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Enclosure 19

Response to Request for Additional Information

Preliminary Human Health Risk Assessment Westinghouse Columbia Fuel Fabrication Facility 5801 Bluff Road Hopkins South Carolina

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Westinghouse Columbia Fuel Fabrication Facility
5801 Bluff Road
Hopkins, South Carolina

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LIST OF ACRONYMS

ATSDR	Agency for Toxic Substances and Disease Registry
BRA	baseline risk assessment
cis-1,2-DCE	cis-1,2-dichloroethene
CFFF	(Westinghouse) Columbia Fuel Fabrication Facility
COPC	chemical of potential concern
EPD	exposure pathway diagram
ERA	ecological risk assessment
HHRA	human health risk assessment
HQ	hazard quotient
MCL	maximum contaminant level
mg/L	milligrams per liter
mrem/yr	millirems per year
NBS	National Bureau of Standards
NRWQC	national recommended water quality criteria
PCE	tetrachloroethene
pCi//L	picocuries per liter
RAGS	Risk Assessment Guidance for Superfund
RI	remedial investigation
RL	reporting limit
RSL	regional screening level
SCRDI	South Carolina Recycling and Disposal, Inc.
Tc-99	technetium-99
TCE	trichloroethene
USDOC	United States Department of Commerce
USEPA	United States Environmental Protection Agency
VISL	vapor intrusion screening level
VOC	volatile organic compound
WWTP	wastewater treatment plant

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1.0 INTRODUCTION

This report presents the initial portions of a Human Health Risk Assessment (HHRA) for the Westinghouse Columbia Fuel Fabrication Facility (CFFF). A Preliminary HHRA previously was performed at the CFFF in 2014 as part of a Preliminary Baseline Risk Assessment (BRA), which included both HHRA and Ecological Risk Assessment (ERA) components. The 2014 Preliminary HHRA was based on data collected at the site between 2008 and 2013. This Phase 2 Preliminary HHRA provides an updated evaluation based on recent data collected in 2018. It includes the initial steps of the HHRA process, consisting of an evaluation of the exposure setting, development of a preliminary conceptual site model, and conservative screenings of recent data collected at the site. The results of the Preliminary HHRA can be used to determine if additional data need to be collected and/or additional steps in the HHRA process need to be performed to complete the HHRA.

2.0 SITE DESCRIPTION

The CFFF is located at 5801 Bluff Road (SC Hwy 48) in a rural portion of Richland County near Hopkins, South Carolina. The CFFF property consists of approximately 1,200 acres. The plant building and the wastewater treatment plant (WWTP) are situated on the northern portion of the property. The plant building is located approximately 2,700 feet southwest of Bluff Road, and the WWTP is located near the southwest corner of the plant building. Process water is temporarily stored, sampled, and treated (if necessary) in the lagoons at the WWTP. The East Lagoon is utilized as extra capacity for the other lagoons and for one non-special nuclear material (SNM) process water waste stream. The West 1 and West 2 lagoons are utilized for a second waste stream. Both waste streams are then sent to either the North or South lagoons. Sanitary wastewater is treated in the sanitary lagoon followed by chlorination and de-chlorination. All treated wastewater is then discharged to the Congaree River through a diffuser at the base of the river channel at a location approximately 3 miles southwest of the CFFF.

A small man-made pond, which existed prior to construction of the CFFF, is located approximately 500 feet southwest of the WWTP. A small spring discharges into the northern edge of the pond. No surface water outflow occurs from the pond. Sunset Lake is located immediately west and south of the pond, approximately 900 feet southwest of the WWTP. Sunset Lake is located within a natural oxbow lake and consists of upper and lower sections separated by a man-made dam (causeway) with a channel through which Mill Creek can flow from Upper to Lower Sunset Lake. A manmade dam approximately 1,700 feet south of the WWTP backs up Mill Creek to create Lower Sunset Lake. The southern portions of the property, including the pond, Mill Creek, and both portions of Sunset Lake, are located within the floodplain of Mill Creek and the Congaree River. The plant/WWTP area and the floodplain are separated by a bluff approximately 20 feet high, which is located immediately south of the WWTP.

3.0 DATA COLLECTION AND EVALUATION

3.1 Data Collection

Data used in this Phase 2 Preliminary HHRA were collected from investigation and ongoing monitoring activities conducted on and downstream of the CFFF predominantly in 2018. The data were obtained from analysis of samples from groundwater, soil, surface water, sediment, vegetation, and fish tissue. The chemicals that were the focus of the analysis were identified as potentially site-related chemicals during previous investigations. It should be noted that in 2018 the CFFF revised its environmental monitoring program to require analysis of groundwater for uranium and technetium-99 (Tc-99) in addition to alpha and beta indicator parameters (gross alpha and gross beta). Uranium is the alpha emitter from site operations, and Tc-99 is the beta emitter. This analysis provides a better characterization of potential radionuclide impacts that could originate from the CFFF. Uranium analysis also was added for soil, vegetation, sediment, and fish monitoring.

Groundwater data used in this Phase 2 Preliminary HHRA were collected from 38 shallow wells in 2018. In accordance with United States Environmental Protection Agency (USEPA) guidance (USEPA, February 2014), data from the two most recent rounds of sampling for each well were included in the groundwater data set. Constituents analyzed included volatile organic compounds (VOCs) (cis-1,2-dichloroethene [cis-1,2-DCE], tetrachloroethene [PCE], trichloroethene [TCE], chloroform, 1,1-biphenyl, carbazole, naphthalene, phenanthrene, and carbon disulfide); inorganics (fluoride, ammonia, and nitrate); and radionuclides (gross alpha, gross beta, uranium, and Tc-99). Groundwater location W24 was considered a background location not affected by site activities.

Surface water samples are collected monthly from six locations on the CFFF property (entrance, roadway, causeway, pond, spillway, and exit) and were analyzed for gross alpha and gross beta. Surface water samples also were collected for analysis of fluoride from five of these locations monthly (entrance, roadway, causeway, spillway, and exit) and from three of these locations weekly (roadway, causeway, and spillway).

In addition, surface water samples are collected monthly from four locations on the Congaree River (at the Blossom Street bridge, above the facility's National Pollutant Discharge Elimination System (NPDES) discharge, below the discharge, and where Mill Creek joins the river) and analyzed for gross alpha and gross beta.

Soil and vegetation samples are collected twice annually at four locations around the perimeter of the CFFF property. These samples are analyzed for total uranium, gross alpha, and gross beta. None of these sample locations are considered background.

Sediment and fish tissue samples are collected once annually at or near the location of the NPDES permitted effluent discharge from the CFFF into the Congaree River. These samples are analyzed for total uranium, gross alpha, and gross beta.

3.2 Data Evaluation

The analytical data described above were evaluated prior to use in this Phase 2 Preliminary HHRA. The goal of data evaluation is to select data that are valid for use in the HHRA and to identify chemicals that are potentially site-related. The initial steps in identifying human health chemicals of potential concern (COPCs) involve the evaluation and aggregation of data and are described below. When results from multiple sampling events were available, the more recent results from one or more event(s) were used for each analyte to develop a data group that represents current conditions and encompasses short-term variability in the data.

Step A.1: Sort the data into groups.

After the analytical data are compiled, they are sorted based on medium and exposure area to form data groups for evaluation. An exposure area is a geographical area over which receptors are likely to average their exposures, based on observed or assumed patterns of receptor behavior and the patterns and extent of contamination. The data for each medium are sorted based on exposure areas to form data groups for use in evaluating risk.

Groundwater

Groundwater was evaluated using data from shallow monitoring wells at the site. As discussed in Section 4.1.2, the only potentially complete groundwater exposure pathway under current conditions is vapor intrusion, in which VOCs volatilize from shallow groundwater and enter buildings. The vapor intrusion pathway is of concern only for VOC contamination in shallow groundwater within 100 feet of an occupied building. Under future conditions, it was assumed that a building could be constructed and occupied by workers anywhere on the site. In this scenario, future workers could be exposed to VOCs in groundwater as a result of vapor intrusion, as described above for current workers. Therefore, data from all site wells in which VOCs were detected were used to constitute a data group to be screened for vapor intrusion COPCs under a future industrial scenario.

Also under future conditions, it was assumed that additional groundwater exposure pathways potentially could be complete for a hypothetical future resident. To be conservative, it was assumed that the residents' potable water could be obtained from a well installed at any location and screened at any depth at the site. Under this scenario, an on-site resident could be exposed through direct ingestion of and dermal contact with groundwater and inhalation of vapors during showering and other household uses of groundwater. Data from all wells except the three deep wells were used to constitute a data group to be screened for groundwater COPCs under a future residential scenario.

Surface Water

For surface water, the potentially downgradient sample locations were separated into two data groups to be screened for surface water COPCs: five locations on the CFFF property and two in the Congaree River. The entrance location is considered the background location for onsite surface water. It is located west of and upstream of the CFFF at the flood gate valve that

controls flow from Mill Creek Swamp into Upper Sunset Lake. Background locations for river surface water are at the Blossom Street bridge and above the facility's NPDES discharge, both of which are upstream of any potential influence from the CFFF. Data from the one background location on the property and the two background locations on the river were not included in their respective data groups. Monthly data from the entire year 2018 were included in the data groups to allow for the variability in surface water data.

Soil and Vegetation

For soil and vegetation, data from the four sample locations were screened for COPCs based on data groups consisting of the two most recent samples (i.e., two samples of each medium at each location collected biannually in 2018).

Sediment and Fish Tissue

For sediment and fish tissue, data from the single sample location were screened for COPCs based on data groups consisting of the two most recent years of data (i.e., two samples of each medium collected annually in 2017 and 2018).

Step A.2: Eliminate non-detected analytes.

Those analytes not detected in any samples in a particular medium or data group were eliminated from the data set.

Step A.3: Determine data parameters.

For each analyte in each data group, the following data parameters are presented in Tables 3-1 through 3-6: minimum and maximum detected concentrations, location of the maximum detected concentration, detection frequency, and range of reporting limits.

After the completion of Steps A.1 through A.3, the data sets were screened to identify human health COPCs, as described below.

4.0 HUMAN HEALTH RISK ASSESSMENT

The purpose of the HHRA portion of a BRA is to characterize the potential for carcinogenic risk and noncarcinogenic hazard to human receptors exposed to site-related contaminants under current and hypothetical future land use conditions if no remedial action is performed. The preliminary steps of an HHRA include an evaluation of exposure setting, development of a preliminary conceptual site model and associated exposure pathway diagram (EPD), and conservative screening of existing data. Contaminants determined to have the potential to pose risk or hazard to human receptors are identified as human health COPCs. Information from the preliminary steps of the HHRA supports risk management decisions regarding the need for additional data or additional steps of the HHRA. This preliminary HHRA for the Westinghouse CFFF uses recent data and current guidance to update the preliminary HHRA completed in February 2014.

This preliminary HHRA was conducted in accordance with the following USEPA guidance documents:

Risk Assessment Guidance for Superfund (RAGS), *Volume I, Human Health Evaluation Manual (Part A), Interim Final* (USEPA, December 1989);

RAGS, Volume I, Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments), Final (USEPA, December 2001);

RAGS, Volume I, Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final (USEPA, July 2004);

RAGS, Volume I, Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment), Final (USEPA, January 2009); and

Region 4 Human Health Risk Assessment Supplemental Guidance (USEPA, March 2018).

4.1 Identification of Chemicals of Potential Concern

The selection of COPCs is a step-wise process that evaluates appropriate analytical data in order to identify those chemicals that are likely to be site-related (i.e., not present at the site due to natural conditions or detected in samples due to field or laboratory error) and that have the potential to pose cancer risk or noncancer hazard to human receptors. If a chemical is selected as a COPC, it does not imply that the chemical poses a health risk or that it will contribute to a significant risk in an environmental medium. COPCs are merely those chemicals that need to be further evaluated for their potential human health effects. The rationale and criteria used to identify COPCs followed applicable USEPA Region 4 guidance (USEPA, March 2018). The analytes that passed through the data evaluation procedure described in Section 3.2 (Steps A.1 – A.3) were evaluated to identify COPCs. The COPC selection process for this Preliminary HHRA is described in Steps B.1 through B.4 below.

Step B.1: Compare analyte concentrations to risk-based screening levels.

Screening Level Sources

An analyte is eliminated as a COPC if its maximum detected concentration is less than its risk-based screening level. The chemical-specific screening levels for each medium were from the following sources:

Groundwater

USEPA Regional Screening Levels (RSLs) for tap water, at a risk level of 10^{-6} or hazard quotient (HQ) of 0.1 (USEPA, November 2018), for future exposure to residential receptors via direct contact.

USEPA Maximum Contaminant Levels (MCLs) (USEPA, March 2018).

Surface Water

USEPA National Recommended Water Quality Criteria (NRWQC), Consumption of Water + Organism, (USEPA, June 2015).

USEPA MCLs (USEPA, March 2018).

Sediment

USEPA Regional Screening Levels (RSLs) for residential soil, based on a carcinogenic risk level of 10^{-6} or noncarcinogenic HQ of 0.1 (USEPA, November 2018).

Screening of Gross Beta

The screening level used for gross beta in both groundwater and surface water was the MCL. The MCL for gross beta is expressed as a dose of 4 millirems per year (mrem/yr). Therefore, the measured gross beta activity concentrations in picocuries per liter (pCi/L) were converted to doses for comparison to the MCL. The maximum detected gross beta activity values for the groundwater and surface water data groups were converted from pCi/L to mrem/yr based on the "sum-of-the-fractions" method provided by USEPA (March 2002). This method is used to add the contribution of each beta emitter to determine compliance with the gross beta MCL. The "sum-of-the fractions" method is shown below:

$$\text{Gross beta (mrem/yr)} = 4 \cdot \sum (x/y)$$

Where:

x = adjusted gross beta value in pCi/L

y = equivalent of 4 mrem annual exposure in pCi/L (from National Bureau of Standards [NBS] Handbook 69; United States Department of Commerce [USDOC], August 1963)

The conversion from pCi/L to mrem/yr was based on the assumption that Tc-99 is the primary beta emitter in groundwater at the site, as demonstrated by a Westinghouse investigation performed for the Nuclear Regulatory Commission in 1998 (AECOM, April 2009). According to the EPA "Radionuclides Rule" (65 FR 76708) (USEPA, December 2000), the total dose limit of 4 mrem/yr from beta emitters applies to the total human body and to critical organs. Also, derived radionuclide-specific activity concentrations that yield 4 mrem/yr should be based on values contained in the NBS Handbook 69 (USDOC, August 1963) and based on a drinking water intake rate of 2 liters per day. The derived concentration of Tc-99 in drinking water that yields a dose of 4 mrem/yr to the total body or critical organs is 900 pCi/L, as defined in the conversion tables listed in NBS Handbook 69 (USDOC, August 1963).

Using this method and assuming Tc-99 is the predominant beta emitter present in groundwater and surface water, the maximum detected gross beta values for groundwater and surface water in pCi/L were divided by 900 pCi/L and multiplied by 4 mrem/yr to convert them to estimated doses. These doses based on the maximum activities were then compared to the gross beta MCL of 4 mrem/yr (Tables 3-1 and 3-2).

Vapor Intrusion Screening

Risk-based screening levels for groundwater based on the indoor air exposure pathway were derived using the USEPA Vapor Intrusion Screening Level (VISL) Calculator, (USEPA, June 2018), which uses current USEPA inhalation toxicological data in the calculations. Groundwater screening concentrations were derived for the residential exposure scenario using a target risk of 10^{-6} for carcinogens and a target HQ of 0.1 for noncarcinogens. The VISL Calculator includes chemicals that could volatilize from groundwater into indoor air and that have been identified as potentially causing cancer risk or noncancer hazard through the inhalation pathway. Chemicals evaluated in the VISL calculator were those VOCs detected in groundwater from any site locations during the most recent sampling events.

Step B.2: Compare analyte concentrations to background levels

An analyte may be eliminated as a COPC if its maximum detected concentration is less than its background concentration. As mentioned in Section 3.0, location W24 was considered the groundwater background location, the entrance location was considered background for onsite surface water, and the Blossom Street bridge and above discharge location were considered background for river surface water. No background data were collected for soil, vegetation, sediment, or fish.

Groundwater background concentrations were calculated as two times the mean of the two most recent concentrations in well W24, using one-half the reporting limit as a surrogate concentration for non-detects. Background results were available only for inorganics, gross

alpha, and gross beta. No chemicals were eliminated as COPCs in groundwater based on comparison of maximum detected concentrations to background values.

Step B.3: Delete media and/or exposure groups

In this step, it is determined whether any COPCs remain for each medium and data group. If not, the medium and/or data group is dropped from consideration in the HHRA. COPCs remained in every medium and data group except surface water (onsite and river).

Step B.4: Define COPCs and data groups.

The chemicals remaining in each medium and data group after the completion of Steps A.1 to A.3 and B.1 to B.3 are the human health COPCs. The COPCs identified through the methods and rationale described above are presented in Tables 3-1 through 3-6 for groundwater, surface water, soil, vegetation, sediment, and fish, respectively. These tables list the analytes detected in the data group, their occurrence (maximum and minimum detected concentrations, location of maximum concentration), frequency of detection, range of reporting limits (RLs), and screening value, and they indicate which analytes are COPCs and the rationale for their selection or deletion. Table 4-1 presents the VISL Calculator inputs and results. Table 4-2 presents the groundwater vapor intrusion COPCs.

4.2 Exposure Assessment

The exposure assessment describes exposure scenarios and develops information on exposure pathways. This section addresses the potential pathways by which human populations could be exposed to the COPCs identified in Section 4.1. In identifying primary pathways of exposure, both current and potential future land uses on the site and surrounding areas were considered.

4.2.1 Characterization of Exposure Setting

This section describes the overall exposure setting in terms of the natural environment and land use. The description of the exposure setting provides information pertinent to the identification of potential human exposure pathways and the estimation of exposure factors for current and hypothetical future human receptors.

4.2.1.1 Natural Environment

The CFFF site encompasses approximately 1200 acres. The northern portion of the property consists of a relatively flat, upland area located on an ancient terrace. The southern portion of the property lies within the floodplain of Mill Creek and the Congaree River. The upland area and floodplain are separated by a bluff, approximately 20 feet high, located immediately south of the WWTP. Surface drainage at the site flows toward several drainage ditches that cross the property and surrounding areas. These ditches flow into upstream areas of Mill Creek (approximately 3,000 feet west of the plant) and Upper Sunset Lake (approximately 1,500 feet west of the plant).

There is a cultivated hayfield northeast of the facility, between the building and Bluff Road, and forested areas (mainly pine plantations) to the west, northwest, and east of the facility. The floodplain area includes extensive wetlands consisting mainly of swamps associated with Sunset Lake and Mill Creek, as well as the manmade pond immediately south of the facility.

4.2.1.2 Land Use

The CFFF site is an active manufacturing facility. The buildings, WWTP, and parking lot are situated within a fenced area on the northern portion of the property. The main building is located approximately 2700 feet southwest of Bluff Road. Site access is limited to the main entrance off Bluff Road, which connects to security facilities, the plant area, and other gravel and dirt roads that cross the property outside the fenced area.

Current land use at the facility is industrial. Land use in the surrounding area can be characterized as rural. The South Carolina Recycling and Disposal, Inc. (SCRDI) Superfund Site is located across Bluff Road to the northeast. That site formerly was a solvent recovery facility that resulted in VOC contamination of groundwater. Undeveloped forested lands are located in the upland to the north and northeast of Bluff Road and the SCRDI Site and to the east of the CFFF property. Forested lands also are located south and west of the facility within the Congaree River floodplain. Forested and agricultural areas are located to west and northwest of the site.

Potential receptors most likely to exist under current conditions include industrial workers who work indoors at the facility and maintenance workers who mow the grass and perform general maintenance activities along the on-site ditches. The reasonably anticipated future land use at the site is expected to remain industrial, and industrial workers and maintenance workers are considered to be the potential human receptors on the site.

4.2.2 Identification of Human Health Exposure Pathways

Potential human exposure pathways were identified for the CFFF based on current and potential future land uses as well as the extent and distribution of COPCs at the site. A complete pathway includes: (1) a chemical source and release mechanism, (2) a transport or retention medium, (3) an exposure point where human contact with the contaminated medium occurs, and (4) a route of intake for the contaminant into the body at the exposure point. If any of these elements is missing, the pathway is considered incomplete and is not considered further in the HHRA. An EPD has been developed to illustrate the potential exposure pathways for the site (Figure 4-1). In the diagram, the potentially complete pathways, which would be quantitatively evaluated if additional steps in the BRA process were needed, are indicated by an "X" in a box. Pathways that are potentially complete but are insignificant and do not warrant quantification are designated by an asterisk. A box without an "X" or an asterisk (*) indicates an incomplete pathway.

The environmental media with the greatest potential to contain site-related contaminants are groundwater and surface water of the onsite water bodies near the facility. Although soil and vegetation on the perimeter of the site property have been periodically sampled and are

screened in this preliminary evaluation, these media are unlikely to contain contaminants from site-related activities. Therefore, exposure pathways for soil and vegetation are not discussed below.

4.2.2.1 Current Land Use Scenario

The CFFF is an active industrial facility. Under current conditions, industrial workers are likely to have a potential for exposure to site-related contaminants in groundwater. Potential groundwater exposure routes involving direct contact are incomplete under current conditions because potable water used at the facility is not obtained from site groundwater. However, exposure to groundwater contaminants via vapor intrusion is a potentially complete pathway for workers in a building located above or near (within approximately 100 feet horizontally or vertically) where VOCs have been detected in shallow groundwater (i.e., the uppermost saturated zone) (USEPA, November 2002). Indoor workers potentially could be exposed to volatile groundwater contaminants by inhaling indoor air containing vapor that has infiltrated the building in which they work. However, indoor air sampling has been performed periodically throughout the CFFF buildings, and all VOC levels have been below permissible exposure limits established by the Occupational Safety and Health Administration (OSHA). Therefore, inhalation is not a significant exposure pathway for industrial workers under current conditions.

A current maintenance worker is potentially exposed to site-related contaminants in surface water while maintaining the drainage ditches through the western side of the facility. Potential exposure routes include ingestion and dermal absorption. Potential groundwater exposure pathways are incomplete under current conditions because potable water used at the facility is not obtained from site groundwater and the maintenance worker is not expected to perform excavation activities that would result in contact with groundwater.

A fisher in the Congaree River potentially could be exposed to constituents that enter the river via the facility's wastewater discharge permitted under the National Pollutant Discharge Elimination System (NPDES). Although incidental contact with river surface water and sediment would not be expected to result in significant exposure, ingestion of fish may be a pathway that warrants evaluation given the potential for uptake of some constituents from water to fish tissue.

4.2.2.2 Future Land Use Scenario

The future land use scenario at the CFFF is expected to remain the same as that identified under current conditions. Industrial workers and maintenance workers are the human receptors with a potential for exposure to site-related contaminants. The future scenario assumes that the current buildings at the site will remain and that additional buildings may be constructed.

Potential exposure of a future industrial worker to groundwater contaminants is assumed to occur through vapor intrusion. Other groundwater exposure pathways unlikely to be complete for a future industrial worker are ingestion and dermal absorption from hand washing. However, it is assumed that potable water will continue to be obtained from an off-site source, and that no potable water supply wells will be installed on the site.

Exposure routes for a future maintenance worker are assumed to remain the same as under current conditions, with ingestion and dermal absorption the potential surface water exposure routes and potential groundwater exposure pathways being incomplete.

An unlikely future scenario is residential, which is standardly included as a conservative scenario for comparison. It is conservatively assumed that direct exposures to site groundwater could occur through the use of an on-site well as a potable water source for on-site residents (adult and child). Future residents living off-site but in the vicinity of the site and downgradient of the site with regard to groundwater flow also may be exposed to site-related groundwater contaminants through the use of an off-site well as a potable water source. Potentially complete groundwater exposure pathways for a future on-site or off-site resident include groundwater ingestion, dermal absorption while bathing, and inhalation of vapors from showering and other household uses of groundwater. Additionally, inhalation of vapors migrating from groundwater into indoor air is considered a potentially complete exposure pathway.

As under current conditions, a future fisher in the Congaree River potentially could be exposed to constituents that enter the river via the NPDES discharge. Should access to onsite water bodies become available to fishers in the future, a fisher also could be exposed by consuming fish caught in onsite water bodies. Therefore, future ingestion of fish may be a pathway that warrants evaluation given the potential for uptake of some constituents from water to fish tissue.

4.3 Identification of Human Health COPCs

The preliminary COPCs initially identified in the screening described in Section 4.1 are summarized below.

4.3.1 Groundwater

Four VOCs (chloroform, cis-1,2-DCE, PCE, and TCE) and two SVOCs (1,1-biphenyl and naphthalene) were initially identified as preliminary COPCs in groundwater because their maximum detected concentrations exceeded their screening values (Table 3-1). Carbazole was identified as a preliminary COPC because it lacked a screening value. The screening value exceeded for these VOCs and SVOCs was their respective USEPA RSL for tap water, which is derived to be protective of regular long-term use of water for drinking and bathing.

The inorganics fluoride and nitrate were initially identified as preliminary COPCs in groundwater because their maximum detected concentrations exceeded their screening values (Table 3-1). Fluoride and nitrate exceeded screening values based on tap water RSLs, and fluoride also exceeded its MCL. Ammonia was identified as a preliminary COPC because it lacked a screening value. Ammonia was detected in 75 of 86 groundwater samples, with concentrations ranging from 0.01 milligrams per liter (mg/L) to 123 mg/L. Ammonia is found naturally throughout the environment, is a major component of the nitrogen cycle, and is an important source of nitrogen for plants. Most ammonia in the environment comes from the natural breakdown of organic matter. Most of the ammonia that enters the human body in food or water rapidly changes into other substances that are not harmful, and the rest of this ammonia leaves

the body in urine within a couple of days. The main toxic effects of ammonia are restricted to areas of direct contact (i.e., skin, eyes, respiratory tract, mouth, and digestive tract) where irritation may occur from exposure to concentrated amounts (Agency for Toxic Substances & Disease Registry [ATSDR], September 2004). The potential for oral ingestion of ammonia in groundwater is insignificant because the only potential receptor with an opportunity for exposure is a maintenance worker, who may mow the grass or perform activities along the onsite ditches. Because of its natural occurrence in the environment, its low toxicity, and the minimal potential for receptor exposure at the site, ammonia is not considered to warrant retention as a COPC in groundwater.

The radionuclides uranium, Tc-99, gross alpha, and gross beta were identified as COPCs because their maximum detected concentrations (uranium) or activities (Tc-99, gross alpha, and gross beta) exceeded their screening values (Table 3-1). Uranium exceeded its screening value based on the tap water RSL (0.4 ug/L) and also exceeded its MCL (30 ug/L). Tc-99, gross alpha, and gross beta activities exceeded screening values based on their MCLs. The uranium isotopes detected do not have isotope-specific screening values but are identified as preliminary COPCs due to the exceedances by total uranium. Site groundwater is not used for drinking or other purposes for which the RSLs and MCLs were derived to be protective under current conditions, and it is unlikely to be used for these purposes under future conditions; therefore, this screening is very conservative.

As discussed in Section 4.1, the VISL Calculator (Table 4-1) was used to identify vapor intrusion COPCs in groundwater. The analytes evaluated in the VISL calculator were those detected in groundwater samples, which have the potential to volatilize from groundwater and enter buildings on the site. Nine analytes detected in groundwater samples met this criterion and were evaluated (Table 4-2). An analyte was eliminated as a vapor intrusion preliminary COPC if its maximum detected concentration was less than its VISL groundwater screening target concentration or if no inhalation toxicity criteria were available to evaluate the analyte. The VISL calculator is presented as Table 4-1, and the vapor intrusion COPCs are presented in Table 4-2. Chloroform, PCE, TCE, 1,1-biphenyl, and ammonia were identified as vapor intrusion preliminary COPCs in groundwater.

4.3.2 Surface Water

Because of the absence of surface water screening criteria for the chemicals analyzed in surface water (fluoride, gross alpha, and gross beta), the values used for screening were MCLs, which are drinking water standards protective of regular consumption of drinking water (Table 3-2). Fluoride concentrations and gross alpha and gross beta activities in surface water did not exceed their respective screening values conservatively based on MCLs in either the onsite surface water bodies or the Congaree River. Accordingly, no preliminary COPCs were identified in surface water.

4.3.3 Soil and Vegetation

Uranium was not identified as a preliminary COPC in surface soil because its maximum detected activity, when converted to a concentration, did not exceed its screening value, which was a residential soil RSL based on an HQ of 0.1 (Table 3-3). Gross alpha and gross beta were initially identified as preliminary COPCs in soil because they have no established screening values in soil for protection of human health.

In the absence of a screening value for uranium in vegetation, the residential soil RSL also was used for vegetation and was not exceeded (Table 3-4). Therefore, uranium was not identified as a preliminary COPC in vegetation. Gross alpha and gross beta were initially identified as preliminary COPCs in vegetation because they have no established screening values in vegetation for protection of human health.

4.3.4 Sediment and Fish

Uranium was not identified as a COPC in river sediment because its maximum detected activity, when converted to a concentration, did not exceed its screening value (Table 3-5). In the absence of an established sediment screening value, the residential soil RSL for uranium based on an HQ of 0.1 was used as a very conservative screening value for river sediment. Gross alpha and gross beta were identified as preliminary COPCs in sediment because they have no established screening values in sediment for protection of human health.

Uranium was not identified as a COPC in fish tissue from the Congaree River because its maximum detected activity, when converted to a concentration, did not exceed its screening value (Table 3-6). The screening value was a fish-ingestion RSL that was based on uranium's chemical toxicity effects and on the conservative assumption of regular and substantial consumption of fish from the water body sampled. Gross alpha and gross beta were identified as preliminary COPCs in fish because they have no established screening values in fish for protection of human health.

4.4 Uncertainty

The evaluation of chemical risks to human health is necessarily based on a number of assumptions with inherent uncertainties. This section provides a discussion of the uncertainties associated with key site-related variables and major assumptions used in the preliminary HHRA, in order to address their potential effect on the identification of COPCs. This preliminary HHRA provides an initial, conservative assessment of the potential for site-related contaminants to pose risk to human health, but it does not quantify cancer risks or noncancer hazards associated with COPCs.

The sampling data collected at locations at the CFFF site are inevitably a limited subset of the nearly unlimited quantity of data that potentially could be collected, and as such, may not be completely representative of site contaminant levels. However, samples were not collected on a random basis (e.g., sampling focused in potential source areas) and are likely to be biased toward overestimation of chemical concentrations. Uncertainty also is inherent in the selection

of site-related COPCs. Uncertainty in contaminant identification is considered low because sampling protocols generally target appropriate analytes based on historical information and guidance.

There is uncertainty associated with use of the VISL Calculator. The calculator is based on assumptions about the site, including homogenous vadose zone soil and a building with a poured concrete foundation (USEPA, June 2018). The VISL calculator uses generic attenuation factors developed by USEPA that assume vapor concentrations will be reduced as they migrate upward from the groundwater and that concentrations will be further reduced as they mix with air in the buildings. Factors that may not support use of the VISL Calculator include: very shallow groundwater (e.g., less than 5 feet below the foundation) or buildings with significant openings to the subsurface (e.g., unlined crawlspace). These factors need to be considered in determining if the generic attenuation factors are appropriate for a particular site.

Factors that contribute to uncertainty in the exposure assessment include identification of exposure pathways, assumptions for scenario development, and exposure point concentrations. The identification of potential exposure pathways and receptors was based on site-specific, plausible, current, and hypothetical future land use scenarios. Site-specific receptors were identified to the extent possible in order to minimize uncertainty in the postulated exposure scenarios. In accordance with USEPA Region 4 guidance, a future residential exposure scenario was included. This scenario is highly unlikely given that the expected future land use in the vicinity of the CFFF will likely remain industrial, similar to current conditions.

For screening purposes in this HHRA, the exposure point concentration for each chemical in each medium was conservatively based upon the maximum detected concentration detected in recent samples of these media. The use of maximum detected concentrations is likely to overestimate the potential for risk at the site.

4.5 Summary

This preliminary HHRA comprises the initial steps of the HHRA for the Westinghouse CFFF and provides conservative screenings of recent data collected on and in the vicinity of the CFFF property. The chemicals initially identified as preliminary COPCs based on their exceedance of conservative screening values included VOCs, SVOCs, inorganics, and radionuclides in groundwater (Table 3-1). Gross alpha and gross beta were retained as preliminary COPCs in soil, vegetation, sediment, and fish simply because they have no established screening values for protection of human health in these media.

The groundwater screening level exceeded for each VOC was its USEPA RSL for tap water, which was derived to be protective of regular long-term use of water for drinking and bathing, or its MCL, which is protective of similar uses. Because site groundwater is not used for these purposes under current conditions and is unlikely to be used for such purposes in the future, this screening is very conservative. In addition, five of the volatile groundwater COPCs also were identified as vapor intrusion COPCs in groundwater for a hypothetical residential exposure scenario. In subsequent steps of the HHRA process, these groundwater COPCs would be

further evaluated to calculate the cancer risk or noncancer hazard they may pose based on reasonable maximum estimates of concentrations and potential exposures at the site.

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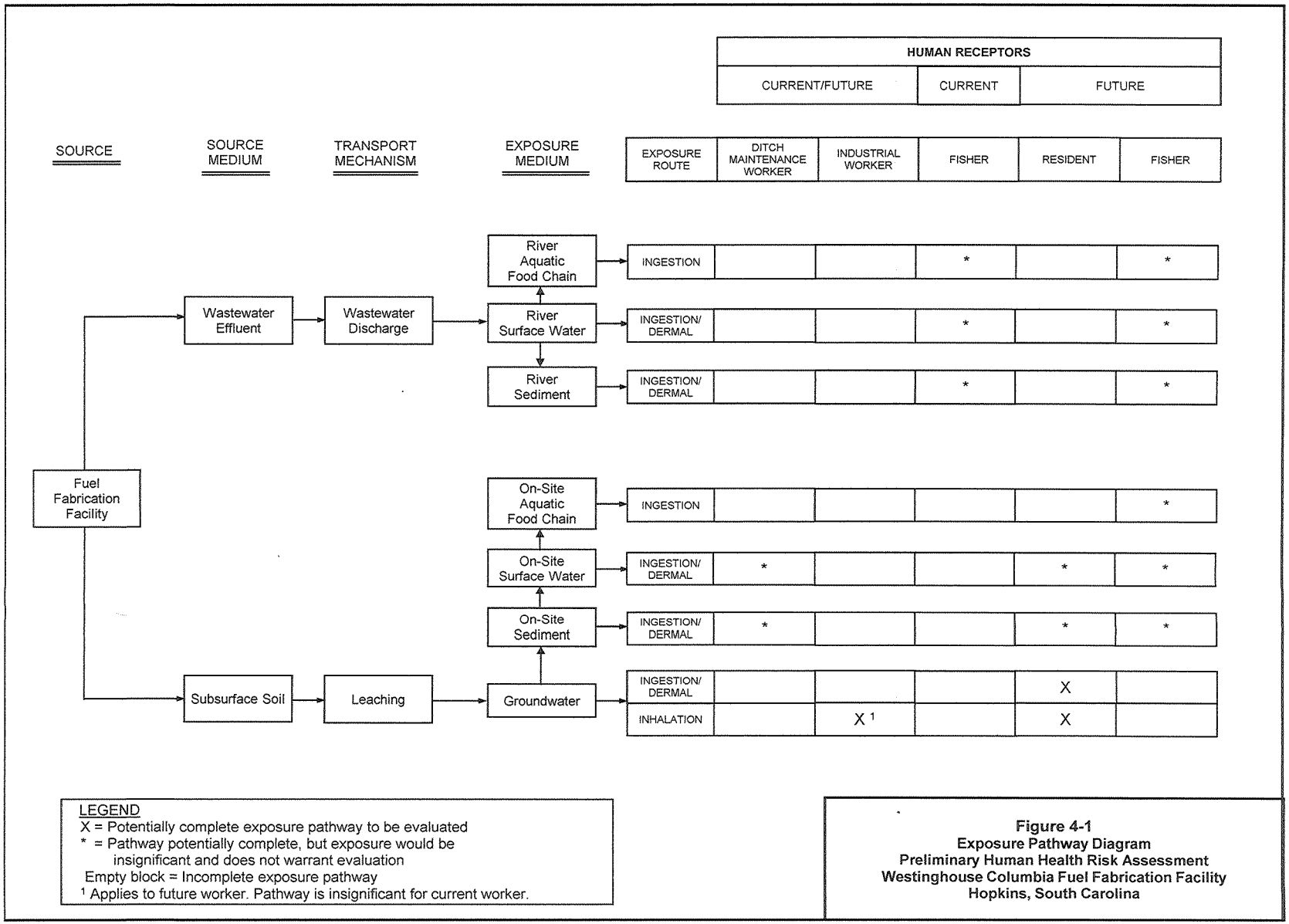
FIGURE



LEGEND
X = Potentially complete exposure pathway to be evaluated
* = Pathway potentially complete, but exposure would be insignificant and does not warrant evaluation
Empty block = Incomplete exposure pathway
[1] Applies to future worker. Pathway is insignificant for current worker.

Figure 4-1
Exposure Pathway Diagram
Preliminary Human Health Risk Assessment
Westinghouse Columbia Fuel Fabrication Facility
Hopkins, South Carolina

TABLES

Table 3-1
Occurrence, Distribution and Selection of Chemicals of Potential Concern in Groundwater (Future)
Westinghouse Columbia Fuel Fabrication Facility
Hopkins, South Carolina

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical	Minimum [1] Concentration	Maximum [1] Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Reporting Limits	Concentration Used for Screening [2]	Background Value [3]	Screening Value [4]		COPC Flag (Y/N)	Rationale for Selection or Deletion [5]
	VOCs												
Groundwater	Carbon disulfide	9.4	9.4	ug/L	W60	1 / 56	1 - 25	9.4	NA	81	(a)	N	BSL
	Chloroform	1.6	5.2	ug/L	W61	3 / 81	1 - 25	5.2	NA	0.22	(a)	Y	**ASL**
	cis-1,2-Dichloroethene	1.1	19	ug/L	TMW-3 W53	13 / 81	1 - 25	19	NA	3.6	(a)	Y	**ASL**
	Tetrachloroethene	1.3	540	ug/L	W33	36 / 81	1 - 5	540	NA	4.1	(a)	Y	**ASL**
	Trichloroethene	1.9	93	ug/L	W65	22 / 81	1 - 5	93	NA	0.28	(a)	Y	**ASL**
	SVOCs												
	1,1-Biphenyl	13	13	ug/L	TMW-1 W51	1 / 56	4 - 40	13	NA	0.083	(a)	Y	**ASL**
	Carbazole	4.5	4.5	ug/L	TMW-1 W51	1 / 56	4 - 40	4.5	NA	NS		Y	**NSL**
	Naphthalene	0.9	4.5	ug/L	W47	27 / 56	0.8 - 0.9	4.5	NA	0.17	(a)	Y	**ASL**
	Phenanthrene	1.8	1.8	ug/L	TMW-1 W51	1 / 56	0.8 - 8	1.8	NA	12	(a)	N	BSL
	Inorganics												
	Fluoride	5	10,000	ug/L	W29	76 / 86	100 - 100	10,000	37.5	80	(a)	Y	**ASL**
	Ammonia (as nitrogen)	11.2	123,000	ug/L	W18	75 / 86	100 - 100	123,000	34.1	NS		Y	**NSL**
	Nitrate	30	840,000	ug/L	W18	83 / 87	20 - 20	840,000	31	3200	(a)	Y	**ASL**
	Radionuclides												
	Isotopic U234	0.0452 J	0.052	ug/L	TMW-5 W55	2 / 56	0.01 - 0.01	0.052	ND	NS		Y	**NSL**
	Isotopic U235	0.0106 J	6.07	ug/L	TMW-5 W55	12 / 56	0.01 - 0.01	6.07	ND	NS		Y	**NSL**
	Isotopic U238	0.0784 J	181	ug/L	TMW-5 W55	26 / 56	0.067 - 0.067	181	ND	NS		Y	**NSL**
	Total uranium (U)	0.0784 J	187	ug/L	TMW-5 W55	26 / 56	0.067 - 0.067	187	ND	0.4	(a)	Y	**ASL**
	Isotopic U233/234	0.146	308	pCi/L	TMW-5 W55	23 / 41	0.201 - 0.357	308	NA	NS		Y	**NSL**
	Isotopic U235/236	0.125	15.4	pCi/L	TMW-5 W55	14 / 41	0.0862 - 0.344	15.4	NA	NS		Y	**NSL**
	Isotopic U238	0.118	64.8	pCi/L	TMW-5 W55	21 / 41	0.105 - 0.35	64.8	NA	NS		Y	**NSL**
	Tc-99	45.4	3640	pCi/L	W11	23 / 48	36.4 - 300	3640	NA	900	(b)	Y	**ASL**
	Gross alpha	1.39	425	pCi/L	TMW-5 W55	34 / 86	3.31 - 4.99	425	3.3	15	(b)	Y	**ASL**
	Gross beta [6]	3.45	2450	pCi/L	W11	64 / 86	2.65 - 4.87	2450	ND	NS		---	--
	Gross beta [6]	--	--	mrem/yr	W11	64 / 86	--	10.9	ND	4	(b)	Y	**ASL**

Notes:

(1) Minimum/maximum detected concentration from the two most recent rounds of sampling from 38 shallow wells. For uranium, results were reported as both concentrations and activities. For other radionuclides, value shown is an activity.

(2) Maximum concentration is used for screening.

(3) Groundwater location W24 is considered background. The background value, when available, is two times the mean of the two most recent concentrations in this well, using one-half the reporting limit for non-detected concentrations.

Definitions:

COPC - chemical of potential concern
ND - not detected
NA - not applicable or not available
NS - no screening value
pCi/L - picocuries per liter
ug/L - micrograms per liter
SVOC - semivolatile organic compound
VOC - volatile organic compound

Notes are continued on the following page.

Table 3-1
Occurrence, Distribution and Selection of Chemicals of Potential Concern in Groundwater (Future)
Westinghouse Columbia Fuel Fabrication Facility
Hopkins, South Carolina

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical	Minimum [1] Concentration	Maximum [1] Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Reporting Limits	Concentration Used for Screening [2]	Background Value [3]	Screening Value [4]	COPC Flag (Y/N)	Rationale for Selection or Deletion [5]

Notes:

(4) Screening value sources:

(a) Tapwater values from the USEPA Regional Screening Level (RSL) Table, based on risk of 10-6 for carcinogens and HQ of 0.1 for noncarcinogens (USEPA, November 2018). All are noncarcinogens except chloroform and naphthalene. The RSL for pyrene was used as a surrogate value for phenanthrene.

(b) Maximum contaminant levels (MCLs) (USEPA, March 2018). For comparison to the MCL, maximum detected gross beta activity (2450 pCi/L) was converted to a dose (10.9 mrem/yr) based on the assumption that Tc-99 is the principal beta emitter present, as discussed in Note 6 and the text.
For Tc-99, the activity that is the equivalent of the gross beta MCL (4 mrem/yr) is 900 pCi/L (from National Bureau of Standards Handbook 69).

(5) Rationale Codes:

Selection Reason: Above Screening Level (ASL)
No Screening Level (NSL)

Deletion Reason: Below Screening Level (BSL)

(6) As discussed in the text, gross beta is converted from pCi/L to mrem/yr based on the "sum-of-the-fractions" method provided by EPA (EPA 816-F-00-002) and the assumption that technetium-99 (Tc-99) is the primary beta emitter in these wells, as demonstrated by a Westinghouse investigation performed for the Nuclear Regulatory Commission in 1998. The derived concentration of Tc-99 in drinking water yielding a dose of 4 mrem/yr to the total body or critical organ is 900 pCi/L (National Bureau of Standards Handbook 69). The maximum detected gross beta activity in pCi/L was divided by 900 pCi/L and multiplied by 4 mrem/yr to convert it to an estimated dose:

Gross beta (mrem/yr) = 4 (sum of (x/y))
where:
x = gross beta value in pCi/L
y = equivalent of 4 mrem annual exposure in pCi/L = 900 pCi/L for Tc-99 (from National Bureau of Standards Handbook 69)

Chemicals in **bold** are retained as preliminary COPCs.

Table 3-2
Occurrence, Distribution and Selection of Chemicals of Potential Concern in Surface Water (Current/Future)
Westinghouse Columbia Fuel Fabrication Facility
Hopkins, South Carolina

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Point	Chemical	Minimum [1] Concentration	Maximum [1] Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Reporting Limits	Concentration Used for Screening [2]	Background Value [3]	Screening Value [4]	COPC Flag (Y/N)	Rationale for Selection or Deletion [5]
Onsite Surface Water	***Inorganics***											
	Fluoride	216	604	ug/L	causeway	9 / 9	--	604	496	4000	N	BSL
	Radionuclides											
	Gross alpha	ND	11	pCi/L	roadway	45 / 60	--	11	4.0	15	N	BSL
	Gross beta [6]	ND	43	pCi/L	pond	57 / 60	--	43	5.1	NS	--	--
	Gross beta [6]	--	--	mrem/yr	pond	57 / 60	--	0.19	NA	4	N	BSL
River Surface Water	***Radionuclides***											
	Gross alpha	ND	5	pCi/L	Mill Creek	7 / 9	--	5	4.5	15	N	BSL
	Gross beta [6]	ND	10	pCi/L	Mill Creek	9 / 9	--	10	6.4	NS	--	--
	Gross beta [6]	--	--	mrem/yr	Mill Creek	9 / 9	--	0.04	NA	4	N	BSL

Notes:

(1) For gross alpha and beta, value shown is a maximum activity based on 12 monthly samples at six locations onsite and eight monthly samples from two locations on the river. For fluoride, value shown is a maximum concentration based on the two most recent samples at three locations onsite.

(2) Maximum concentration is used for screening.

(3) Onsite surface water background from entrance location. River background from Blossom St. bridge and above discharge.

(4) Screening value sources: In the absence of surface water quality criteria, were conservatively based on groundwater maximum contaminant levels (MCLs) (USEPA, March 2018). For comparison to the MCL, maximum detected gross beta activity (pCi/L) was converted to a dose (mrem/yr) based on the assumption that Tc-99 is the principal beta emitter present, as discussed in Note 6 and the text.

(5) Rationale Codes:
Selection Reason: Above Screening Level (ASL)
No Screening Level (NSL)
Deletion Reason: Below Screening Level (BSL)

(6) As discussed in the text, for groundwater (potential drinking water) gross beta was converted from pCi/L to mrem/yr based on the "sum-of-the-fractions" method provided by EPA (EPA 816-F-00-002) and the assumption that technetium-99 (Tc-99) is the primary beta emitter in site groundwater. The derived concentration of Tc-99 in drinking water yielding a dose of 4 mrem/yr to the total body or critical organ is 900 pCi/L (National Bureau of Standards Handbook 69). The maximum detected gross beta value in pCi/L was divided by 900 pCi/L and multiplied by 4 mrem/yr to convert it to an estimated dose:

Gross beta (mrem/yr) = 4 (sum of (x/y))

where:

x = gross beta value in pCi/L

y = equivalent of 4 mrem annual exposure in pCi/L = 900 pCi/L for Tc-99 (from National Bureau of Standards Handbook 69)

Definitions:

COPC - chemical of potential concern
mg/L - milligrams per liter
mrem/yr - millirem (roentgen equivalent in man) per year
NA - not applicable or not available
ND - not detected
pCi/L - picocuries per liter

Chemicals in **bold** are retained as preliminary COPCs.

Table 3-3
Occurrence, Distribution and Selection of Chemicals of Potential Concern in Soil (Future)
Westinghouse Columbia Fuel Fabrication Facility
Hopkins, South Carolina

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil

Exposure Point	Chemical	Minimum [1] Concentration	Maximum [1] Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Reporting Limits	Concentration Used for Screening [2]	Background Value [3]	Screening Value [4]	COPC Flag (Y/N)	Rationale for Selection or Deletion [5]
Soil	***Radionuclides***											
	Total uranium	0.63	2.98	pCi/g	Station 2	8 / 8	NA	2.98	NA	4.5	N	BSL
	Total uranium	0.22	1.1	mg/kg	Station 2	8 / 8	NA	1.1	NA	1.6	N	BSL
	Gross alpha	9.6	30.5	pCi/g	Station 2	8 / 8	NA	30.5	NA	NSL	**Y**	**NSL**
	Gross beta	15	27.5	pCi/g	Station 1	8 / 8	NA	27.5	NA	NSL	**Y**	**NSL**

Notes:

(1) Minimum/maximum detected concentration from the two most recent biannual samples at four locations. Values measured for radionuclides were specific activities (pCi/g). A conversion factor for uranium (1 ug = 2.81 pCi) based on the current weighted specific activity at WCFFF was used to convert the detected activities to concentrations.

(2) Maximum concentration used for screening. A conversion factor for uranium (1 ug = 2.81 pCi) based on the current weighted specific activity at WCFFF was used to convert the maximum detected activity to a concentration for screening.

(3) Soil background data are not available.

(4) Screening value for uranium is the residential soil value (1.6 mg/kg) from the USEPA Regional Screening Level Table, based on an HQ of 0.1 for noncarcinogens (USEPA, November 2018). A conversion factor for uranium based on the current weighted specific activity at WCFFF (1 ug = 2.81 pCi) was used to convert the uranium residential soil RSL to an activity for screening.

(5) Rationale Codes:
Selection Reason: Above Screening Level (ASL)
No Screening Level (NSL)
Deletion Reason: Below Screening Level (BSL)

Chemicals in **bold** are retained as preliminary COPCs.

Definitions:

COPC - Chemical of Potential Concern
NA - not applicable or not available
NSL - no screening level
mg/kg - milligrams per kilogram
pCi/g - picocuries per gram

Table 3-4
Occurrence, Distribution and Selection of Chemicals of Potential Concern in Vegetation (Future)
Westinghouse Columbia Fuel Fabrication Facility
Hopkins, South Carolina

Scenario Timeframe: Future
Medium: Vegetation
Exposure Medium: Soil

Exposure Point	Chemical	Minimum [1] Concentration	Maximum [1] Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Reporting Limits	Concentration Used for Screening [2]	Background Value [3]	Screening Value [4]	COPC Flag (Y/N)	Rationale for Selection or Deletion [5]
Vegetation	***Radionuclides***											
	Total uranium	ND	0.10	pCi/g	Station 2	6 / 8	NA	0.10	NA	4.5	N	BSL
	Total uranium	ND	0.04	mg/kg	Station 2	6 / 8	NA	0.04	NA	1.6	N	BSL
	Gross alpha	ND	3.0	pCi/g	Station 3	7 / 8	NA	3.0	NA	NSL	Y	**NSL**
	Gross beta	4.84	23.4	pCi/g	Station 1	8 / 8	NA	23.4	NA	NSL	Y	**NSL**

Notes:

(1) Minimum/maximum detected concentration from the two most recent biannual samples at four locations. Values measured for radionuclides were activities (pCi/g). A conversion factor for uranium (1 ug = 2.81 pCi) based on the current weighted specific activity at WCFFF was used to convert the detected activities to concentrations.

(2) Maximum concentration used for screening. A conversion factor for uranium (1 ug = 2.81 pCi) based on the current weighted specific activity at WCFFF was used to convert the maximum detected activity to a concentration for screening.

(3) Vegetation background data are not available.

(4) Screening value assumed for uranium is the residential soil value (1.6 mg/kg) from the USEPA Regional Screening Level Table, based on an HQ of 0.1 for noncarcinogens (USEPA, November 2018). A conversion factor for uranium based on the current weighted specific activity at WCFFF (1 ug = 2.81 pCi) was used to convert the uranium residential soil RSL to an activity for screening.

(5) Rationale Codes:
Selection Reason: Above Screening Level (ASL)
No Screening Level (NSL)
Deletion Reason: Below Screening Level (BSL)

Chemicals in **bold** are retained as preliminary COPCs.

Definitions:

COPC - Chemical of Potential Concern
NA - not applicable or not available
NSL - no screening level
mg/kg - milligrams per kilogram
pCi/g - picocuries per gram

Table 3-5
Occurrence, Distribution and Selection of Chemicals of Potential Concern in Sediment (Current/Future)
Westinghouse Columbia Fuel Fabrication Facility
Hopkins, South Carolina

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Point	Chemical	Minimum [1] Concentration	Maximum [1] Concentration	Units	Concentration Used for Screening [2]	Background Value [3]	Screening Value [4]	COPC Flag (Y/N)	Rationale for Selection or Deletion [5]
River Sediment	***Radionuclides***								
	Total uranium	0.56	0.92	pCi/g	0.92	NA	4.5	N	BSL
	Total uranium	0.20	0.33	mg/kg	0.33	NA	1.6	N	BSL
	Gross alpha	4.70	6.37	pCi/g	6.37	NA	NSL	**Y**	**NSL**
	Gross beta	15.1	80.8	pCi/g	80.8	NA	NSL	**Y**	**NSL**

Notes:

(1) Minimum/maximum detected concentration from the two most recent annual samples at one location on the river. Values measured for radionuclides were specific activities (pCi/g). A conversion factor for uranium (1 ug = 2.81 pCi) based on the current weighted specific activity at WCFFF was used to convert the detected activities to concentrations.

(2) Maximum concentration used for screening. A conversion factor for uranium (1 ug = 2.81 pCi) based on the current weighted specific activity at WCFFF was used to convert the maximum detected activity to a concentration for screening.

(3) Soil background data are not available.

(4) Screening value for uranium is the residential soil value (1.6 mg/kg) from the USEPA Regional Screening Level Table, based on an HQ of 0.1 for noncarcinogens (USEPA, November 2018). A conversion factor for uranium based on the current weighted specific activity at WCFFF (1 ug = 2.81 pCi) was used to convert the uranium residential soil RSL to an activity for screening.

(5) Rationale Codes:
Selection Reason: Above Screening Level (ASL)
No Screening Level (NSL)
Deletion Reason: Below Screening Level (BSL)

Chemicals in **bold** are retained as preliminary COPCs.

Definitions:
COPC - Chemical of Potential Concern
mg/kg - milligrams per kilogram
NA - not applicable or not available
NSL - no screening level

Table 3-6
Occurrence, Distribution and Selection of Chemicals of Potential Concern in Fish (Current/Future)
Westinghouse Columbia Fuel Fabrication Facility
Hopkins, South Carolina

Scenario Timeframe: Current/Future
Medium: Fish
Exposure Medium: Fish (river)

Exposure Point	Chemical	Minimum [1] Concentration	Maximum [1] Concentration	Units	Concentration Used for Screening [2]	Background Value [3]	Screening Toxicity Value [4]	COPC Flag (Y/N)	Rationale for Selection or Deletion [5]
Fish	***Radionuclides***								
	Total uranium	0.36	0.53	pCi/g	0.53	NA	0.77	N	BSL
	Total uranium	0.13	0.19	mg/kg	0.19	NA	0.27	N	BSL
	Gross alpha	ND	0.92	pCi/g	0.92	NA	NSL	**Y**	**NSL**
	Gross beta	13.8	15.4	pCi/g	15.4	NA	NSL	**Y**	**NSL**

Notes:

(1) Minimum/maximum detected concentration from the two most recent annual samples at one location on the river. Values measured for radionuclides were specific activities (pCi/g). A conversion factor for uranium (1 ug = 2.81 pCi) based on the current weighted specific activity at WCFFF was used to convert the detected activities to concentrations.

(2) Maximum concentration used for screening. A conversion factor for uranium (1 ug = 2.81 pCi) based on the current weighted specific activity at WCFFF was used to convert the maximum detected activity to a concentration for screening.

(3) Fish tissue background data are not available.

(4) Screening value for uranium derived from the fish tissue concentration for uranium (soluble salts) from the USEPA Regional Screening Level (RSL) Fish Ingestion Table (USEPA, June 2011), based on an HQ of 1 for noncarcinogens (4.1 mg/kg). That RSL, which was calculated using an RfD of 0.003 mg/kg-day, was modified to reflect the current RfD for uranium, 0.0002 mg/kg-day, resulting in a screening value of 0.27 mg/kg in fish tissue. A conversion factor for uranium (1 ug = 2.81 pCi) based on the current weighted specific activity at WCFFF was used to convert the uranium fish tissue RSL to an activity for screening.

(5) Rationale Codes:
Selection Reason: Above Screening Level (ASL)
No Screening Level (NSL)
Deletion Reason: Below Screening Level (BSL)

Chemicals in **bold** are retained as preliminary COPCs.

Definitions:
COPC - Chemical of Potential Concern
mg/kg - milligrams per kilogram
NA - not applicable or not available
NSL - no screening level
pCi/g - picocuries per gram
RfD - reference dose

Table 4-1
VISL Calculator
Westinghouse Columbia Fuel Fabrication Facility
Hopkins, South Carolina

Resident Vapor Intrusion Screening Levels (VISL)

Key: I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN; H = HEAST; W = see RSL user guide Section 2.3.5; E = see RSL user guide Section 2.3.6; S = see RSL user's guide Section 5.

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Soil Source? (C_{vp} > $C_{i,a}$,Target?)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Groundwater Source? (C_{hc} > $C_{i,a}$,Target?)	Target Indoor Air Concentration (TCR=1E-06 or THQ=0.1) MIN($C_{ia,c}$,$C_{ia,nc}$) ($\mu g/m^3$)	Toxicity Basis	Target Sub-Slab and Near-source Soil Gas Concentration (TCR=1E-06 or THQ=0.1) C_{sg},Target ($\mu g/m^3$)	Target Groundwater Concentration (TCR=1E-06 or THQ=0.1) C_{gw},Target ($\mu g/L$)	Is Target Groundwater Concentration < MCL? (C_{gw} < MCL?)	Pure Phase Vapor Concentration C_{vp} (18 °C) ($\mu g/m^3$)	Maximum Groundwater Vapor Concentration C_{hc} ($\mu g/m^3$)	Temperature for Maximum Groundwater Vapor Concentration (°C)	Lower Explosive Limit LEL (% by volume)	LEL Ref	IUR ($ug/m^3)^{-1}$	IUR Ref	RfC (mg/m^3)	RfC Ref	Mutagenic Indicator	Carcinogenic VISL TCR=1E-06 $C_{ia,c}$ ($\mu g/m^3$)	Noncarcinogenic VISL THQ=0.1 $C_{ia,nc}$ ($\mu g/m^3$)
Carbon Disulfide	75-15-0	Yes	Yes	Yes	Yes	73	NC	2430	158	--	1470000000	995000000	18	1.3	CRC89	-		0.7	I	No	-	73
Chloroform	67-66-3	Yes	Yes	Yes	Yes	0.122	CA	4.07	1.08	Yes (80)	1260000000	902000000	18	-		0.000023	I	0.0977	A	No	0.122	10.2
Dichloroethylene, 1,2-cis-	156-59-2	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	-		-	-		1040000000	801000000	18	3	CRC89	-		-		No	-	-
Tetrachloroethylene	127-18-4	Yes	Yes	Yes	Yes	4.17	NC	139	8.27	No (5)	165000000	104000000	18	-		2.6E-07	I	0.04	I	No	10.8	4.17
Trichloroethylene	79-01-6	Yes	Yes	Yes	Yes	0.209	NC	6.95	0.708	Yes (5)	488000000	377000000	18	8	CRC89	0.0000041	I	0.002	I	Mut	0.478	0.209
Biphenyl, 1,1'-	92-52-4	Yes	Yes	Yes	Yes	0.0417	NC	1.39	5.76	--	74100	54200	18	0.6	CRC89	-		0.0004	X	No	-	0.0417
Naphthalene	91-20-3	Yes	Yes	Yes	Yes	0.0826	CA	2.75	7.55	--	586000	339000	18	0.9	CRC89	0.000034	C	0.003	I	No	0.0826	0.313
Phenanthrene	85-01-8	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	-		-	-		1160	982	18	0.7	YAWS	-		-		No	-	-
Ammonia	7664-41-7	Yes	Yes	Yes	Yes	52.1	NC	1740	94600	--	6880000000	266000000	18	16	CRC89	-		0.5	I	No	-	52.1

Table 4-2
Selection of COPCs for Groundwater Vapors in Indoor Air
Westinghouse Columbia Fuel Fabrication Facility
Hopkins, South Carolina

Chemical	Units	Maximum Detected Concentration	Target Groundwater Concentration (VISL Calculator)	COPC? (Max Detection Exceeds Target GW Concentration)
VOCs				
Carbon disulfide	ug/L	9.4	158	No
Chloroform	ug/L	5.2	1.08	**Yes**
cis-1,2-Dichloroethene	ug/L	19	—	No
Tetrachloroethene	ug/L	540	8.27	**Yes**
Trichloroethene	ug/L	93	0.708	**Yes**
SVOCs				
1,1-Biphenyl	ug/L	13	5.76	**Yes**
Naphthalene	ug/L	4.5	7.55	No
Phenanthrene	ug/L	1.8	—	No
Inorganics				
Ammonia (as nitrogen)	ug/L	123,000	94,600	**Yes**

Notes:
Target groundwater concentration is from USEPA's VISL Calculator for a residential scenario, based on a target risk of 1E-6, a hazard quotient of 0.1, and a groundwater temperature of 18 degrees Celsius.
Chemicals in **bold** are retained as preliminary COPCs.

— - No Inhalation Toxicity Information
COPC - Chemical of Potential Concern
VISL - Vapor Intrusion Screening Level