Omaha Public Power District

10 CFR 50.90
10 CFR 50.82

LIC-23-0005
August 24, 2023

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Fort Calhoun Station (FCS), Unit 1
Renewed Facility Operating License No. DPR-40
NRC Docket No. 50-285

Fort Calhoun Station
Independent Spent Fuel Storage Installation
NRC Docket No. 72-054

Subject: Response to FORT CALHOUN STATION, UNIT NO. 1 – REVIEW OF LICENSE AMENDMENT REQUEST TO ADD LICENSE CONDITION TO INCLUDE LICENSE TERMINATION PLAN REQUIREMENTS – 2nd REQUEST FOR ADDITIONAL INFORMATION (EPID L-2021-LIT-0000) JUNE 2, 2023.

References:

1. Letter from OPPD (M. Fisher) to USNRC (Document Control Desk), "License Amendment Request (LAR) 21-01: Revised Fort Calhoun Station License to Add License Condition 3.D to include License Termination Plan Requirements," dated August 3, 2021 (LIC-21-0005) (ML21271A143)
2. Letter from NRC (J. Parrot) to OPPD (T. Via), "Fort Calhoun Station, Unit No. 1 – Review Of License Amendment Request To Add License Condition To Include License Termination Plan Requirements – 2nd Request For Additional Information (EPID L-2021-LIT-0000) June 2, 2023. (ML23151A003)
3. Attachment to EPID L-2021-LIT-0000 [Reference 2], "Fort Calhoun License Termination Plan Review Request for Additional Information for the Technical Evaluation" June 2, 2023. (ML23151A004)

By letter dated August 3, 2021 (Reference 1) (ML21271A143), Omaha Public Power District (OPPD) submitted a License Amendment Request (LAR) to add a license condition, 3.D, to include License Termination Plan Requirements.

On June 12, 2023 (Reference 2), the NRC provided OPPD with a second Request for Additional Information (RAI) regarding the License Termination Plan (LTP) LAR. Attachment 1 of this letter provides the responses to the RAIs.

This letter contains no regulatory commitments.

If you should have any questions regarding this submittal or require additional information, please contact Mrs. Andrea K. Barker, CHP – Regulatory Assurance and Emergency Planning Manager at (531) 226-6051.

Respectfully,

Andrea K. Barker, CHP, MHP
Regulatory Assurance and Emergency Planning Manager

AKB/akb

Attachments: 1.) Response to Request for Additional Information 2

c: S. A. Morris, NRC Regional Administrator, Region IV
J. D. Moninger, NRC Deputy Regional Administrator, Region IV
J. D. Parrott, NRC Senior Project Manager
S. Anderson, NRC Health Physicist, Region IV
Director of Consumer Health Services, Department of Regulation and Licensure, Nebraska Health and Human Services, State of Nebraska

ATTACHMENT 1
FORT CALHOUN LICENSE TERMINATION PLAN REVIEW
REQUEST FOR ADDITIONAL INFORMATION FOR THE TECHNICAL EVALUATION
OMAHA PUBLIC POWER DISTRICT
FORT CALHOUN STATION UNIT NO. 1
DOCKET NO. 50-285, 72-054

By letter dated August 3, 2021 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21271A178), as supplemented by letter dated January 13, 2022 (ADAMS Accession No. ML22034A602), and letter dated February 27, 2023 (ADAMS Accession No. ML23060A197), Omaha Public Power District (OPPD) submitted a license amendment request for Fort Calhoun Station, Unit No. 1 (FCS).

To support the U.S. Nuclear Regulatory Commission (NRC) staff's technical review of the LTP license amendment request pursuant to the regulations in Title 10 Code of Federal Regulations (10 CFR) Part 50, please provide the additional information described in the enclosure.

Chapter 2 - Site Characterization

TE2-1: Background for Characterization Data

Comment: *Provide the background data for the samples/measurements performed in the site characterization or justify why background was not needed for this assessment.*

Basis: *Per NUREG-1700, Revision 2, Section 2.2.1, the site characterization should include "the background levels used during scoping or characterization surveys." This does not appear to be addressed other than tables of data for direct measurement or scanning. Utilizing no background or ambient background for structural measurements appears adequately justified in section 5.2.4 of the LTP but nothing appears to discuss background for open land areas, subsurface soil, or why it is not needed. The licensee should describe the background/reference materials used to evaluate the characterization data and provide data, as appropriate. This information is needed for staff to determine if the licensee is in adequate compliance with 10 CFR 50.82(a)(9)(ii) that the LTP includes a site characterization.*

Request: *Provide the background data utilized to support the characterization surveys or discuss why such was not needed.*

OPPD Response:

Background data for surface and subsurface soil was not collected, and was not necessary, during site characterization, because the Sign Test will be utilized during the FSS of open land areas. Section 5.2.4 of the LTP states:

> *The collected data is typically used as the reference area data set when using the Wilcoxon Rank Sum test, but at FCS the Sign test will be used, as background is expected to constitute a small fraction of the $DCGL_W$ based on the results of characterization surveys.*

This is allowable under the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) in Section 5.5.2.3 which states:

> *For the situation where the contaminant is not present in background or is present at such a small fraction of the $DCGL_W$ as to be considered insignificant, a background reference area is not necessary.*

Ambient background was utilized for gamma walkover surveys of land areas to determine the survey scan minimum detectable concentration ($MDC_{Scan)}$ and surveyor minimum detectable count rate ($MDCR_{Surveyor))}$. Ambient background was also subtracted from total surface contamination survey measurements of structures.

TE2-2: Sr-90 as a Soil ROC in the Deconstruction Area

Comment: *Please provide justification why Sr-90 was not considered as a Radionuclide of Concern (ROC) in Deconstruction Area (DA) soil since it had been identified in monitoring wells.*

Basis: *Section 2.4.2 of the LTP discusses Sr-90 and H-3 in groundwater. In the 1st paragraph of this section, it states that "the episodic but low Sr-90 concentrations reported in the shallow monitoring wells within the DA suggest that a small Sr-90 release has occurred at the site." Given this statement, why isn't Sr-90 a ROC in soil in the DA? In addition, Sr-90 is a ROC in the structures and piping being removed so there is a significant likelihood of cross contamination. This information is needed for staff to determine if the licensee is in adequate compliance with 10 CFR 50.82(a)(9)(ii) that the LTP includes a site characterization.*

Request: *Evaluate Sr-90 as a ROC for soil in the DA portion of the site based on previous release/leak involving this radionuclide and risk of cross contamination or justify why it merits only being considered an insignificant contributor.*

OPPD Response:

The selection of the initial suite of radionuclides included identifying the potential radionuclides, as well as eliminating those radionuclides which would not be present due to decay or may be present but in insignificant concentrations. A systematic approach was taken including reviewing applicable nuclear industry guidance documents, relevant FCS site-specific historical information, and available representative sample radionuclide data. An extensive concrete sampling plan was developed and used to determine the ROC for use in buildings and structures at FCS.

The references for each type of media are discussed in the Technical Support Document, TSD 21-043, "Radionuclides of Concern in Support of the Fort Calhoun License Termination Plan," (p. 9), which is a reference to the LTP.

Sr-90 did not meet the criteria for an ROC in soil. Soil was sampled for Sr-90 during the scoping process with no Sr-90 detected in the soil samples (see Table 2-82 in the LTP). The Sr-90 question concerning groundwater does not impact the selection of Sr-90 as an Insignificant Contributor for soil. The highest likelihood of occurrence of Sr-90 is within plant structures or components. FCS has never identified an existing leak or plume of Sr-90 or tritium, including an absence of other nuclides you would expect to identify in groundwater samples if there were a recent release.

There is a continuing characterization process in place is to ensure no issues with ROCs from piping causing cross-contamination concerns (see LTP Section 2.5). The initial suite of radionuclides that were analyzed is referenced in Table 5-2 of the LTP. Sections 5.4.1.3.3 and 5.4.1.3.4 of the LTP discuss the sampling of soils beneath structure basement foundations and volumetric concrete sampling, respectively, to explain the ongoing measures ensuring no cross-contamination occurs. These measures include sending 10% of continuing characterization samples to be analyzed for the suite of nuclides from Table 5-2. The LTP section referenced in the basis for this TE does say, "the episodic but low Sr-90 concentrations reported in the shallow monitoring wells within the DA suggest that a small Sr-90 release has occurred at the site." However, no consistent, beyond statistically measurable groundwater data exists to suggest a release or plume in the DA and this verbiage will be removed from the LTP.

The data does not justify changing the designation of Sr-90 from an insignificant contributor to an ROC for soil or buried pipe. The dose contribution from Sr-90 and the other insignificant contributors must be accounted for in the final DCGLs. However, although Sr-90 does not meet the definition of an ROC for soil or piping, it is a normal part of the Groundwater Monitoring program and will continue to be analyzed in accordance with that program. . The other defined ROCs for groundwater (Co-60, Cs-137, Eu-152, and C-14) will be measured along with Sr-90 in accordance with the site's groundwater monitoring program. The program procedure, FCSD-CH-104, is being revised to include the process for analyzing for these nuclides; any other affected procedures will be revised in kind. The ROCs will be measured at the intervals prescribed by the NEI-07-07 guidance, FSS guidance, and site procedure requirements. The insignificant contributors will be accounted for by adding 10% for the final dose calculated from the detected radionuclides present in the Groundwater sampling. The dose contribution from Sr-90 in groundwater will be incorporated in the final dose assessment in the manner prescribed in the LTP, also. If the trends become identified during the GW monitoring program, these will be evaluated and changes made, as needed, to the LTP guidance or Groundwater Monitoring Program as prescribed by guidance. There are currently no trends for nuclides in groundwater beyond the sporadic, statistical identification of the Sr-90 as discussed here and in TE2-3.

TE2-3: Estimation of Sr-90 for Existing Groundwater Dose

Comment: *Data for existing Sr-90 groundwater contamination does not support use of existing monitoring well data locations as the sole basis for estimating the maximum groundwater Sr-90 at the site to be used for the Final Status Survey (FSS) dose calculation.*

Basis: *LTP Section 2.4.2 summarized Sr-90 results for the groundwater during the period 2011 through 2018 as sporadic and low. However, staff review of Sr-90 data in FCS Annual Radiological Effluent Release Reports (ARERR) for 2007 through 2021 reveals a persistent, but sporadic, presence at different wells in and surrounding the DA. The continued presence of Sr- 90 residual radioactivity in the groundwater indicates a persistent source that has not shown signs of abating. Staff identified 65 Sr-90 results above the lower limit of detection (LLD) for the period 2007 through 2021. Two elevated Sr-90 results were also found in deep wells. Staff also assessed the Sr-90 results for the period 2011 through 2018, which was the period used for the summary provided in LTP Section 2.4.2 and found 36 results above LLD. Assessment of these Sr-90 values do not support a decreasing trend in Sr-90 over time. In addition, staff also notes that uncertainty and LLD were not provided with the ARERR Table III.9 groundwater results.*

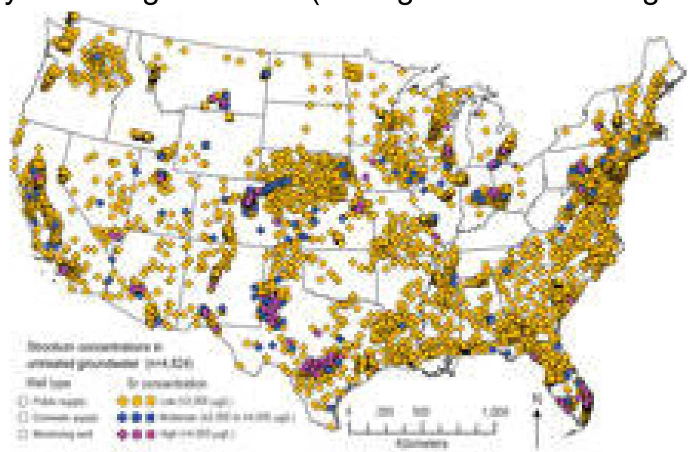
The uncertainty may reflect on estimates of maximum Sr-90 activity needed for the FSS dose calculation.

There are several factors that influence the estimate of maximum Sr-90 groundwater concentration at the site. The source area for the Sr-90 contamination within the protected area is not known. Modeling to narrow possible source areas will be complex due to historical groundwater gradients influenced by onsite well pumping, flux of groundwater into the Turbine Building sump, and significant river stage changes occurring during water level measurement. Staff assessment of the historical groundwater data indicated gradients approximately equally divided between plant-west (inland), mounded under the site, and plant-east (towards the river). There is a broad area in the footprint of the plant and towards the river that is not covered by monitoring wells, i.e., the important zone between wells MW-7 and MW-6. Also, the possibility of a source area affected by rising and falling river stage cannot be discounted based on available hydrologic data and sporadic Sr-90 results. Full evaluation of Sr-90 in groundwater is needed to complete the site characterization required by 10 CFR 50.82(a)(9)(ii).

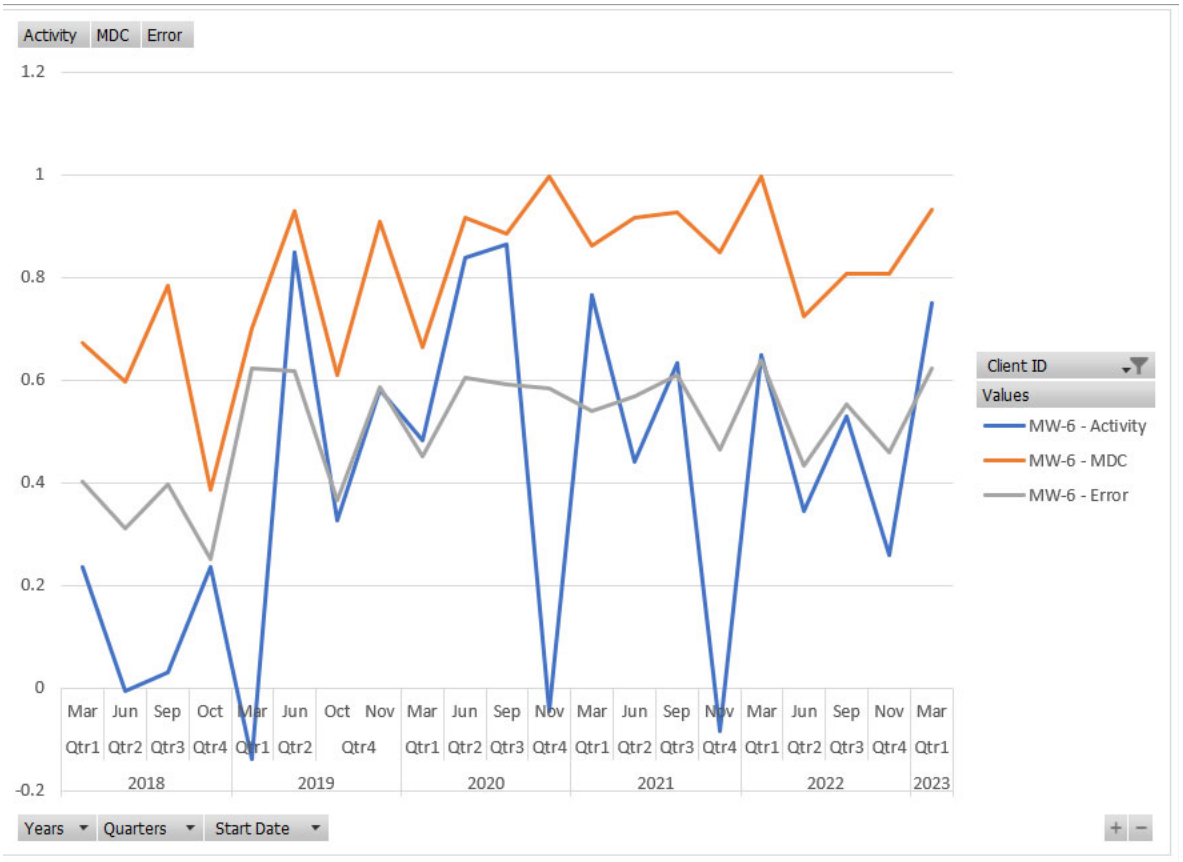
Request: *Provide an estimate of the maximum Sr-90 in the groundwater for the entire site that includes the area below the structures within the DA where the maximum contamination is expected to occur.*

OPPD Response:

The conditions mentioned in the basis are the reason there is not any more extensive Sr-90 investigation planned. From the historical data, there have been four samples total that have been above minimum detectable activity (MDA); the rest have been between 2-sigma error and MDA. The uncertainty and LLD are not included in the table of results in the annual reports because the system does not allow posting of negative values or characters that would indicate a non-detect. The procedure for LLD from the testing lab has been provided to the NRC for their information and review. The responsible group on-site maintains the raw data. The level of uncertainty is typically high due to the high levels of naturally occurring strontium (see figure from USGS.gov, January 2021)) in the water in Nebraska (the 2-sigma uncertainty was 0.545 pCi/L in the most recent round of sampling and the baseline sample was approximately 0.3 pCi/L). There are low-level amounts (greater than 2-sigma from the mean) that sporadically appear at or around the same levels that were identified prior to operation at Fort Calhoun Station (FCS). The groundwater monitoring program continues to identify these statistical detects which, by NEI guidance, are reviewed for further investigation by the groundwater program owner. Given the persistent and static presentation of Sr-90 in the wells, the Groundwater program owner has not identified a plume or a source of any leaks that indicate a plant condition that could result in such detects. Because these identifications are sporadic in nature, i.e., no one well has shown a history of consistent detects; occur within the statistical margin of error for detection; and have occurred in groundwater wells upgradient from the operational areas of the plant, no further analysis has been justified. This data had been included in previous annual reports to support this conclusion for eventual decommissioning.



With a monitoring sample of approximately 0.3 pCi/L and a 2-sigma error of 0.545 pCi/L, any sample taken in the area could result in a statistical identification but is indicative of existing conditions and statistical variances, not the existence of a plume or Sr-90 leak. The figure that follows is representative of the data from the wells on site showing the data from MW-6, specifically. The lines plotted show the measured activity, the Minimum Detectable Concentration (MDC), and the associated error. All the recorded points are less than the MDC.



In FCS's original FSAR (June 1970), Sr-90 was identified in surface water, well water, aquatic biota, milk, vegetation, and wildlife. These results were obtained during a trial period that occurred over nine months starting in September 1968 to ensure the availability of adequate sample types. The results of that analysis provided the background conditions present prior to any operational surveillances. The well water samples obtained during that period extended out four miles from the planned plant site. The well samples and surface water samples showed 0.1 and 1.3 pCi/liter, respectively. The last detection greater than MDA occurred in 2009 and measured 1 pCi/liter. Any statistical detects are often found in shallow wells. There has been no identification of tritium or Nickel-65 to indicate that the low-level identification was from a plant generated source.

Throughout FCS operation, and specifically since the implementation of the NEI-07-07 guidance on Groundwater monitoring, there have been no concerns during Environmental Monitoring inspections from the NRC on Sr-90 or any requests to do any additional sampling or testing than what has already been done. The Historical Site Assessments used in drafting the LTP and used in the design of survey areas also have not indicated any source or a persistent plume of Sr-90 coming from any plant operations. From TSD 20-001, "Fort Calhoun Historical Site Assessment," Rev. 0 (p. 13, 2020), it says:

> *"… FCS has implemented guidance contained in NEI 07-07, "Industry Groundwater Protection Initiative" (GPI) [3]. The objective of FCS's Groundwater Protection Program is to identify, monitor and quantify the nature and extent of radiological contamination that may exist in site groundwater. To date, the GPI at FCS has not identified any plumes of radionuclides in site groundwater, however minor detections of tritium and Strontium-90 have episodically been present at concentrations just above the minimum detectable concentration (MDC) [4]."*

Additionally, from TSD 20-001 (p.36, 2020,) there is the following:

> *"The minimal tritium detections and the minor sporadic detections of Strontium-90 indicate that groundwater at the FCS site is not significantly impacted by radiological contaminants, and that a plume of tritium or Strontium-90 is not migrating off-site."*

If conditions changed or new nuclides were seen as part of groundwater monitoring, additional investigation would be driven by our groundwater monitoring program and updates made to any LTP chapters, as appropriate. As noted in TE2-2, although Sr-90 is not an ROC for soil or piping, it is a routine part of the Groundwater Monitoring program, and, as such, the dose contribution from Sr-90 in groundwater will be incorporated into the dose assessment for the site. This will be done in accordance with regulatory guidance and the LTP by using the highest value for Sr-90 obtained from a review of the Groundwater Monitoring program when the final source material has been removed from site.

TE2-4: Groundwater Monitoring Network

Comment: *Given the historical distribution of Sr-90 results from groundwater samples, do the remaining wells serve either function of detection or estimation of residual radioactivity for FSS? This information is needed for staff to determine if the licensee is in adequate compliance with 10 CFR 50.82(a)(9)(ii) that the LTP includes a site characterization.*

Basis: *Several documents provide maps of well locations. The LTP cites two supporting documents, Haley & Aldrich (2021) and the Historical Site Assessment (2020), that contain maps of the well locations. The following documents were used to tally the monitoring well locations:*

- *LTP Revision 0 (ADAMS accession number ML21271A144) Figure 2-6*
- *Haley & Aldrich (2021, Rev 5), earlier version cited in the LTP (ADAMS accession number ML22034A594), including citation as the source of LTP Figures 6-5 and 6-6*
- *Historical Site Assessment (2020) (ADAMS accession number ML21271A609),*

cited in LTP; includes current and historical wells

- *2021 Annual Radiological Effluent Release Report (ARERR) (ADAMS accession number ML22110A216)*

Staff presumes that LTP Figure 2-6 includes the wells that will be used until license termination. However, during the NRC site visit of July 13, 2022, staff learned that several wells were recently or would soon to be abandoned due to proximity to dismantlement activities. Based on the site visit and comparisons of the site to the documents above, the remaining question is whether the MW-1A/B well pair will be or was abandoned. Wells abandoned in 2021 and 2022 include MW-2A/B, MW-4A, MW-7, MW-8, MW-9, MW-10, MW-11. Of the ten wells with historical Sr-90 results above lower limit of detection, three were abandoned in recent years: MW-2A, MW-2B, and MW-9.) In addition, according to the 2021 ARERR, monitoring wells MW- 15 and MW-16 replaced abandoned wells MW-7 and MW-4A, respectively.

For the bank storage conceptual site model and its implementation in dose modeling, it is not clear how the monitoring network serves its purpose of detection and support for estimation of maximum existing groundwater contamination. An evaluation of the adequacy of a monitoring well network necessarily includes the conceptual site model and historical residual radioactivity. The assessment of the monitoring network should include that historical Sr-90 results for the groundwater have occurred on all sides of the site. This information is needed for staff to determine if the licensee is in adequate compliance with 10 CFR 50.82(a)(9)(ii) that the LTP includes a site characterization.

Request: *Please identify which wells of the groundwater monitoring network will continue to be sampled and monitored during decommissioning and until license termination. Describe how that network serves its detection purpose and supports estimation of existing contamination for final status survey, and how they may reflect potential Sr-90 or other residual radioactivity migrating from the DA given the historical distribution. Please also submit the Terracon (2022) Hydrogeologic Assessment and Conceptual Site Model Report, as discussed during the NRC's site visit in July 2022, as information needed by NRC to support evaluation of the LTP.*

OPPD Response:

The groundwater monitoring wells which are currently part of our program will continue to be in operation and will be monitored until any potential source material is removed. The removal of Class 1 area materials and release would signify the removal of source material. As noted in TE2-3, no known sources of Sr-90 or other nuclides are known to be migrating from within the DA.

The monitoring well network has been designed and operated in accordance with NEI 07-07 and is reviewed every five years. The five-year review includes the re-performance of the Site Conceptual Model (SCM) on which the monitoring network is based. If changes are made to the site that would impact the SCM, those changes are reviewed and updates are made to monitoring, as needed. The 2002 SCM was performed due to substantial changes during decommissioning. The update drove the addition of wells downgradient from SSC's and work practices that had the high priority index scores. These continuing actions will ensure that the modeling network is sufficient to detect nuclides and contaminants until the termination of our license. Any groundwater monitoring (i.e., environmental monitoring, if required by the Nebraska Department of Energy and Environment (NDEE)), would be conducted under state oversight and industry guidance.

TE2-5: Broken Drain Lines Below Turbine Building

Comment: *Information is needed for the historical event below the Turbine Building where broken drain lines led to cavities caused by soil erosion and groundwater entry to the building basement.*

Basis: *This information is needed for staff to determine if the licensee is in adequate compliance with 10 CFR 50.82(a)(9)(ii) that the LTP includes a site characterization. Staff noted in the 2012 "Flood Recovery Action Plan 4.1" (ADAMS accession number ML21272A219) that broken drain lines and cavities in the sediments below the Turbine Building were first identified in the 1990s. There was concern in the Flood Report that the cavities in the sediments below the building floor may have been enlarged during the 2011 flood event leading to structural concerns for the building. Groundwater flow and sediment transport occurred into the Turbine building basement with the broken drain lines as the entry pathway. Whereas the Flood Report discussed structural and geotechnical aspects important for the flood recovery planning, it did not provide information on other potential consequences of broken drain lines. Staff is concerned that the broken lines have not been sealed or plugged, liquids draining along the lines to the sump may have contained residual radioactivity, and those liquids may have been released to the unconsolidated sediments below the Turbine Building leading subsurface contamination of sediments and groundwater.*

Request: *To support the NRC staff's understanding of the characterization of the Turbine Building subsurface, please provide a basis for why no subsurface soil contamination exists below the Turbine Building due to the broken drain lines. This basis should include (i) the function of the drain lines, (ii) when and how the drains were sealed or grouted, (iii) description of liquids carried in the broken drain lines and any summary sampling or characterization of those liquids in the lines or destination sump, (iv) continuing characterization surveys (including locations) of drain lines and sampling of sediments near the broken drain lines, and (v) where the characterization will be documented (e.g., continuing characterization report and FSS release report) with reference to the broken drain lines.*

OPPD Response:

No subsurface soil contamination exists below the Turbine Building due to broken drain lines because the Turbine Building and the associated drain lines were radiologically clean buildings. The basis for this conclusion starts with the function of the drain lines in the Turbine Building which were to capture and drain water from the basement level floor from the secondary systems (i.e., non-radioactive systems) when taken out of service and to receive condenser water box blow down water. The systems feeding the drains were all secondary systems that supported the operation of the turbine generator and did not interact with the primary (i.e., radioactive) systems. The condenser water boxes were on the river side of the condenser and were used to remove rock and sediment from the condenser tube sheets. The drain lines sent water to the Turbine Building sump which was then pumped to the river thru separate piping to the outfall tunnel.

The issue with the Turbine Building drain lines having in-leakage was identified as early as 1993. Numerous attempts to seal or grout the drain lines had occurred during the operation of the plant. In 2009, a Condition Report was written and an attempt to fill with grout was made. The attempt was performed with a contract company who cleaned the drain lines. This involved using a rotor to grind the sediment out of the drain and then probes to install grout. This was stopped due to the identified potential of collapsing the drain lines based on an inspection performed and the material conditions identified.

In 2011, the Post-Flooding Recovery Plan actions included an assessment of potential voids under structures and one indicator of such a void was the increased in-leakage into the Turbine Building. As a result of the data gathering and investigations, Engineering Change (EC) 46706 was initiated to repair the drain lines. This involved temporary plug installation and then placement of Cured-in-Place Piping (CIPP) in 4^{th} quarter 2012. The EC approval included reviews by Radiation Protection, Chemistry, and Environmental that identified no concerns with the changes due to no interaction with radioactive systems. This EC, and associated work orders, were completed prior to the plant restart in December 2013. As part of the site's Inspection Manual Chapter 0350 required restart actions, flooding recovery actions, Class 1 Structure inspections, and associated Licensing actions were reviewed by the NRC and deemed appropriate.

The main source of water carried thru the Turbine Building drains was Missouri River water which was associated with blow down of the water boxes which occurred at least once per shift. Water from secondary support systems was the second most prominent liquid in these drains. Sampling was conducted as part of Chemistry's routine water sampling to ensure no incidental radioactive material would make its way through the clean structure. The Historical Site Assessments reviewed the Chemistry sampling and the Condition Reporting system for to identify any historical concerns, either radiological or environmental, and no such areas of concern were identified with the drain lines in the Turbine Building.

Radiological characterization of the Turbine Building was completed in February 2020. At the time that radiological characterization was completed access to the embedded piping and piping below the slab was inaccessible so only qualitative readings were obtained. URS of the Turbine Building was completed in October 2021. At the time that URS was completed access to the embedded piping and piping below the slab was inaccessible so only qualitative readings were obtained.

Following URS of the Turbine Building demolition commenced and completed in March 2023. All demolition debris was transported offsite for recycle or disposal at a sanitary landfill. All demolition debris sent offsite for disposal passed through a portal monitor prior to leaving site. Any loads that set off the portal monitor alarm were investigated onsite and determined to be Naturally Occurring Radioactive Material (NORM).

FSS of the Turbine Building basement, embedded piping and penetrations was completed in March 2023. Survey results indicated nothing above the BcDCGL for embedded piping. Survey results were recorded in Sample Plan 3102-F Turbine Building Embedded piping. Following FSS continuing characterization of the soil beneath the slab was completed. Survey and sample results indicated nothing above the BcDCGL. Survey and sample results were recorded in Sample Plan 3100-F Turbine Building Basement Surface FSS Plan.

Chapter 5 – Final Status Survey Plan

TE2-6: RAs and RASSs in Excavations

Comment: *Provide clarification as to what a Radiological Assessment (RA) or Remedial Action Support Survey (RASS) will consist of for excavations and how it will be applied and documented in FSS reports.*

Basis: *10 CFR 50.82(a)(9)(ii)(D) states that a license termination plan will contain a detailed final status survey plan. In Section 5.1.4.1 of the LTP, the licensee states that "In areas where remediation is required, a remedial action support survey (RASS) will be performed to confirm that remediation was successful prior to initiating FSS activities. Radiological Assessments (RA) or turnover surveys for areas not requiring remediation, may be performed to verify the area is suitable for FSS. The results of RASS and RA will be documented in the applicable FSS release records." Similarly, in Section 5.2.3.1 of the LTP, the licensee states that "[t]he determination of readiness for controls and the preparation for FSS will be based on the results of characterization, RAs, and/or RASS that indicate residual radioactivity is unlikely to exceed the applicable DCGLs in the respective survey unit." In Section 5.2.5 of the LTP, the licensee states that "RAs are a form of continuing characterization and…a limited number of soil samples are typically collected as a part of the RA. Ten percent of any soil samples collected during an RA in a survey unit, with a minimum of one sample taken, will be analyzed for the full suite of radionuclides from Table 5-2." In*

Section 2.5 of the LTP it states that "the results of continuing characterization surveys will be addressed with revisions to the Radiological Characterization Report." Section 5.4.1.4, "Excavations," states that "any surface or subsurface soil contamination identified by continuing characterization or operational radiological surveys that is excess of the Base Case DCGLs for each of the potential ROCs as presented in Table 5-7 will be remediated." It goes on to discuss how a RASS would be performed consistent with the Data Quality Objectives (DQOs) of a FSS with scanning and sampling. Alternatively, a NaI detector or germanium detector may be used to scan the excavation to demonstrate that the area meets the Operational DCGLs and only if exceeding the Operational DCGLs would additional investigation/sampling occur (staff assume that level of survey to be a RA).

It appears that the intent of RAs/RASSs is to primarily demonstrate the area of the site being assessed is ready for FSS as opposed to being the final survey of record. Section 5.4.1.4 states that excavations will be assessed against Base Case DCGLs vs Operational DCGLs for a RASS while the RA will be assessed against Operational DCGLs. For example, if RAs/RASSs may be the surveys of record performed for small excavations (e.g., <400 m^2 in planer area or less than $1/5^{th}$ of the Class 1 survey unit area limit), then some random samples should be obtained to add consideration of the excavation in the FSS of the survey unit. The number of samples could be related to the sampling density of Class 1 open land areas (e.g., 15 samples per 2,000 m^2 = 1 sample/133 m^2 area with a minimum of 1 sample) and added to the systematic sample data for the survey unit as an additional data point(s). NRC staff agree that scanning of accessible areas in excavations is warranted (e.g., bottom and sidewalls of excavations) with additional judgmental samples taken based on scanning results. The related information can be added to the FSS report of the survey unit(s) in which the excavation was performed, like how radiologically elevated areas are typically discussed in a FSS report. Larger excavations could be assessed as a standalone survey unit before being backfilled.

If scanning or a sample demonstrates that soil in a small excavation exceeds the Operational DCGL for subsurface soil, then it should be investigated as a possible elevated area in the survey unit consistent with the Final Status Survey Plan of the LTP (Section 5.2.6 of the LTP states that Operational DCGLs are used for the FSS design of a survey unit including surrogate DCGLs, investigation levels, etc.). Any RASS of a small excavation that results in remediation due to the presence of radiological materials necessitates a class 1 FSS survey.

Clarification of this issue is needed for staff to determine if the licensee is in adequate compliance with the requirement in 10 CFR 50.82(a)(9)(ii) that the LTP include a site characterization and detailed plans for the final radiation survey and the requirement *in 10 CFR 20.1501 that licensees must make or cause to be made, survey of areas, including the subsurface.*

<u>Request</u>: *Clarify the scope and intent of RAs and RASSs in the LTP with respect to how they will be conducted in excavations and documented in the survey unit FSS report. Specifically, clarify when each type of survey will be performed, what level of QA (if any) will be conducted with these surveys, what DQOs will be applicable, and what documentation will be provided to supplement the FSS Reports for the survey units in which these are conducted. Justify why Base Case DCGLs, Table 5-7, will be the primary criteria applied in excavations as opposed to Operational DCGLs, Table 5-8, which will be in effect for open land area surveys and describe how any residual radioactivity present in excavations will be considered in demonstrating compliance for the survey unit. Update Section 5.4.1.4 of the LTP, "Excavations," as appropriate, based on the discussion presented.*

<u>OPPD Response:</u>

The results of all RA and RASS will be documented in each applicable Survey Unit Release Record as stated in LTP Sections 5.4.1.4 and 5.7.1. If an RA or RASS is performed in an excavation or area that traverses multiple open land survey units, then the data from the RA or RASS will be documented in the release records for each survey unit that was traversed by the RA or RASS. The third paragraph of LTP Section 5.1.4.1 will be revised to clarify the scope and intent of RAs and RASSs as follows (changes made are in red):

> *In areas where remediation is known to be required (prior to the performance of FSS) or identified during FSS, a remedial action support survey (RASS) will be performed to provide real-time data collection to verify that remediation was successful, and that the area is suitable for initiating or completing FSS ~~confirm that remediation was successful prior to initiating FSS activities~~. In areas where remediation is not required, radiological assessments (RA) will be performed to determine if the radiological conditions in an area or structure are suitable for performing FSS (turnover survey), update the existing characterization survey results with additional survey data (continuing characterization), and assessing the radiological conditions of excavations performed to expose/remove or install buried components. ~~Radiological assessments (RA) or turnover surveys for areas not requiring remediation, may be performed to verify the area is suitable for FSS.~~ The design and performance of RA and RASS will be in accordance with procedures. ~~The results of RASS and RA will be documented in the applicable FSS release records.~~*

Because an RA is a form of continuing characterization, the requirement in LTP Section 2.5 of the LTP which states that "*the results of continuing characterization surveys will* *be addressed with revisions to the Radiological Characterization Report",* is inaccurate and will be revised to state:

> *"The results of continuing characterization surveys will be documented in each applicable Survey Unit Release Record."*

As stated in LTP Sections 5.3.3, 5.4.1.4, 5.5.4, and 5.5.5.2, any survey unit with residual contamination that is in excess of the Base Case DCGLs for each of the potential ROC will be remediated. This requirement is also applicable to open land survey units with residual radioactivity above the $DCGL_{EMC}$. For this reason, the use of the Base Case DCGL as the target of RASS is justified. It should be noted that remediation will typically remove most contamination to residual levels that are below Operational DCGLs. Any remediation performed in areas that had residual radioactivity in excess of the Base Case DCGLs for each of the ROC will automatically cause the survey unit, or portion of the survey unit, to be reclassified as Class 1 (prior remediation precludes a survey unit from being designated as Class 2 or Class 3). Additionally, OPPD will perform an FSS in any excavation where remediation has occurred, and a RASS was performed (LTP Section 5.4.1.4 will be revised accordingly).

Initial characterization survey results for FCS are provided in Chapter 2 of the LTP and are never used to demonstrate compliance with the radiological criteria for unrestricted use specified in 10 CFR 20.1402. Section 2.5 of the LTP states that the results of continuing characterization will be documented in each applicable Survey Unit Release Record. Like the initial characterization survey results, the results of continuing characterization are not used to demonstrate compliance with the radiological criteria for unrestricted use. As stated in LTP Section 5.2.5, an RA is a form of continuing characterization; therefore, the results of RAs are not required to be used to demonstrate compliance with the radiological criteria for unrestricted use. However, as a conservative measure, OPPD will compare the average BcSOF from the RA to the average BcSOF of the applicable open land survey unit, utilizing the surface soil BcDCGL, and the larger of the two will be included in consideration for use in the compliance matrix.

The following text will be included after the fourth paragraph of Section 5.2.6.8:

> *The average BcSOF from an RA performed in support of an excavation will be compared to the average BcSOF of the applicable open land survey unit, utilizing the surface soil BcDCGL, and the larger of the two will be included in consideration for use in the compliance matrix (Equation 5-7).*

For an RA and RASS, there are no requirements for QA sampling. However, all other QA requirements specified in Section 5.6 of the LTP and the "Quality Assurance Project Plan for the License Termination Plan Development, Site Characterization and Final Status Survey Project at Fort Calhoun Station", will be adhered to. In order to verify that the radionuclide mixture fractions have not changed during decommissioning, 10% of samples obtained during an RA will be analyzed at an accredited offsite laboratory for the initial suite of radionuclides shown in Table 5-2 of the LTP.

Section 5.4.1.4 of the LTP will be revised as follows (changes made are in red):

> *Any soil excavation created to expose or remove a potentially contaminated basement structure will be subjected to FSS prior to backfill. Additionally, any excavation where remediation has occurred due to radionuclide concentrations in excess of the BcDCGLs, will also be subjected to FSS prior to backfill. The FSS will be designed as an open land survey using the most restrictive classification of the removed structure in accordance with Section* ***Error! Reference source not found.*** *of the LTP using the Operational DCGLs for surface soils or subsurface soils (depending on the thickness of contamination) as the release criterion. The FSS of excavations where remediation has occurred due to radionuclide concentrations in excess of the BcDCGLs, will be performed as a Class 1 open land survey.*
>
> *If an excavation is performed for the purpose of removing a system or component that has the potential to contain residual radioactivity in excess of the OpDCGLs, then the excavation must undergo an FSS prior to backfill.*
>
> *During decommissioning of FCS, any surface or subsurface soil contamination that is identified by continuing characterization or operational radiological surveys that is in excess of the Base Case DCGLs for each of the potential ROC as presented in Table 5-7 will be remediated. The remediation process will include performing a RASS of the open excavations in accordance with procedures. The RASS will include scan surveys and the collection of soil samples during excavation to gauge the effectiveness of remediation, and to identify locations requiring additional excavation. The scan surveys and the collection of and subsequent laboratory analysis of soil samples will be performed in a manner that is intended to ~~meet the DQOs of FSS. The data obtained during the RASS is expected to~~ provide a high degree of confidence that the excavation, or relevant portion of the excavation, meets the criterion for the unrestricted release of open land survey units. Soil samples will be collected to depths at which there is high confidence that deeper samples will not result in higher concentrations. Alternatively, an NaI detector or intrinsic germanium detector of sufficient sensitivity to detect residual radioactivity at the Operational DCGL can be used to scan the exposed soils in an open excavation to identify the presence or absence of soil contamination, and the extent of such contamination. If the detector identifies the presence of contamination at a significant fraction of the Operational DCGL, additional confirmatory investigation and analyses of soil samples of the suspect areas will be performed.*

Section 5.4.1.5 of the LTP will be revised to provide additional details for the reuse of excavated soils as follows:

> *OPPD will not stockpile and store excavated soil for reuse as backfill in basements, with the exception of the soil that was excavated as part of the rail spur expansion project. Approximately 132,000 cubic yards of spoils produced from the excavation of this area are planned to be used on-site as fill material in basement structures after FSS of the structure surfaces and embedded pipe. As such, the survey of this material was equivalent to an FSS, and a dose will be attributed to the material and included in the basement fill inventory. Chapter 6 of the LTP, Section 6.20, provides a detailed discussion on establishing the basement fill material DCGLs (adjusted for IC dose).*
>
> *There will be overburden soils that are created to expose buried components (e.g., concrete pads, buried pipe, buried conduit, etc.) that will be removed and disposed of as waste or, to install a new buried system. In these cases, the overburden soil will be removed, the component will be removed or installed, and the overburden soil will be replaced back into the excavation from whence it came (provided radiological surveys do not identify activity in excess of the investigation levels in Table 5-24 using the surface soil Operational DCGLs). In these cases, an RA will be performed. The footprint of the excavation, and areas adjacent to the excavation where the soil will be temporarily staged, will be scanned prior to the excavation at a frequency used for FSS commensurate with the classification of the land area in which the excavation is located. In addition, periodic scans will be performed on the soil as it is excavated, and the exposed surfaces of the excavated soil will be scanned after it is piled next to the excavation for reuse. In addition, a final scan will be performed when the excavation is complete.*
>
> *Soil samples will be obtained throughout the excavation process at the location of any elevated areas identified during the scan and on a periodic basis at ~~a frequency of approximately one sample for every 300 cubic feet of soil removed; however,~~ the frequencies provided in Table 5-21, with a minimum of four samples ~~will~~ being obtained prior to backfill. Additionally, a soil sample will be acquired at any scan location that indicates activity in excess of the investigation levels in **Error! Reference source not found.** using the surface soil Operational DCGLs. Any soil confirmed as containing residual radioactivity at concentrations exceeding the investigation levels in **Error! Reference source not found.** using the surface soil Operational DCGLs will not be used to backfill the excavation and will be disposed of as waste. All soil samples taken during the RA of an excavation will be analyzed by gamma spectrometry using the on-site laboratory. Additionally, 10 percent of all soil samples collected during the RA of an excavation will be analyzed for the initial suite of radionuclides from **Error! Reference source not found.**.*

Table 5-21 Recommended Scan and Soil Sampling Frequencies for Reuse of Excavated Soil

Class	***Scan Frequency***	***Recommended Minimum Soil Sample Frequency***
1	*100%*	*1 per 20 cubic meters*
2	*25% - 50%*	*1 per 100 cubic meters*
3	*1% - 10%*	*1 per 500 cubic meters*

The recommended sample frequencies in Table 5-21 were calculated using the maximum recommended survey unit size for open land areas provided in MARSSIM. A size of 50,000 m^2 was assumed for a Class 3 open land area. Note, the average size of a Class 1 open land survey unit at FCS is approximately 1,998 m^2. The assumed survey unit size was multiplied by 0.15 m (depth of a surface soil sample) and then divided by 15 which is the assumed number of samples obtained during the FSS of an open land survey unit.

*There are some structures at FCS where the base slab sits many feet above grade level and when the slabs are removed there is an excessive amount of soil that must be assessed via an RA. Contrary to the scan frequency requirements described above, the scanning of soil under a raised slab may be done at the frequency used for FSS commensurate with the classification of the slab for which the soil resides under, provided the soil under the slab can be isolated and controlled from adjacent soil areas which may be impacted (e.g., if a Class 3 building is located in a Class 1 soil area, the soil beneath the building can be treated as Class 3 and the adjacent Class 1 soil shall receive a 100% scan to verify it is suitable as an interim laydown area). It should be noted that gamma scans performed with a sodium iodide detector are assumed to detect radioactivity at a depth of 15 cm. Performing scans in 15 cm lifts may be required. The soil sampling frequency recommended in Table 5-21 will be applicable to the RA performed on this excess soil. This soil may not be used as a fill material for basements but may be used in other areas of the site provided the RA does not identify activity in excess of the investigation levels in **Error! Reference source not found.** using the surface soil Operational DCGLs.*

An RA is performed prior to introducing off-site material to OPPD for use as backfill in a basement, or for any other use. The RA will be performed at the borrow pit, landfill, or other location from where the material originated and will consist of gamma scans and material sampling using the criteria specified in procedures ~~in the preceding paragraph.~~ Gamma scans are performed in situ, or by package (using a hand-held instrument or through the use of a truck monitor). Soil samples of overburden soils will be analyzed by gamma spectroscopy.

All RAs will be documented in the release record for the relevant survey units in which they are performed.

TE2-7: Justification for media specific reference materials

<u>Comment</u>: *Provide a description of media specific reference materials, if planning to use, and justification for their selection.*

<u>Basis</u>: *10 CFR 50.82(a)(9)(ii)(D) states that a license termination plan will contain a detailed final status survey plan. NUREG-1757, Vol 2, Section 4.4.1.1.3, provides a list of information that should be submitted with the LTP with regards to Final Status Survey Planning. This includes bullet 3, "a description of the background reference areas and materials, if they will be used, and a justification for their selection." In the LTP, Section 5.2.4, the licensee states that determination of media specific background will be evaluated in a technical support document and available for inspection. Submittal of this document as suggested in the guidance will support staff's review of the LTP.*

<u>Request</u>: *Provide the technical support document(s) identifying and justifying the reference areas/materials that will be used to support final status surveys or revise the LTP to discuss the reference areas/materials in detail so that that information can be used in NRC's evaluation of the FSSs.*

<u>OPPD Response:</u>

A background reference area will not be utilized, and is not necessary, for surface and subsurface soils, because the Sign Test will be utilized during the FSS of open land areas. Section 5.2.4 of the LTP states:

> *The collected data is typically used as the reference area data set when using the Wilcoxon Rank Sum test, but at FCS the Sign test will be used, as background is expected to constitute a small fraction of the $DCGL_W$ based on the results of characterization surveys.*

This is allowable under MARSSIM in Section 5.5.2.3 which states:

> *For the situation where the contaminant is not present in background or is present at such a small fraction of the $DCGL_W$ as to be considered insignificant, a background reference area is not necessary.*

Ambient background will be utilized for gamma walkover surveys of land areas to determine the survey MDC_{Scan} and $MDCR_{Surveyor}$. Ambient background will also be subtracted from total surface contamination survey measurements of structures. Background subtraction for piping may be performed utilizing measurements obtained in a radiologically clean environment in radiologically clean piping of similar size and construction material. Background will not be subtracted for measurements performed using an In Situ Object Counting System. Therefore, no revision to the LTP is necessary.

TE2-8: Characterization of soil beneath paved areas

Comment: *Clarify how soil beneath areas that will remain pavement covered will be characterized.*

Basis: *Section 5.4.1.6 of the LTP discusses that pavement covered areas will be incorporated into the FSS of the open land areas and if the pavement does not meet the DCGL for surface soil the pavement will be removed and disposed of, and the soil beneath would be investigated/surveyed as per the classification of open land areas. Section 2.5 of the LTP (Continuing Characterization) states - "Radiological Assessments (RAs) will be performed in currently inaccessible soil areas that are exposed after removal of asphalt or concrete roadways and parking lots, rail lines, buried piping, or building foundation pads (slab on grade). Survey results for RAs will be presented in the relevant survey unit release records." However, there is no discussion of how subsurface soil beneath paved areas will be characterized if pavement will remain at the time of license termination. This is a concern if an area may have been contaminated and then later paved over during operations. This information is needed for staff to determine if the licensee is in adequate compliance with the requirement in 10 CFR 50.82(a)(9)(ii) that the LTP includes a site characterization and detailed plans for the final radiation survey.*

Request: *Clarify in Section 5.4.1. the approach for characterizing the subsurface beneath paved areas that will remain at the time of license termination.*

OPPD Response:

All paved areas present in Class 1 Survey Units (e.g., within the former Protected Area) will have the paving removed with surveys and sampling performed after removal in the form of an RA. Paved areas within Class 2 and 3 Survey Units may remain and would be treated in the same manner as soils in open land. Sample locations within Class 2 and 3 Survey Units which fall on a paved area would have both a pavement sample and an underlying soil sample obtained. If the sample location is part of the statistical population, the sample results from the uppermost stratum would be used for the tests. The other stratum samples are treated as judgmental samples in the reports. These clarifications will be included in Section 5.4.1.6 of the LTP.

5.4.1.6 Pavement Covered Areas

Paved surfaces that remain at the site following decommissioning activities will require surveys for residual radioactivity when present in Class 1 areas. Paved areas will be incorporated into the larger open land survey units in which they *reside when present within Class 2 or 3 areas. This is appropriate as the pavement is outdoors where the exposure scenario is most similar to direct radiation from surface soil. Pavement will be released as a surface soil and surveyed accordingly in accordance with the classification of the open land survey unit in which it resides. Samples of the pavement will be acquired at each systematic sample location. The sample media will be pulverized, analyzed by gamma spectrometry and compared with the Operational DCGL for surface soil for each of the potential ROC.*

If pavement exhibits residual radioactivity in excess of the Base Case DCGL for surface soil, then the pavement will be removed and disposed of as radioactive waste and the soil beneath will be investigated. Additionally, a surface soil sample will be obtained from the location of the pavement sample. Sample locations within Class 2 and 3 Survey Units which fall on a paved area would have both a pavement sample and an underlying soil sample obtained. If the sample location is part of the statistical population, the sample results from the uppermost stratum would be used for the tests. The other stratum samples are treated as judgmental samples in the reports. Sample locations within Class 2 and 3 Survey Units which fall on a paved area would have both a pavement sample and an underlying soil sample obtained. If the sample location is part of the statistical population, the sample results from the uppermost stratum would be used for the tests. The other stratum samples are treated as judgmental samples in the reports.

TE2-9: Measurement Sensitivity

Comment: *Section 5.4.2.4, Measurement Sensitivity, discusses the a priori calculation of the static and scan minimum detectable concentration (MDC) for instruments and techniques used for the Final Status Survey (FSS). Included in this discussion are the equations used to calculate MDCstatic (Equation 5-19) and the MDCscan for beta-gamma (Equation 5-20). Table 5-21 lists the typical FSS survey instruments including the effective detector area. The d' value is given as 1.38 (page 5-57). The surveyor efficiency (p) is set at 0.5-0.75 (page 5-58). Table 5-22 includes the typical FSS instrument detector sensitivities for several instrument model, including values for MDCstatic and MDCscan. The numbers provided in Table 5-22 (i.e., 510 dpm/100 cm2 and 1591) for the Ludlum Model 44-116 were not reproducible with the equations provided.*

Basis: *10 CFR 20, Subpart F, "Surveys and Monitoring," §20.1501, specifies that the licensee shall conduct surveys of areas that evaluate the concentrations or quantities of residual radioactivity. NUREG-1700, Standard Review Plan for Evaluating Nuclear*

Power Reactor License Termination Plans, A.4, Final Status Survey Design, indicates that in situ measurements by field instruments demonstrate adequate sensitivity. NUREG-1757, Volume 2, Consolidated Decommissioning Guidance: Characterization, Survey, and Determination of Radiological Criteria, A.6, Instrument Selection and Calibration reiterates that to demonstrate that the radiological criteria for license termination in 10 CFR 20.1402 has been met, the measurement instruments should have adequate sensitivity, and be calibrated and undergo period proper response checks. Thus, demonstrating that MDCs have the appropriate sensitivity is critical to the decision-making process.

Request: *Verify all the calculations for the MDCstatic and MDCscan values listed in Table 5-22. If necessary, clarify any assumptions not already specified in the LTP.*

OPPD Response:

Table 5-22 was intended to provide typical values for the instrumentation. The values have been updated to remove rounding issues associated with the utilization of a spreadsheet to calculate the MDC_{Scan}. In addition, the MDC_{Scan} values for the Model 44-10 and 44-20 have been updated to the values utilized to date, and additional details have been included in the footnotes. These changes will be incorporated into the LTP.

TE2-10: Documenting Excavation Radiological Assessments and Backfill Characteristics

Comment: *The LTP does not identify the process used for documenting both the results of gamma scans and analyses of soil samples of the backfill material collected following excavation and prior to backfilling as well as the specific characteristics of the compacted material identified in the "Fort Calhoun Station Backfill Requirements" (ADAMS accession number ML21271A200) document.*

Basis: *10 CFR 50.82(a)(9)(ii)(D) states that a license termination plan will contain a detailed final status survey plan. Multiple sections of the LTP note that following excavation the licensee will perform a radiological assessment of excavated areas that consist of gamma scans and soil sampling prior to backfilling. The LTP also notes that backfilling of the excavated areas will be performed in accordance with the "Fort Calhoun Excavation and Backfill Requirements" document. The requirements include ensuring that the fill material will not include "rocks or stones larger than three (3) inches and shall be free of frozen lumps, organic matter, trash, snow, ice contamination or other deleterious material," the backfill material will be placed in twelve inch lifts and "compacted to at least 85% of the maximum Modified Proctor in accordance with ASTM D1557, or 90% of the maximum Standard Proctor density in accordance with ASTM D698," and that the compacted material will be "within plus or minus 3% of the optimum moisture content in accordance with the applicable ASTM D1557 or ASTM D698 standards.*

Request: *"Clarify how the licensee intends to document the results of both the radiological assessments of the excavated areas performed prior to backfilling as well as the analyses performed to ensure that the compacted backfill material meets the requirements dictated in the "Fort Calhoun Station Backfill Requirements" document.*

OPPD Response:

Radiological assessments (RA) and remedial action support surveys (RASS) will be documented in accordance with FCSD-RA-LT-306, "Radiological Assessments and Remedial Action Support Surveys." Results of the RA and RASS will be included in the release record for the survey unit in which the RA/RASS was performed.

Reference document "Fort Calhoun Excavation and Backfill Requirements" is strictly a contractual guidance document to provide subcontractors with minimum criteria for backfill compaction and suitability of soil and was not used for developing the basement fill model. Consequently, references to "Fort Calhoun Excavation and Backfill Requirements" will be removed from the LTP:

- Section 3.4.3: Demolition and Dismantlement of Non-Radiological Structures
- Section 3.4.5: Buried Utilities, Tanks and Piping Removal
- Section 3.5.1.3: General Backfill Considerations
- Section 3.5.2.7: Sewage Lagoon Piping and Lift Stations
- Section 3.5.3.1: Turbine Building
- Section 3.7, References: Reference 14 - Omaha Public Power District, "Fort Calhoun Excavation and Backfill Requirements"

Subcontractors will document the analyses performed to ensure that the compacted backfill material meets the requirements dictated in the "Fort Calhoun Station Backfill Requirements" in Decommissioning Work Packages, which are inspectable by the NRC. Results will not be included in the RA documentation.

TE2-11: Loam-Based Sorption Coefficients for the Contaminated Zone

Comment: *Selection of sorption coefficient distributions for uncertainty analyses and deterministic values for soil DCGLs assume the soil is loam for the contaminated zone (CZ) and unsaturated zone (UZ), though confounding information in the LTP is provided for those assumptions.*

Basis: *The LTP does not provide sufficient information on the basis for selecting loam for the contaminated zone and whether the available information provides reasonable assurance that the final conditions of the site are consistent with the dose criteria in 10 CFR 20.1402 and that the site has been adequately characterized per 10 CFR 20.1501.*

The basis provided for sorption coefficient (K_d) ranges for uncertainty analyses provided in Table A.1.1 were the sand, loam, and generic (default values) tables from the Data Collection Handbook (Argonne National Laboratory, ANL/EVS/TM-12/4, 2015). Similarly, for the soil scenario DCGLs, LTP Tables 6-5 and 6-6 provided deterministic K_d values based on the Data Collection Handbook tables. For both the uncertainty analyses and *selection of deterministic K_d values for soil DCGLs, the licensee selected values from the loam table for the UZ and CZ in RESRAD simulations. Because the release model uses an equilibrium desorption-based model, the consequence of the loam assumption for the CZ leads to smaller releases from the contaminated zone, possibly affecting the sensitivity of dose to saturated zone parameters.*

Descriptions of the unconsolidated sediments provided in the geology sections of LTP Chapters 1 and 6, which staff presumed contained the basis for selecting loam for the CZ and UZ. The Defueled Safety Analysis Report or DSAR (ADAMS accession number ML18010A129) and the TSSD Services Fort Calhoun Nuclear Station Limited Site Non-Radiological Characterization Survey Report or TSSD Services Report (ADAMS Accession Number ML21271A181) were cited as supporting documents for geology in LTP Section 1.3.5. The upper 20 to 50 feet of unconsolidated sediments are variously described in the LTP and cited supporting documents for geology:

- *LTP Section 1.3.5 as fine-grained sandy clay with silt*
- *LTP Section 6.2.1 as fine-grained sand and silt with some clay*
- *DSAR Section 2.6 as predominantly sandy silts and silty sands, though borehole logs in DSAR Appendix C suggest a prominence of SP soils below the uppermost 2 to 10 ft*
- *TSSD Services Report Section 2.2.2 as fine-grained sandy clay with silt*

These brief descriptions of sediments in the upper 20 to 50 feet reflect a summary and interpretation of the data from borehole logs of test borings and monitoring wells. Secondary documents with borehole logs and summary tables variously use Unified Soil Classification System (USCS), the USDA Textural Classification System (TCS), abbreviated or qualitative sediment names. These secondary documents include the DSAR (ADAMS accession number ML18010A129) Appendix C, Fort Calhoun Nuclear Station Limited Non-Radiological Characterization Survey Report (2017, ADAMS accession number ML21271A181), Haley and Aldrich (2021, Hydrogeological Conceptual Site Model, Revision 5) (ADAMS accession number ML22034A594), and Flood Recovery Action Plan 4.1 (2012, ADAMS accession number ML21272A219). Information gaps include (i) the drilling approach of hydrojetting the top 10 feet of the borehole instead of collecting core (e.g., the 2007 monitoring wells), (ii) no description of the construction fill material during initial plant construction or later modifications, and (iii) no locations provided for borings (e.g., Haley & Aldrich, 2021) that would enable an assessment of representativeness. In addition to the difficulty in using different classification systems to apply sediment classification to the K_d estimation approach, the borehole logs and associated descriptions illustrate the lensing and interstratification of sediment layers consistent with the ascribed fluvial and glacial environment. If releases to the subsurface are limited to a subset of sediments at the site, a basis should be provided, or a conservative approach should be taken.

Neither the USCS nor USDA TCS classification system map cleanly to the soil categories used in sorption coefficient databases, such as that in the Data Collection Handbook (2015) cited in LTP Table A.1.1. The compilations of K_d values use the following criteria for categories of sand, loam, and clay:

- *Sand category was defined as >70% sand-sized particles*
- *Loam category as even distribution of sand, silt, clay, and up to 80% silt*
- *Clay category as >=35% clay*

The criteria are based on Sheppard and Thibault (1990), Default Soil Solid/Liquid Partition Coefficients, K_ds for Four Major Soil Types: A Compendium, Health Physics 59(4), which was the early version of the K_d compilation on which later compilations expanded.

Request: *Provide justification for using sorption coefficients for the contaminated zone in RESRAD based on loam rather than the soil material used for the saturated zone calculation of DCGLs.*

OPPD Response:

Site-specific K_d analyses would be performed for the grout to be used for basement fill; soil to be used for basement fill; unsaturated soil; and saturated soil. The site-specific K_d analyses eliminates the need for further evaluation of site soil types and corresponding literature K_d values.

Upon receipt of the site-specific K_ds, the DCGLs will be reanalyzed using the RESRAD input files submitted with LTP Chapter 6, Revision 0 with one parameter modification which is the K_d values being updated to site-specific K_ds. Fort Calhoun intends to utilize the DCGL values submitted in the LTP if the site-specific values return at a higher level. If the site-specific K_ds were to result in a non-conservative state (lower K_d values), the lower DCGLs will be used.

After the reanalysis is completed, the results would be available to the NRC for information and inspection. The report would include the following:

- the sample plan used to ensure that the soils collected and analyzed for K_d are sufficiently representative of unsaturated and saturated soils onsite
- a description of the grout and fill material used to backfill basements that are analyzed for Kd
- the approach for selecting the analytical, site-specific Kds to apply in the reanalysis (maximum, minimum or mean)
- the methods used to reanalyze the applicable RESRAD files using the site-specific Kd values, including reperforming the probabilistic uncertainty analysis for the ROC after replacing the Kd probabilistic density functions with site-specific deterministic K_d values.

- a table of the reanalyzed DCGLs for soil, basement surfaces, embedded pipe, buried pipe, as well as the existing groundwater dose factors, using the site-specific Kd values
- a list of the FSS release records that require revision to incorporate non-conservative (lower Kd) ROC DCGLs, if applicable. Note that if the reanalyzed ROC DCGLs are conservative (higher) revision of FSS release records will not be required since the DCGL values provided in the LTP will not be changed.

TE2-12: RESRAD Inputs Representing Groundwater Conditions

Comment: *The RESRAD input presumed to be representative of long-term conditions for groundwater is supported by a single measurement cycle made on June 16 and 17, 2020, that did not include river stage.*

Basis: *Information is needed to demonstrate that the final conditions of the site are consistent with the dose criteria in 10 CFR 20.1402 and that the site has been adequately characterized per 10 CFR 20.1501. The licensee stated that the conceptual site model is bank storage where prior and current river stage strongly affect groundwater levels across the site. Staff reviewed groundwater contours reported in the Terracon (2022) and the Flood Recovery Plan Report (2012). Staff also analyzed historical groundwater and river stage levels provided by OPPD in a response to a request for supplemental information January 13, 2022 (ADAMS accession number ML22034A602). Staff found that gradients inland, towards the river, and mounding under the site all occur and are consistent with a bank storage conceptual site model (CSM). Use of the June 2020 groundwater gradient towards the river represents only one condition reflected in historical data.*

Staff acknowledges difficulties in using historical data to represent future conditions at Fort Calhoun. Though theoretically there may be influx from the higher elevation bluffs to the west, staff notes that there are confounding conditions in monitoring well data that might affect groundwater levels under the Deconstruction Area. Interpretations of natural gradients from historical groundwater data is confounded by: (i) pumping from a well from 2007 through 2018, (ii) measurement cycles where river stage changed significantly during the cycle, (iii) later measurement cycles that did not include river stage, and (v) no measurement point between the bluffs and the Deconstruction Area; note that top of the collar or MW-12A/B has not been surveyed and thus provides no groundwater elevation data.

In addition, intermittent flow in Fish Creek may also influence site groundwater conditions but no hydrological information was found to assess that influence. A continuous pump rate of 200 gpm from the well at the northwestern corner of the old warehouse slab for supporting the reverse osmosis process from the period 2007 through 2018 was stated to induce a cone of depression extending 600 feet. For reference, the distance from the pumping well to the river is approximately 800 feet, thus covering a significant portion of the Deconstruction Area.

For river stage measurements, staff notes that there are indications early measurements have concurrent river stage levels, either actual site measurement or use of an adjustment factor of 2.11 to represent site conditions compared to the river stage measured at the U.S. Geological Survey station near Blair NE. The groundwater measurement cycle in June 2020 used for the LTP does not appear to use site-relevant river stage data. There is also indications that river stage levels representative of the site were discontinued once decommissioning started.

Request: *Explain why the June 16-17, 2020, measurement cycle best represents the long-term average gradient across the site, or why the gradient magnitude is not important in the DCGL calculations.*

OPPD Response:

The groundwater concentrations, and corresponding DCGLs, in the basement fill model (BFM) are calculated in RESRAD using a screening model that assumes instant release and mixing. The DCGLs are not sensitive to the hydraulic gradient or other hydrogeological parameters (except K_d as discussed in the response to RAI TE2-11). A sensitivity analysis of hydraulic gradient and hydraulic conductivity was performed using the BFM *in situ* DSR RESRAD file to support the qualitative assessment. As expected, varying the parameter ranges (by a factor of 10) had no effect on dose. No revision of the LTP is deemed necessary to address uncertainty in the magnitude of the gradient because it is not important in the DCGL calculations.

TE2-13: Values used to calculate the buried pipe DCGLs

Comment: *Clarify the total length and surface area values used to calculate the buried pipe DCGLs.*

Basis: *Section 6.14.1 of the LTP discusses the buried piping source term for the buried pipes that will remain onsite at license termination. Internal pipe diameter values provided in the text and the pipe length values provided in Table 6-22 were used to determine the interior surface area of the remaining pipes, which equates to the amount of material that will be released to the soil and serves as the "Area of Contaminated Zone (m^2)" value when calculating the buried pipe DCGL values. As noted in the LTP Section 6.14.1 text and Table 6-22, the remaining buried pipes include 955.9 m of storm drainpipes with internal diameters ranging from 8 inches to 84 inches (0.2 m to 2.13 m) and 54.9 m of service water pipes with an internal diameter of 2.9 inches (0.07 m). Using the formula, π X Length X Diameter = Surface Area, NRC staff independently calculated an internal surface area for the service water pipes equaling the value provided in Table 6-22 (12.7 m^2). However, NRC staff were unable to independently reproduce the total internal surface area value, 2167.8 m^2, provided for storm drainpipes. The NRC staff calculated a range of 610.2 m^2 to 6407.3 m^2 based on the assumption that all the storm drainpipes had diameters of either 8 inches (0.2 m) or 84 inches (2.13 m), respectively.*

This information is needed to have reasonable assurance that the site will meet the unrestricted release criteria in 10 CFR 20.1402.

Request: *Clarify the calculation inputs used to determine the internal surface area of the storm drainpipes provided in the LTP. If necessary, update the buried pipe DCGL values using the appropriate internal surface area value for the "Area of Contaminated Zone (m^2)" parameter value.*

OPPD Response:

The internal surface area of 2,167.8 m^2 assigned to the storm drains is provided in FCS TSD FC-21-002, Table 3. LTP Section 6.14.1 references TSD FC-21-002 as the source of the 2167.8 m^2 value. The storm drain diameters and lengths used to calculate the 2,167.8 m^2 surface area are provided in Appendix A of TSD FC-21-002. No update to the LTP is required.

TE2-14: Calculation of soil area factors

Comment: *Clarify issues related to the specific areas evaluated as part of the soil area factor evaluation process and the radionuclides considered. This information is needed to have reasonable assurance that the site will meet the unrestricted release criteria in 10 CFR 20.1402.*

Basis: *LTP Section 6.20 outlines the process used by the licensee to calculate soil area factors for the ROCs, which are reported in Tables 6-37 and 6-38. The analyses, performed using the RESRAD computer code, consider area factors for a range of "generic areas" (e.g., 1 m^2, 2 m^2, 5 m^2, 10 m^2, 100 m^2) as well as the specific area of 143 m^2. The LTP does not provide the basis for using that specific area for the evaluation.*

Additionally, the RESRAD analyses associated with the area factors provided with the LTP consider Ni-63 and Sr-90 but Tables 6-37 and 6-38 do not include them.

Request: *Provide the basis for considering an area factor for the specific area of 143 m^2. The licensee should also provide the basis for excluding the calculated area factor values for Ni-63 and Sr-90 from Tables 6-37 and 6-38.*

OPPD Response:

The 143 m^2 area factor does not have a specific application in Chapter 6, Revision 0, and will be deleted from LTP Tables 6-37 and 6-38. The Ni-63 and Sr-90 area factors were not included because they are not ROCs, and will not be added.

TE2-15: RESRAD Uncertainty Analyses

Comment: *Additional clarification is needed regarding the RESRAD uncertainty analyses. This information is needed to have reasonable assurance that the site will meet the unrestricted release criteria in 10 CFR 20.1402.*

Basis: *Although the LTP says that the NUREG/CR-6697 values were used in the uncertainty analyses, the specific values used in the uncertainty analyses were not identified in the LTP. Additionally, the methodology used to determine the 25% and 75% values from the distributions was not included. This information is needed for NRC to verify the uncertainty and sensitivity analysis results used to develop the DCGLs that Ft. Calhoun intends to use as the basis for ensuring compliance with the unrestricted release criteria in 10 CFR 20.1402*

It also was not clear whether correlations were used in RESRAD for parameter values that are expected to be correlated (e.g., K_d values in multiple layers, groundwater flow parameters), and, if so, what values were assumed for the correlations. Neglecting to correlate parameters appropriately in a probabilistic analysis can lead to an underestimation of the true uncertainty in the dose estimates and can lead to a misidentification of whether a parameter is risk-significant or not (see Appendix I and Appendix Q in NUREG-1757 Vol 2, Rev 2).

Request: *Provide the parameter distributions used for the RESRAD uncertainty analyses. Specifically, the details on the calculations used to determine the 25% and 75% deterministic values and why selecting the 25% vs the 75% (or vis versa) was the appropriate assumption for the conceptual model. Describe if related parameters (e.g., K_d) were correlated in the uncertainty analyses and provide the correlations used. Describe the basis for correlating the parameters, or not, as well as the specific values used for the correlations.*

OPPD Response:

The parameter distribution functions (PDFs) used for the uncertainty analysis are listed in LTP Chapter 6, Revision 0, Table A.1.1. The 25^{th}, 75^{th}, and median values for K_d lognormal distributions are calculated in Excel using the LOGNORM.INV (probability, mean, standard_dev) function. The percentiles for parameter PDFs other than K_d were calculated using the RESRAD-OFFSITE “step by step” function in the “uncertainty and probabilistic analysis” module. The 25^{th}, 75^{th}, and median values applicable to each PDF used in the uncertainty analysis are provided in LTP Chapter 6, Revision 0, Section A.6.1.10.

The Zion and La Crosse LTPs assigned the 25^{th} or 75^{th} percentiles as the deterministic values for sensitive parameters. Based on the precedent at Zion and La Crosse, the 25^{th} and 75^{th} percentiles were also assigned as the deterministic values for sensitive parameters at FCS. The 25^{th} and 75^{th} values are considered to be reasonably conservative and to reduce the effect of outliers in the PDFs.

One justification for the use of the 25th and 75th percentiles is found in NUREG/CR-7267, Section 6 which states the following in regards to the process used for a generic RESRAD evaluation:

> *If the parameter had a significant effect on peak total dose (see Section 5), reasonable effort should be made to obtain the site-specific value. If the site-specific value was not available, for a positively correlated parameter the higher percentile (e.g., 75 percent) was used, and for a negatively correlated parameter, the lower percentile (e.g., 25 percent) from the parameter distribution was used.*

NUREG/CR-7267, Section 6.1 states the following in regard to the results of RESRAD analysis when the 75th and 25th percentile deterministic values are applied:

> *For all radionuclides, dose is higher than the peak of the mean and 75th percentile dose values.*

NRC guidance in NUREG/1757, Volume 2, Revision 2, states that the peak of the mean dose is an acceptable compliance dose when probabilistic analysis is used. The 75th percentile of dose a more conservative value, i.e., higher, then the peak of the mean when in a probabilistic analysis is used and would also be acceptable.

In summary, the use of the 75th percentile with positively correlated parameters and 25th percentile with negatively correlated parameters is consistent with precedent at Zion and La Crosse and is shown to provide reasonably conservative results in a generic analysis provided in NUREG/CR-7267. There is no clear justification for applying different percentiles. OPPD proposes to maintain the use of the 75th and 25th percentiles for the deterministic values assigned to sensitive parameters. Note that the OPPD response to TE2-11 states that the ROC would undergo an additional uncertainty analysis using the site-specific, deterministic K_ds to confirm the expectation that the results of the uncertainty analysis reported in the LTP do not change after replacing the K_d PDF with the deterministic site-specific values.

The uncertainty analysis did not include parameter correlations because the majority of the potentially correlated parameters are site-specific deterministic values. This conclusion was based on a review of tables from NUREG/CR-7267 and NUREG/CR-6697 that provide lists of potential parameter correlations. The tables and an assessment of whether parameter correlations apply are provided below:

NUREG/CR-7267, Table B-9 Parameter Correlations for Probabilistic Analyses

Parameter 1	**Parameter 2**	**Probabilistic Correlation Applicable?**
Area of contaminated zone	Length parallel to aquifer flow	NO - Both parameters deterministic
Fraction of vegetation carbon absorbed from air	Fraction of vegetation carbon absorbed from soil	NO - No PDFs available for these parameters
Contaminated zone soil density	Contaminated zone total porosity	NO-Site-specific deterministic values
Unsaturated zone soil density	Unsaturated zone total porosity	NO-Site-specific deterministic values
Unsaturated zone soil density	Unsaturated zone effective porosity	NO-Site-specific deterministic values
Saturated zone soil density	Saturated zone total porosity	NO-Site-specific deterministic values
Saturated zone soil density	Saturated zone effective porosity	NO-Site-specific deterministic values
Unsaturated zone total porosity	Unsaturated zone effective porosity	NO-Site-specific deterministic values
Saturated zone total porosity	Saturated zone effective porosity	NO-Site-specific deterministic values
Kd of U-234 in contaminated zone	Kd of U-238 in contaminated zone	NO – uncertainty analysis run with single radionuclides

NUREG/CR-7267, Table B-9 Parameter Correlations for Probabilistic Analyses

Parameter 1	Parameter 2	Probabilistic Correlation Applicable?
Kd of U-234 in unsaturated zone	Kd of U-238 in unsaturated zone	NO – uncertainty analysis run with single radionuclides
Kd of U-234 in saturated zone	Kd of U-238 in saturated zone	NO – uncertainty analysis run with single radionuclides

NUREG/CR-6697, Table 2.4-1 Parameter Correlations for Probabilistic Analyses

Parameter 1	Parameter 2	Probabilistic Correlation Applicable?
Depth of Roots	Precipitation Rate	NO – precipitation rate deterministic site-specific
Distribution coefficients	Soil/plant transfer factors	NO – soil/plant transfer factor deterministic 75th percentile values
Drinking water intake	Well pumping rate, milk consumption	NO - Drinking water intake deterministic value
Effective porosity	Total porosity	NO - Porosities site-specific deterministic
Erosion rate[1]	**Wind speed[1], runoff coefficient[1],** precipitation rate	**Yes** – Erosion rate with wind speed and runoff coefficient. All three parameters are represented by PDFs in the uncertainty analysis

Parameter 1	**Parameter 2**	**Probabilistic Correlation Applicable?**
Evapotranspiration coefficient	Irrigation rate	NO – irrigation rate site-specific deterministic
Irrigation rate	Precipitation rate, well pumping rate, evapotranspiration coefficient	NO – irrigation rate site-specific deterministic
Precipitation rate	Irrigation rate, erosion rate, runoff coefficient, wet foliar interception fraction for leafy vegetables, depth of roots, soil ingestion rate	NO- precipitation rate site-specific deterministic
Runoff coefficient	Erosion rate, precipitation rate	NO – precipitation rate site-specific deterministic. Runoff and erosion addressed above
soil density	Total porosity	NO – site specific deterministic
Soil ingestion rate	Precipitation rate	NO – precipitation rate site-specific deterministic
Soil/plant transfer factors	Distribution coefficients	NO – soil/plant transfer factors deterministic
Total porosity	Soil density, effective porosity	NO – porosity, density, effective porosity site-specific deterministic
Well pumping rate	Drinking water intake, irrigation rate	NO – all parameters deterministic
Wind speed	Erosion rate	NO – addressed above

1) Parameter sets where each parameter is represented by a PDF and correlation could be entered foe the uncertainty analysis

As shown in bold in the table from NUREG/CR-6697, there are only two correlated parameter sets where both parameters are represented by PDFs in the uncertainty analysis; erosion rate with wind speed and erosion rate with runoff coefficient. The potential for the correlation of these parameters to affect the uncertainty analysis, and ultimately the dose, is low. This assumption was checked by performing the uncertainty analysis for the ROCs in soil with positive correlations between erosion rate and wind speed and erosion rate and runoff coefficient. There were no changes in the uncertainty analysis results with correlations included.

TE2-16: Source for RESRAD parameter values

Comment: *Provide justification for the use of NUREG/CR-6697, "Development of Probabilistic RESRAD 6.0 and RESRAD-BUILD 3.0 Computer Codes," (2000) in Chapter 6 of the LTP, instead of NUREG/CR-7267, "Default Parameter Values and Distribution in RESRAD-ONSITE V7.2, RESRAD-BUILD V3.5, and RESRAD-OFFSITE V4.0 Computer Codes," (2020) as the reference for parameter values and parameter distributions used when assessing whether doses calculated in accordance with the LTP meet the radiological criteria for unrestricted use in 10 CFR 20.1402.*

Basis: *When assessing the doses relative to the radiological criteria for unrestricted use in 10 CFR 20.1402, the uncertainty/sensitivity analyses discussed in the LTP references the use of NUREG/CR-6697, "Development of Probabilistic RESRAD 6.0 and RESRAD-BUILD 3.0 Computer Codes," as the source for parameter values and parameter distributions. NUREG/CR-6697 was published in 2000 as part of a series of documents addressing the procedures used to enhance the deterministic RESRAD and RESRAD-BUILD codes for probabilistic analysis. NUREG/CR-7267, "Default Parameter Values and Distribution in RESRAD-ONSITE V7.2, RESRAD-BUILD V3.5, and RESRAD-OFFSITE V4.0 Computer Codes," provides updated information on the default parameter values and parameter distributions in combination with ANL/EVS/TM-14-4, "Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil and Building Structures," which was published in 2015. NUREG/CR-7267 provided new and more up-to-date information on default parameter values and, depending on the information available, includes new and/or updated distributions for specific RESRAD parameters.*

Request: *Clarify the basis of continuing to use the parameter values and parameter distributions referenced from NUREG/CR-6697 instead of the updated values and distributions included in NUREG/CR-7267 when assessing the doses relative to the radiological criteria for unrestricted use in 10 CFR 20.1402.*

OPPD Response:

The RESRAD default PDFs were used in the uncertainty analysis for parameters that were not site specific. The use of RESRAD default PDFs in uncertainty analysis is consistent with NRC guidance in NUREG-1757, Vol. 2, Rev. 2. If the uncertainty analysis identified a parameter as sensitive, the LTP used the same PDF to determine the 75th or 25th percentile deterministic value (or the median if not sensitive) to assign for the final dose assessment.

In response to RAI TE2-16, the PDFs for physical parameters in NUREG/CR-7267, Appendix C were reviewed to determine if one or more of the NUREG/CR-7267 PDFs differed from the RESRAD defaults. Metabolic and behavioral parameters were assigned the deterministic values in NUREG-5512, Vol. 3, Table 6.87 consistent with NRC guidance in NUREG 1757, Vol. 2, Rev. 2. If a PDF in NUREG/CR-7267 was different from the RESRAD default, the 75th, 25th, or median deterministic value of the NUREG/CR-7267 PDF was calculated and compared to the deterministic value assigned in the LTP. The effects of the different deterministic values on dose were assessed. The results of the NUREG/CR-7267 assessment are described in the Table below.

Evaluation of the Potential Effect on Dose from Applying NUREG/CR-7267 PDFs

NUREG/CR-7267 Parameter	NUREG/CR-7267 Parameter Assessment	Effect on Dose
Soil Density	NA - site-specific value applied in LTP	NA
Porosity	NA - site-specific value applied in LTP	NA
Effective Porosity	NA - site-specific value applied in LTP	NA
Hydraulic Conductivity	NA - site-specific value applied in LTP	NA
b-parameter	NA - site-specific value applied in LTP	NA
Hydraulic Gradient	NA - site-specific value applied in LTP	NA
Unsaturated Zone Thickness	NA - site-specific value applied in LTP	NA
Erosion Rate	NA - site-specific value applied in LTP	NA
K_d	K_d PDFs were from the 2015 Data Collection Handbook which is the reference for K_d in NUREG/CR-7267	NA
Well pump rate	NA - site-specific value applied in LTP	NA
Well Pump Intake Depth	NA - site-specific value applied in LTP	NA

Evaluation of the Potential Effect on Dose from Applying NUREG/CR-7267 PDFs

NUREG/CR-7267 Parameter	NUREG/CR-7267 Parameter Assessment	Effect on Dose
Depth of Soil Mixing	NA - site-specific value applied in LTP	NA
C14 Evasion Layer	Same as NUREG/CR 6697	NA
Precipitation Rate	NA – site specific value applied in LTP	NA
Runoff Coefficient	NA - site-specific value applied in LTP	NA
Evapotranspiration	NA – site-specific value applied in LTP	NA
Humidity	Same as NUREG/CR 6697	NA
Wind Speed	NA - site-specific value applied in LTP	NA
Mass Loading for Inhalation	The “Mass Loading for Inhalation” PDF in NUREG/CR-7267 represents higher values than the PDF in NUREG/CR-6697	See discussion below
Depth of Roots	The NUREG/CR-7267 PDF is a uniform distribution with minimum of 0.3 and a maximum of 3.6. The NUREG/CR-6697 PDF is a uniform distribution with a minimum of 0.3 and a maximum of 0.4	The difference between the PDFs is not significant
Wet weight Crop Yield	Same as NUREG/CR 6697	NA

Evaluation of the Potential Effect on Dose from Applying NUREG/CR-7267 PDFs

NUREG/CR-7267 Parameter	NUREG/CR-7267 Parameter Assessment	Effect on Dose
Weathering Removal Constant	Same as NUREG/CR 6697	NA
Plant, Meat, and Milk Transfer Factors	The transfer factors in NUREG/CR-7267 differ from NUREG/CR-6697	See discussion below

Mass Loading for Inhalation

The "Mass Loading for Inhalation" PDF in NUREG/CR-7267 represents higher values than the PDF in NUREG/CR-6697. The 75th percentile of the NUREG/CR-7267 PDF is 6.08E-05 versus 2.87E-05 in NUREG/CR-6697. As an example of how this increase may affect doses, the 0.15-meter soil DCGLs for the transuranic radionuclides that are sensitive to mass loading (Am-241, Pu-238, Pu-239/240, Pu-241, Cm-243/244), and positively correlated, were evaluated with the increased mass loading value. The dose increased by ~5% when the 75th percentile from NUREG/CR-7267 was applied in place of the NUREG/CR-6697 75th percentile that was used in the LTP.

The sensitive transuranic radionuclides in question are designated as insignificant contributors (IC) in TSD 21-043, Rev. 0, *Radionuclides of Concern in Support of Fort Calhoun License Termination Plan*. The total IC dose fraction attributed to the seven affected radionuclides is 2.33E-05 (reference TSD 21-043, Table 32). Increasing this dose by 5% increases the dose fraction for the seven radionuclides by 5%, i.e., 1.16E-06. Adding this increase to the dose contribution from all IC radionuclides would increase the IC dose from 7.90E-04 to 7.91E-04. The IC dose fraction assigned in the LTP is 0.05 to account for uncertainty. The actual IC dose fraction with the increase from the mass loading parameter is still well below the assigned fraction of 0.05. No change to the LTP is warranted due to this very small increase in IC dose fraction.

Plant, Meat, and Milk Transfer Factors

The plant, meat, and milk transfer factor (TF) PDFs in NUREG/CR-7267 differ from the TF PDFs in NUEG/CR-6697. The ratios of the 75th percentile TFs in NUREG/CR-7267 to those in NUREG/CR-6697 are provided in the table below.

Ratios of 75th Percentile Transfer Factors: NUREG/CR-7267 to NUREG/CR-6697

Radionuclide	75th Percentile Transfer Factor Ratios NUREG/CR-7267 / NUREG/CR-6697		
	Plant	**Meat**	**Milk**
Am-241	1.01E+00	1.14E+00	1.00E+00
C-14[1]	NA	NA	NA
Ce-144	1.01E+00	1.00E+00	1.00E+00
Cm-243/ 244	1.08E+00	1.00E+00	1.00E+00
Co-58	1.03E+00	1.26E-02	5.45E-02
Co-60	1.03E+00	1.26E-02	5.45E-02
Cs-134	1.02E+00	6.17E-01	5.30E-01
Cs-137	1.02E+00	6.17E-01	5.30E-01
Eu-152	1.01E+00	1.00E+00	1.00E+00
Eu-154	1.01E+00	1.00E+00	1.00E+00
Eu-155	1.01E+00	1.00E+00	1.00E+00
Fe-55	1.16E+00	4.68E-01	1.16E-01
H-3[1]	NA	NA	NA
Nb-93m	9.44E-01	1.00E+00	1.00E+00
Nb-94	9.44E-01	1.00E+00	1.00E+00
Ni-59	1.00E+00	1.00E+00	1.00E+00
Ni-63	1.00E+00	1.00E+00	1.00E+00
Np-237	1.01E+00	1.00E+00	1.00E+00
Pm-147	1.01E+00	1.00E+00	1.00E+00
Pu-238	1.01E+00	8.32E-02	1.00E+00
Pu-239/240	1.01E+00	8.32E-02	1.00E+00
Pu-241	1.01E+00	8.32E-02	1.00E+00
Sb-125	1.01E+00	1.00E+00	6.31E-01
Sr-90	1.00E+00	2.08E-01	6.44E-01

Radionuclide	75th Percentile Transfer Factor Ratios NUREG/CR-7267 / NUREG/CR-6697		
	Plant	**Meat**	**Milk**
Tc-99	9.000.090E-01	1.00E+00	1.00E+00
Mean	0.97	0.65	0.81
Standard Deviation	0.21	0.43	0.32

1) NUREG/CR-7267 does not provide a PDF for C-14 or H-3

The TFs are positively correlated with dose. The above table indicates that the majority of the 75th percentile TFs in NUREG/CR-7267 are lower than those provided in NUREG.CR-6697. The means of the 75th percentile NUREG/CR-7267 / NUREG/CR-6697 ratios for the three food types, i.e., plant, meat, and milk, are all less than 1.0. The maximum ratio is 1.16 (Fe-55 - plant). A ratio of 1.14 was found for Am-241 in plants. A number of the TF ratios in the plant category are 1.01 - 1.03. This is due to the reporting of an additional significant figure in the NUREG/CR-6697 TFs for PDFs that are otherwise the same for both NUREGs.

A qualitative assessment concludes that the few TF ratios that exceed 1.0 are very unlikely to result in significant differences in the DCGLs reported in the LTP. A revision to the LTP DCGLs does not appear to be justified due to TF differences.