-custody form with a unique sample identification number, and the corresponding off-site laboratory sample identification number will be noted on the chain-of-custody form. Although no sample holding times apply, the sample will be analyzed as soon as possible using the on-site laboratory. Results will be reported daily.

Off-site laboratory analytical verification sample results for radium-226, total uranium, and thorium-230 will be provided to IEMA prior to excavation backfill. For radium-226, excavation backfill decisions may be made, in coordination with IEMA, based on preliminary off-site laboratory analytical results (*i.e.*, results received within approximately 7 days, which will not include the 21-day ingrowth period).

7.6 BACKFILL SAMPLES

After the excavation is complete and subsequent radiation surveys and verification sampling have been conducted to document that soil remediation criteria have been achieved, the excavation area will be backfilled to within 6 inches of final grade with virgin stone. The top 6 inches of the excavation will be backfilled with topsoil in the greenspace area and stormwater basin. The topsoil materials will be obtained from a local source and will meet design specifications. Prior to import, topsoil materials will be sampled for analysis of site-specific radiological COCs and the Illinois Environmental Protection Agency's Target Compound List (TCL) in Title 35, IAC, Part 740, Appendix A, Tables A through D to verify that the fill meets the site-specific soil remediation criteria and the most stringent criteria set forth in Title 35, IAC, Part 742, Appendix B, Tables A and B, Tier 1 Soil Remediation Objectives and/or the maximum allowable concentrations for chemical constituents in uncontaminated soils presented in Title 35, IAC, Part 1100, Subpart F. General fill materials, excluding topsoil, will be sampled for geotechnical parameters to provide data to be used to evaluate field compaction and lift intervals. The geotechnical parameters include moisture content, Atterberg limits, standard proctor, grain size, unit weight, and visual classification analysis. A quarry certification will be obtained for the virgin stone prior to commencement of backfilling activities.

Prior to import to the site, the topsoil source materials will be sampled for radiological and chemical parameters at a rate of one sample per 500 cubic yards. Each topsoil sample will be composed of five sample aliquots per about 500 cubic yards of backfill, which will be homogenized into a single composite soil sample. However, samples for analysis of VOCs will be collected separately as a single grab sample.

On-site excavation overburden or additional soil removed for excavation benching may be used as backfill in the excavation area. Any available on-site backfill will be sampled and analyzed to ensure that the backfill material does not exceed the soil remediation criteria. Each on-site stockpile to be used for backfill will be sampled at a rate of one five-point composite on-site screening laboratory sample per approximately 22 tons and one off-site laboratory sample per approximately 1,000 cubic yards (1,530 tons) of backfill material. Samples for analysis of VOCs will be collected first, placed directly into the appropriate sample container leaving no headspace (VOC samples will not be composited), followed by samples collected for the remaining contaminants. IEMA may also choose to sample or screen the overburden material.

7.7 POST-BACKFILL SURVEYS

The final status survey consists of conducting a final surface radiation survey after backfilling is complete within each 10 meter by 10-meter grid (EPA and others 2000). Measurements will be obtained using a

Ludlum Model 2221 Scaler/Ratemeter with attached Ludlum Model 44-10 2x2 NaI detector, or equivalent, coupled with a Trimble GeoExplorer 6000 Model GeoXH, or equivalent, to provide GPS data along with count rate data for each grid. Measurements will be taken while the NaI detector is held at approximately 2 inches (6 centimeters) above the ground surface while the surveyor walks a grid with serpentine traverses spaced no more than 1 meter apart. The survey will be conducted while the surveyor walks at a speed of approximately 0.5 meter (1.5 feet) per second. Surface radiation readings, along with GPS data, will be recorded at an interval of one reading per second.

8.0 LABORATORY ANALYTICAL METHODS

Table 2 presents the laboratory methods that will be used to analyze the samples collected during site decommissioning. Analytical services will be provided by accredited laboratories acceptable to IEMA. An on-site field laboratory will also analyze samples for total radium using gamma spectroscopy.

TABLE 2
ANALYTICAL METHODS SUMMARY

Parameter	Analytical Method
SOIL VERIFICATION SAMPLES	
Radium-226	EPA Method 901.1M and on-site gamma spectroscopy
Uranium (U-234, U-235 and -238)	HASL 300 U-02/A-01-R (alpha spectrometry) or EPA SW-846 Method 6020
Thorium-230	HASL 300 Th-01/A-01-R (alpha spectrometry)
VOC	EPA SW-846 Method 5035/8260
SVOC	EPA SW-846 Method 8270
Pesticides	EPA SW-846 Method 8081
Herbicides	EPA SW-846 Method 8151
PCB	EPA SW-846 Method 8082
Metals	EPA SW-846 Method 6020/7471
Total cyanide	EPA SW-846 Method 9012
pH	EPA SW-846 Method 9045
DISPOSAL PARAMETER SAMPLES	
Radiological Waste	
Radium (Ra-226 and -228)	EPA Method 901.1M and on-site gamma spectroscopy
Uranium (U-234, U-235 and -238)	HASL 300 U-02/A-01-R (alpha spectrometry) or EPA SW-846 Method 6020
Thorium-230	HASL 300 Th-01/A-01-R (alpha spectrometry)
Special Waste – Soil/Construction Debris	
TCLP VOCs	EPA SW-846 Method 8260
TCLP SVOCs	EPA SW-846 Method 8270
TCLP Pesticides	EPA SW-846 Method 8081
TCLP Herbicides	EPA SW-846 Method 8151
TCLP Metals	EPA SW-846 Method 6010/7470
Total Cyanide	EPA SW-846 Chapter 7 Section 7.3.3
Reactive Sulfide	EPA SW-846 Chapter 7 Section 7.3.4
Paint Filter Liquids Test	EPA SW-846 Method 9095
pH	EPA SW-846 Method 9045
Ignitability	EPA SW-846 Method 1010 or 1020
Total PCBs	EPA SW-846 Method 8082
Extractable organic halides (EOX)	EPA SW-846 Method 9023
Total Phenol	EPA Method 420.4
Radium (Ra-226 and -228)	EPA Method 901.1M and on-site gamma spectroscopy
Uranium (U-234, U-235 and -238)	HASL 300 U-02/A-01-R (alpha spectrometry) or EPA SW-846 Method 6020
Thorium-230	HASL 300 Th-01/A-01-R (alpha spectrometry)
Water	
Radium-226	EPA Method 903.1
Radium-228	EPA Method 904.0
Uranium (Uranium-234, -235, -238)	HASL 300 U-02/A-01-R (alpha spectrometry) or EPA SW-846 Method 6020
Thorium-230	HASL 300 Th-01/A-01-R (alpha spectrometry)
VOCs	EPA SW-846 Method 8260

Parameter	Analytical Method
BOD	EPA Method 405.1
Fluoride	EPA Method 300.0A
Sulfide	EPA SW-846 Chapter 7.3.4
Hexavalent chromium	EPA SW-846 Method 7196A
Total metals	EPA SW-846 Method 6010C/7470A
Total cyanide	EPA SW-846 Method 9012
Phenolics	EPA SW-846 Method 9066
Oil (hexane soluble)	EPA Method 1664
TSS	Standard Method 2540 D
pH	EPA SW-846 Method 9040
Backfill	
VOC	EPA SW-846 Method 5035/8260
SVOC	EPA SW-846 Method 8270
Pesticides	EPA SW-846 Method 8081
Herbicides	EPA SW-846 Method 8151
PCB	EPA SW-846 Method 8082
Metals	EPA SW-846 Method 6020/7471
Total cyanide	EPA SW-846 Method 9012
pH	EPA SW-846 Method 9045
Radium-226	EPA Method 901.1M
Uranium (Uranium-234, -235, -238)	HASL 300 U-02/A-01-R (alpha spectrometry) or EPA SW-846 Method 6020
Thorium-230	HASL 300 Th-01/A-01-R (alpha spectrometry)
Moisture content	ASTM D2974
Atterberg Limits	ASTM D4318
Standard Proctor	ASTM D698
Grain size	ASTM D422
Unit weight	ASTM D2937
Visual classification	ASTM D2488

Notes:

ASTM ASTM International
BOD Biochemical oxygen demand
EPA U.S. Environmental Protection Agency
PCB Polychlorinated biphenyl
SVOC Semivolatile organic compound
TCLP Toxicity characteristic leaching procedure
TSS Total suspended solids
VOC Volatile organic compound

See Section 15.0 for complete citation of references for analytical methods (EPA 2012b, 2019; ASTM 2007, 2009, 2010a, 2010b, 2012, 2014).

9.0 DECONTAMINATION PROCEDURES

This section specifies decontamination procedures to be implemented during sampling. Other decontamination procedures implemented before personnel or equipment leave the work zone within the radiological control areas (RCA) or in conjunction with any other activity when the potential for contamination transfer exists are specified in the HASP/RPP, which are among the site-specific plans to be prepared for this project.

During sampling, Tetra Tech will follow decontamination procedures as outlined below. Non-dedicated sampling equipment, such as stainless steel scoops, shovels, and bowls, will be decontaminated before samples are collected. During sampling operations, this sampling equipment will be cleaned using a non-phosphate detergent (such as Alconox) wash and a potable water rinse. Except for the detergent that will be used for the initial cleaning, the solutions used to decontaminate the field equipment will not be reused. Sampling equipment will be allowed to air dry outside of the RCA after it is decontaminated.

All water derived from decontamination procedures will be collected in an on-site storage tank for on-site treatment, sampling, and discharge to the MWRDGC. Water samples will be collected directly from the holding tank or treatment system spigot; therefore, decontamination procedures are not warranted.

Spent disposable personal protective equipment (PPE) will be disposed of with the radiological waste; therefore, decontamination procedures are not warranted.

10.0 DISPOSAL OF INVESTIGATION-DERIVED WASTE

Investigation-derived waste (IDW) is waste generated during field sampling or excavation at the Carnotite site that is suspected or known to be radiologically contaminated. IDW may include decontamination water, used sampling equipment (such as spoons, bowls, and unusable sample containers), and disposable PPE. In addition, IDW generated during previous investigations and currently staged onsite will be managed and disposed during remediation activities. On-site IDW includes water from sewer cleanout activities, monitoring well purge water, soil cuttings from monitoring well installation and soil borings, and plastic sleeves from soil borings. In general, IDW will be managed in accordance with the EPA's "Guide to Management of Investigation-Derived Waste," published by the EPA Office of Solid Waste and Emergency Response on January 15, 1992 (EPA 1992).

Decontamination water will be collected at a portable or temporary decontamination pad, which will be set up by a subcontractor. Water will be pumped from the decontamination pad into an on-site portable storage tank and treatment system. Before this water is discharged or transported and disposed of, disposal parameter samples will be collected as described in Section 7.3.2. Rain water or groundwater removed from the on-site excavation will be collected in the same manner.

Reusable sampling equipment and PPE waste will be surveyed for surface contamination. If the sampling equipment or PPE waste exceeds the surface contamination guide criteria in Title 32 IAC, Part 340, Appendix A, the waste will be transported off site for disposal as a radiological waste. If the equipment or PPE does not exceed the surface contamination guide criteria, it may be reused or transported off site for disposal as special waste or general refuse.

General refuse generated during field sampling or excavation will be disposed of in an on-site or off-site dumpster or other trash receptacles. General refuse is waste material generated outside the RCA that has not come in contact with contaminated environmental media and may include cardboard, plastic, paper, ice bags, and other uncontaminated refuse.

11.0 HEALTH AND SAFETY PROCEDURES

All field activities will be conducted in accordance with a decommissioning HASP/RPP, which will be prepared for IEMA’s review and approval before decommissioning begins. Separate decommissioning HASP/RPPs will be prepared by the remediation oversight contractor and the excavation, transportation, and disposal contractor to cover the activities to be conducted by each contractor. Decommissioning HASP/RPPs must be prepared in accordance with AIS’ site-specific HASP/RPP requirements.

Before field activities begin, all field personnel, including subcontractors, will read and sign the HASP/RPP that applies to their organization, indicating that they understand the plan and agree to operate in accordance with its requirements. Daily tailgate meetings will be conducted to review daily activities and task-specific hazards. All on-site personnel and subcontractors must have 40-hour hazardous waste and emergency response training, and proof of certification must be filed with the signed HASP/RPP. A complete copy of the site-specific plans, including contractor’s HASP/RPPs, will be maintained at the site. All personnel will also participate in site-specific radiation training conducted by the Radiation Safety Officers. Also, air monitoring will be conducted in excavation and loading areas and may require additional personal protective equipment if excess dust levels are detected. Detailed procedures for the personnel air monitoring will be provided in the decommissioning HASP/RPP.

12.0 QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

All quality assurance (QA) activities will be conducted in accordance with a decommissioning QAPP, which will be prepared for IEMA's review and approval before decommissioning begins. A copy of the QAPP will be maintained by the field sampling team for immediate use in resolving any QA issues that might arise during field activities.

QC samples will be collected at the following frequencies:

- Field Duplicate: One per 10 environmental samples will be collected, with a minimum of one per sample matrix.
- Trip Blank Samples: Trip blanks will not be included with sample shipments. No aqueous VOC samples are planned.
- Equipment Blank Samples: Equipment blanks will be collected daily after decontamination of non-disposable sampling equipment such as scoops and bowls.
- MS/MSD Samples: One per 20 environmental samples per matrix, excluding radiological samples, will be collected

Field duplicate samples consist of two separate samples collected from the same sampling location and depth, using the same equipment and sampling procedures.

MS/MSD is an environmental sample divided into two separate aliquots, each of which is spiked with known concentrations of target aliquots. The two spiked aliquots, in addition to an un-spiked sample aliquot, are analyzed separately and the results are compared to determine the effects of the matrix on the precision and accuracy of the analysis. For groundwater samples, the MS/MSD requires collecting triple sample volume, while for solid matrices, the MS/MSD does not require collection of extra volume. All samples should be identified as MS/MSD for the laboratory.

13.0 SITE COORDINATION

Coordination with neighboring property owners north of the site and with Metra, which operates an adjacent commuter rail passenger station at 27th Street, is ongoing. Along the northwest portion of the licensed area, 26th Street is an open public roadway that provides access to the former Advocate Medical Group facility located at 2545-55 S. Dr. Martin Luther King Jr. Drive. Before that roadway can be closed for site decommissioning activities, AIS, or designee, will communicate with the property owner, King Sykes, LLC, to notify the current facility occupants of the date of closure. The 2545-55 S. Dr. Martin Luther King Jr. Drive facility must be accessed from one of two alternative driveways located north of 26th Street for the duration of the decommissioning activities. In addition, an access agreement with the current property owner may be required to access the parking lot area to place barriers adjacent to excavation areas for excavation safety purposes. Also, AIS continues to discuss with the north property owner the potential for soil excavation on the north property for sidewall sloping purposes in lieu of sheet piling.

The pedestrian walkway that traverses the licensed area along 26th Street and South Ellis Avenue and provides public access to the Metra Electric District line 27th Street station also must be closed during decommissioning. AIS has coordinated with Metra regarding notification of passengers and identified the need for pedestrian wayfinding signage to direct Metra passengers to the 27th Street station via 29th Street, Vernon Avenue, and Ellis Avenue upon closure of 26th Street. The wayfinding signage will be installed before closing 26th Street.

Additional coordination or notification may also be required for the adjacent Prairie Shores Apartments and other neighbors that may be affected by decommissioning activities.

14.0 REFERENCES

AECOM Technical Services, Inc. (AECOM). 2011a. "Interior Radiological Survey Results for Building No. 1, Former Carnotite Reduction Company Investigation." Prepared for the Chicago Public Building Commission (PBC). January 26.

AECOM. 2011b. "Radiological Surface Gamma Survey Results – Former Carnotite Reduction Company Investigation." Prepared for PBC. February 8.

AECOM. 2012a. "Final Subsurface Gamma Screening Results." June 11.

AECOM. 2012b. "Radiological Surface Surveillance of Demolition Operations for Building No. 1." October 22.

AECOM. 2012c. "Radiological Surface Gamma Survey Results-Areas A & B." October 31.

AECOM. 2013. "Radiological Surface Gamma and Dose Rate Survey Results." June 28.

AECOM. 2014. "Subsurface Gamma Screening Report – Former Michael Reese Hospital Campus." May 22.

ASTM International (ASTM). 2007. "Standard Test Method for Particle-Size Analysis of Soils." ASTM D422-63(2007)e2.

ASTM. 2009. "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)." ASTM D2488-09a.

ASTM. 2010a. "Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method." ASTM D2937-10.

ASTM. 2010b. "Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils." ASTM D4318-10e1. ASTM D698-12e1.

ASTM. 2012. "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3))." ASTM D698-12e1.

ASTM. 2014. "Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils." ASTM D2974-14.

Carnow, Conibear & Associates. 2012. Letter Report Summarizing the Underground Storage Tanks at the Former Michael Reese Hospital Site, Building 1, and Their Status. July 19.

CH2MHILL. 2008. "Phase II Environmental Site Assessment Report – Micheal Reese Hospital Site, Chicago, Illinois." August.

City of Chicago Department of Fleet and Facility Management (2FM). 2013. Correspondence Regarding Illinois Emergency Management Agency Radioactive Material Storage License Application and Planned Investigations at the Carnotite Reduction Company Site. From Kimberly Worthington, Deputy Commissioner, Bureau of Environmental, Health, and Safety Management. To Samuel Borries, U.S. Environmental Protection Agency (EPA), Region 5. October 2.

2FM. 2015a. Partial Notice to Proceed for Task Order Request 14-2FMEHS-00018, Carnotite Reduction Radioactive Licensing and Remediation Oversight, Specification # 110564, PO # 29555. March 4.

2FM. 2015b. "Radioactive Facility License Application, Former Carnotite Reduction Company, 434 E. 26th Street, Chicago, Illinois." May 13.

2FM. 2019a. Correspondence Regarding Alternative Disposal Methodology Application. From Kimberly Worthington, PE, LEED AP, Deputy Commissioner. To Kelly Horn, Section Head, Environmental Management, Bureau of Radiation Safety, Illinois Emergency Management Agency (IEMA). October 24.

2FM. 2019b. Correspondence Regarding Radon Monitoring Vendor Change. From Kimberly Worthington, PE, LEED AP, Deputy Commissioner. To Kelly Horn, Section Head, Environmental Management, Bureau of Radiation Safety, IEMA. March 5.

City of Chicago Department of Transportation (CDOT). 2019. "Restoration Waiver Request for Carnotite Reduction Company Remediation Project, 434 E. 26th Street." Email correspondence from Michael Simon, CDOT, to Abigail Mazza, 2FM, approving the restoration waiver. June 11.

Environmental Design International, Inc. (EDI). 2008. "Phase I Environmental Site Assessment Update Report – Micheal Reese Hospital and Medical Center, Chicago, Illinois." August.

EDI. 2009. "Addendum #1: Phase I Environmental Site Assessment Update Report – Micheal Reese Hospital and Medical Center, Chicago, Illinois." June.

EDI. 2019a. Plat of Topography, 26th Street Topographic Survey. February 25.

EDI. 2019b. Plat of Topography, 26th Street Topographic Survey (including select sewers and surface flow on portions of the north property). August 23.

GSG Consultants, Inc. (GSG). 2019a. "Geotechnical Investigation Report, Sheet Pile Wall Design, 434 East 26th Street, Chicago, Illinois." January 25.

GSG. 2019b. "Geotechnical Engineering Services, Former Carnotite Reduction Company Site – Excavation Plan." July 30.

HBK Engineering, LLC (HBK). 2012. "ALTA/ASCM Land Title Survey or Plat of Survey." April.

Illinois Department of Public Health (IDPH). 1979. Letter to City of Chicago, Department of Environmental Control, re: preliminary radiation survey conducted at the Michael Reese Hospital site. March 29.

IDPH. 2013. "Letter Health Consultation – Carnotite Reduction Company Site, Chicago, Illinois." December.

Illinois Emergency Management Agency (IEMA). 2007. "Decommissioning Guidance for Radioactive Materials Licensees, Revision 0." Division of Nuclear Safety, Bureau of Environmental Safety. February 2007.

IEMA. 2013. "Response to Prairie Shores Apartments – Radiological Investigations." March.

IEMA. 2015. Correspondence Regarding Radioactive Material License IL-02467-01, including attached license. From Kelly Horn, Section Head, Environmental Management, Bureau of Radiation Safety. To Abby Mazza, P.E., Environmental Engineer III, 2FM. July 10.

IEMA. 2016. Correspondence Regarding Amendment Number 1 of Radioactive Material License IL-02467-01, including attached license amendment. From Kelly Horn, Section Head, Environmental

Management, Bureau of Radiation Safety. To Abby Mazza, P.E., Environmental Engineer III, 2FM. July 18.

IEMA. 2017a. Correspondence Regarding Amendment Number 2 of Radioactive Material License IL-02467-01, including attached license amendment. From Kelly Horn, Section Head, Environmental Management, Bureau of Radiation Safety. To Abby Mazza, P.E., Environmental Engineer III, 2FM. November 27.

IEMA. 2017b. Correspondence Regarding Granting Relief from Environmental Monitoring Requirements in Radioactive Materials License IL-02467-01 for the Carnotite site. From Kelly Horn, Section Head, Environmental Management, Bureau of Radiation Safety. To Kimberly Worthington, P.E., Deputy Commissioner, 2FM. March 20.

IEMA. 2017c. Correspondence Regarding Radioactive Materials License IL-02467-01, Public Dose Evaluation Review. From Kelly Horn, Section Head, Environmental Management, Bureau of Radiation Safety. To Kimberly Worthington, P.E., Deputy Commissioner, 2FM. October 31.

IEMA. 2018a. Correspondence Regarding Amendment Number 3 of Radioactive Material License IL-02467-01, including attached license amendment. From Kelly Horn, Section Head, Environmental Management, Bureau of Radiation Safety. To Abby Mazza, P.E., Environmental Engineer III, 2FM. October1.

IEMA. 2018b. Correspondence Regarding Comments on Pre-Design Investigation Summary Report and ALARA Requirements for Background. From Kelly Horn, Section Head, Environmental Management, Bureau of Radiation Safety. To Abby Mazza, P.E., Environmental Engineer III, 2FM. October 19.

IEMA. 2018c. Correspondence Regarding Review Comments on Draft Decommissioning Plan, Radioactive Materials License IL-02467-01. From Kelly Horn, Head of Environmental Management, Bureau of Radiation Safety. To Kimberly Worthington, P.E., Deputy Commissioner, 2FM. August 9.

IEMA. 2019a. Correspondence Regarding Comments on Decommissioning Plan. From Kelly Horn, Section Head, Environmental Management, Bureau of Radiation Safety. To Abby Mazza, P.E., Environmental Engineer III, 2FM. March 8.

IEMA. 2019b. Correspondence Regarding Alternative Disposal Methodology Application. From Kelly Horn, Section Head, Environmental Management, Bureau of Radiation Safety. To Abby Mazza, P.E., Environmental Engineer III, 2FM. November 25.

IEMA. 2020. Correspondence Regarding Review Comments on Decommissioning Plan, Revision 3, Radioactive Materials License IL-02467-01. From Kelly Horn, Head of Environmental Management, Division of Nuclear Safety. To Kimberly Worthington, P.E., Deputy Commissioner, 2FM. April 13.

Office of the Illinois State Fire Marshal (OSFM). 2012. “Notification Form for Underground Storage Tanks.” Regarding Abandonment In Place of Underground Storage Tank 2 at the Former Michael Reese Hospital Site. August.

Prairie Shores Apartments (Prairie Shores). 2013. “Prairie Shores Apartments – Radiological Investigations.” February.

Tetra Tech, Inc (Tetra Tech). 2015a “Environmental Monitoring Plan, Former Carnotite Reduction Company Site, 434 East 26th Street, Chicago, Illinois.” May 28.

Tetra Tech. 2015b. "Quality Assurance Project Plan For Environmental Monitoring, Former Carnotite Reduction Company Site, 434 East 26th Street, Chicago, Illinois." June.

Tetra Tech. 2015c. Correspondence Regarding Environmental Monitoring Plan and Quality Assurance Project Plan – Addenda, Sewer Monitoring, including Addenda. From Kristine Schnoes, Project Manager. To Kelly Horn, IEMA. November 10.

Tetra Tech. 2015d. "Health and Safety and Radiation Protection Plan, Former Carnotite Reduction Company Site, 434 East 26th Street, Chicago, Illinois." December.

Tetra Tech. 2016a. "Dose Assessment Report for Uranium Soil Cleanup Objective Determination, Former Carnotite Reduction Company Site." October.

Tetra Tech. 2016b. Correspondence Regarding Environmental Monitoring Plan and Quality Assurance Project Plan – Addenda 2, Radon Monitoring, including Addenda. From Kristine Schnoes, Project Manager. To Kelly Horn, IEMA. June 27.

Tetra Tech. 2017a. Correspondence Regarding Surface Soil Sampling, Former Carnotite Reduction Company Site. From Kristine Schnoes, Project Manager. To Kelly Horn, IEMA. May 10.

Tetra Tech. 2017b. "Annual Environmental Monitoring Report, Fourth Quarter 2015 through Third Quarter 2016, Former Carnotite Reduction Company Site." January 10.

Tetra Tech. 2017c. "Public Dose Evaluation, IEMA Radioactive Materials License No. IL-02467-01, Former Carnotite Reduction Company Site." September 8.

Tetra Tech. 2018a. "Pre-Design Investigation Summary Report, Former Carnotite Reduction Company Site." Prepared for 2FM. October 2.

Tetra Tech. 2018b. "Annual Environmental Monitoring Report, Fourth Quarter 2016 through Third Quarter 2017, Former Carnotite Reduction Company Site." January 12.

Tetra Tech. 2018c. "Public Dose Evaluation, IEMA Radioactive Materials License No. IL-02467-01, Former Carnotite Reduction Company Site." August 27.

Tetra Tech. 2019a. "Hydrogeologic Assessment, Former Carnotite Reduction Company Site." January 14.

Tetra Tech. 2019b. "Investigation Summary Report – January/March 2019 Sampling Events, Former Carnotite Reduction Company Site." July 31.

Tetra Tech. 2019c. "Summary of Sewer Cleanout and Investigation, Former Carnotite Reduction Company Site." October 7.

Tetra Tech. 2019d. "Annual Environmental Monitoring Report, Fourth Quarter 2017 through Third Quarter 2018, Former Carnotite Reduction Company Site." January 24.

Tetra Tech. 2019e. "Former Carnotite Reduction Company Site Remediation Stormwater Management Plan." November 13.U.S. Environmental Protection Agency (EPA). 1992. "Guide to Management of Investigation-Derived Waste." Office of Solid Waste and Emergency Response. January 15.

Tetra Tech. 2020a. "Investigation Summary Report – Hand Boring Investigation – February 2020, Former Carnotite Reduction Company Site." April 20.

Tetra Tech. 2020b. "Annual Environmental Monitoring Report and Public Dose Evaluation, Fourth Quarter 2018 through Third Quarter 2019, Former Carnotite Reduction Company Site." January 23.

U.S. Environmental Protection Agency (EPA). 2009. "Carnotite Surface Survey." December.

EPA. 2012a. "Carnotite Nearby Properties, Vicinity Properties, Prairie Shores Parks Total Gamma cps Surveys." June.

EPA. 2012b. EPA Standardized Analytical Methods. On-line Address: http://www.epa.gov/sam/.

EPA. 2013. "Carnotite Reduction/Michael Reese Site, Chicago, Illinois Cleanup Estimate." May.

EPA. 2017. Superfund X-Ray Fluorescence Field Operations Guide. SFDGUID-001-R0. July.

EPA. 2019. Hazardous Waste Test Methods, SW-846, Update VI, Phase 3. May. https://www.epa.gov/hw-sw846/sw-846-compendium

U.S. Patent Office. 1916. "Herbert N. McCoy, of Chicago, Illinois, Process for Concentrating Carnotite Sandstone." August 22.

U.S. Patent Office. 1919. "Herbert N. McCoy, of Chicago, Illinois, Assignor to Carnotite Reduction Company, of Chicago, Illinois, a Corporation of Colorado, Art of Recovering Radium." January 21.

TABLE 3

Table 3
Soil Analytical Results Summary
Former Carnotite Reduction Company Site

Sample Location	Sampling Depth (ft bgs)	Sample Date	Units	Radium-226		Radium-228		Total Radium	Radium-226 SRC	Thorium-230		Thorium-230 SRC	Uranium-234		Uranium-235		Uranium-238		Total Uranium	Total Uranium SRC ≤5 meters bgs	Total Uranium SRC >5 meters bgs
				Result	Uncertainty	Result	Uncertainty			Result	Uncertainty		Result	Uncertainty	Result	Uncertainty	Result	Uncertainty			
2012 Soil Investigation [a]																					
A-12	2	4/22/2011	pCi/g	**56.96**	NA	1.94	NA	58.90	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	**24.66**	22	52
A-6	2	4/22/2011	pCi/g	**13.66**	NA	0.83	NA	14.49	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	17.12	22	52
B-11	2	4/25/2011	pCi/g	**364.56**	NA	2.15	NA	366.7	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	**78.18**	22	52
B-4	2	4/22/2011	pCi/g	2.22	NA	0.53	NA	2.75	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	2.79	22	52
C-13	2	4/18/2011	pCi/g	5.69	NA	1.03	NA	6.71	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	4.01	22	52
D-12	2	4/18/2011	pCi/g	**5.91**	NA	0.81	NA	6.72	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	7.35	22	52
D-4	2	4/25/2011	pCi/g	1.08	NA	0.34	NA	1.42	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	1.98	22	52
D-7	1	4/25/2011	pCi/g	**240.05**	NA	5.64	NA	245.69	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	**157.59**	22	52
E-10	1	4/20/2011	pCi/g	**77.46**	NA	1.45	NA	78.91	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	ND	22	52
E-7	2	4/26/2011	pCi/g	**6.28**	NA	0.57	NA	6.85	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	6.47	22	52
F-11	1	4/18/2011	pCi/g	5.22	NA	0.66	NA	5.88	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	6.35	22	52
G-11	2	4/18/2011	pCi/g	1.55	NA	3.70	NA	5.25	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	10.28	22	52
G-12	2	4/18/2011	pCi/g	**527.66**	NA	2.32	NA	529.98	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	**31.84**	22	52
G-6#	1	4/28/2011	pCi/g	2.70	NA	0.45	NA	3.15	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	4.33	22	52
G-8	2	4/21/2011	pCi/g	**109.08**	NA	1.26	NA	110.34	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	**54.45**	22	52
H-10	1	4/20/2011	pCi/g	**31.57**	NA	1.00	NA	32.57	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	ND	22	52
H-4	2	4/26/2011	pCi/g	1.33	NA	0.76	NA	2.09	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	1.19	22	52
H-7#	2	4/28/2011	pCi/g	0.44	NA	1.58	NA	2.02	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	3.9	22	52
H-7#	5	4/28/2011	pCi/g	1.39	NA	0.91	NA	2.3	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	3.95	22	52
I-8#	2	4/29/2011	pCi/g	1.59	NA	0.76	NA	2.34	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	2.15	22	52
I-9	1	4/21/2011	pCi/g	**9.72**	NA	0.46	NA	10.18	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	6.44	22	52
J-10	1	4/24/2011	pCi/g	4.51	NA	0.52	NA	5.03	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	4.55	22	52
J-13	2	4/19/2011	pCi/g	**8.78**	NA	0.59	NA	9.37	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	3.18	22	52
K-13	2	4/15/2011	pCi/g	**7.53**	NA	0.57	NA	8.11	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	1.72	22	52
L-19	2	4/13/2011	pCi/g	1.33	NA	0.44	NA	1.77	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	1.45	22	52
M-12	2	4/28/2011	pCi/g	2.06	NA	0.52	NA	2.58	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	2.45	22	52
M-15	2	4/15/2011	pCi/g	**6.30**	NA	0.39	NA	6.7	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	1.09	22	52
M-22	2	4/13/2011	pCi/g	4.57	NA	0.61	NA	5.18	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	0.63	22	52
N-14	1	4/28/2011	pCi/g	1.89	NA	0.32	NA	2.21	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	1.29	22	52
N-19	1	4/27/2011	pCi/g	**14.99**	NA	0.71	NA	15.71	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	15.09	22	52
N-22	1	4/27/2011	pCi/g	**11.00**	NA	0.64	NA	11.64	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	5.57	22	52
N-27	1	4/12/2011	pCi/g	3.73	NA	0.47	NA	4.2	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	3.36	22	52
O-17	2	4/14/2011	pCi/g	2.18	NA	0.56	NA	2.74	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	1.56	22	52
O-23	2	4/14/2011	pCi/g	1.34	NA	0.45	NA	1.78	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	1.74	22	52
O-26	2	4/14/2011	pCi/g	**14.67**	NA	0.63	NA	15.29	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	3.68	22	52
O-28	2	4/26/2011	pCi/g	1.74	NA	0.88	NA	2.62	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	2.31	22	52
P-19	2	4/29/2011	pCi/g	0.86	NA	0.44	NA	1.3	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	1.69	22	52
Q-24	2	5/3/2011	pCi/g	**16.48**	NA	0.64	NA	17.12	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	**36.71**	22	52
A-6	5	4/22/2011	pCi/g	0.50	NA	0.34	NA	0.85	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	9.89	22	52
A-8	10	4/22/2011	pCi/g	1.34	NA	0.71	NA	2.05	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	**2990.19**	22	52
B-6	3	4/22/2011	pCi/g	**28.56**	NA	3.00	NA	31.56	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	**2434.95**	22	52
B-8	3	4/25/2011	pCi/g	**274.19**	NA	3.76	NA	277.96	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	**162.16**	22	52
B-8	11	4/25/2011	pCi/g	1.27	NA	0.65	NA	1.92	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	**3310.75**	22	52
B-9	4	4/25/2011	pCi/g	**18.91**	NA	2.60	NA	21.52	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	**2444.96**	22	52
B-9	7	4/25/2011	pCi/g	**52.13**	NA	3.49	NA	55.63	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	**3670.42**	22	52
C-10	7	4/20/2011	pCi/g	**16.37**	NA	0.37	NA	16.74	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	**261.89**	22	52
E-12	5	4/18/2011	pCi/g	**1124.31**	NA	56.33	NA	1180.63	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	**826.36**	22	52
E-3	3	4/26/2011	pCi/g	1.02	NA	0.5	NA	1.52	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	ND	22	52
F-5	7	4/26/2011	pCi/g	3.72	NA	0.67	NA	4.4	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	3.77	22	52
G-8	3	4/21/2011	pCi/g	4.91	NA	0.79	NA	5.7	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	**27.30**	22	52
H-12	4	4/19/2011	pCi/g	**61.78**	NA	1.39	NA	63.16	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	11.11	22	52
H-6	3	4/26/2011	pCi/g	2.33	NA	0.34	NA	2.67	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	2.02	22	52
J-13	3	4/19/2011	pCi/g	**7.56**	NA	0.39	NA	7.95	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	4.26	22	52
J-15	9	4/19/2011	pCi/g	0.67	NA	0.31	NA	0.98	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	1.08	22	52
K-12	3	4/15/2011	pCi/g	3.83	NA	0.65	NA	4.48	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	6.2	22	52
M-15	3	4/15/2011	pCi/g	**8.06**	NA	0.40	NA	8.46	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	1.86	22	52
O-23	3	4/14/2011	pCi/g	**100.14**	NA	3.23	NA	103.37	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	**44.12**	22	52
R-25	3	5/3/2011	pCi/g	**48.43**	NA	1.17	NA	49.61	5.9	NA	NA	5.5	NA	NA	NA	NA	NA	NA	16.12	22	52

Table 3
Soil Analytical Results Summary
Former Carnotite Reduction Company Site

Sample Location	Sampling Depth (ft bgs)	Sample Date	Units	Radium-226		Radium-228		Total Radium	Radium-226 SRC	Thorium-230		Thorium-230 SRC	Uranium-234		Uranium-235		Uranium-238		Total Uranium	Total Uranium SRC ≤5 meters bgs	Total Uranium SRC >5 meters bgs
				Result	Uncertainty	Result	Uncertainty			Result	Uncertainty		Result	Uncertainty	Result	Uncertainty	Result	Uncertainty			
2017 Soil Investigation [b]																					
SS-01	2.5	4/3/2017	pCi/g	**592.00**	± 61.80	0.96 U	± 1.18	592	5.9	**445.00**	37.6	5.5	NA	NA	6.55	± 5.24	41.4	± 20.8	**47.95**	22	52
SS-02	1	4/3/2017	pCi/g	**57.90**	± 6.15	1.26	± 0.61	59.2	5.9	**106.00**	9.20	5.5	NA	NA	3.51	± 1.19	33.0	± 6.25	**36.51**	22	52
2018 Predesign Investigation [c]																					
CRC-B1-0002	0 to 2	7/10/2018	pCi/g	**11.3** J-	± 1.29	0.341 U	± 0.579	11.3 J-	5.9	**36.3**	± 3.32	5.5	5.07	± 0.617	1.27	± 0.708	5.38	± 0.644	11.7	22	52
CRC-B1-0406	4 to 6	7/10/2018	pCi/g	NA	NA	NA	NA	NA	5.9	1.11	± 0.227	5.5	3.05	± 0.424	0.0986	± 0.0705	3.09	± 0.427	6.24	22	52
CRC-B1-1214	12 to 14	7/10/2018	pCi/g	0.338	± 0.126	0.442	± 0.162	0.78	5.9	0.32	± 0.16	5.5	0.322	± 0.124	0.0596 U	± 0.137	0.617 U	± 1.02	0.322	22	52
CRC-B1-1820	18 to 20	7/10/2018	pCi/g	0.329	± 0.138	0.272 U	± 0.267	0.329	5.9	0.343	± 0.158	5.5	0.229	± 0.106	0.0228 U	± 0.0405	0.667 U	± 0.509	0.229	22	52
CRC-B3-0204	2 to 4	7/12/2018	pCi/g	1.19	± 0.250	0.411	± 0.305	1.60	5.9	0.803	± 0.226	5.5	0.700	± 0.182	0.151 U	± 0.295	0.795	± 0.195	1.50	22	52
CRC-B3-0608	6 to 8	7/12/2018	pCi/g	0.26	± 0.115	0.182 U	± 0.193	0.260	5.9	0.326	± 0.156	5.5	0.222	± 0.108	0.000 U	± 0.00567	1.4	± 0.860	1.62	22	52
CRC-B3-1618	16 to 18	7/12/2018	pCi/g	0.594	± 0.207	0.227 U	± 0.305	0.594	5.9	0.536	± 0.190	5.5	0.415	± 0.141	-0.323 U	± 0.44	0.462	± 0.149	0.877	22	52
CRC-B4-0608	6 to 8	7/26/2018	pCi/g	NA	NA	NA	NA	NA	5.9	0.451	± 0.162	5.5	0.229	± 0.091	0.0000 U	± 0.00532	0.220	± 0.089	0.449	22	52
CRC-B4-1012	10 to 12	7/26/2018	pCi/g	0.304	± 0.0999	0.164	± 0.131	0.468	5.9	0.204	± 0.120	5.5	0.265	± 0.100	0.0111 U	± 0.034	0.115	± 0.0648	0.380	22	52
CRC-B4-1820	18 to 20	7/26/2018	pCi/g	0.457	± 0.181	0.549	± 0.176	1.01	5.9	0.458	± 0.153	5.5	0.417	± 0.130	0.0459	± 0.046	0.493	± 0.142	0.956	22	52
CRC-B4-2628	26 to 28	7/26/2018	pCi/g	0.703	± 0.192	0.495	± 0.261	1.20	5.9	0.429	± 0.152	5.5	0.389	± 0.122	0.0421	± 0.0423	0.454	± 0.130	0.885	22	52
CRC-B5-0204	2 to 4	7/30/2018	pCi/g	NA	NA	NA	NA	NA	5.9	**8.76**	± 0.920	5.5	1.72	± 0.289	0.0536 U	± 0.051	1.67	± 0.283	3.39	22	52
CRC-B5-0608	6 to 8	7/30/2018	pCi/g	NA	NA	NA	NA	NA	5.9	0.182	± 0.118	5.5	0.244	± 0.0963	0.00845 U	± 0.0232	0.187	± 0.084	0.431	22	52
CRC-B5-1214	12 to 14	7/30/2018	pCi/g	0.294	± 0.128	0.234	± 0.150	0.528	5.9	0.256	± 0.127	5.5	0.277	± 0.101	0.0215 U	± 0.136	0.215	± 0.089	0.492	22	52
CRC-B5-1618	16 to 18	7/30/2018	pCi/g	0.437	± 0.157	0.181 U	± 0.330	0.437	5.9	0.545	± 0.178	5.5	0.294	± 0.0999	0.00975 U	± 0.0195	0.422	± 0.120	0.716	22	52
CRC-B5-2224	22 to 24	7/30/2018	pCi/g	0.344	± 0.0925	0.193 U	± 0.240	0.344	5.9	0.543	± 0.172	5.5	0.310	± 0.114	0.0986 U	± 0.155	0.261	± 0.104	0.571	22	52
CRC-B5-2830	28 to 30	7/30/2018	pCi/g	0.912	± 0.238	0.656	± 0.271	1.57	5.9	0.515	± 0.165	5.5	0.489	± 0.132	0.0298	± 0.0345	0.382	± 0.115	0.901	22	52
CRC-B6-0204	2 to 4	7/11/2018	pCi/g	NA	NA	NA	NA	NA	5.9	**11.6**	± 1.17	5.5	5.07	± 0.604	0.214	± 0.0998	4.88	± 0.587	10.2	22	52
CRC-B6-1618	16 to 18	7/11/2018	pCi/g	0.405	± 0.139	0.432	± 0.149	0.837	5.9	0.406	± 0.17	5.5	0.347	± 0.125	0.150 U	± 0.455	0.317	± 0.119	0.664	22	52
CRC-B6-2426	24 to 26	7/11/2018	pCi/g	0.885	± 0.223	0.530	± 0.217	1.42	5.9	0.391	± 0.165	5.5	0.339	± 0.124	0.0488 U	± 0.196	2.01	± 1.18	2.35	22	52
CRC-B7-0204	2 to 4	7/11/2018	pCi/g	**135**	± 14.2	0.877 U	± 1.95	135	5.9	**165**	± 14.1	5.5	56	± 5.03	5.4	± 3.07	54.6	± 4.91	**116**	22	52
CRC-B7-0406	4 to 6	7/11/2018	pCi/g	NA	NA	NA	NA	NA	5.9	2.65	± 0.393	5.5	7.39	± 0.817	0.414	± 0.144	7.5	± 0.826	15.3	22	52
CRC-B7-1416	14 to 16	7/11/2018	pCi/g	0.422	± 0.168	0.335	± 0.154	0.757	5.9	0.385	± 0.172	5.5	0.315	± 0.123	0.0778 U	± 0.198	0.312	± 0.12	0.627	22	52
CRC-B7-2224	22 to 24	7/11/2018	pCi/g	0.671	± 0.189	0.16 U	± 0.286	0.671	5.9	0.491	± 0.175	5.5	0.582	± 0.161	0.133 U	± 0.604	0.604	± 0.163	1.186	22	52
CRC-B7-2628	26 to 28	7/11/2018	pCi/g	0.47	± 0.153	0.657	± 0.214	1.127	5.9	0.34	± 0.165	5.5	1.14	± 0.236	0.219 U	± 0.187	1.42	± 0.269	2.56	22	52
CRC-B9-0406	4 to 6	7/12/2018	pCi/g	0.956	± 0.213	0.318 U	± 0.256	0.956	5.9	1.00	± 0.225	5.5	0.523	± 0.143	0.0653	± 0.0536	0.565	± 0.149	1.15	22	52
CRC-B9-1416	14 to 16	7/12/2018	pCi/g	0.342	± 0.110	0.140 U	± 0.189	0.342	5.9	0.408	± 0.172	5.5	0.276	± 0.114	0.135 U	± 0.294	0.340	± 0.127	0.616	22	52
CRC-B9-2022	20 to 22	7/12/2018	pCi/g	0.592	± 0.172	0.356	± 0.267	0.948	5.9	0.382	± 0.165	5.5	0.259	± 0.107	0.128 U	± 0.320	0.356	± 0.124	0.615	22	52
CRC-B11-0204	2 to 4	7/30/2018	pCi/g	**8.82**	± 1.08	1.04	± 0.425	9.86	5.9	**10.3**	± 1.04	5.5	1.58	± 0.265	0.0621	± 0.0509	1.39	± 0.245	3.03	22	52
CRC-B11-1214	12 to 14	7/30/2018	pCi/g	0.435	± 0.133	0.204 U	± 0.206	0.435	5.9	0.297	± 0.129	5.5	0.296	± 0.108	0.191 U	± 0.441	0.264	± 0.100	0.560	22	52
CRC-B11-2022	20 to 22	7/30/2018	pCi/g	0.632	± 0.17	0.339	± 0.265	0.971	5.9	0.335	± 0.139	5.5	0.351	± 0.114	0.0736	± 0.056	0.371	± 0.116	0.796	22	52
CRC-B11-2628	26 to 28	7/30/2018	pCi/g	0.501	± 0.185	0.562	± 0.201	1.06	5.9	0.455	± 0.16	5.5	0.334	± 0.114	0.00547 U	± 0.0232	0.27	± 0.102	0.604	22	52
CRC-B12-0002	0 to 2	7/26/2018	pCi/g	2.60	± 0.427	1.08	± 0.273	3.68	5.9	5.34	± 0.625	5.5	1.12	± 0.214	0.0591	± 0.0508	1.10	± 0.212	2.28	22	52
CRC-B12-0406	4 to 6	7/26/2018	pCi/g	0.295	± 0.104	0.227	± 0.105	0.522	5.9	0.438	± 0.161	5.5	0.17	± 0.0795	0.0108 U	± 0.0217	0.311	± 0.108	0.481	22	52
CRC-B12-1214	12 to 14	7/26/2018	pCi/g	0.301	± 0.111	0.177 U	± 0.218	0.301	5.9	0.129	± 0.109	5.5	0.18	± 0.0829	0.00849 U	± 0.0234	0.225	± 0.0929	0.405	22	52
CRC-B13-0305	3 to 5	7/12/2018	pCi/g	0.433	± 0.149	0.304	± 0.245	0.737	5.9	0.402	± 0.179	5.5	0.339	± 0.139	0.0467 U	± 0.0579	0.485	± 0.167	0.824	22	52
CRC-B13-0608	6 to 8	7/12/2018	pCi/g	0.207	± 0.121	0.0817 U	± 0.158	0.207	5.9	0.25	± 0.143	5.5	0.197	± 0.0953	0.119 U	± 0.24	0.172	± 0.0896	0.369	22	52
CRC-B14-0204	2 to 4	7/27/2018	pCi/g	2.51	± 0.374	0.921	± 0.256	3.43	5.9	**14.1**	± 1.4	5.5	1.75	± 0.289	0.104	± 0.0705	1.72	± 0.286	3.57	22	52
CRC-B14-0608	6 to 8	7/27/2018	pCi/g	0.195	± 0.103	0.146 U	± 0.188	0.195	5.9	0.149	± 0.117	5.5	0.144	± 0.0734	0.131 U	± 0.467	0.154	± 0.0728	0.298	22	52
CRC-B14-1012	10 to 12	7/27/2018	pCi/g	0.0312 U	± 0.166	0.282	± 0.195	0.282	5.9	0.177	± 0.118	5.5	0.205	± 0.0867	0.0079 U	± 0.0217	0.167	± 0.0770	0.372	22	52
CRC-B14-1618	16 to 18	7/27/2018	pCi/g	0.463	± 0.117	0.346	± 0.197	0.809	5.9	0.315	± 0.139	5.5	0.313	± 0.110	0.00552 U	± 0.0234	0.370	± 0.119	0.683	22	52
CRC-B14-2426	24 to 26	7/27/2018	pCi/g	0.519	± 0.148	0.493	± 0.200	1.01	5.9	0.320	± 0.136	5.5	0.281	± 0.0993	0.169 U	± 0.318	0.331	± 0.108	0.612	22	52
CRC-B15-0204	2 to 4	7/13/2018	pCi/g	1.06	± 0.244	0.699	± 0.220	1.76	5.9	1.61	± 0.329	5.5	0.695	± 0.182	0.178 U	± 0.802	0.722	± 0.185	1.42	22	52
CRC-B15-0608	6 to 8	7/13/2018	pCi/g	0.244	± 0.107	0.328	± 0.141	0.572	5.9	0.321	± 0.158	5.5	0.250	± 0.107	0.126 U	± 0.322	0.262	± 0.107	0.512	22	52
CRC-B15-1214	12 to 14	7/13/2018	pCi/g	0.396	± 0.148	0.112 U	± 0.203	0.396	5.9	0.176	± 0.133	5.5	0.174	± 0.095	0.141 U	± 0.280	0.277	± 0.118	0.451	22	52
CRC-B16-0204	2 to 4	7/13/2018	pCi/g	1.09	± 0.286	0.293 U	± 0.370	1.09	5.9	1.25	± 0.289	5.5	0.860	± 0.210	0.0394 U	± 0.0489	0.814	± 0.204	1.67	22	52
CRC-B16-0608	6 to 8	7/13/2018	pCi/g	0.429	± 0.148	0.345	± 0.188	0.774	5.9	0.197	± 0.141	5.5	0.205	± 0.104	0.0256 U	± 0.0991	0.308	± 0.127	0.513	22	52
CRC-B16-1416	14 to 16	7/13/2018	pCi/g	0.191	± 0.0863	0.112 U	± 0.192	0.191	5.9	0.240	± 0.145	5.5	0.308	± 0.121	0.181 U	± 0.281	0.262	± 0.111	0.570	22	52
CRC-B17-0204	2 to 4	7/27/2018	pCi/g	**24.7**	± 2.73	0.775 U	± 0.498	24.7	5.9	**89.3**	± 7.69	5.5	18.3	± 1.84	0.874	± 0.257	18.9	± 4.37	**38.1**	22	52
CRC-B17-0406	4 to 6	7/27/2018	pCi/g	**19.0**	± 2.08	0.908	± 0.321	19.9	5.9	**361**	± 42.2	5.5	13.1	± 1.28	2.04	± 0.884	12.8	± 1.26	**27.9**	22	52
CRC-B17-0810	8 to 10	7/27/2018	pCi/g	1.19	± 0.263	0.915	± 0.259	2.11	5.9	1.56	± 0.277	5.5	4.46	± 0.555	0.216	± 0.104	4.37	± 0.546	9.05	22	52
CRC-B17-1820	18 to 20	7/27/2018	pCi/g	0.377	± 0.146	0.0725 U	± 0.212	0.377	5.9	0.415	± 0.145	5.5	0.44	± 0.139	0.0503	± 0.051	0.429	± 0.137	0.919	22	52
CRC-B17-2628	26 to 28	7/30/2018	pCi/g	0.684	± 0.212	0.575	± 0.212	1.26	5.9	0.496	± 0.157	5.5	0.462	± 0.137	0.0606 U	± 0.176	0.403	± 0.125	0.865	22	52
CRC-B18-0204	2 to 4	7/13/2018	pCi/g	1.54 J-	± 0.301	1.08 J-	± 0.260	2.62 J-	5.9	1.56	± 0.305	5.5	1.46	± 0.284	0.214 U	± 0.455	1.43	± 0.281	2.89	22	52
CRC-B18-0608	6 to 8	7/13/2018	pCi/g	1.54	± 0.310	0.758	± 0.254	2.30	5.9	1.29	± 0.278	5.5	0.985	± 0.221	0.221 U	± 0.836	0.897	± 0.210	1.88	22	52
CRC-B18-0809	8 to 9	7/13/2018	pCi/g	0.719	± 0.205	0.526	± 0.165	1.25	5.9	0.909	± 0.246	5.5	0.642	± 0.173	0.0364 U	± 0.0452	0.509	± 0.152	1.15	22	52
CRC-B19-0204	2 to 4	7/13/2018	pCi/g	1.39	± 0.302	1.02	± 0.321	2.41	5.9	1.26	± 0.286	5.5	1.43	± 0.278	0.0452 U	± 0.168	1.21	± 0.251	2.64	22	52
CRC-B19-0810	8 to 10	7/13/2018	pCi/g	1.78	± 0.318	1.08	± 0.296	2.86	5.9	1.15	± 0.267	5.5	0.935	± 0.217	0.0542	± 0.0544	1.00	± 0.225	1.99	22	52
CRC-B19-1618	16 to 18	7/13/2018	pCi/g	0.362	± 0.149	0.404	± 0.234	0.766	5.9	0.281	± 0.139	5.5	0.278	± 0.113	0.0404	± 0.0468	0.389	± 0.134	0.707	22	52
CRC-B19-2224	22 to 24	7/13/2018	pCi/g	0.524	± 0.138	0.288	± 0.177	0.812	5.9	0.366	± 0.153	5.5	0.263	± 0.110	0.0274 U	± 0.0389	0.484	± 0.152	0.747	22	52
CRC-B20-0206	2 to 6	7/11/2018	pCi/g	**17.6**	± 2.03	1.37	± 0.562	19.0	5.9	**35**	± 3.16	5.5	19.2	± 1.84	2.18	± 1.03	19.9	± 1.89	**41.3**	22	52

Table 3
Soil Analytical Results Summary
Former Carnotite Reduction Company Site

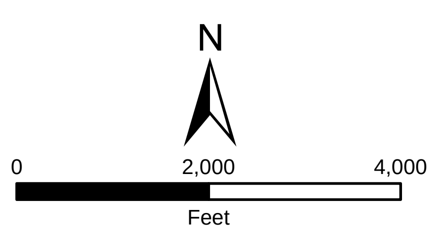
Sample Location	Sampling Depth (ft bgs)	Sample Date	Units	Radium-226 Result		Radium-226 Uncertainty	Radium-228 Result		Radium-228 Uncertainty	Total Radium	Radium-226 SRC	Thorium-230 Result		Thorium-230 Uncertainty	Thorium-230 SRC	Uranium-234 Result		Uranium-234 Uncertainty	Uranium-235 Result		Uranium-235 Uncertainty	Uranium-238 Result		Uranium-238 Uncertainty	Total Uranium	Total Uranium SRC ≤5 meters bgs	Total Uranium SRC >5 meters bgs
CRC-B20-1214	12 to 14	7/11/2018	pCi/g	0.305	±	0.145	0.366	±	0.237	0.671	5.9	0.621	±	0.207	5.5	1.22	±	0.246	0.0587 U	±	0.0574	1.51 U	±	0.677	1.22	22	52
CRC-B20-1820	18 to 20	7/11/2018	pCi/g	0.357	±	0.151	0.386	±	0.137	0.743	5.9	0.679	±	0.213	5.5	0.749	±	0.185	0.0226 U	±	0.0357	1.55 U	±	1.21	0.749	22	52
CRC-B20-2628	26 to 28	7/11/2018	pCi/g	0.65	±	0.21	0.554	±	0.206	1.204	5.9	0.383	±	0.166	5.5	3.88	±	0.526	0.556	±	0.31	4.16	±	1.14	8.596	22	52
CRC-B22-0506	5 to 6	7/12/2018	pCi/g	NA		NA	NA		NA	NA	5.9	0.311	±	0.136	5.5	0.579	±	0.152	0.0635	±	0.0547	0.609	±	0.156	1.25	22	52
2019 Soil Investigation[d]																											
CRC-SB-01-1113	11 to 13	1/15/2019	pCi/g	0.196 U	±	0.148	0.259 U	±	0.252	0.455 U	5.9	0.512	±	0.157	5.5	3.63	±	0.462	0.203	±	0.0936	3.42	±	0.442	7.25	22	52
CRC-SB-01-1315	13 to 15	1/15/2019	pCi/g	0.120 U	±	0.108	-0.055 U	±	0.298	0.120 U	5.9	0.361	±	0.144	5.5	0.499	±	0.140	0.0165 U	±	0.0321	0.463	±	0.134	0.962	22	52
CRC-SB-01-1517	15 to 17	1/15/2019	pCi/g	0.282	±	0.099	0.395	±	0.153	0.677	5.9	0.255	±	0.129	5.5	1.10	±	0.212	0.0722	±	0.0549	1.10	±	0.212	2.20	22	52
CRC-SB-02-0608	6 to 8	1/15/2019	pCi/g	0.949	±	0.213	0.176 U	±	0.189	0.949	5.9	1.51	±	0.295	5.5	14.7	±	1.51	0.731	±	0.229	15.9	±	1.62	**31.3**	22	52
CRC-SB-02-1012	10 to 12	1/15/2019	pCi/g	0.437	±	0.144	0.136 U	±	0.301	0.437	5.9	0.32	±	0.130	5.5	1.4	±	0.23	0.047	±	0.042	1.5	±	0.24	2.9	22	52
CRC-SB-02-1214	12 to 14	1/15/2019	pCi/g	0.408	±	0.154	0.327	±	0.202	0.735	5.9	0.34	±	0.133	5.5	2.4	±	0.35	0.130	±	0.073	2.3	±	0.34	4.9	22	52
CRC-SB-03-0204	2 to 4	1/15/2019	pCi/g	**26.9**	±	2.96	2.12	±	0.605	29.02	5.9	**89.2**	±	7.70	5.5	20.1	±	1.97	1.07	±	0.281	19.6	±	1.94	**40.77**	22	52
CRC-SB-03-0608	6 to 8	1/15/2019	pCi/g	0.317 U	±	0.169	0.164 U	±	0.215	0.481 U	5.9	1.21	±	0.251	5.5	1.17	±	0.228	0.0884 U	±	0.0677	1.15	±	0.227	2.32	22	52
CRC-SB-03-0810	8 to 10	1/15/2019	pCi/g	0.345	±	0.106	0.181	±	0.151	0.526	5.9	0.331	±	0.137	5.5	0.686	±	0.168	0.0491 U	±	0.0496	0.987	±	0.205	1.673	22	52
CRC-SB-03-1012	10 to 12	1/15/2019	pCi/g	0.353	±	0.132	0.243 U	±	0.233	0.353	5.9	0.417	±	0.143	5.5	27.3	±	2.67	1.38	±	0.365	28.4	±	2.77	**57.1**	22	52
CRC-SB-03-1214	12 to 14	1/15/2019	pCi/g	0.468	±	0.159	0.244	±	0.178	0.712	5.9	0.356	±	0.146	5.5	11.8	±	1.23	0.643	±	0.198	11.9	±	1.23	**24.3**	22	52
CRC-SB-03-1416	14 to 16	1/15/2019	pCi/g	0.167	±	0.0775	0.106 U	±	0.193	0.167	5.9	0.186	±	0.119	5.5	1.07	±	0.220	0.0689	±	0.0566	0.935	±	0.202	2.074	22	52
CRC-SB-04-0002	0 to 2	1/15/2019	pCi/g	3.43	±	0.534	0.838	±	0.336	4.268	5.9	**10.5**	±	1.07	5.5	1.54	±	0.262	0.0461 U	±	0.0519	1.41	±	0.249	2.95	22	52
CRC-SB-04-0204	2 to 4	1/15/2019	pCi/g	0.720	±	0.208	0.584	±	0.215	1.304	5.9	0.612	±	0.171	5.5	0.548	±	0.140	0.0663	±	0.0525	0.563	±	0.143	1.177	22	52
CRC-SB-04-0406	4 to 6	1/15/2019	pCi/g	0.520	±	0.145	0.508	±	0.188	1.028	5.9	0.741	±	0.184	5.5	0.545	±	0.145	0.0188 U	±	0.0308	0.484	±	0.136	1.029	22	52
CRC-HB-01-0002	0 to 2	3/30/2019	pCi/g	0.746	±	0.157	0.797	±	0.228	1.543	5.9	0.945	±	0.209	5.5	0.880	±	0.190	0.0857	±	0.0610	1.010	±	0.205	1.976	22	52
2020 Soil Investigation[e]																											
HB-01-021120	0 to 2	2/11/2020	pCi/g	NA		NA	NA		NA	NA	5.9	1.560	±	0.268	5.5	NA		NA	NA		NA	NA		NA	NA	22	52
HB-03-021120	0 to 2	2/11/2020	pCi/g	NA		NA	NA		NA	NA	5.9	1.220	±	0.241	5.5	NA		NA	NA		NA	NA		NA	NA	22	52
HB-04-021120	0 to 2	2/11/2020	pCi/g	NA		NA	NA		NA	NA	5.9	2.140	±	0.322	5.5	NA		NA	NA		NA	NA		NA	NA	22	52
HB-05-021120	0 to 2	2/11/2020	pCi/g	NA		NA	NA		NA	NA	5.9	1.290	±	0.243	5.5	NA		NA	NA		NA	NA		NA	NA	22	52
HB-06-021120	0 to 2	2/11/2020	pCi/g	NA		NA	NA		NA	NA	5.9	1.800	±	0.305	5.5	NA		NA	NA		NA	NA		NA	NA	22	52
HB-07-021120	0 to 2	2/11/2020	pCi/g	NA		NA	NA		NA	NA	5.9	2.560	±	0.366	5.5	NA		NA	NA		NA	NA		NA	NA	22	52
HB-08-021120	0 to 2	2/11/2020	pCi/g	NA		NA	NA		NA	NA	5.9	1.520	±	0.270	5.5	NA		NA	NA		NA	NA		NA	NA	22	52
HB-09-021120	0 to 2	2/11/2020	pCi/g	NA		NA	NA		NA	NA	5.9	1.840	±	0.295	5.5	NA		NA	NA		NA	NA		NA	NA	22	52

Notes:

NA = Not available
NP = Not provided
pCi/g = Picocuries per gram
SRC = Site-specific soil remediation criteria from the Carnotite radioactive materials license issued by IEMA (IL-02467-01).
U = Result is less than the sample detection limit.
J- = Isotope is present at an estimated concentration and may be biased low.
XXX Result is greater than the site-specific soil remediation criteria.

[a] Analytical results from “Final Subsurface Gamma Screening Results” letter report prepared by AECOM Technical Services, Inc. dated June 11, 2012.
[b] Analytical results from correspondence regarding surface soil sampling at the Former Carnotite Reduction Company Site from Tetra Tech, Inc. (Tetra Tech) to the Illinois Emergency Management Agency dated May 10, 2017.
[c] Analytical results from "“Pre-Design Investigation Summary Report” prepared by Tetra Tech and dated October 2, 2018.
[d] Analytical results from “Investigation Summary Report – January/March 2019 Sampling Events” prepared by Tetra Tech and dated July 31, 2019.
[e] Analytical results from “Investigation Summary Report – Hand Boring Investigation – February 2020.” prepared by Tetra Tech and dated April 20, 2020.

FIGURES



FORMER CARNOTITE REDUCTION COMPANY SITE
434 E. 26th STREET
CHICAGO, ILLINOIS

FIGURE 1
SITE LOCATION MAP

TETRA TECH

4/6/2015 G:\S\3284 Chicago 2FM01004 Carnotite\mxd\Fig1-SiteLoc.mxd m.banh

Legend

- Monitoring Well Location
- Air Monitoring Station Including Particulate, Passive Gamma, and Radon Monitoring
- Passive Gamma and Radon Monitoring Location
- Background Monitoring Location
- Storm Sewer Monitoring Location
- Fence
- Gate
- Cargo Storage Container
- Radioactive Facility License Boundary

N

0 100 200

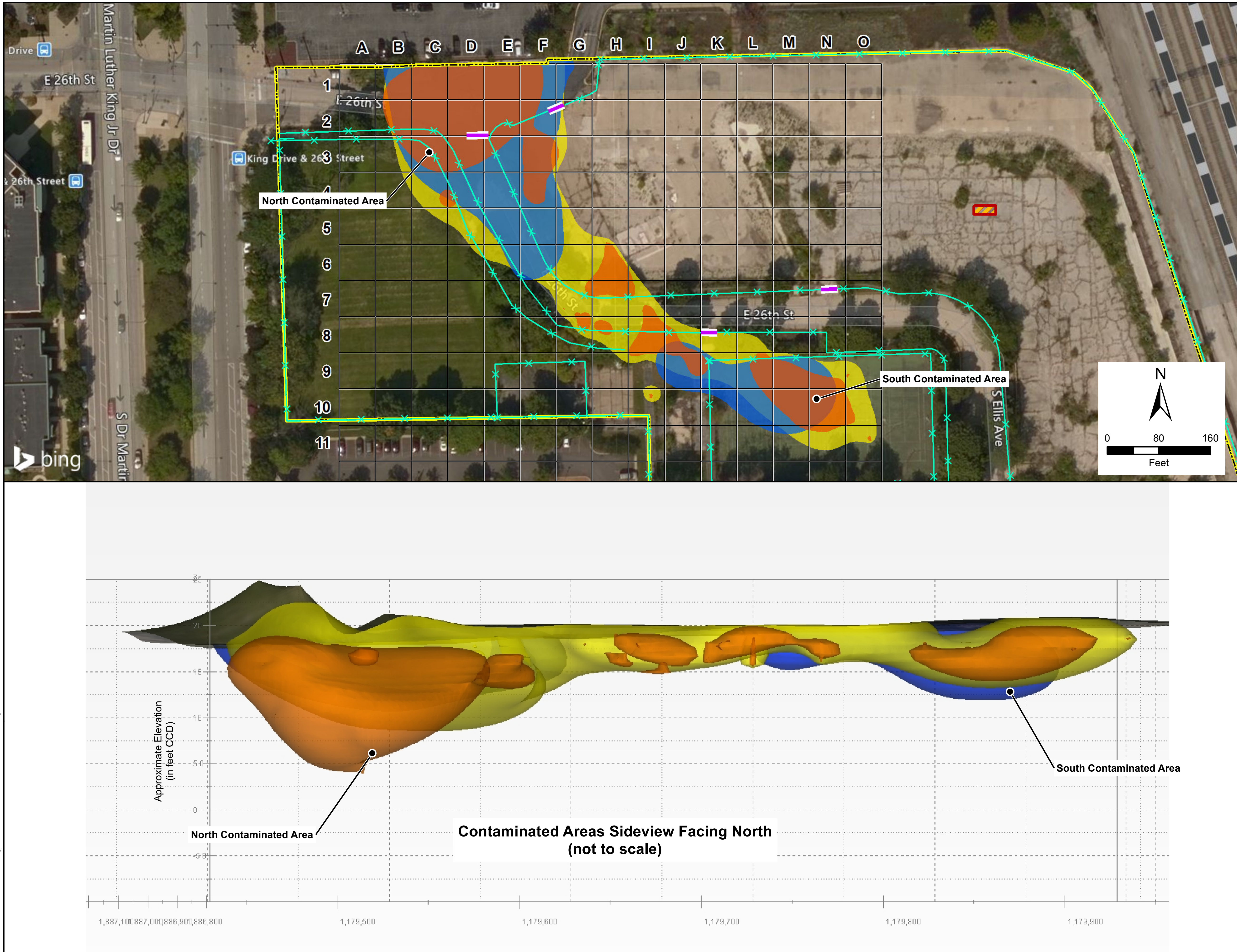
Feet

FORMER CARNOTITE REDUCTION COMPANY SITE
434 E. 26th STREET
CHICAGO, ILLINOIS

FIGURE 2
LICENSE BOUNDARY AND ENVIRONMENTAL MONITORING LOCATIONS

TETRA TECH

1/29/2020 G:\S\3284 Chicago 2FM01004 Carnotite\mxd\2020-01\Fig2-LicenseBoundary.mxd



Legend

- Fence
- Gate
- Cargo Storage Container
- Radioactive Facility License Boundary
- 33' x 33' Grid
- Radium-226 in soil above 5.9 pCi/g
- Total uranium in soil above 22 pCi/g above 5 meters bgs
- Thorium-230 in soil above 5.5 pCi/g
- Ground Surface

bgs = below ground surface
pCi/g = picoCuries per gram

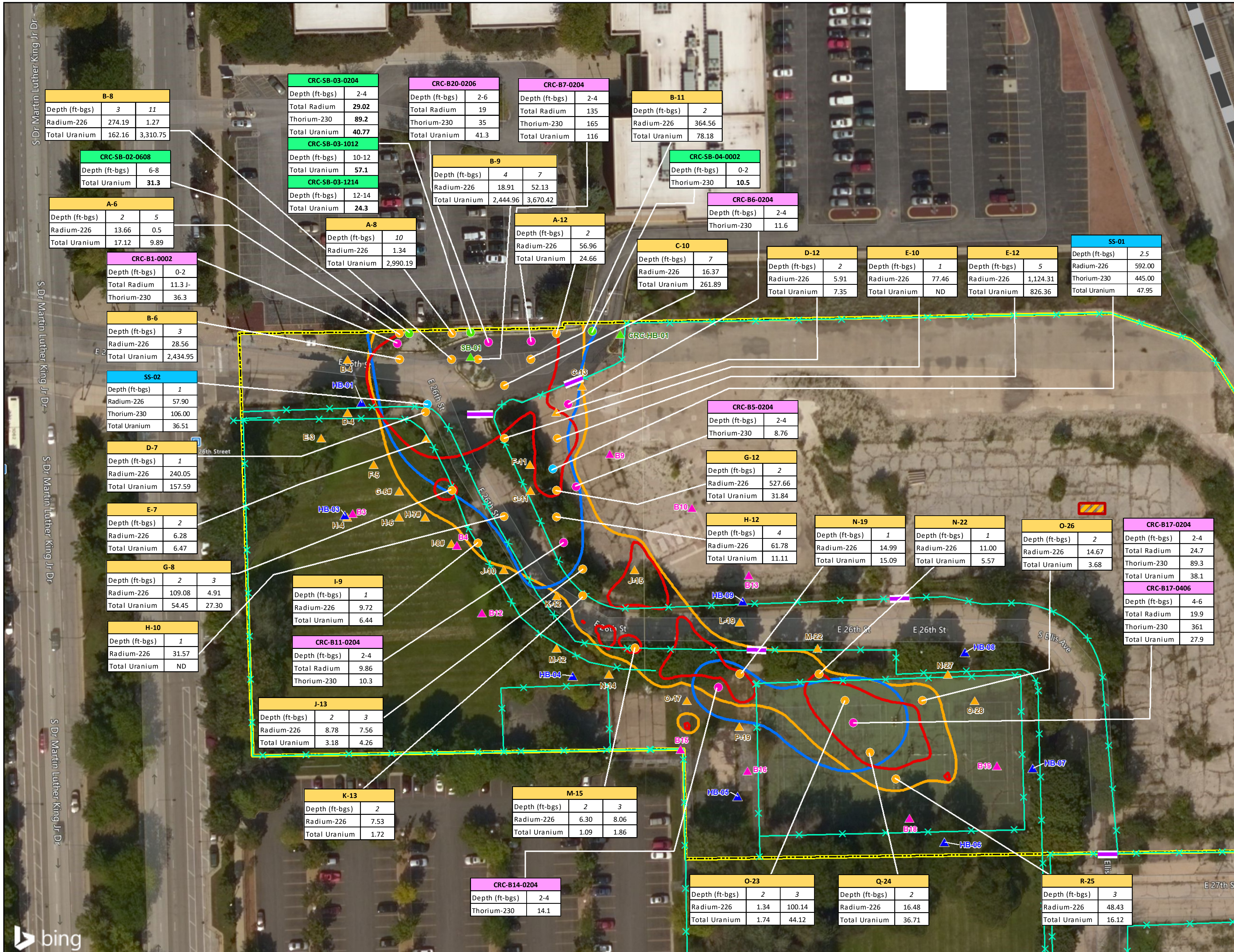
Note:
Extent of radium, uranium, and thorium contamination is based on soil analytical results, gamma survey data, and modeling.

FORMER CARNOTITE REDUCTION COMPANY SITE
434 E. 26th STREET
CHICAGO, ILLINOIS

FIGURE 3
RADIUM, URANIUM, AND THORIUM CONTAMINATED AREAS

TETRA TECH

G:\S13284 Chicago 2FM01004 Carnotite\mxd\2019-12\Fig3-ContaminatedPlumes.mxd
11/26/2019



B-8		
Depth (ft-bgs)	3	11
Radium-226	274.19	1.27
Total Uranium	162.16	3,310.75

CRC-SB-02-0608	
Depth (ft-bgs)	6-8
Total Uranium	31.3

A-6		
Depth (ft-bgs)	2	5
Radium-226	13.66	0.5
Total Uranium	17.12	9.89

CRC-B1-0002	
Depth (ft-bgs)	0-2
Total Radium	11.3 J-
Thorium-230	36.3

B-6	
Depth (ft-bgs)	3
Radium-226	28.56
Total Uranium	2,434.95

SS-02	
Depth (ft-bgs)	1
Radium-226	57.90
Thorium-230	106.00
Total Uranium	36.51

D-7	
Depth (ft-bgs)	1
Radium-226	240.05
Total Uranium	157.59

E-7	
Depth (ft-bgs)	2
Radium-226	6.28
Total Uranium	6.47

G-8		
Depth (ft-bgs)	2	3
Radium-226	109.08	4.91
Total Uranium	54.45	27.30

H-10	
Depth (ft-bgs)	1
Radium-226	31.57
Total Uranium	ND

CRC-SB-03-0204	
Depth (ft-bgs)	2-4
Total Radium	29.02
Thorium-230	89.2
Total Uranium	40.77

CRC-SB-03-1012	
Depth (ft-bgs)	10-12
Total Uranium	57.1

CRC-SB-03-1214	
Depth (ft-bgs)	12-14
Total Uranium	24.3

A-8	
Depth (ft-bgs)	10
Radium-226	1.34
Total Uranium	2,990.19

CRC-B20-0206	
Depth (ft-bgs)	2-6
Total Radium	19
Thorium-230	35
Total Uranium	41.3

B-9		
Depth (ft-bgs)	4	7
Radium-226	18.91	52.13
Total Uranium	2,444.96	3,670.42

CRC-B7-0204	
Depth (ft-bgs)	2-4
Total Radium	135
Thorium-230	165
Total Uranium	116

A-12	
Depth (ft-bgs)	2
Radium-226	56.96
Total Uranium	24.66

B-11	
Depth (ft-bgs)	2
Radium-226	364.56
Total Uranium	78.18

CRC-SB-04-0002	
Depth (ft-bgs)	0-2
Thorium-230	10.5

CRC-B6-0204	
Depth (ft-bgs)	2-4
Thorium-230	11.6

C-10	
Depth (ft-bgs)	7
Radium-226	16.37
Total Uranium	261.89

D-12	
Depth (ft-bgs)	2
Radium-226	5.91
Total Uranium	7.35

E-10	
Depth (ft-bgs)	1
Radium-226	77.46
Total Uranium	ND

E-12	
Depth (ft-bgs)	5
Radium-226	1,124.31
Total Uranium	826.36

SS-01	
Depth (ft-bgs)	2.5
Radium-226	592.00
Thorium-230	445.00
Total Uranium	47.95

CRC-B5-0204	
Depth (ft-bgs)	2-4
Thorium-230	8.76

G-12	
Depth (ft-bgs)	2
Radium-226	527.66
Total Uranium	31.84

H-12	
Depth (ft-bgs)	4
Radium-226	61.78
Total Uranium	11.11

N-19	
Depth (ft-bgs)	1
Radium-226	14.99
Total Uranium	15.09

N-22	
Depth (ft-bgs)	1
Radium-226	11.00
Total Uranium	5.57

O-26	
Depth (ft-bgs)	2
Radium-226	14.67
Total Uranium	3.68

CRC-B17-0204	
Depth (ft-bgs)	2-4
Total Radium	24.7
Thorium-230	89.3
Total Uranium	38.1

CRC-B17-0406	
Depth (ft-bgs)	4-6
Total Radium	19.9
Thorium-230	361
Total Uranium	27.9

I-9	
Depth (ft-bgs)	1
Radium-226	9.72
Total Uranium	6.44

CRC-B11-0204	
Depth (ft-bgs)	2-4
Total Radium	9.86
Thorium-230	10.3

J-13		
Depth (ft-bgs)	2	3
Radium-226	8.78	7.56
Total Uranium	3.18	4.26

K-13	
Depth (ft-bgs)	2
Radium-226	7.53
Total Uranium	1.72

M-15		
Depth (ft-bgs)	2	3
Radium-226	6.30	8.06
Total Uranium	1.09	1.86

CRC-B14-0204	
Depth (ft-bgs)	2-4
Thorium-230	14.1

O-23		
Depth (ft-bgs)	2	3
Radium-226	1.34	100.14
Total Uranium	1.74	44.12

Q-24	
Depth (ft-bgs)	2
Radium-226	16.48
Total Uranium	36.71

R-25	
Depth (ft-bgs)	3
Radium-226	48.43
Total Uranium	16.12

Legend

- Hand Boring Location - 2020 Concentration below soil remediation criteria
- Soil Sample Location – 2019
- Soil Sample Location – 2019 Concentration below soil remediation criteria
- Soil Sample Location – 2012
- Soil Sample Location – 2012 Concentration below soil remediation criteria
- Soil Sample Location – 2017
- Soil Sample Location – 2018
- Soil Sample Location – 2018 Concentration below soil remediation criteria
- Fence
- Gate
- Total uranium in soil above 22 pCi/g above 5 meters bgs
- Thorium-230 in soil above 5.5 pCi/g
- Radium-226 in soil above 5.9 pCi/g
- Cargo Storage Container
- Radioactive Facility License Boundary

All results presented in units of pCi/g
ft-bgs = feet-below ground surface
pCi/g = picoCuries per gram

N

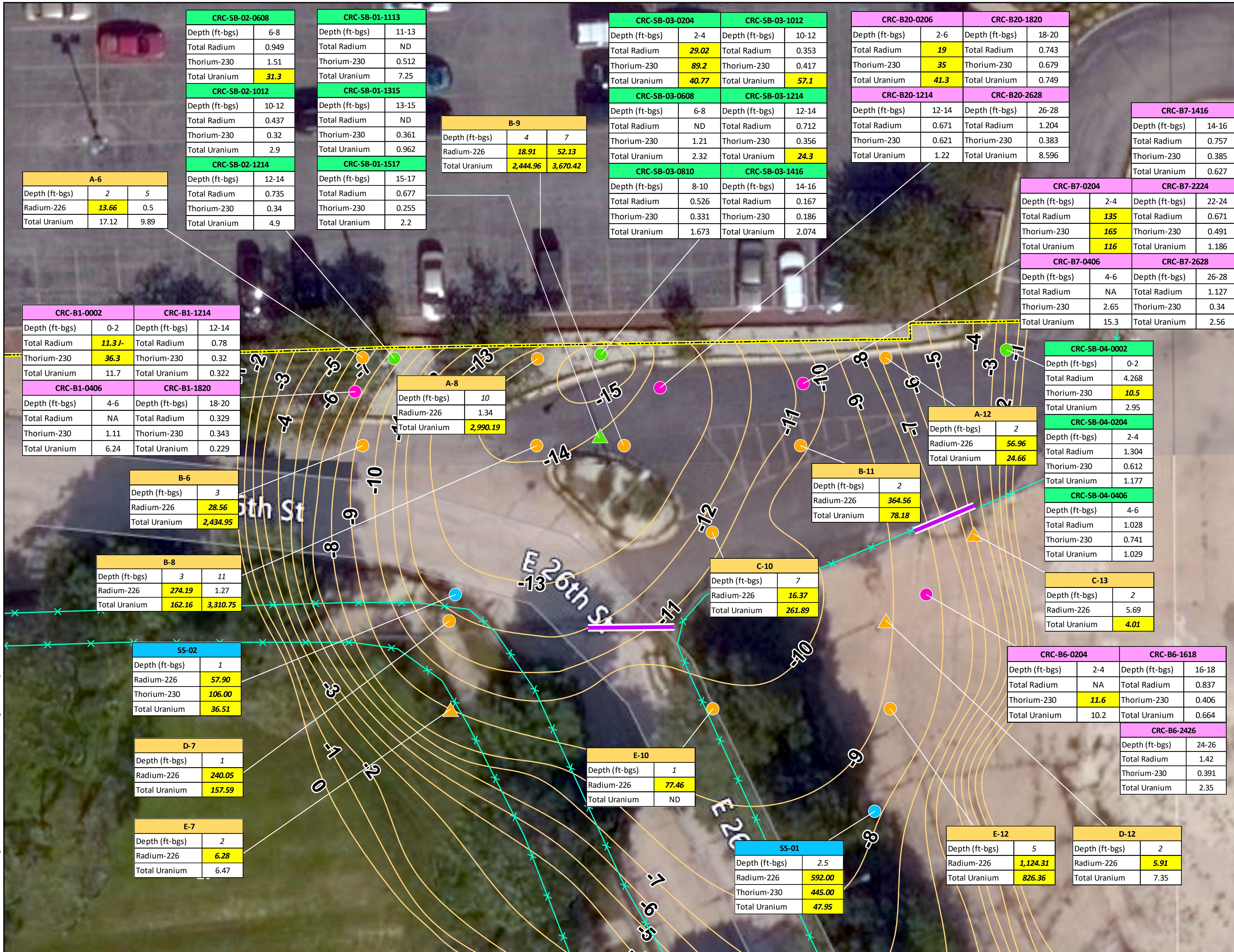
0 50 100
Feet

FORMER CARNOTITE REDUCTION COMPANY SITE
434 E. 26th STREET
CHICAGO, ILLINOIS

FIGURE 4
SOIL ANALYTICAL RESULTS ABOVE REMEDIATION CRITERIA

TETRA TECH

G:\S3284 Chicago 2FM\01004 Carnotite\mxd\2020-04\Fig4-SoilAnalyticalResults.mxd
4/23/2020



CRC-SB-02-0608	
Depth (ft-bgs)	6-8
Total Radium	0.949
Thorium-230	1.51
Total Uranium	**31.3**

CRC-SB-02-1012	
Depth (ft-bgs)	10-12
Total Radium	0.437
Thorium-230	0.32
Total Uranium	2.9

CRC-SB-02-1214	
Depth (ft-bgs)	12-14
Total Radium	0.735
Thorium-230	0.34
Total Uranium	4.9

CRC-SB-01-1113	
Depth (ft-bgs)	11-13
Total Radium	ND
Thorium-230	0.512
Total Uranium	7.25

CRC-SB-01-1315	
Depth (ft-bgs)	13-15
Total Radium	ND
Thorium-230	0.361
Total Uranium	0.962

CRC-SB-01-1517	
Depth (ft-bgs)	15-17
Total Radium	0.677
Thorium-230	0.255
Total Uranium	2.2

A-6		
Depth (ft-bgs)	2	5
Radium-226	**13.66**	0.5
Total Uranium	17.12	9.89

B-9		
Depth (ft-bgs)	4	7
Radium-226	**18.91**	**52.13**
Total Uranium	**2,444.96**	**3,670.42**

CRC-SB-03-0204	
Depth (ft-bgs)	2-4
Total Radium	**29.02**
Thorium-230	**89.2**
Total Uranium	**40.77**

CRC-SB-03-1012	
Depth (ft-bgs)	10-12
Total Radium	0.353
Thorium-230	0.417
Total Uranium	**57.1**

CRC-SB-03-0608	
Depth (ft-bgs)	6-8
Total Radium	ND
Thorium-230	1.21
Total Uranium	2.32

CRC-SB-03-1214	
Depth (ft-bgs)	12-14
Total Radium	0.712
Thorium-230	0.356
Total Uranium	**24.3**

CRC-SB-03-0810	
Depth (ft-bgs)	8-10
Total Radium	0.526
Thorium-230	0.331
Total Uranium	1.673

CRC-SB-03-1416	
Depth (ft-bgs)	14-16
Total Radium	0.167
Thorium-230	0.186
Total Uranium	2.074

CRC-B20-0206	
Depth (ft-bgs)	2-6
Total Radium	**19**
Thorium-230	**35**
Total Uranium	**41.3**

CRC-B20-1820	
Depth (ft-bgs)	18-20
Total Radium	0.743
Thorium-230	0.679
Total Uranium	0.749

CRC-B20-1214	
Depth (ft-bgs)	12-14
Total Radium	0.671
Thorium-230	0.621
Total Uranium	1.22

CRC-B20-2628	
Depth (ft-bgs)	26-28
Total Radium	1.204
Thorium-230	0.383
Total Uranium	8.596

CRC-B7-1416	
Depth (ft-bgs)	14-16
Total Radium	0.757
Thorium-230	0.385
Total Uranium	0.627

CRC-B7-0204	
Depth (ft-bgs)	2-4
Total Radium	**135**
Thorium-230	**165**
Total Uranium	**116**

CRC-B7-2224	
Depth (ft-bgs)	22-24
Total Radium	0.671
Thorium-230	0.491
Total Uranium	1.186

CRC-B7-0406	
Depth (ft-bgs)	4-6
Total Radium	NA
Thorium-230	2.65
Total Uranium	15.3

CRC-B7-2628	
Depth (ft-bgs)	26-28
Total Radium	1.127
Thorium-230	0.34
Total Uranium	2.56

CRC-B1-0002	
Depth (ft-bgs)	0-2
Total Radium	**11.3 J-**
Thorium-230	**36.3**
Total Uranium	11.7

CRC-B1-1214	
Depth (ft-bgs)	12-14
Total Radium	0.78
Thorium-230	0.32
Total Uranium	0.322

CRC-B1-0406	
Depth (ft-bgs)	4-6
Total Radium	NA
Thorium-230	1.11
Total Uranium	6.24

CRC-B1-1820	
Depth (ft-bgs)	18-20
Total Radium	0.329
Thorium-230	0.343
Total Uranium	0.229

A-8	
Depth (ft-bgs)	10
Radium-226	1.34
Total Uranium	**2,990.19**

CRC-SB-04-0002	
Depth (ft-bgs)	0-2
Total Radium	4.268
Thorium-230	**10.5**
Total Uranium	2.95

CRC-SB-04-0204	
Depth (ft-bgs)	2-4
Total Radium	1.304
Thorium-230	0.612
Total Uranium	1.177

CRC-SB-04-0406	
Depth (ft-bgs)	4-6
Total Radium	1.028
Thorium-230	0.741
Total Uranium	1.029

A-12	
Depth (ft-bgs)	2
Radium-226	**56.96**
Total Uranium	**24.66**

B-11	
Depth (ft-bgs)	2
Radium-226	**364.56**
Total Uranium	**78.18**

B-6	
Depth (ft-bgs)	3
Radium-226	**28.56**
Total Uranium	**2,434.95**

B-8		
Depth (ft-bgs)	3	11
Radium-226	**274.19**	1.27
Total Uranium	**162.16**	**3,310.75**

C-10	
Depth (ft-bgs)	7
Radium-226	**16.37**
Total Uranium	**261.89**

C-13	
Depth (ft-bgs)	2
Radium-226	5.69
Total Uranium	**4.01**

SS-02	
Depth (ft-bgs)	1
Radium-226	**57.90**
Thorium-230	**106.00**
Total Uranium	**36.51**

CRC-B6-0204	
Depth (ft-bgs)	2-4
Total Radium	NA
Thorium-230	**11.6**
Total Uranium	10.2

CRC-B6-1618	
Depth (ft-bgs)	16-18
Total Radium	0.837
Thorium-230	0.406
Total Uranium	0.664

CRC-B6-2426	
Depth (ft-bgs)	24-26
Total Radium	1.42
Thorium-230	0.391
Total Uranium	2.35

D-7	
Depth (ft-bgs)	1
Radium-226	**240.05**
Total Uranium	**157.59**

E-10	
Depth (ft-bgs)	1
Radium-226	**77.46**
Total Uranium	ND

E-7	
Depth (ft-bgs)	2
Radium-226	**6.28**
Total Uranium	6.47

SS-01	
Depth (ft-bgs)	2.5
Radium-226	**592.00**
Thorium-230	**445.00**
Total Uranium	**47.95**

E-12	
Depth (ft-bgs)	5
Radium-226	**1,124.31**
Total Uranium	**826.36**

D-12	
Depth (ft-bgs)	2
Radium-226	**5.91**
Total Uranium	7.35

Legend

- Soil Sample Location – 2019
- Soil Sample Location – 2019 Concentration below soil remediation criteria
- Soil Sample Location – 2012
- Soil Sample Location – 2012 Concentration below soil remediation criteria
- Soil Sample Location – 2017
- Soil Sample Location – 2018
- Excavation Depth Contour
- Fence
- Gate
- Radioactive Facility License Boundary
- xxx.xx Concentration above site-specific soil remediation criteria

All results presented in units of pCi/g
ft-bgs = feet-below ground surface
ND = Non-detect
NA = Not analyzed

N

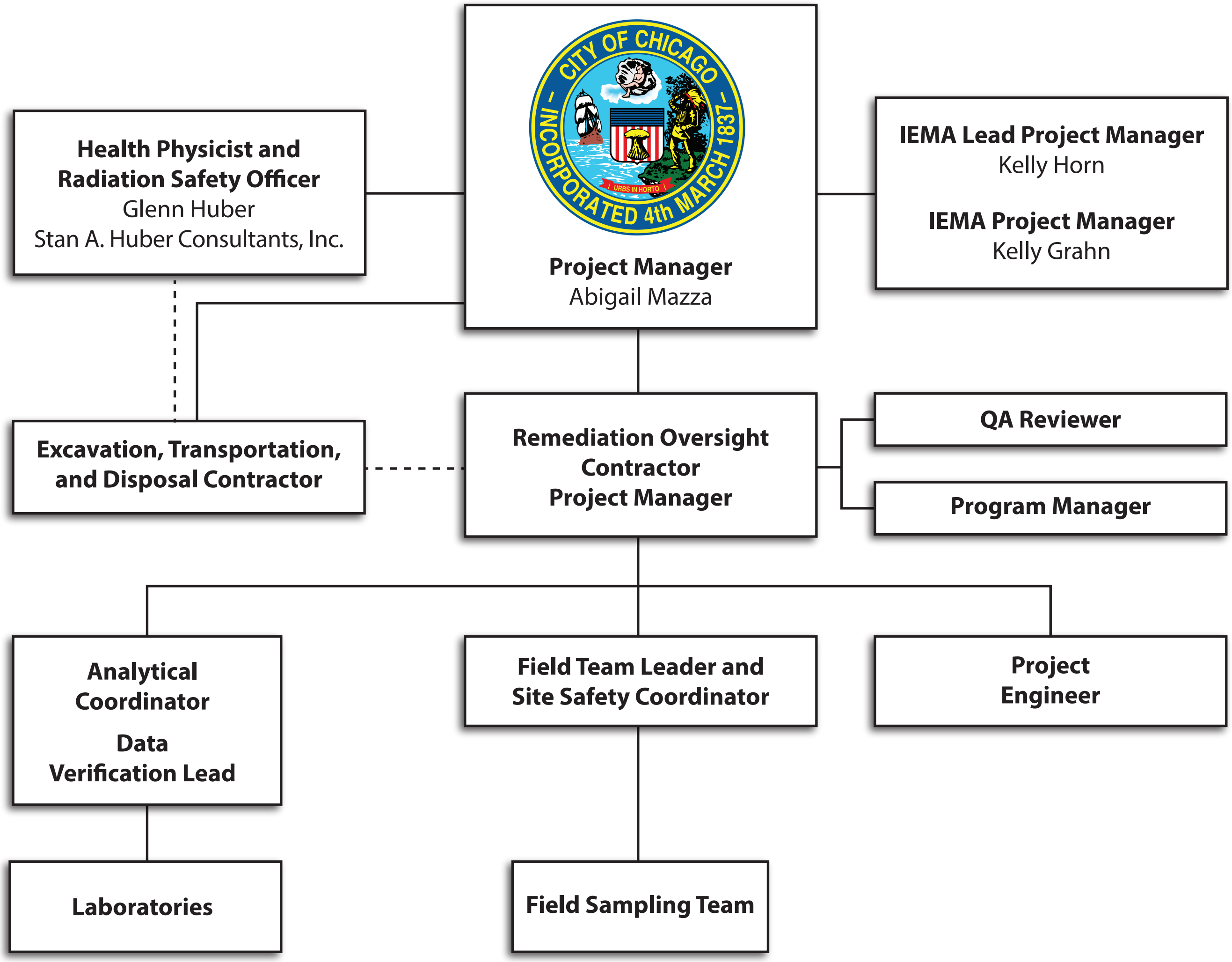
0 20 40
Feet

FORMER CARNOTITE REDUCTION COMPANY SITE
434 E. 26th STREET
CHICAGO, ILLINOIS

FIGURE 5
DEEP EXCAVATION AREA
SOIL ANALYTICAL RESULTS

TETRA TECH

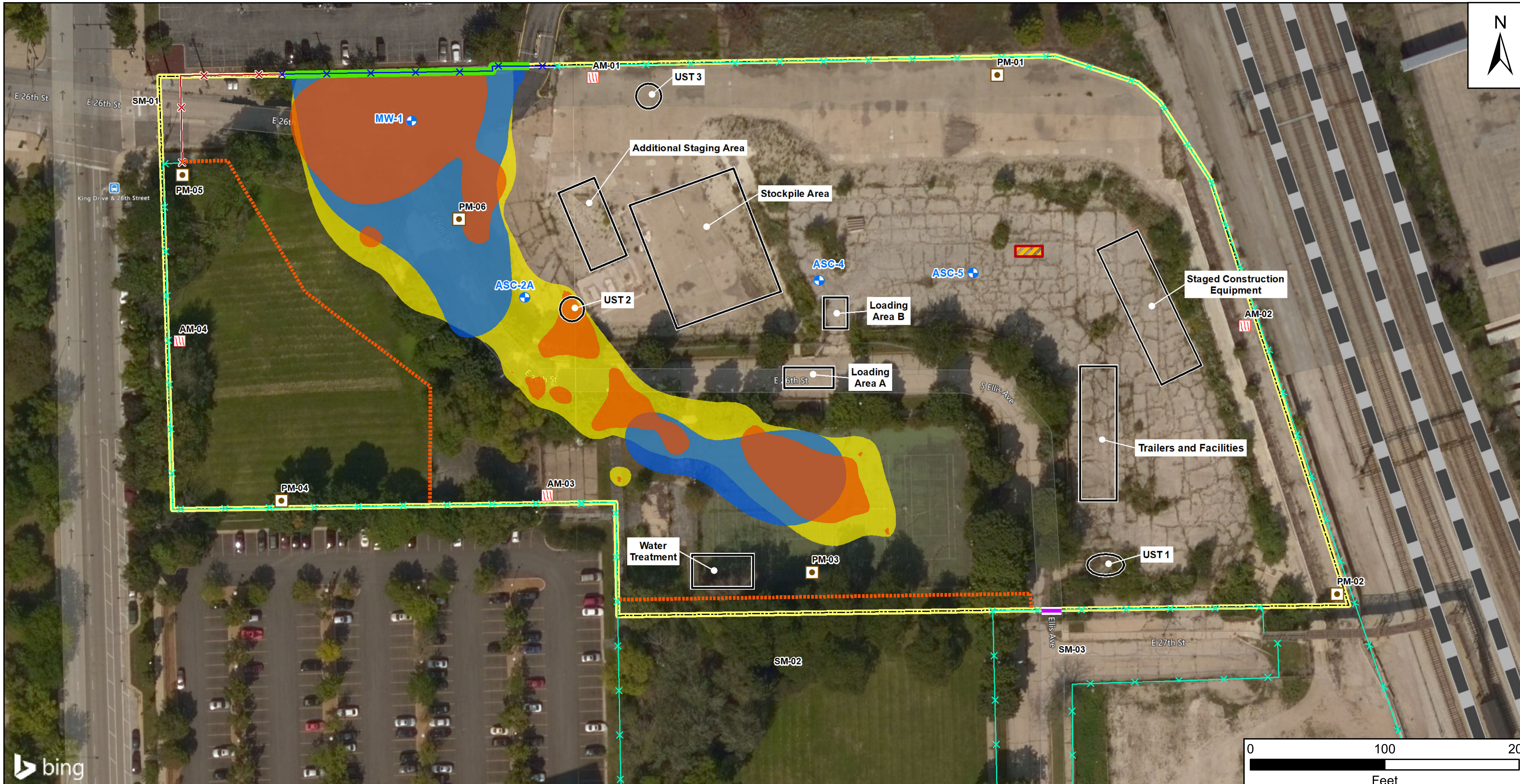
G:\S\3284 Chicago 2FM01004 Carnotite\mxd\2020-04\Fig5-SoilAnalyticalResults-26thSt.mxd
4/20/2020



FORMER CARNOTITE REDUCTION COMPANY SITE
434 E. 26th STREET
CHICAGO, ILLINOIS

FIGURE 6
PROJECT ORGANIZATION CHART

TETRA TECH



Legend

Air Monitoring Station	Construction Fence	Cargo Storage Container
Passive Gamma and Radon Monitoring Location	New Permanent Fence	Radioactive Facility License Boundary
Monitoring Well Location	Temporary Fence	Estimated Extent of Sheet Pile Wall
	Fence	
	Gate	

Total uranium in soil above 22 pCi/g above 5 meters bgs

Thorium-230 in soil above 5.5 pCi/g

Radium-226 in soil above 5.9 pCi/g

FORMER CARNOTITE REDUCTION COMPANY SITE
434 E. 26th STREET
CHICAGO, ILLINOIS

FIGURE 7
REMEDIATION SITE PLAN

TETRA TECH

G:\S\3284 Chicago 2FM01004 Carnotite\mxd\2020-01\Fig7-RemediationSitePlan.mxd

1/29/2020

ATTACHMENT 1

REMEDIATION COST ESTIMATES

SCENARIO 1 - EXCAVATION TO 15', TRUCKING TO RADIOACTIVE WASTE LANDFILL	
Site:	Carnotite Reduction Company
Location:	Chicago, IL
Phase:	Decommissioning
Base Year:	2020
Assumptions:	
	Production Estimate
Daily Production (CY)	150
Excavation Volume (CY)*	16,250
Site Preparation (Days)	35
Site Excavation/T&D (Days)	125
Backfill (Days)	54
Sewer Construction (Days)	10
Site Restoration (Days)	30
Demobilization (Days)	30
Total Number of Days	**284**
[redacted]	[redacted]

[redacted]

REMEDIATION COST ESTIMATE
SCENARIO 1

[redacted]

SCENARIO 2 - EXCAVATION TO 15', TRUCKING TO RADIOACTIVE WASTE AND SUBTITLE C LANDFILLS	
Site:	Carnotite Reduction Company
Location:	Chicago, IL
Phase:	Decommissioning
Base Year:	2020
Assumptions:	
	Production Estimate
Daily Production (CY)	150
Excavation Volume (CY)*	16,250
Site Preparation (Days)	35
Site Excavation/T&D (Days)	125
Backfill (Days)	54
Sewer Construction (Days)	10
Site Restoration (Days)	30
Demobilization (Days)	30
Total Number of Days	**284**

[redacted]

REMEDIATION COST ESTIMATE
SCENARIO 2

[redacted]