DEPARTMENT OF FLEET AND FACILITY MANAGEMENT
CITY OF CHICAGO

December 12, 2018

Mr. Kelly Horn
Section Head, Environmental Management
Bureau of Radiation Safety
Illinois Emergency Management Agency (IEMA)
1035 Outer Park Drive
Springfield, IL 62704

Subject: Revised Decommissioning Plan
Radioactive Materials License IL-02467-01
Former Carnotite Reduction Company Site – Chicago, IL

Dear Mr. Horn:

The City of Chicago, Department of Fleet and Facility Management is submitting this revised Decommissioning Plan for the Former Carnotite Reduction Company site for IEMA's review. The report has been revised to include pre-design investigation results, remediation cost estimates, as well as revised volume estimates, soil remediation criteria, and uncertainties. The report has been updated to address IEMA's comments dated August 9, 2018, as summarized below.

IEMA Comment #1:
Since there are a number of disparate site investigations, it would be helpful to summarize, particularly the radiological investigations at the end of section 2.3 to understand why this project is proceeding and what drove the City getting a radioactive materials license. The information is presented, but later in the document.

Response: At the conclusion of Section 2.3, a summary of radiological investigations was added clarifying the requirement for radioactive materials licensing.

IEMA Comment #2:
Since a sprung (or similar) structure will be used for mixing to limit emissions, the conclusion is that these contaminants will be concentrated inside the structure. Make sure occupational monitoring is addressed in the final document.

Response: General occupational monitoring requirements for the on-site sprung-like structure were added to the conclusion of Section 11. Detailed procedures will be included in the remediation health and safety and radiation protection plan.

IEMA Comment #3:
In the remediation strategy section, the management of clean, uncontaminated overburden needs to be addressed, how to characterize it, how to segregate it, and how to prevent it's contamination from other operations. Sampling gets addressed in section 7.6, but should be summarized here.

Response: In the second paragraph of Section 6.2, additional information was added regarding clean overburden management.

IEMA Comment #4: Gamma screening is discussed in great detail in section 7 .5, including instrument choices and field technique. This is also covered in a procedure, or will be and this level of detail is inconsistent with other COC measurement descriptions (i.e. XRF and FIDLER)

Response: Detailed gamma screening procedures were removed from Section 7.5.

IEMA Comment #5:
Section 7.5.3 mentions MARSSIM and a Final Status Survey. This project may utilize some MARSSIM terms, but is not being done with a MARSSIM methodology based on discussions. A final status survey is the bottom of excavation, confirmation of remediation, verification survey for this type of project. A "final walkover survey" may be conducted after backfill is complete.

Response: MARSSIM references were removed from Sections 7.5.3 and 15.

If you have any questions, please contact Abby Mazza at (312) 744-3161.

Sincerely,

Kimberly Worthington, PE, LEED AP
Deputy Commissioner

cc: Kelly Grahn, IEMA (via email and hard copy)
Kris Schnoes, Tetra Tech, Inc. (via email)
Glenn Huber, Stan A. Huber Consultants, Inc. (via email)

DECOMMISSIONING PLAN

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

Prepared by

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December 2018

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1 REMEDIATION COST ESTIMATES

ACRONYMS AND ABBREVIATIONS

µCi/ml	MicroCuries per milliliter
2FM	Chicago Department of Fleet and Facility Management
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	
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	Nuclear Regulatory Commission
OFSM	Office of State Fire Marshal
OSL	Optically stimulated luminescence

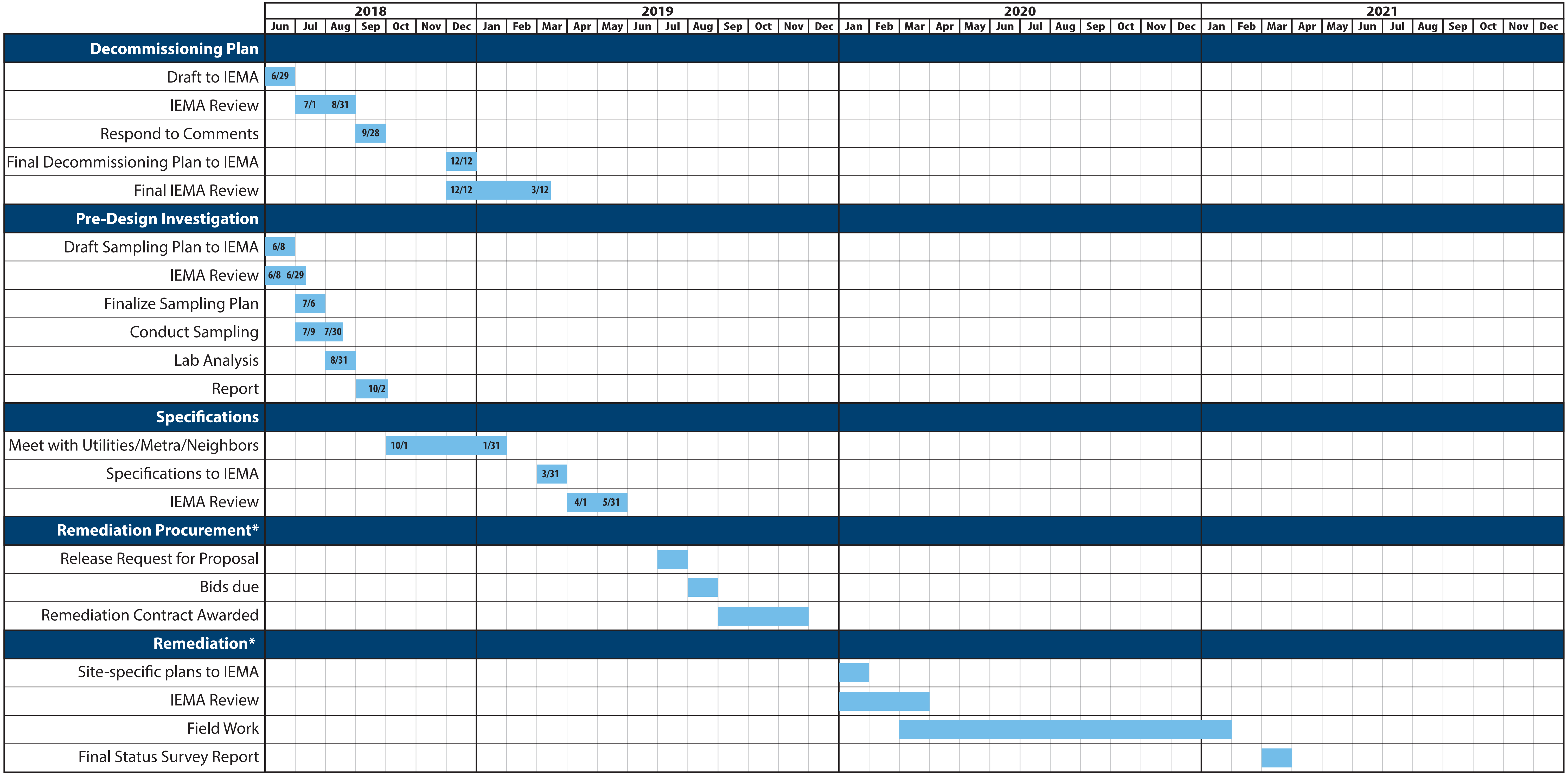
PBC	Public Building Commission
PCB	Polychlorinated biphenyl
PCC	Portland cement concrete
pCI/g	PicoCuries per gram
pCi/l	PicoCuries per liter
PPE	Personal protective equipment
ppm	Parts per million
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality Control
Ra-226	Radium 226
Ra-228	Radium 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 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). 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. 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.

2FM 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. 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), uncertainties (Section 14), and references (Section 15). Figures appear following Section 15.



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

TABLE 1
DECOMMISSIONING TIMELINE

TETRA TECH

***Note:** Bidding and construction timing is dependent on the City's budget appropriation

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, 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, 2FM 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 (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 north by Advocate Health Center, 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 King 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 12 feet bgs within the northwest portion of the site (AECOM 2012a).

The site is 0.25 mile west of Lake Michigan and 1.20 miles southeast of the Chicago River (see Figure 1). 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 on the east side of the intersection of South King Drive 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).

<u>Radiological Site Investigations</u>

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 (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 picocuries per gram (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 King 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 contaminants of concern 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 of 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 2FM 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, 2FM 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 indicated that public dose rates for commuters traversing accessible portions of the site were not expected to exceed acceptable dose limits (IDPH 2013).

On May 22, 2014, AECOM submitted a report to 2FM 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 2FM. 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 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).

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 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 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 Martin Luther King 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. In 2012, no contamination was detected above site-specific concentrations of concern in soil analytical or gamma screening results collected west of the contaminated area. Also, the results indicate that uranium and thorium are not likely present outside the previously delineated areas of contamination.

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. For uranium concentrations near the XRF detection limit range of 15 to 25 ppm, the difference between XRF and laboratory analytical results was greater but remained within the acceptable range of difference between soil duplicate samples. However, the uranium COC at depths less than 5 meters is 22 pCi/g, which is less than or within the XRF detection range. Therefore, uranium concentrations near the COC may not be detected by the XRF. Accurate determination of thorium-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 5.8 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 remediation criteria (Tetra Tech 2018a).Ongoing environmental monitoring activities and associated reporting are discussed in Section 2.5.

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 radium, uranium and Th-230 soil contamination. Soil analytical results from 2012, 2017, and 2018 site investigations are presented on Figure 4. 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 (2FM) 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.

2.4 LICENSE HISTORY

On May 13, 2015, 2FM 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. The license also requires an environmental monitoring program (IEMA 2015, 2016, 2017a, and 2018a), which has been implemented by 2FM and is further described in Section 2.5. On March 20, 2017, IEMA modified the license requirements to provide temporary relief from environmental monitoring program Conditions 8A, air particulate sampling; 8D, water sampling; and 8E, sewer sediment sampling, until remediation activities begin. 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 2FM. 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, 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, Inc. (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 2FM 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 2FM 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 2FM 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).

Ongoing environmental monitoring activities conducted after September 30, 2017, and associated results and public dose evaluation will be documented in the next annual environmental monitoring report, which will be completed before January 28, 2019, in accordance with radioactive material license Condition 8.E.

3.0 NATURE AND EXTENT OF CONTAMINATION

Investigation activities have been conducted in 2012, 2017, and 2018 to evaluate the extent of contamination in shallow and deep soil, sewer sediment and water, or groundwater as described below. The investigation was conducted by AECOM and Tetra Tech on behalf of 2FM. The investigation included both field screening activities and the collection of samples that were then laboratory-analyzed for compounds of concern. 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).

Based on results of the 2012, 2017, and 2018 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 a land title survey document produced by HBK (HBK 2012). Tetra Tech developed a database using the 2012, 2017, and 2018 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 14,000 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

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, 2FM 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, residual U-234 and U-235, and Th-330.

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 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.

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 is **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 2018). 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 soil stockpiling and blending operations within a sprung structure on site 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 2FM's Bureau of Environmental, Health and Safety Management is managing the overall decommissioning process as the licensee. Tetra Tech is responsible for planning site decommissioning on behalf of 2FM in accordance with the existing site radioactive material license and other relevant requirements. At this time, 2FM, 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. Figure 5 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. Figure 6 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 and uranium at concentrations above the site-specific cleanup objectives using the Studio 3DVA software and the 2012 subsurface investigation results (AECOM 2012a). Based on the assumptions presented in Section 3.0, the volume of contaminated soil is estimated to be 14,000 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 (13 feet bgs). Sheet piling will also be installed around the perimeter of the excavation in certain locations where contaminated soil extends below the groundwater table 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 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 soil screening area for further characterization. Additional details regarding soil screening and characterization techniques are presented in Section 7.0. A sprung-like structure will be installed near the northeast side of the excavation area. The Sprung structure is an enclosed structure that allows for managing soils without generating dust or emissions and limiting run-on or run-off. The soil screening and mixing will be conducted within the sprung-like structure, where it will be protected from the elements and to limit emissions.

The total depth of the excavation is estimated to be 14 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 13 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. Shoring of the north and west sides of the deep excavation is recommended because of the non-cohesive soils and excessive volume of groundwater that would be generated using standard excavation means.

To reduce the need to manage excessive groundwater, the preferred shoring method for this site is cantilever sheet piling, which would be installed to a depth of 33 feet to allow it to key into the clay layer (additional structural evaluation will be conducted to evaluate the depth of safe excavation below the water table and possible need for further lateral structural support for the sheet pile wall). The sheet piling would be installed in areas close to the deeper portion of the contamination to limit the volume of groundwater that would be required to be removed and treated. The sheet piling would be installed around the deeper portion of the plume to provide stability along E 26th St and Dr. Martin Luther King Jr Dr. Excavation north of the licensed area will not occur. The deep excavation area would be dewatered using down-hole pumps installed in temporary sumps. 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 within the interior of the sheet pile walls 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 technologically enhanced naturally occurring radioactive material (TENORM), if possible. However, clean soil (radionuclide concentrations below site-specific soil remediation criteria) will not be blended with contaminated soil. Blending will occur under a sprung-like structure to minimize dust migration and public exposure. 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 will be installed in the excavation and the soil will be dewatered. It is assumed that four temporary sumps with submersible pumps of 50 gpm or other appropriate capacity will be used. The water will be pumped to a treatment system that includes a Lakos cyclone sand separator and anionic and cationic resin. It is assumed that the volume of water to be removed will entail initial dewatering of the excavation area and continuous removal of groundwater. A seepage rate of 20 gpm was assumed for this project based on typical seepage rates for sheet piling systems. The treated water will be sampled daily for analysis of 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 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 waste transportation and disposal contractor will also be responsible for all necessary transportation permits and approvals. The Carnotite site waste is expected to be characterized as TENORM. TENORM is defined as naturally occurring radioactive materials that have been concentrated or exposed to the accessible environment resulting from human activities such as manufacturing, mineral extraction, or water processing (EPA 2008a). As such, Carnotite waste is expected to be accepted by Subtitle C landfills permitted to accept certain concentrations of TENORM, as well as 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 remediation oversight contractor using a Ludlum Model 19 microR meter, or equivalent. 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 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

A post-excavation surface gamma survey and verification sampling will be performed by the remediation oversight contractor to ensure the site-specific soil remediation criteria are met. Virgin stone will be used to backfill to the water table, approximately 12 feet bgs. 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 removed, as appropriate.

The City may provide a waiver of 26th Street re-construction requirements based on future development plans. If a waiver is not received and reconstruction of 26th Street is required, it will include installation of drainage systems, curbs, and street lighting. The non-paved areas will be restored by installation of a 6-inch topsoil layer and hydroseeding with grass seed.

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 $22.2 MM to $29.1 MM 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 Resource Conservation and Recovery Act 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 subcontractor to mark the underground utilities including water, sanitary sewers, stormwater sewers, gas lines, single connections, and telecommunications. Four 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. 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 will be plugged and then removed during excavation. Based on existing sewer maps, both sewer lines are believed to be storm water sewers. However, previous environmental monitoring activities included collecting samples from a combined sewer manhole on 26th Street near Martin Luther King Drive located adjacent to the remediation area. Therefore, the existing sewer beneath 26th Street may be a combined sewer. The status of sewers to be removed will be determined prior to remediation activities. Two manholes located at the south side of the project site and on the corner of South Dr. Martin Luther King 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 run along 26th Street and through the excavation area; these lines will be relocated along the west side of the site prior to excavation. Two separate trenches for water and gas relocation are assumed, as utilities typically have a separation requirement. The water utility trench is anticipated to be 5 feet wide and 5 feet deep because water lines must be installed below the frost line, while the gas utility line will be 2 feet wide and 2 feet deep. The water and gas lines are assumed to be service lines and have a 2-inch-diameter pipe. Utility requirements will be confirmed with relevant utility companies or City departments prior to remediation.

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 6 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 around the deeper portion of the excavation area to ensure structural stability throughout the project and reduce water management and treatment costs. For the purposes of the cost estimate, cantilevered sheet piling was assumed to be installed 3 feet into the clay layer, approximately 33 feet bgs. A shallower sheet pile wall with tiebacks was considered; however, when the difficulty and time it would take to install and remove the tiebacks and the potential presence of utilities were considered, this method was deemed inefficient and costly. In addition, depending on the depth of the tiebacks, groundwater may enter the excavation area. The sheet pile will be left in place and cut to a depth of 3 feet below grade when the project is completed or removed, as appropriate. The cantilevered method is proposed because it can reduce the amount of groundwater that may enter the excavation, and is more cost effective than the tieback method. The geotechnical investigation will be conducted to evaluate the most appropriate method to shore the sidewalls of the excavation.

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-foot excavation.

Excavation and Soil Blending: A 1 CY hydraulic excavator is assumed to perform excavations to a depth of 14 feet bgs. An overall daily production rate of 150 CY is anticipated considering expected difficulties for excavation beyond 13 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 3.5 months 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. The sprung structure will prevent migrating dust and will protect the soil from precipitation during blending activities. The structure dimensions are anticipated to be 80 feet by 100 feet to allow sufficient room for staging, screening, blending, and filling the IP bags.

Water Management: An approximately 50 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. One water disposal sample will be collected each day of water treatment operation 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 contaminants of concern above the site-specific cleanup levels 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. Approximately five 110-ton rail cars will be used. 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. For the dump truck transportation option, IP bags will not be required.

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. Approximately 10% of the overburden material is anticipated to be clean overburden material. Demobilization will entail removal of staging areas including the sprung-like structure, water treatment equipment, support facilities, and loading area. Seeding and fertilization will be completed by either hydro seeding or air seeding depending on the site conditions at the time.

Restoration and Backfill: Since it is not known for certain if a waiver of site reconstruction will be issued by the Chicago Department of Transportation (CDOT), it is assumed for cost estimating purposes that the portions of 26th Street impacted by remedial activities will be restored to original conditions with the exception of the area south of 26th Street. The area south of 26th Street will be backfilled with stone but not re-paved. Restoration includes replacing the sewer lines; it is assumed the piping for the sewers will be 18-inch-diameter reinforced concrete pipe. Approximately 10,400 square feet of concrete curbing north of 26th Street will be affected by remedial activities and will be restored with stone. Approximately 25,380 square feet of 26th Street and 1,450 feet of curb will require restoration. Street restoration will include a 4-inch layer of CA-6 crushed stone base, 9-inch Portland cement concrete (PCC) base course, and 3 inches of N70 binder and surface course. Street lights will be designed and installed by CDOT electrical division for approximately $180,000. CDOT anticipates street light installations will take approximately 5 months for design and installation based on funding and scheduling constraints. Seeding and fertilization of 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 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 radiation safety officer (RSO) except the waste transportation sampling, which will likely be conducted by the transportation and disposal contractor.

7.1 FIELD SCREENING SURVEYS

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. 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)

Portable X-ray fluorescence (XRF) analyzers may be used to screen for uranium in soil above 13 feet bgs, 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).

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.

One in 10 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, 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 9×10^{-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 2FM, 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).

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, 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, groundwater, and decontamination water from the site — 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. 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, a concrete pad, and trees, will be removed from the site during site preparation. Subsurface debris may also be encountered during excavation. The debris will be screened for radiation using a Ludlum Model 3 Survey Meter with attached Model 44-9 pancake G-M probe, or equivalent, or 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 gamma count rates of greater than background, the debris will be disposed of as radioactive waste. If the debris radiation count rates do not exceed background, 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 SURFACE RADIATION SURVEY, VERIFICATION SAMPLING, AND FINAL STATUS SURVEY

A final surface radiation survey will be conducted along the base of the excavation before verification sampling and before the area is backfilled. Measurements will be obtained using a NaI detector. No surface radiation survey will be conducted if the excavation base is submerged. A final status survey, similar to the final surface radiation survey, will be conducted after backfilling is complete. Final surface radiation survey, verification sampling, and final status survey procedures are described below.

7.5.1 Final Surface Radiation Survey

After excavation is complete, a final surface radiation survey and, if applicable, XRF or FIDLER survey will be conducted. The surface radiation surveys will measure the gamma radiation levels at the near surface of the excavation floor and sidewalls. The XRF or FIDLER will measure uranium concentrations. If the average gamma radiation level or uranium concentration of a 100-square-meter area exceeds the FAL, then the area 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 the results do not exceed the FAL or soil remediation criteria, then excavation will be considered complete and verification samples will be collected.

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.

7.5.2 Verification Samples

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 from the surface, or an excavator or backhoe may facilitate collection. 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.

7.5.3 Final Status Survey

After remediation is complete but before backfill, a final status survey will be performed within each 10 meter by 10-meter grid (EPA and others 2000). Grids that do not exhibit evidence of contamination at the surface, or at depth in adjacent grids, may be surveyed without excavation. The final status survey consists of conducting a final surface radiation survey after backfilling is complete. 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.

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 and general fill. Virgin stone will be used as backfill up to at least the top of the apparent groundwater table, which is assumed at about 12 feet below grade. General fill will consist of clean soil (sand, silt or clayey soil). The top 6 inches of the excavation will be backfilled with topsoil in greenspace areas. The general fill and topsoil materials will be obtained from a local source and will meet design specifications. General fill and topsoil materials will be sampled for analysis of radiological parameters and chemical parameters. The results will 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 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 import to the site, the general fill and topsoil source materials will be sampled for radiological and chemical parameters at a rate of one sample per 1,000 cubic yards. Each general fill and topsoil sample will be composed of five sample aliquots per about 1,000 cubic yards of backfill, which will be homogenized into a single composite soil sample. 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 chemicals.

In addition to obtaining backfill from a local source, 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.

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)
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)
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)
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)
Thorium-230	HASL 300 Th-01/A-01-R (alpha spectrometry)
VOCs	EPA SW-846 Method 8260
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

Parameter	Analytical Method
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)
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 2008b, 2012b; 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 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 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.

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 waste does not exceed the surface contamination guide criteria, it will be transported off site for disposal as special waste.

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. Before field activities begin, all field personnel, including subcontractors, will read and sign the HASP/RPP, 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. A complete copy of the site-specific plans, including the updated HASP, will be maintained by the field sampling team at the site. All personnel will also participate in site-specific radiation training conducted by the Radiation Safety Officer. Also, personnel air monitoring will be conducted in excavation and loading areas, including within the sprung-like structure onsite using lapel air samplers or personal air monitors and may require additional personal protective equipment if excess dust levels are detected in the structure. 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.
- 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

Before decommissioning begins, coordination will be required with neighboring property owners north of the site and with Metra, which operates an adjacent commuter rail passenger station at 27th Street. 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. Martin Luther King Drive. Before that roadway can be closed for site decommissioning activities, 2FM, or designee, will communicate with the property owner, King Sykes, LLC, to notify the current facility occupants of the closure. The 2545-55 S. Martin Luther King 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.

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. Therefore, coordination with Metra is required to notify passengers of closures and potentially provide alternative access to the station.

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 UNCERTAINTIES

The extent of Th-230 west of the north contaminated area along 26th Street is estimated based on 2012 soil sample analyses that did not contain radium or uranium. Based on the results of the 2018 Pre-Design Investigation, Th-230 is not expected to be present outside of the contaminated area; however, soil samples could not be collected in 2018 due to access and the presence of utilities. In addition, the current cost estimate includes shoring for the entire perimeter of the north contaminated area excavation because contamination is expected to extend to the groundwater table. However, if contamination is not encountered below the groundwater table, more limited shoring may be appropriate.

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FIGURES

REFERENCE MAP

N

0 2,000 4,000
Feet

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

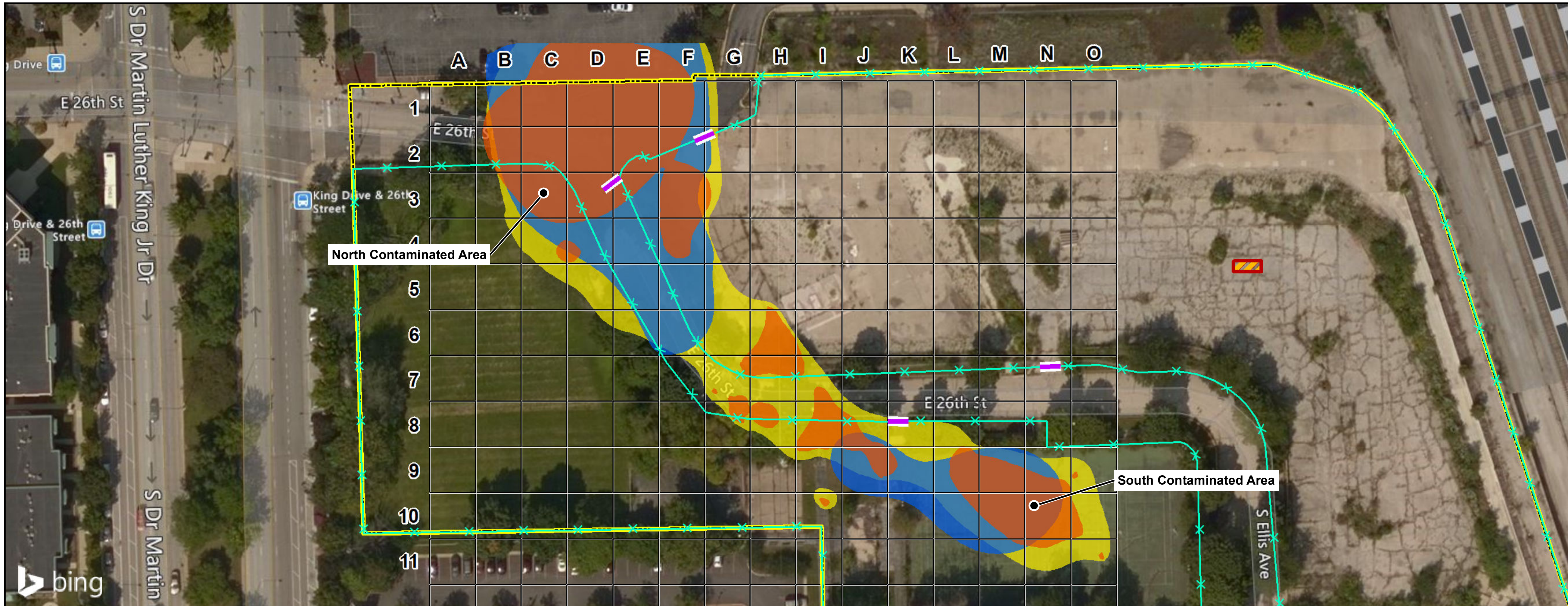
Feet

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

FIGURE 2
LICENSE BOUNDARY AND ENVIRONMENTAL MONITORING LOCATIONS

TETRA TECH

10/31/2018 G:\S3284 Chicago 2FM01004 Carnotite\mxd\2018-10\Fig2-LicenseBoundary.mxd

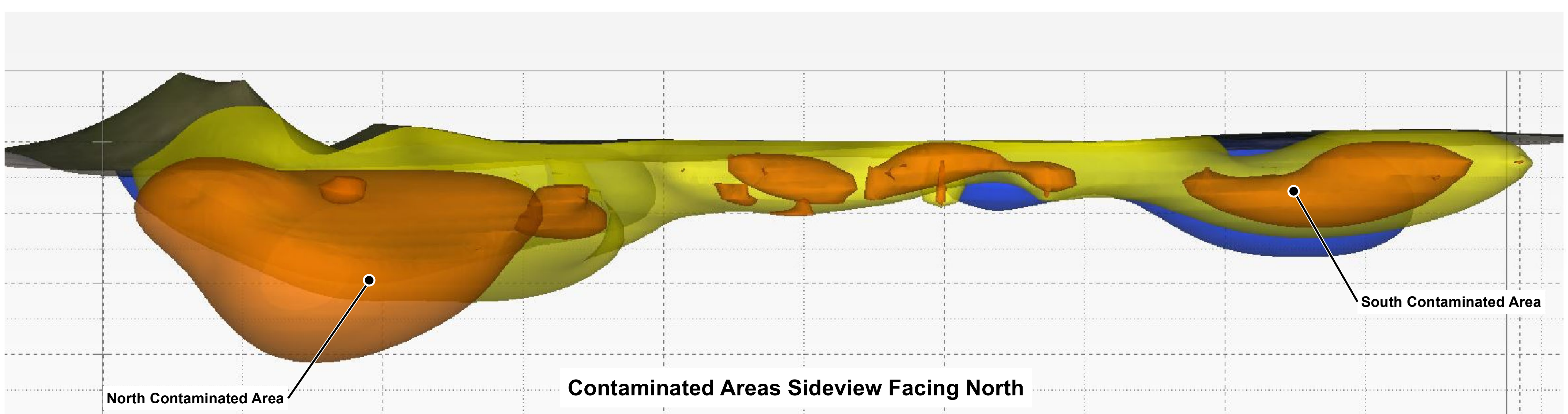


Legend

- 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.



Contaminated Areas Sideview Facing North

N

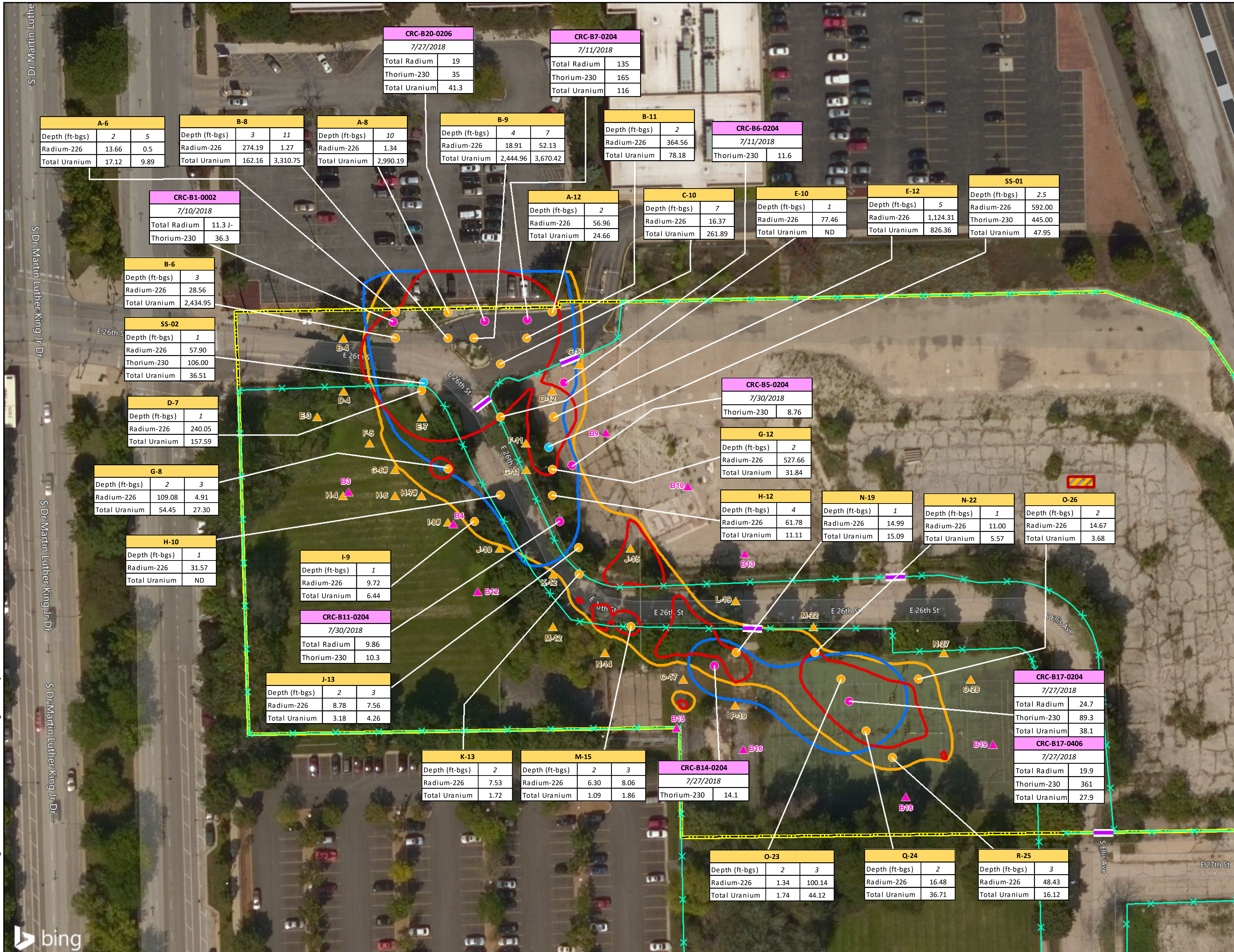
0 50 100
Feet

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

FIGURE 3
RADIUM, URANIUM, AND THORIUM CONTAMINATED AREAS

TETRA TECH

11/29/2018 G:\S\3284 Chicago 2FM01004 Carnotite\mxd\2018-10\Fig3-ContaminatedPlumes.mxd



Legend

- 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

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

FIGURE 4
SOIL ANALYTICAL RESULTS ABOVE REMEDIATION CRITERIA

TETRA TECH

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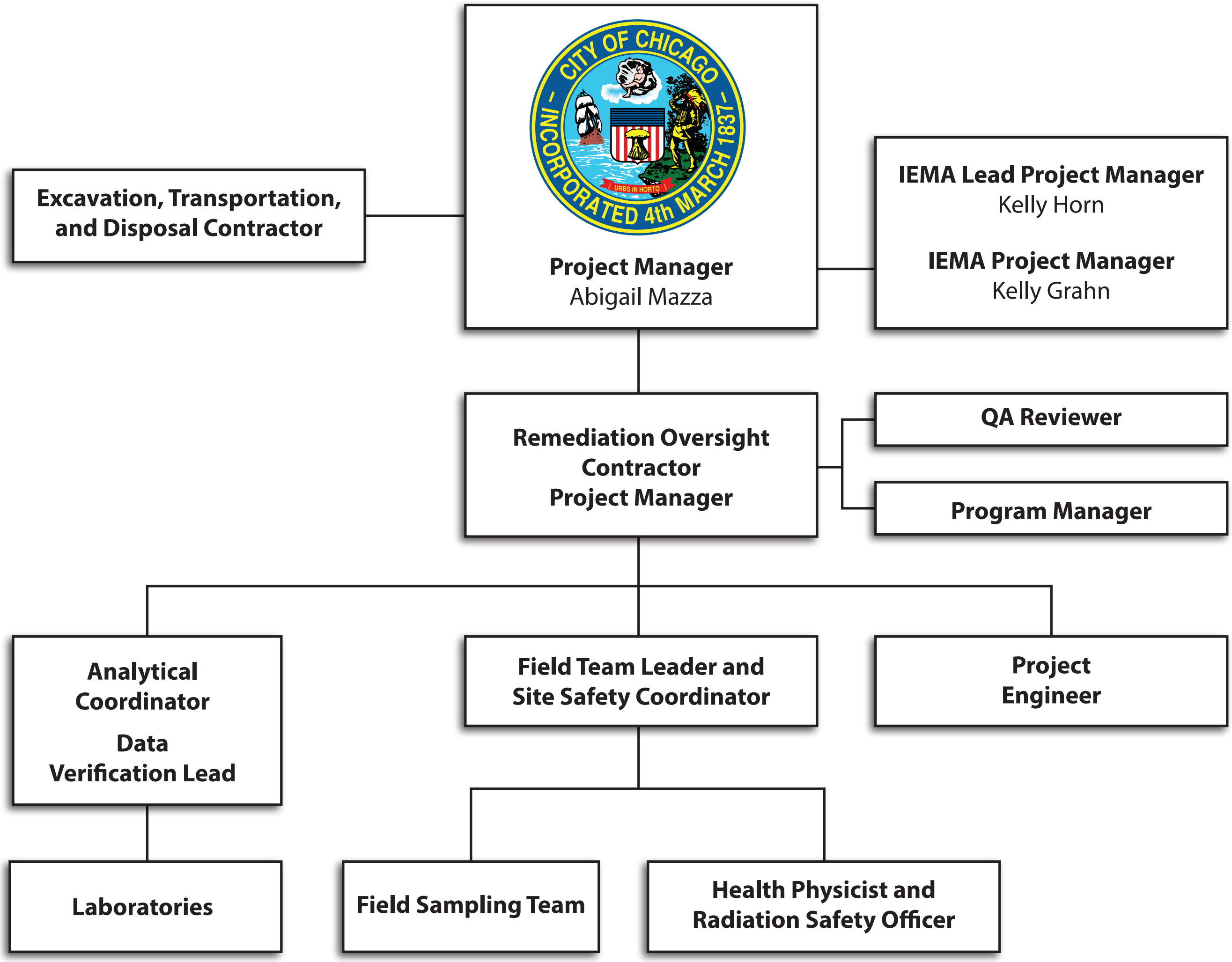
12/4/2018



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

FIGURE 5
PROJECT ORGANIZATION CHART

TETRA TECH

Legend

- Monitoring Well Location
- Fence to be removed
- Fence
- Temporay Fence
- Gate
- Approximate Sheet Piling Location
- Cargo Storage Container
- Radioactive Facility License Boundary
- 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

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

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

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

FIGURE 6
REMEDIATION SITE PLAN

TETRA TECH

G:\S\3284 Chicago 2FM01004 Carnotite\mxd\2018-10\Fig6-RemediationSitePlan.mxd
12/4/2018

ATTACHMENT 1

REMEDIATION COST ESTIMATES

SCENARIO 1 - EXCAVATION TO 14', TRUCKING TO RADIOACTIVE WASTE LANDFILL	
Site:	Carnotite Reduction Company
Location:	Chicago, IL
Phase:	Decommissioning
Base Year:	2018
Assumptions:	
	Production Estimate
Daily Production (CY)	150
Excavation Volume (CY)*	14,000
Site Preparation (Days)	30
Site Excavation/T&D (Days)	107
Backfill (Days)	47
Site Restoration (Days)	30
Demobilization (Days)	30
Street Construction (Days)	12
Street Lighting (Days)	10
Total Number of Days	**266**
CAPITAL COSTS:	**$29,075,375.00**

DESCRIPTION	QTY	UNIT	UNIT PRICE	COST	COMMENTS
Design and Plan Preparation and Permitting					
Draft Design and Project Plans	1	LS	$84,855.00	$84,855.00	Assumes Design Plans/Specs, Work Plans, Safety Plans, and QAPP
Draft Final and Project Plans	1	LS	$106,068.75	$106,069.00	Assumes Design Plans/Specs, Work Plans, Safety Plans, and QAPP
Final Design and Project Plans	1	LS	$70,712.50	$70,713.00	Assumes Design Plans/Specs, Work Plans, Safety Plans, and QAPP
Geotechnical Design for sheet pile wall	1	LS	$25,000.00	$25,000.00	
Site Plans - Health Physics Contractor	1	LS	$10,000.00	$10,000.00	Assumes Final Work Plan required for the RFP
Permits and Easements	1	LS	$100,000.00	$100,000.00	
IEPA and MWRD Water Treatment and Discharge Permits	1	LS	$20,000.00	$20,000.00	
SUBTOTAL				**$417,000.00**	
Mobilization / Demobilization					
Heavy Equipment Mobilization / Demobilization	1	LS	$100,000.00	$100,000.00	Assumes excavators: excavation and blending; assumes roll-off; assumes dozer for backfill; assumes one crane for loading
Personnel Mobilization / Demobilization	1	LS	$15,000.00	$15,000.00	
Subcontractor Submittals	1	LS	$15,000.00	$15,000.00	Assumes but not limited to HASP, Work Plan, T&D Plan
Bonds	1	LS	$567,257.50	$567,258.00	Assumes 2% of the total cost for bonds
SUBTOTAL				**$697,000.00**	
Site Preparation					
Perimeter Construction Fencing	740	LF	$29.27	$21,660.00	Assumes 8-ft tall fence with wind screen around the perimeter of the proposed excavation.
Silt Fence Installation	725	LF	$3.18	$2,306.00	Assumes installation, maintenance, and removal of silt fence on the west and south side of plume
Stabilized Construction Fence Entrance	2	Ea	$777.51	$1,555.00	Assumes 8-ft high and 16-ft wide entrance gate
Construction Trailer/Facilities	7	Mo	$888.92	$5,926.00	Includes Trailer, Water Service and Sanitary Facilities
Staging and Decon Area Construction	1	LS	$32,889.71	$32,890.00	
Clearing and Grubbing	30,000	SF	$0.26	$7,800.00	Assumes removal of brush and trees within and surrounding the excavation footprint for staging areas
Demolition of Pavement	4,000	SY	$33.47	$133,880.00	Assumes removal of 6" thick rod-enforced asphalt and concrete paved areas within excavation footprint
Demolition of Curb	1,450	LF	$9.03	$13,094.00	Assumes plain concrete curb within excavation footprint
Decommission sewer line	2	Ea	$1,614.35	$3,229.00	Assumes 2 manholes will be plugged by sealing laterals from the main at the south side of the project site and on the corner of S Dr. Martin Luther King Dr. and E 26th St
Transportation and Disposal of Construction Debris	1,306	Tons	$53.94	$70,446.00	
Sprung Structure 80 x 100 (Installation and Rental)	4	Mo	$13,261.13	$53,045.00	Assumes delivery, installation, and rental on a 6 month period
Pre-Construction Survey	1	Acre	$3,113.55	$3,114.00	Assumes topographic survey of the project site prior to work
Utility Locate	1	LS	$51,101.13	$51,101.00	Assumes identification of water, sanitary, stormwater, gas, single connection, and telecommunication in addition the DIGGER utility locate services
Utility Trenching, Water Line	622	CY	$16.89	$10,506.00	Assumes 5' wide and 5' deep utility trench
Utility Trenching, Gas Line	154	CY	$16.19	$2,493.00	Assumes 24" wide and 24" deep utility trench
Relocate water utilities	560	LF	$45.92	$25,715.00	Assumes 2" diameter copper pipe and plumber. Does not include excavation and backfill
Relocate gas line utilities	865	LF	$38.14	$32,991.00	Assumes 2" diameter steel pipe, plumber, welder, and welding equipment
Stormwater Protection	1	LS	$26,311.77	$26,312.00	
Pedestrian Lighting along 26th street	2	Ea	$2,490.84	$4,982.00	Assumes pole mounted lighting, 86 watts, 4350 lumens, assume 1 electrician
Power Pole Removal and Replacement	1	LS	$55,000.00	$55,000.00	
SUBTOTAL				**$558,000.00**	
UST Removal					
Meeting with agencies for access	1	LS	$3,891.94	$3,892.00	
Demolish 6" thick concrete	40	SY	$26.23	$1,049.00	Assumes 6" thick concrete, mesh reinforced
Removal Underground Storage Tank 2 (1000, gallons, contains diesel fuel and out of service)	1	Ea	$1,868.13	$1,868.00	Assumes excavation and loading UST onto trailer. Assumes UST contains a flowable fill material which will properly disposed
Disconnect and remove piping	1	LS	$280.22	$280.00	Assumes backhoe loader 48 HP to remove 30' of piping for UST 2
Cleaning tank (1.5lb/100 gal)	1,500	lb.	$4.44	$6,660.00	Assumes cleaning UST 2 only
Remove sludge, wash and wipe tank	2	Ea	$255.31	$511.00	Assumes removal of flowable fill from UST 2
Haul tank to certified salvage dump	1	Ea	$1,548.99	$1,549.00	Assumes 100 mile round trip to nearest certified salvage dump
Liquid contents removal, transportation, and disposal	1,000	gal	$1.64	$1,640.00	
Backfill	20	CY	$42.81	$856.00	Assumes CA-6 for backfill material and compaction
SUBTOTAL				**$18,000.00**	
Remedial Excavation					
Roll off Box	107	Day	$116.76	$12,532.00	Assumes 10 CY roll off dumpster
Screening Tech	107	Day	$917.02	$98,427.00	Assumes 1 technician dedicated to screening the footprint of each excavator
Laborer	107	Day	$747.25	$80,205.00	Assumes Labor to assist in rigging, setting up super sacks, and tie up super sacks
Foreman	107	Day	$1,183.15	$126,991.00	
Site Manager	266	Day	$1,373.08	$365,239.00	Assumes Site Manager to be onsite during the entire length of the project
Project Manager/Administration	107	Day	$1,373.08	$147,377.00	
Excavation	14,000	CY	$27.03	$378,420.00	Assumes excavation to 14' bgs
Cantilever Sheet piling	30,360	SF	$78.94	$2,396,618.00	Assumes cantilever shoring to a depth of 33' bgs along all four sides of the deep plume
Dump Truck	5	Mo	$12,217.57	$56,575.00	Assumes 8 CY dump truck to transport expatiated material deep excavation area to ground surface
Stone Ramp	74	LCY	$56.04	$4,141.00	Assumes 1-1/2" stone for 3/4:1 slope and 15 foot wide ramp, assumes spreading with a 200 HP dozer, no compaction.
Soil Staging	14,000	CY	$14.48	$202,720.00	Assumes labor and operations. Soil will be staged to be screened prior to loading. Unit price based on stockpiling unit price from CostWorks
Post Excavation Survey	1	Acre	$3,113.55	$3,113.55	Assumes topographic survey of the project site upon completion of excavated area
SUBTOTAL				**$3,872,000.00**	

REMEDIATION COST ESTIMATE
SCENARIO 1

DESCRIPTION	QTY	UNIT	UNIT PRICE	COST	COMMENTS
Trucking Transportation and Disposal					
Forklift	107	Day	$1,750.00	$187,833.00	Assumes forklift to load trucks with super sacks at the Site
Laborer	107	Day	$747.25	$80,205.00	Assumes Labor to assist in rigging
Screening Tech	107	Day	$917.02	$98,427.00	Assumes screening tech to verify successful decontamination of trucks exiting the Site
Transportation and Disposal of special waste	1,960	Ton	$43.94	$86,122.00	Assumes loading, transportation, and disposal. Assumes 10% of soil excavated will require disposal as special waste to landfill in Northern Illinois
Trucking Transportation to Radioactive Waste Landfill	19,600	Ton	$261.41	$5,123,636.00	Assumes transportation of all Radium-226 Uranium, and Thorium contaminated soils. Assumes driver, truck rental, and fuel.
Disposal of all contaminated soils at Radioactive Waste Landfill	19,600	Ton	$426.14	$8,352,344.00	Assumes disposal of all Radium-226, Uranium, and Thorium contaminated soils.
10 CY Burrito Super Sack Bags	1,400	Ea	$118.40	$165,760.00	Assumes material being transported to will be placed in super sacks
SUBTOTAL				**$14,094,000.00**	
Site Restoration					
Dozer, 200 HP	47	Days	$3,042.79	$141,997.00	Assumes hourly operation costs
Backfill - Overburden/Over-Excavated Soils	147	CY	$15.79	$2,327.00	Assumes 10% of excavated material will qualify as clean soil
Backfill Material	14,584	Ton	$59.94	$874,153.00	Assumes backfill with CA-6 or similar clean granular material. Assumes 15% of total excavated material is categorized as clean and re-used as backfill. A compaction factor of 1.2 is assumed.
Backfill Placement	14,584	Ton	$6.54	$95,378.00	Assumes placement backfill with CA-6 or similar clean granular material and restoration to impacted asphalt and concrete
Topsoil	500	CY	$55.27	$27,635.00	Assumes material and spreading 6" topsoil
Crushed Stone	3,274	LCY	$64.61	$211,540.00	Assumes 1-1/2" crushed stone to act as fill up to the groundwater table to 12 feet bgs and compaction factor of 1.2
Removal of Staging Areas	1	LS	$19,733.83	$19,734.00	Assumes demobilization of sprung structure, onsite water treatment facility, and construction facilities
Seeding Mulching	3,000	SY	$1.28	$3,840.00	Assumes hydro or air seeding with seed fertilizer and mulch
Restoration of storm sewers	657	LF	$64.61	$42,449.00	Assumes 18" diameter galvanized steel drainage piping. Assumes labor and heavy equipment
Restoration of 26th street	1	LS	$314,951.89	$314,952.00	Assumes installation and compaction of granular base course for site concrete and asphalt paving
Restoration of street lighting on 26th street	1	LS	$236,805.93	$236,806.00	Assumes contractor to perform design and installation of lighting along impacted area of 26th street
Post Construction Survey	1	Acre	$3,113.55	$3,113.55	Assumes topographic survey of the project site upon completion of site restoration
SUBTOTAL				**$1,974,000.00**	
Dewatering System					
TDH discharge capacity pumps 50 GPM, 10 HP	4	Ea	$3,500.00	$14,000.00	Assumes 160' TDH discharge capacity pumps, 50 GPM, 10 HP
Dewatering wells	4	Ea	$4,000.00	$16,000.00	Assumes dewatering well with 6' diameter, 30' deep, and 20 foot screen
Lakos Cyclone Sand Separator	3	Mo	$2,661.00	$8,183.00	Assumes 8x30 dual bag filters skids, two TIGG CP500 adsorbers (anion and cation), connecting hosing and fittings
Anionic and Cationic Resin Replacement	10	Ea	$7,000.00	$70,000.00	Assumes replacement of anionic and cationic resin for Cyclone Separator
Laborer	107	Days	$1,174.25	$126,036.00	Assumes one laborer to monitor dewatering pump for 12 hours a day from Monday to Saturday
Discharge of treated water	10	MG	$396.55	$3,966.00	Assumes treated water will be drained to the MWRD sewer and discharge limit is < 5pCi/L
SUBTOTAL				**$238,000.00**	
Laboratory Analysis					
Water Disposal Samples	120	Ea	$600.00	$71,958.00	Project-specific unit costs
Waste characterization samples, including special waste	3	Ea	$1,500.00	$4,500.00	Project-specific unit costs
TACO Confirmation Samples	75	Ea	$650.00	$48,750.00	Unit cost from other Illinois projects
Isotopic Uranium and Thorium-230-Alpha Spec (24-hour TAT, off-site lab)	80	Ea	$400.00	$32,000.00	Project-specific unit costs
Soil Verification Samples (Radium, Uranium, Thorium)	75	Ea	$300.00	$22,500.00	Project-specific unit costs
Air Particulate Perimeter Sample Analysis and Supplies	2	Ea	$1,200.00	$2,400.00	Project-specific unit costs per quarter, assume 2 full quarters of monitoring including before and after remediation
Radon Perimeter Monitoring	2	Ea	$1,000.00	$2,000.00	Project-specific unit costs
Gamma Radiation Perimeter Monitoring	2	Ea	$1,000.00	$2,000.00	Project-specific unit costs
Sample shipping	300	Ea	$30.00	$9,000.00	Estimate
SUBTOTAL				**$195,000.00**	
Site Engineer/Remediation Direction, Support, and Confirmation					
Site Engineer	60	Days	$2,000.00	$120,000.00	Assume site engineer to conduct onsite inspections and support as needed.
Project Manager	266	Days	$1,100.00	$292,600.00	Assume project manager onsite for duration of project.
Scientist	230	Days	$1,000.00	$230,000.00	Assume field staff onsite for excavation, transportation and disposal, as well as, additional support during remainder of the project
Scientist	120	Days	$1,000.00	$120,000.00	Assume field staff onsite for excavation, transportation and disposal
				$763,000.00	
Health and Safety					
Health Physicist Technician	120	Days	$1,150.00	$138,000.00	Assume one Health Physics Technician to perform radiological screening during excavation, stockpiling, clearance surveys, and confirmation sample collected and analysis. Assume HP Technician on site for 50 hours per week
Health Physicist Supervisor	120	Days	$1,800.00	$216,000.00	Assume one Health Physics Supervisor to perform radiological screening during excavation, stockpiling, clearance surveys, air sampling, supervision of Health Physics Technician during field work, project management and coordination and reporting. Assume HP Supervisor onsite for 50 hours per week
Travel Expenses for HP Supervisor and Technician	120	Days	$297.32	$35,678.00	Travel expenses as allowable in accordance with the City of Chicago Travel Guidelines.
Perimeter and Work Area Dust Monitoring	5	Mo	$5,262.35	$26,312.00	Assumes 4 DustTraks for air monitoring during excavation and backfill activities
Radiological Screening Equipment	20	Wk	$4,113.10	$82,262.00	Assumes 2 G-M pancake detectors, 2x2 NaI detector/GPS combination, 2x2 NaI detector, Micro-R meter, alpha tray counter, 3 lapel air samplers, 4 air sampling stations, NIST traceable check sources, external dosimetry for personnel, and complete gamma spectroscopy system for onsite analysis. Cost includes providing field screening, laboratory analytical, air monitoring, dosimetry data, and other data collected during the work to Contractor.
XRF	4	Mo	$3,729.69	$15,333.00	Assumes XRF rental during the duration of excavation activities
PPE	200	Day	$105.25	$21,050.00	Assumes Level D PPE for all onsite workers and Level C PPE for workers that may enter structure
SUBTOTAL				**$535,000.00**	
Equipment Decontamination					
Equipment Decon	5	Ea	$2,374.08	$11,870.00	
SUBTOTAL				**$11,900.00**	
Remediation Reporting					
Draft and final site remediation completion report	1	Ea	$50,000.00	$50,000.00	
SUBTOTAL				**$50,000.00**	
Contingency	25%			**$5,652,475.00**	
TOTAL CAPITAL COST				**$29,075,375.00**	

SCENARIO 2 - EXCAVATION TO 14', TRUCKING TO SUBTITLE C AND RADIOACTIVE WASTE LANDFILLS	
Site:	Carnotite Reduction Company
Location:	Chicago, IL
Phase:	Decommissioning
Base Year:	2018
Assumptions:	
	Production Estimate
Daily Production (CY)	150
Excavation Volume (CY)*	14,000
Site Preparation (Days)	30
Site Excavation/T&D (Days)	107
Backfill (Days)	47
Site Restoration (Days)	30
Demobilization (Days)	30
Street Construction (Days)	12
Street Lighting (Days)	10
Total Number of Days	**266**
CAPITAL COSTS:	**$22,205,000.00**

DESCRIPTION	QTY	UNIT	UNIT PRICE	COST	COMMENTS
Design and Plan Preparation and Permitting					
Draft Design and Project Plans	1	LS	$84,855.00	$84,855.00	Assumes Design Plans/Specs, Work Plans, Safety Plans, and QAPP
Draft Final and Project Plans	1	LS	$106,068.75	$106,069.00	Assumes Design Plans/Specs, Work Plans, Safety Plans, and QAPP
Final Design and Project Plans	1	LS	$70,712.50	$70,713.00	Assumes Design Plans/Specs, Work Plans, Safety Plans, and QAPP
Geotechnical Design for sheet pile wall	1	LS	$25,000.00	$25,000.00	
Site Plans - Health Physics Contractor	1	LS	$10,000.00	$10,000.00	Assumes Final Work Plan required for the RFP
Permits and Easements	1	LS	$100,000.00	$100,000.00	
IEPA and MWRD Water Treatment and Discharge Permits	1	LS	$20,000.00	$20,000.00	
SUBTOTAL				**$417,000.00**	
Mobilization / Demobilization					
Heavy Equipment Mobilization / Demobilization	1	LS	$100,000.00	$100,000.00	Assumes excavators: excavation and blending; assumes roll-off; assumes dozer for backfill; assumes one crane for loading
Personnel Mobilization / Demobilization	1	LS	$15,000.00	$15,000.00	
Subcontractor Submittals	1	LS	$15,000.00	$15,000.00	Assumes but not limited to HASP, Work Plan, T&D Plan
Bonds	1	LS	$433,200.00	$433,200.00	Assumes 2% of the total cost for bonds
SUBTOTAL				**$563,000.00**	
Site Preparation					
Perimeter Construction Fencing	740	LF	$29.27	$21,660.00	Assumes 8-ft tall fence with wind screen around the perimeter of the proposed remedial excavation.
Silt Fence Installation	725	LF	$3.18	$2,306.00	Assumes installation, maintenance, and removal of silt fence along the west and south side of plume
Stabilized Construction Fence Entrance	2	Ea	$777.51	$1,555.00	Assumes 8-ft high and 16-ft wide entrance gate
Construction Trailer/Facilities	7	Mo	$888.92	$5,926.00	Includes Trailer, Water Service and Sanitary Facilities
Staging and Decon Area Construction	1	LS	$32,889.71	$32,890.00	
Clearing and Grubbing	30,000	SF	$0.26	$7,800.00	Assumes removal of brush and trees within and surrounding the excavation footprint for staging areas
Demolition of Pavement	4,000	SY	$33.47	$133,880.00	Assumes removal of 6" thick rod-enforced asphalt and concrete paved areas within excavation footprint
Demolition of Curb	1,450	LF	$9.03	$13,094.00	Assumes plain concrete curb within excavation footprint
Decommission sewer line	2	Ea	$1,614.35	$3,229.00	Assumes 2 manholes will be plugged by sealing laterals from the main at the south side of the project site and on the corner of S Dr. Martin Luther King Dr. and E 26th St
Transportation and Disposal of Construction Debris	1,306	Tons	$53.94	$70,446.00	
Sprung Structure 80 x 100 (Installation and Rental)	4	Mo	$13,261.13	$53,045.00	Assumes delivery, installation, and rental on a 6 month period
Pre-Construction Survey	1	Acre	$3,113.55	$3,113.55	Assumes topographic survey of the project site prior to work
Utility Locate	1	LS	$51,101.13	$51,101.13	Assumes identification of water, sanitary, stormwater, gas, single connection, and telecommunication in addition to DIGGER utility locate services
Utility Trenching, Water Line	622	CY	$16.89	$10,505.58	Assumes 5' wide and 5' deep utility trench
Utility Trenching, Gas Line	154	CY	$16.19	$2,493.26	Assumes 24" wide and 24" deep utility trench
Relocate water utilities	560	LF	$45.92	$25,715.20	Assumes 2" diameter copper pipe and plumber. Does not include excavation and backfill
Relocate gas line utilities	865	LF	$38.14	$32,991.10	Assumes 2" diameter steel pipe, plumber, welder, and welding equipment
Stormwater Protection	1	LS	$26,311.77	$26,311.77	
Pedestrian Lighting along 26th street	2	Ea	$2,490.84	$4,981.68	Assumes pole mounted lighting, 86 watts, 4350 lumens, assume 1 electrician
Power Pole Removal and Replacement	1	LS	$55,000.00	$55,000.00	
SUBTOTAL				**$558,000.00**	
UST Removal					
Meeting with agencies for access	1	LS	$3,891.94	$3,892.00	Assumes 1% for scheduling and coordinating with the Fire Marshal
Demolish 6" thick concrete	40	SY	$26.23	$1,049.00	Assumes 6" thick concrete, mesh reinforced
Removal Underground Storage Tank 2 (1000 gallons, contains diesel fuel and out of service)	1	Ea	$1,868.13	$1,868.00	Assumes excavation and loading UST onto trailer. Assumes UST contains a flowable fill material which will be properly disposed
Disconnect and remove piping	1	LS	$280.22	$280.00	Assumes backhoe loader 48 HP to remove 30' of piping for UST 2
Cleaning tanks (1.5lb/100 gal)	1,500	lb.	$4.44	$6,660.00	Assumes cleaning of UST 2 only
Remove sludge, wash and wipe tank	2	Ea	$255.31	$511.00	Assumes removal of flowable fill from UST 2
Haul tank to certified salvage dump	1	Ea	$1,548.99	$1,549.00	Assumes 100 mile round trip to nearest certified salvage dump
Liquid contents removal, transportation, and disposal	1,000	gal	$1.64	$1,640.00	
Backfill	20	CY	$42.81	$856.00	Assumes CA-6 for backfill material and compaction
SUBTOTAL				**$18,000.00**	
Remedial Excavation					
Roll off Box	107	Day	$116.76	$12,532.00	Assumes 10 CY roll off dumpster
Screening Tech	107	Day	$917.02	$98,427.00	Assumes 1 technician dedicated to screening the footprint of each excavator
Laborer	107	Day	$747.25	$80,205.00	Assumes Labor to assist in rigging, setting up super sacks, and tie up super sacks
Foreman	107	Day	$1,183.15	$126,991.00	
Site Manager	266	Day	$1,373.08	$365,239.00	Assumes Site Manager to be onsite during the entire length of the project
Project Manager/Administration	107	Day	$1,373.08	$147,377.00	
Excavation	14,000	CY	$27.03	$378,420.00	Assumes excavation to 14' bgs
Cantilever Sheet piling	30,360	SF	$78.94	$2,396,618.00	Assumes cantilever shoring to a depth of 33' bgs along all four sides of the deep plume
Dump Truck	5	Mo	$12,217.57	$57,015.00	Assumes 8 CY dump truck to transport excavated material deep excavation area to ground surface and transporting backfill material into the excavation area during site restoration
Stone Ramp	74	LCY	$56.04	$4,141.00	Assumes 1-1/2" stone for 3/4:1 slope and 15 foot wide ramp, assumes spreading with a 200 HP dozer, no compaction.
Soil Staging	14,000	CY	$14.48	$202,720.00	Assumes labor and operations. Soil will be staged to be screened prior to loading.
Blending	5	Day	$2,814.65	$14,073.00	Assumes 1 CY hydraulic excavator for blending , operator, and laborer.
Post Excavation Survey	1	Acre	$3,113.55	$3,113.55	Assumes topographic survey of the project site upon completion of excavated area
SUBTOTAL				**$3,887,000.00**	
Trucking Transportation and Disposal					
Forklift	5	Day	$1,750.00	$8,750.00	Assumes forklift to load trucks with super sacks at the Site
FE Loader, 1.5 CY	15,154	CY	$4.67	$70,770.00	Assumes 1.5 CY FE Loader and equipment operator (medium) to load loose soil into dump trucks
Laborer	93	Day	$747.25	$69,743.00	Assumes Labor to assist in rigging

REMEDIATION COST ESTIMATE
SCENARIO 2

DESCRIPTION	QTY	UNIT	UNIT PRICE	COST	COMMENTS
Screening Tech	93	Day	$917.02	$85,589.00	Assumes screening tech to verify successful decontamination of trucks exiting the Site
Transportation and Disposal of special waste	1,960	Ton	$45.92	$90,003.00	Assumes loading, transportation, and disposal. Assumes 10% of soil excavated will require disposal as special waste to landfill in Northern Illinois
Trucking Transportation to Subtitle C Landfill in Midwest	4,875	Ton	$44.88	$218,794.00	Assumes transportation of soil that will be disposed of at a Subtitle C Landfill permitted to accept certain quantities of radioactive material.
Disposal at Subtitle C Landfill in Midwest	4,875	Ton	$197.74	$963,998.00	Assumes disposal of soil with a total concentration of Radium, Uranium, Thorium less than 167 pCi/g, Radium greater than 5.9 pCi/g to 50 pCi/g and Uranium greater than 22 or 52 pCi/g depending on depth and Throium-230 greater than 5.5 pCi/g to a max combined concentration of 167 pCi/g.
Trucking Transportation to Subtitle C Landfill in Western U.S.	16,341	Ton	$279.77	$4,571,668.00	Assumes transportation of soil that will be disposed of at a Subtitle C Landfill permitted to accept certain quantities of radioactive material.
Disposal at Subtitle C Landfill in Western U.S.	16,341	Ton	$121.57	$1,986,552.00	Assumes disposal of soil with a total concentration of Radium-226, Uranium, and Thorium greater than 167 pCi/g to 2,000 pCi/g including Uranium greater than 22 pCi/g above 5 meters and 52 pCi/g below 5 meters. Assumes radium greater than 50 pCi/g to 222 pCi/g.
Trucking Transportation to Radioactive Waste Landfill in Western U.S.	1,063	Ton	$261.41	$277,955.00	Assumes transportation of all Radium-226, Uranium, and Thorium contaminated soils to radioactive waste landfill. Assumes driver, truck rental, and fuel.
Disposal at Radioactive Waste Landfill in Western U.S.	1,063	Ton	$426.14	$453,111.00	Assumes disposal of soil with a total concentration of Radium, Uranium, and Thorium greater than 2,000 pCi/g including all radium concentrations greater than 222 pCi/g.
10 CY Burrito Super Sack Bags	76	Ea	$118.40	$8,992.00	Assumes material being transported to Radioactive Waste Landfill will be placed in super sacks
SUBTOTAL				**$8,806,000.00**	
Site Restoration					
Dozer, 200 HP	47	Days	$3,042.79	$141,997.00	Assumes hourly operation costs
Backfill - Overburden/Over-Excavated Soils	147	CY	$15.79	$2,327.00	Assumes 10% of excavated material will qualify as clean soil
Backfill Material	14,584	Ton	$59.94	$874,153.00	Assumes backfill with CA-6 or similar clean granular material. Assumes 15% of total excavated material is categorized as clean and re-used as backfill. A compaction factor of 1.2 is assumed.
Backfill Placement	14,584	Ton	$6.54	$95,378.00	Assumes placement backfill with CA-6 or similar clean granular material and restoration to impacted asphalt and concrete
Topsoil	500	CY	$55.27	$27,635.00	Assumes material and spreading 6" topsoil
Crushed Stone	3,274	LCY	$64.61	$211,540.00	Assumes 1-1/2" crushed stone to act as fill up to the groundwater table to 12 feet bgs and compaction factor of 1.2
Removal of Staging Areas	1	LS	$15,000.00	$15,000.00	Assumes demobilization of sprung structure, onsite water treatment facility, and construction facilities
Seeding Mulching	3,000	SY	$1.28	$3,840.00	Assumes hydro or air seeding with seed fertilizer, and mulch
Restoration of storm sewers	657	LF	$64.61	$42,449.00	Assumes 18" diameter galvanized steel drainage piping. Assumes labor and heavy equipment
Restoration of 26th street	1	LS	$314,951.89	$314,952.00	Assumes installation and compaction of granular base course for site concrete and asphalt paving
Restoration of street lighting on 26th street	1	LS	$236,805.93	$236,806.00	Assumes contractor to perform design and installation of lighting along impacted area of 26th street
Post Construction Survey	1	Acre	$3,113.55	$3,113.55	Assumes topographic survey of the project site upon completion of site restoration
SUBTOTAL				**$1,969,000.00**	
Dewatering System					
TDH discharge capacity pumps 50 GPM, 10 HP	4	Ea	$3,500.00	$14,000.00	Assumes 160' TDH discharge capacity pumps, 50 GPM, 10 HP
Dewatering wells	4	Ea	$4,000.00	$16,000.00	Assumes dewatering well with 6' diameter, 30' deep, and 20 foot screen
Lakos Cyclone Sand Separator	3	Mo	$2,661.00	$8,183.00	Assumes 8x30 dual bag filters skids, two TIGG CP500 adsorbers (anion and cation), connecting hosing and fittings
Anionic and Cationic Resin Replacement	10	Ea	$7,000.00	$70,000.00	Assumes replacement of anionic and cationic resin for Cyclone Separator
Laborer	92	Days	$1,174.25	$108,328.00	Assumes one laborer to monitor dewatering pump for 12 hours a day from Monday to Saturday
Discharge of treated water	10	MG	$396.55	$3,966.00	Assumes treated water will be drained to the MWRD sewer and discharge limit is < 5pCi/L
SUBTOTAL				**$220,000.00**	
Laboratory Analysis					
Water Disposal Samples	121	Ea	$600.00	$72,800.00	Project-specific unit costs
Waste characterization samples, including special waste	5	Ea	$1,500.00	$7,500.00	Project-specific unit costs
TACO Confirmation Samples	75	Ea	$650.00	$48,750.00	Unit cost from other Illinois projects
Isotopic Uranium and Thorium-230-Alpha Spec (24-hour TAT, off-site lab)	80	Ea	$400.00	$32,000.00	Project-specific unit costs
Soil Verification Samples (Radium, Uranium, Thorium)	75	Ea	$300.00	$22,500.00	Project-specific unit costs
Air Particulate Perimeter Sample Analysis and Supplies	2	Ea	$1,200.00	$2,400.00	Project-specific unit costs per quarter, assume 2 full quarters of monitoring including before and after remediation
Radon Perimeter Monitoring	2	Ea	$1,000.00	$2,000.00	Project-specific unit costs
Gamma Radiation Perimeter Monitoring	2	Ea	$1,000.00	$2,000.00	Project-specific unit costs
Sample shipping	300	Ea	$30.00	$9,000.00	Estimate
SUBTOTAL				**$199,000.00**	
Site Engineer/Remediation Direction, Support, and Confirmation					
Site Engineer	60	Days	$2,000.00	$120,000.00	Assume site engineer to conduct onsite inspections and support as needed.
Project Manager	266	Days	$1,100.00	$292,600.00	Assume project manager onsite for duration of project.
Scientist	230	Days	$750.00	$172,500.00	Assume field staff onsite for excavation, transportation and disposal, as well as, additional support during remainder of the project
Scientist	120	Days	$750.00	$90,000.00	Assume field staff onsite for excavation, transportation and disposal
				$675,000.00	
Health and Safety					
Health Physicist Technician	120	Days	$1,150.00	$138,000.00	Assume one Health Physics Technician to perform radiological screening during excavation, stockpiling, clearance surveys, and confirmation sample collected and analysis. Assume HP Technician on site for 50 hours per week
Health Physicist Supervisor	120	Days	$1,800.00	$216,000.00	Assume one Health Physics Supervisor to perform radiological screening during excavation, stockpiling, clearance surveys, air sampling, supervision of Health Physics Technician during field work, project management and coordination and reporting. Assume HP Supervisor onsite for 50 hours per week
Travel Expenses for HP Supervisor and Technician	120	Days	$297.32	$35,678.00	Travel expenses as allowable in accordance with the City of Chicago Travel Guidelines.
Perimeter Air Monitoring	5	Mo	$5,262.35	$26,312.00	Assumes 4 DustTraks for air monitoring during excavation and backfill activities
Radiological Screening Equipment	20	Wk	$4,113.10	$82,262.00	Assumes 2 G-M pancake detectors, 2x2 NaI detector/GPS combination, 2x2 NaI detector, Micro-R meter, alpha tray counter, 3 lapel air samplers, 3 high volume air samplers, NIST traceable check sources, external dosimetry for personnel, and complete gamma spectroscopy system for onsite analysis. Cost includes providing field screening, laboratory analytical, air monitoring, dosimetry data, and other data collected during the work to Contractor.
XRF	4	Mo	$3,729.69	$15,333.00	Assumes XRF rental during the duration of excavation activities
PPE	200	Day	$105.25	$21,050.00	Assumes Level D PPE for all onsite workers and Level C PPE for workers that may enter structure
SUBTOTAL				**$535,000.00**	
Equipment Decontamination					
Equipment Decon	5	Ea	$2,374.08	$11,870.00	
SUBTOTAL				**$12,000.00**	
Remediation Reporting					
Draft and final site remediation completion report	1	Ea	$50,000.00	$50,000.00	
SUBTOTAL				**$50,000.00**	
Contingency	25%			**$4,296,000.00**	
TOTAL CAPITAL COST				**$22,205,000.00**	