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U.S. NUCLEAR REGULATORY COMMISSION

SAFETY EVALUATION REPORT

BY THE OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS

RELATED TO AMENDMENT NO. 75

TO POSSESSION ONLY LICENSE NO. DPR-45

APPROVAL OF THE LICENSE TERMINATION PLAN

LACROSSE*SOLUTIONS*, LLC

LA CROSSE BOILING WATER REACTOR

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ADAMS	Agencywide Documents Access and Management System
AEC	Atomic Energy Commission
AF	Area Factor
AG	Above Grade
ALARA	As Low as (is) Reasonably Achievable
Am-241	Americium-241
AMCG	Average Member of the Critical Group
AMSL	Above Mean Sea Level
ANL	Argonne National Laboratory
ANSI	American Nation Standards Institute
BcDCGL	Base Case Derived Concentration Guideline Limit
BcSOF	The sum of fractions for each survey unit calculated using the BcDCGL
BFM	Basement Fill Model
Bq	Becquerel
Bq/L	Becquerel per liter
C-14	Carbon-14
CFR	*Code of Federal Regulations*
Ci	Curie
cm	centimeter
cm^2	square centimeter
cm^3	cubic centimeter
Co-60	Cobalt-60
Cs-137	Cesium-137
CVS	Contamination Verification Surveys
D&D	Decontamination and Dismantlement
DCE	Decommissioning Cost Estimate
DCGL	Derived Concentration Guideline Limit
$DCGL_B$	Operational DCGL for basement structural surfaces
$DCGL_{EMC}$	DCGL that represents the same dose to an individual for residual radioactivity in a smaller area within a survey unit, by taking into account the area factor
$DCGL_W$	DCGL for the average residual radioactivity in a survey unit
DECON	A method of decommissioning, in which structures, systems, and components that contain radioactive contamination are removed from a site and safely disposed at a commercially operated low-level waste disposal facility, or decontaminated to a level that permits the site to be released for unrestricted use shortly after it ceases operation
DFS	Decommissioning Funding Status
DP	Decommissioning Plan
DPC	Dairyland Power Cooperative
dpm	disintegrations per minute
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DQA	Data Quality Assessment
DQO	Data Quality Objective
DSAR	Defueled Safety Analysis Report
DSR	Dose to Source Ratio
DTF	Decommissioning Trust Fund
dy	day
EGW	Existing Groundwater
EMC	Elevated Measurement Comparison

EPA	U.S. Environmental Protection Agency
ES	Energy*Solutions*, LLC
Eu-152	Europium-152
Eu-154	Europium-154
FGR	Federal Guidance Report
FOV	Field of View
FR	*Federal Register*
FSAR	Final Safety Analysis Report
FSS	Final Status Survey
ft	foot
ft^2	square foot
g	gram
H-3	tritium
HEPA	High Efficiency Particulate Air Filter
HPGe	High Purity Germanium
hr	hour
HSA	Historical Site Assessment
HTD	Hard to Detect
IC	Insignificant Contributor
in	inch
IR	Incident Report
ISFSI	Independent Spent Fuel Storage Installation
ISGRS	In-Situ Gamma Ray Spectrometry
ISOCS	In-Situ Object Counting System
Kd	distribution coefficient
km	kilometer
LACBWR	La Crosse Boiling Water Reactor
LAR	License Amendment Request
LC	License Condition
LER	Licensee Event Report
L	Liter
L/dy	liters per day
LS	LaCrosse*Solutions*, LLC
LTP	License Termination Plan
m	meter
m^2	square meter
m^3	cubic meter
m^3/hr	cubic meters per hour
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	Maximum Contaminant Level
MDC	Minimum Detectable Concentration
MW	Monitoring Well
NaI	Sodium Iodide
NELAC	National Environmental Laboratory Accreditation Conference
Ni-63	Nickel-63
Np-237	Neptunium-237
MDA	Minimum Detectable Activity
mrem	millirem
mrem/yr	millirem per year
MSL	Mean Sea Level
mSv	milliSievert

mSv/yr	milliSievert per year
NIST	National Institute of Standards and Technology
NRC	U.S. Nuclear Regulatory Commission
NWS	National Weather Service
OB	Other Basement
OBP	Other Buried Pipe
OpDCGL	Operational Derived Concentration Guideline Limit
OpSOF	The sum of fractions for each survey unit calculated using the OpDCGL
ORC	Operational Review Committee
ORISE	Oak Ridge Institute for Science and Education
pCi	picoCurie
pCi/g	picoCurie per gram
pCi/L	picoCurie per Liter
PSDAR	Post-Shutdown Decommissioning Activities Report
Pu-239/240	Plutonium-239 and 240
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
R	Roentgen
RA	Radiological Assessment
RAI	Request for Additional Information
RASS	Remedial Action Support (In-Process) Surveys
Rem	Roentgen equivalent man
REMP	Radioactive Effluent Monitoring Program
RESRAD	The RESRAD family of computer codes is a regulatory tool for evaluating radioactively contaminated sites, specifically designed to help determine the allowable RESidual RADioactivity in site cleanup
RG	Regulatory Guide
ROC	Radionuclide of Concern
SAFSTOR	A method of decommissioning in which a nuclear facility is placed and maintained in a condition that allows the facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use
SER	Safety Evaluation Report
SFP	Spent Fuel Pool
SOF	Sum-of-Fractions
SRC	Safety Review Committee
SRP	Standard Review Plan
Sr-90	Strontium-90
Sv	Sievert
Tc-99	Technetium-99
TEDE	Total Effective Dose Equivalent
TSD	Technical Support Document
USACE	U.S. Army Corps of Engineers
UCL	Upper Confidence Level
UFSAR	Updated Final Safety Analysis Report
WDNR	Wisconsin Department of Natural Resources
WGTV	Waste Gas Tank Vault
WTB	Waste Treatment Building
yr	year
ZNPS	Zion Nuclear Power Station

1.0 INTRODUCTION

On June 27, 2016, LaCrosse*Solutions*, LLC (LS, the licensee)[1] submitted a license termination plan (LTP) and accompanying license amendment request (LAR), "License Amendment Request for the License Termination Plan," for the La Crosse Boiling Water Reactor (LACBWR or the facility) (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16200A095). The LTP was submitted as a supplement to the LACBWR defueled safety analysis report (DSAR), and was accompanied by a proposed license amendment (in the form of a license condition) that establishes the criteria for when changes to the LTP require prior U.S. Nuclear Regulatory Commission (NRC, or the Commission) approval. On December 1, 2016 (ADAMS Accession No. ML16347A025), LS submitted additional information to reflect changes to the LTP made in response to public meetings held to discuss the LTP on September 20, 2016 (ADAMS Accession No. ML16286A049) and October 20, 2016 (ADAMS Accession No. ML16301A031), as well as to incorporate lessons learned from items identified as part of the NRC staff's concurrent review of the License Termination Plan for the Zion Nuclear Power Station (ZNPS) in Zion, Illinois.

On May 31, 2018 (ADAMS Accession No. ML18169A271), the licensee submitted Revision 1 to the LTP (ADAMS Accession No. ML18169A235) with corresponding changes to the LAR that reflect, among other things, changes made in response to requests for additional information (RAIs) that were provided to the licensee in a letter dated August 4, 2017 (ADAMS Accession No. ML17178A252). Finally, on November 15, 2018 (ADAMS Accession No. ML18331A023), the licensee submitted responses to additional RAIs related to groundwater that included a change to the proposed license condition associated with the LTP[2]. The supplements dated December 1, 2016, May 31, 2018, and November 15, 2018, provided additional information that clarified the application, did not expand the scope of the application as originally noticed, and did not change the NRC staff's original proposed no significant hazards consideration determination as published in the *Federal Register* (FR) on August 30, 2016 (81 FR 59663).

The LACBWR LTP provides the details of the plan for characterizing, identifying, and remediating the remaining residual radioactivity at the LACBWR site to a level that will allow the site to be released for unrestricted use. The LACBWR LTP also describes how the licensee will confirm the extent and success of remediation through radiological surveys, provide financial assurance to complete decommissioning, and ensure the environmental impacts of the decommissioning activities are within the scope originally envisioned in the associated environmental documents. Decommissioning activities at the LACBWR site are scheduled to be completed in 2019, with license termination occurring before the end of 2020.

The license amendment request from the licensee proposes to amend Possession Only License No. DPR-45 for LACBWR to reflect approval of the LACBWR LTP. Specifically, the amendment adds License Condition 2.C.(5), which incorporates the approved LACBWR LTP, and associated addendum, and establishes the criteria for determining when changes to the LTP require prior NRC approval. The LTP will become a supplement to LACBWR's other decommissioning documents and will be implemented by the licensee to complete

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1 The terms "LS" and "licensee" are used interchangeably throughout this document.

2 Revision 1 of the LACBWR LTP, as updated by the RAI responses submitted on November 15, 2018, is considered the official LTP for the completion of decommissioning activities at the LACBWR facility and site. A consolidated version of Revision 1 was provided to the NRC for ease of reference on January 10, 2019, and can be located at ADAMS Accession No. ML19011A238. For the purposes of this evaluation, all references to the LACBWR LTP are intended to refer to Revision 1, as updated, unless otherwise noted.

decommissioning activities at the LACBWR site. Once decommissioning is complete, a separate request will be made to the NRC by the licensee to terminate the LACBWR license.

2.0 REGULATORY EVALUATION

2.1 Facility Background

LACBWR was an Atomic Energy Commission (AEC) Demonstration Project Reactor that first went critical in 1967, commenced commercial operation in November 1969, and was capable of producing 50 megawatts of electricity. LACBWR is located on the east bank of the Mississippi River in Vernon County, Wisconsin, about 1 mile south of the Village of Genoa, Wisconsin and approximately 19 miles south of the city of La Crosse, Wisconsin, and is co-located with the Genoa Generating Station (Genoa 3), which is a coal-fired power plant that is still in operation. The Allis-Chalmers Company was the original licensee of LACBWR; the AEC later sold the plant to the Dairyland Power Cooperative (DPC) and granted it Provisional Operating License No. DPR-45 on August 28, 1973 (ADAMS Accession No. ML17080A423).

LACBWR permanently ceased operations on April 30, 1987 (ADAMS Accession No. ML17080A422), and reactor defueling was completed on June 11, 1987 (ADAMS Accession No. ML17080A420). In a letter dated August 4, 1987 (ADAMS Accession No. ML17080A393), the NRC terminated DPC's authority to operate LACBWR under Provisional Operating License No. DPR-45, and granted the licensee a possess-but-not-operate status. By letter dated August 18, 1988 (ADAMS Accession No. ML17080A421), the NRC amended DPC's Provisional Operating License No. DPR-45 to Possession Only License No. DPR-45 to reflect the permanently defueled configuration at LACBWR. Therefore, pursuant to Paragraph (a)(1)(iii) and Paragraph (a)(2) in Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.82, "Termination of license," Possession Only License DPR-45 does not authorize operation of LACBWR or emplacement or retention of fuel into the reactor vessel.

The NRC issued an order to authorize decommissioning of LACBWR and approve the licensee's proposed Decommissioning Plan (DP) on August 7, 1991 (ADAMS Accession No. ML17080A454). Because the NRC approved DPC's DP before August 28, 1996 (the effective date of an NRC final rule concerning reactor decommissioning (61 FR 39278; July 29, 1996)), the DP is considered the Post-Shutdown Decommissioning Activities Report (PSDAR) for LACBWR. The PSDAR public meeting was held on May 13, 1998, and subsequent updates to the LACBWR decommissioning report have combined the DP and PSDAR into the "LACBWR Decommissioning Plan and Post-Shutdown Decommissioning Activities Report" (D-Plan / PSDAR). This document is also considered the Final Safety Analysis Report (FSAR) and DSAR for LACBWR and is updated every 24 months in accordance with Paragraph (e) of 10 CFR 50.71, "Maintenance of records, making of reports." DPC constructed an onsite independent spent fuel storage installation (ISFSI) under its 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste," general license, and completed the movement of all 333 spent nuclear fuel elements to dry cask storage at the ISFSI by September 19, 2012 (ADAMS Accession No. ML12290A027).

By order dated May 20, 2016 (ADAMS Accession No. ML16123A073), the NRC approved the direct transfer of Possession Only License No. DPR-45 for LACBWR from DPC to LS, a wholly-owned subsidiary of Energy*Solutions*, LLC, which was created for the sole purpose of completing the dismantlement and remediation activities at the LACBWR site. The NRC also approved a conforming license amendment, pursuant to 10 CFR 50.80, "Transfer of licenses," and 10 CFR 50.90, "Application for amendment of license, construction permit, or early site permit," to reflect the change. The order was published in the *Federal Register* on June 2, 2016 (81 FR 35383). The transfer assigned DPC's licensed possession, maintenance, and decommissioning authorities for LACBWR to LS in order to implement expedited decommissioning at the LACBWR site. LS commenced decommissioning of the LACBWR site effective June 1, 2016, and will complete all activities necessary to terminate the license and release the LACBWR site for unrestricted use as an industrial site no later than the end of the second quarter of 2019, except for a small area surrounding the ISFSI containing the spent nuclear fuel from LACBWR, until its final disposition. Final license termination survey activities at LACBWR are scheduled to be completed by the end of 2020.

2.2 Regulatory Requirements

In accordance with the requirements of 10 CFR 50.82(a)(9), "[a]ll power reactor licensees must submit an application for termination of license. The application for termination of license must be accompanied or preceded by a license termination plan to be submitted for NRC approval." The licensee has not submitted an application for termination of the license at this time.

Per 10 CFR 50.82(a)(9)(i), the LTP must be a supplement to the updated final safety analysis report (UFSAR), or equivalent. In accordance with 10 CFR 50.82(a)(9)(ii), the LTP must include:

(A) A site characterization;

(B) Identification of remaining dismantlement activities;

(C) Plans for site remediation;

(D) Detailed plans for the final radiation survey;

(E) A description of the end use of the site, if restricted;

(F) An updated site-specific estimate of remaining decommissioning costs;

(G) A supplement to the environmental report, pursuant to § 51.53, "Postconstruction environmental reports," describing any new information or significant environmental change associated with the licensee's proposed termination activities; and

(H) Identification of parts, if any, of the facility or site that were released for use before approval of the license termination plan.

The approval criteria for the LTP are given in 10 CFR 50.82(a)(10), which states:

> If the license termination plan demonstrates that the remainder of decommissioning activities will be performed in accordance with the regulations in this chapter, will not be inimical to the common defense and security or to the health and safety of the public, and will not have a significant effect on the quality of the environment and after notice to interested persons, the Commission shall approve the plan, by license amendment, subject to such conditions and limitations as it deems appropriate and necessary and authorize implementation of the license termination plan.

The licensee also requested a new license condition to allow LS to make certain changes to the approved LACBWR LTP without prior NRC review or approval. The proposed LACBWR License Condition 2.C.(5) would read as follows:

2.C.(5) License Termination Plan (LTP)

LaCrosse*Solutions* shall implement and maintain in effect all provisions of the approved License Termination Plan, Revision 1, as approved in License Amendment No. 75 subject to and as amended by the following stipulations.

LaCrosse*Solutions* may make changes to the LTP without prior approval provided the proposed changes do not meet any of the following criteria:

(A) Require Commission approval pursuant to 10 CFR 50.59[, "Changes, tests and experiments"].

(B) Result in the potential for significant environmental impacts that have not previously been reviewed.

(C) Detract or negate the reasonable assurance that adequate funds will be available for decommissioning.

(D) Decrease a survey unit area classification (i.e., impacted to not impacted; Class 1 to Class 2; Class 2 to Class 3; or Class 1 to Class 3) without providing the NRC a minimum 14 day notification prior to implementing the change in classification.

(E) Increase the derived concentration guideline levels (DCGLs) and related minimum detectable concentrations (MDCs) for both scan and fixed measurement methods. If MDCs are increased (relative to what was approved) the licensee should request NRC approval.

(F) Increase the radioactivity level, relative to the applicable DCGL, at which an investigation occurs.

(G) Change the statistical test applied to a test other than the Sign test or Wilcoxon Rank Sum test.

(H) Increase the probability of making a Type I decision error above the level stated in the LTP.

(I) Change the approach used to demonstrate compliance with the dose criteria (e.g., change from demonstrating compliance using DCGLs to demonstrating compliance using a dose assessment that is based on final concentration data).

(J) Change parameter values or pathway dose conversion used to calculate the dose, such that the resultant dose is lower than in the approved LTP and if a dose assessment is being used to demonstrate compliance with the dose criteria.

3.0 TECHNICAL EVALUATION

3.1 Method of NRC Staff Review

To be approved under 10 CFR 50.82(a)(10), the LTP must demonstrate that "the remainder of decommissioning activities will be performed in accordance with the [Commission's] regulations..., will not be inimical to the common defense and security or to the health and safety of the public, and will not have a significant effect on the quality of the environment." To perform its review of the LACBWR LTP, the NRC staff used the guidance in NUREG-1700, "Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans," Revision 1, dated April 2003 (ADAMS Accession No. ML031270391) and Revision 2, dated April 2018 (ADAMS Accession No. ML18116A124). The licensee also requested an amendment to its license which would add a new license condition (LC) outlining a process making changes the LTP without prior NRC approval after the LTP has received initial NRC approval. In reviewing the LC, the staff used the guidance and model license condition in Appendix 2 of NUREG-1700, Revision 1 and/or Appendix B of NUREG-1700, Revision 2.

The LTP describes LS's decommissioning objective as "to conduct remediation and survey operations such that LACBWR can submit a request to the NRC for unrestricted release of the site (other than the remaining ISFSI licensed facility) in accordance with Subpart E, "Radiological Criteria for License Termination," of 10 CFR Part 20, "Standards for Protection Against Radiation."" The LTP also describes LS's approach for demonstrating compliance with the radiological criteria for unrestricted use. Those criteria are set forth in 10 CFR 20.1402, "Radiological Criteria for unrestricted use," which states:

> A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a [total effective dose equivalent] TEDE to an average member of the critical group that does not exceed 25 [millirem] mrem (0.25 [milliSieverts] mSv) per year [yr], including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). Determination of the levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal.

3.2 Site Characterization

In accordance with the requirements of 10 CFR 50.82(a)(9)(ii)(A) and the guidance of NRC Regulatory Guide (RG) 1.179, "Standard Format and Content of License Termination Plans for Nuclear Power Reactors," Revision 1 (ADAMS Accession No. ML110490419), Chapter 2, "Site Characterization," of the LACBWR LTP, Revision 1, provides a description of the radiological characterization performed by the licensee at the LACBWR site. The purpose of site characterization is to ensure that the LACBWR final status survey (FSS) will be conducted in all areas where contamination existed, remains, or has the potential to exist or remain.

3.2.1 Facility Radiological Status

Licensees conduct site characterization surveys to determine the nature and extent of radioactive contamination in buildings, plant systems and components, site grounds, and surface and groundwater. The major objectives of characterization activities are to: support the planning and conduct of radiological remediation activities; confirm the effectiveness of radiological remediation methods; provide information to develop specifications for FSS; define site and building areas as survey units and assign survey unit classifications; and provide information for dose modeling. The licensee conducted radiological site characterization activities that included a historical site assessment[3] (HSA) (ADAMS Accession No. ML19007A041), scoping surveys, and a characterization survey.

The LACBWR HSA included a review of records maintained to satisfy the requirements of 10 CFR 50.75(g)(1) (requiring the licensee to keep "[r]ecords of spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site"), as well as Operational Review Committee (ORC) meeting minutes, Safety Review Committee (SRC) meeting minutes, Licensee Event Report (LER) summaries, site initiated Incident Reports (IR), operator logs including reactor operator and health physics entries, annual environmental monitoring reports, environmental investigations performed by independent entities, regulatory actions concerning the site, documentation from interviews conducted with retired/separated site personnel, health physics surveys and sampling results associated with identified events, site inspection and surveillance type documents associated with identified events, radiological and environmental survey documents, and quality control (QC) or quality assurance (QA) finding type documents.

Section 2.1.3, "Operational History," of the LACBWR LTP provides a description of the operational history of the facility beginning with initial criticality of the reactor on July 11, 1967, until the unit was permanently shutdown on April 30, 1987, and subsequent decommissioning activities to the present. Spent fuel remained onsite in the spent fuel pool (SFP) until September 2012, when the licensee transferred the fuel to the ISFSI, which is generally licensed by the NRC under 10 CFR 72.210, "General license issued" (issuing a general license for the storage of spent fuel in an ISFSI at power reactor sites to persons authorized to possess or operate reactors under 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," or 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants").

Section 2.1.4, "Incidents," of the LACBWR LTP provides a summary of site incidents based on a review of plant records, with a majority of the events involving radiological spills and chemical spills. Special emphasis was placed on obtaining and reviewing the annual Radioactive Effluent Monitoring Program (REMP) Reports, focusing on gaseous and liquid releases since 1967 and decommissioning activities after the plant shutdown in 1987. An additional release of tritium (H-3) occurred during decommissioning operations in 2017, and was evaluated by the licensee in the supplemental information dated November 15, 2018. This H-3 release is further discussed in Section 3.6.6, "Groundwater Dose Approach," and Section 3.7.8, "Liquid Radiological Spills, Leaks, and Releases," of the SER. As part of the HSA process, the LACBWR facilities and grounds were divided into preliminary survey areas and assigned initial area classifications based on the operational history and the incidents and processes documented for that survey unit. Survey units included Class 1, 2, and 3 structures; Class 1, 2, and 3 open land areas; and non-impacted areas, which were designated in accordance with the guidance provided in NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," Revision 1, dated August 2000 (ADAMS Accession No. ML082470583).

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3 In this context, the term "historical site assessment" concerns the assessment of radiological contamination on the site (essentially, a history of the radioactivity on the site as a result of LACBWR's operation). The historical site assessment does not concern historic properties or cultural resources.

To make the best use of resources for decommissioning, MARSSIM places greater survey efforts on areas that have, or had, the highest potential for contamination. Areas that have no reasonable potential for residual contamination are classified as non-impacted areas. Class 1 areas have, or had prior to remediation, a potential for radioactive contamination (based on site operating history) or known contamination (based on previous radiation surveys) above the DCGL for the average residual radioactivity in a survey unit ($DCGL_W$). Class 2 areas have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the $DCGL_W$. Class 3 areas are not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the $DCGL_W$, based on site operating history and previous radiation surveys.

As part of the Characterization Survey Plan for the La Crosse Boiling Water Reactor, Revision 1 (ADAMS Accession No. ML19007A039), the licensee designed a characterization survey plan consistent with the data quality objectives (DQO) outlined in Appendix D, "The Planning Phase of the Data Life Cycle," of MARSSIM. The LACBWR Characterization Survey Plan incorporated the previous historical operational and radiological information collected and documented in the survey areas from the HSA and previous site characterization efforts. The survey plan specified the number of static measurements and/or samples; determination of static measurement and sample locations, including random and biased survey sample locations; scan coverage; types of measurements and samples, including gamma and beta surface scans, static beta measurements, and volumetric samples; concrete core samples, including judgmental sampling; and material sampling, including a background radiation study, consistent with the DQOs. The selection and use of instrumentation, laboratory requirements, and quality assurance were also specified in accordance with the Quality Assurance Project Plan (QAPP) – LACBWR Site Characterization Project and LACBWR LTP Development, Site Characterization, and Final Radiation Survey Projects (ADAMS Accession Nos. ML19007A033 and ML19007A038).

Energy*Solutions* (ES) Technical Support Document (TSD) RS-TD-313196-001, "Radionuclides of Concern During LACBWR Decommissioning," Revision 5 (ADAMS Accession No. ML19007A040), was prepared to establish the basis for an initial suite of potential radionuclides of concern (ROCs) for the decommissioning of the LACBWR facility and site. Industry guidance was reviewed as well as the analytical results from the sampling of various media from past plant operations. Based on the elimination of some of the potential neutron activation products, noble gases, and radionuclides with a half-life of less than 2 years, an initial suite of potential ROCs for the decommissioning of LACBWR was prepared. The list of potential radionuclides is provided in Table 2-7 of the LACBWR LTP.

In October 2005, DPC performed a limited characterization survey of the LACBWR site prior to placing the unit into a SAFSTOR[4] condition. In preparation for the license transfer to LS and commencement of the DECON[5] stage at LACBWR, the licensee conducted a more detailed radiological site characterization beginning in October 2014. Several background studies were performed at the LACBWR site to assess background for soils, concrete, and asphalt though surface scanning and volumetric sampling and analysis. LS also performed surveys and

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[4] A method of decommissioning in which a nuclear facility is placed and maintained in a condition that allows the facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use.

[5] A method of decommissioning, in which structures, systems, and components that contain radioactive contamination are removed from a site and safely disposed at a commercially operated low-level waste disposal facility, or decontaminated to a level that permits the site to be released for unrestricted use shortly after it ceases operation.

sampling of the various impacted and non-impacted structures, systems, and open land areas, as well as surface and groundwater, and determined the ROCs for each, including analysis for hard to detect (HTD) radionuclides. The results of those characterizations are included in Section 2.3, "Summary of Characterization Survey Results," of the LACBWR LTP.

The LACBWR LTP states that the licensee will continue to characterize the site as decommissioning progresses, making additional areas accessible, collecting additional sampling data as needed, and that the licensee will continue to evaluate data as collected to determine the impact on the radioisotopes present, nuclide fractions, and the classification of structures and environmental media. The LACBWR LTP concludes that the characterization data collected and analyzed to date are of sufficient quantity and quality to provide the basis for the initial classification of survey areas, decontamination and dismantlement (D&D) activities, estimating radioactive waste types and volumes, and for the development of the DCGLs.

3.2.2 Site Characterization Conclusions

The NRC staff reviewed the information in the LACBWR LTP, Revision 1, for the LACBWR facility and site in accordance with Section 2.2, "Site Characterization," of the NUREG-1700, Revision 2, standard review plan (SRP). As described therein, the purposes of the NRC staff's review are (1) to ensure that the site characterization presented in the LTP is complete; and (2) to verify that the licensee obtained the data using sufficiently sensitive instruments and proper quality assurance procedures to obtain reliable data that are relevant to determining whether the site will meet the decommissioning limits if characterization data is used as final survey data. The acceptance criteria for Section 2.2 of the SRP states that the LTP should (1) identify all locations where activities (including spills) could have resulted in contamination; (2) summarize the status of the site; (3) be sufficiently detailed to allow a reader to determine the contamination levels; (4) identify survey instruments and practices; (5) identify background radiation levels; and (6) describe areas and equipment that need further remediation.

The LACBWR LTP, Revision 1, summarizes the original shutdown and current radiological status of the site. The LTP identifies all locations where spills, disposals, operational activities, or other accidents and/or incidents occurred that could have resulted in contamination within and outside the facility. The LTP describes the areas and equipment that need additional remediation, identifies background activity concentrations and radiation exposure readings used during scoping and characterization surveys, and identifies the survey instruments and supporting QA practices used in the site characterization program. The licensee has sufficiently detailed the status of the LACBWR facility and site to allow the NRC staff to determine the extent and range of radiological contamination of the structures and open land areas, as well as surface and groundwater. Therefore, the LACBWR LTP, Revision 1, meets the acceptance criteria as delineated in SRP Section 2.2. Based on this review, the NRC staff determined that the licensee has met the objectives of providing an adequate site characterization as required by 10 CFR 50.82(a)(9)(ii)(A) (requiring the LTP to include "[a] site characterization").

3.3 Remaining Site Dismantlement Activities

In accordance with the requirements of 10 CFR 50.82(a)(9)(ii)(B) and the guidance of RG 1.179, Chapter 3, "Identification of Remaining Site Dismantlement Activities," of the LACBWR LTP, Revision 1, provides a description of the major remaining dismantlement and decontamination activities at the LACBWR site. Those activities will be undertaken pursuant to the current 10 CFR Part 50 license for LACBWR (Possession Only License No. DPR-45), consistent with the LACBWR D-Plan / PSDAR dated March 2014 (ADAMS Accession No. ML18155A396), as updated by LACBWR D-Plan / PSDAR revisions dated June 2016 (ADAMS Accession No. ML16181A117) and May 2018 (ADAMS Accession No. ML18155A396), and do not depend upon approval of the LACBWR LTP to proceed.

3.3.1 Completed and Ongoing D&D Activities

The LACBWR LTP includes a discussion of the remaining D&D tasks; a characterization of the radiological impacts of these remaining decommissioning activities; an estimate of the quantity of radioactive material to be released to unrestricted areas; the proposed control mechanisms to mitigate the recontamination of remediated areas; dose estimates to workers and members of the public; and radioactive waste characterization and projections. The LTP also indicates that the LACBWR decommissioning activities are being coordinated with the applicable Federal, State, and local regulatory agencies, in accordance with plant administrative procedures, and explains how that coordination will occur.

In the LTP, the licensee also describes the areas and equipment that need further remediation in sufficient detail to predict the radiological conditions that will be encountered during remediation. The licensee also states that "decommissioning activities at LACBWR will be conducted in accordance with the requirements of 10 CFR 50.82(a)(6) and (a)(7). At the time of LTP submittal, the remaining activities do not involve any un-reviewed safety questions or changes in the technical specifications for LACBWR. If an activity requires prior NRC approval under 10 CFR 50.59(c)(2), or a change to the technical specifications or license, a submittal will be made to the NRC for review and approval before implementing the activity in question."

As part of the discussion of remaining dismantlement activities, the licensee also discussed the decommissioning activities that have already been completed for the LACBWR facility and site, including the large components that have been shipped offsite for disposal in radiological waste repositories, at landfills, or released for recycling or other disposition. Other completed decommissioning activities include (1) the abatement, packaging and disposal of known and readily accessible lead and/or lead containing material; (2) the abatement, packaging and disposal of known and readily accessible asbestos containing material; (3) the placement of all spent fuel into dry storage in the ISFSI facility and the removal of fuel racks from the SFP; (4) the disconnection of LACBWR from offsite electrical power and placing LACBWR in a "cold and dark" status; and (5) the draining and removal of other miscellaneous system piping. The submission of this information meets the submittal requirements of 10 CFR 50.82(a)(9)(ii)(H).

3.3.2 Remaining Site Dismantlement Conclusions

The NRC staff reviewed the information in the LACBWR LTP, Revision 1, for the LACBWR facility and site in accordance with Section 2.3, "Identification of Remaining Site Dismantlement Activities," of the NUREG-1700, Revision 2, SRP. As described therein, the purposes of the NRC staff's review are to ensure the LTP (1) discusses the remaining tasks associated with D&D, estimates the quantity of radioactive material to be shipped for disposal or processing, describes the proposed control mechanisms to ensure that areas are not re-contaminated, and contains occupational exposure estimates and radioactive waste characterization; (2) describes the remaining dismantlement activities in sufficient detail to identify any associated inspection or technical resources that will be needed; (3) is sufficiently detailed to provide data for use in planning further D&D activities, including decontamination techniques, projected schedules, costs, waste volumes, dose assessments (including groundwater assessments), and health and safety considerations; and (4) lists the remaining activities that do not require any additional licensing action (such as changes to the plant technical specifications).

The LACBWR LTP, Revision 1, summarizes the remaining site dismantlement activities. The LTP includes information regarding those areas and equipment that need further radiological remediation and an estimate of radiological conditions that the licensee may encounter. The LTP includes estimates of associated occupational radiation dose and projected volumes of radioactive waste. The licensee provided an overview and describes the major remaining components of radiologically contaminated plant systems and, as appropriate, a description of specific equipment remediation considerations. The LTP also provides information related to the remaining D&D tasks. This information included an estimate of the quantity of radioactive material to be released in accordance with the licensed material disposal requirement of 10 CFR 20.2001(a)(1), a description of proposed control mechanisms to ensure areas are not re-contaminated, estimates of occupational exposures, and characterization of radiological conditions to be encountered and the types and quantities of radioactive waste.

Therefore, the LACBWR LTP, Revision 1, meets the acceptance criteria as delineated in SRP Section 2.3. Based on this review, the NRC staff determined that the licensee has identified, in sufficient detail, the remaining dismantlement activities necessary to complete decommissioning of the facility, as required by 10 CFR 50.82(a)(9)(ii)(B) (requiring the LTP to include "[i]dentification of remaining dismantlement activities").

3.4 Plans for Radiological Site Remediation

In accordance with the requirements of 10 CFR 50.82(a)(9)(ii)(C) and the guidance of RG 1.179, Chapter 4, "Remediation Plan," of the LACBWR LTP, Revision 1, provides the remediation methods and techniques that the licensee will use to demonstrate that the facility and site areas meet the NRC criteria for license termination in Subpart E of 10 CFR Part 20.

3.4.1 <u>LACBWR Remediation Plans</u>

The LACBWR LTP includes a discussion of the licensee's plans for completing radiological remediation of the site. The licensee plans to remediate the site, including structures and systems that remain on the site, to the criteria of 0.25 mSv/yr (25 mrem/yr) for all pathways, which is the unrestricted use criteria specified in 10 CFR Part 20, Subpart E. The licensee stated that the remaining residual radioactivity must also satisfy the ALARA criterion in 10 CFR 20.1402 (giving the radiological criteria for unrestricted use), which requires an evaluation as to whether it is feasible to further reduce residual radioactivity to levels below those necessary to meet the dose criterion (i.e., to levels that are ALARA). The LACBWR LTP summarizes the changes from the previously approved radiological control program that the licensee will use for the control of radiological contamination associated with the remaining decommissioning and remediation activities, as well as the radiation protection methods and control procedures that will be employed to address the impact of dismantlement and remediation activities. Since the licensee will be remediating the site to the unrestricted release criteria of 10 CFR 20.1402, no submission regarding a restricted end use of the site is required. Therefore, the licensee has complied with the requirement of 10 CFR 50.82(a)(9)(i)(E).

According to the LACBWR LTP, the reactor building and the waste gas tank vault (WGTV) will be demolished and removed to a depth of at least 3 feet below grade, which is equivalent with the 639-foot elevation at the site. All other impacted LACBWR buildings, structures, and components, other than the administration building, crib houses, backup control center, security station, barge wash down area, and transmission sub-station switch house, will be demolished and removed in their entirety. These remaining above grade structures will be subjected to FSS using the acceptable screening values for building surface contamination from Table H.1 of

Appendix H, “Criteria for Conducting Screening Dose Modeling Evaluations,” of NUREG-1757, “Consolidated Decommissioning Guidance,” Volume 2, “Characterization, Survey, and Determination of Radiological Criteria, Final Report,” Revision 1, dated September 2006 (ADAMS Accession No. ML063000252). Section N.1.5 of NUREG-1757, Volume 2, states that “licensees who have remediated surface soil and surfaces to the NRC default screening criteria have remediated soil [and surfaces] such that [they meet] the unrestricted use criteria in 10 CFR 20.1402, or if no residual radioactivity [is] distinguishable from background, [these materials] may be left at the site [and] would not be required to demonstrate that these levels are ALARA.” Therefore, there is no ALARA analysis for above grade structures in the LACBWR LTP.

The LACBWR LTP further states that all impacted systems, components, and structural surfaces above the 636 foot elevation in Class 1 buildings will be removed during the decommissioning process and disposed of as waste. The below grade structural surfaces, or basements that will remain at LACBWR following the termination of the license are solid concrete structures, which will be covered by at least three 3 feet of soil and physically altered to a condition that would not allow the remaining structural surfaces, if excavated, to be realistically occupied. Remediation techniques that may be used for the structural surfaces below the 639 foot elevation (i.e., below grade) include washing, wiping, pressure washing, vacuuming, scabbling, chipping, and sponge or abrasive blasting.

The licensee plans to use an elevated measurement comparison (EMC), as described by MARSSIM Section 2.5.1.1, “Small Areas of Elevated Activity,” to establish a soil $DCGL_{EMC}$ action level, and will remove and dispose of soil contamination above the site specific $DCGL_{EMC}$ as radioactive waste. Soil remediation equipment will include, but not be limited to, shovels, back hoe, and track hoe excavators. Other equipment including soil dredges and vacuum trucks may also be used. As practical, when the remediation depth approaches the soil interface region between unacceptable and acceptable contamination, a squared edge excavator bucket design or similar technique may be used to minimize the mixing of contaminated soils with acceptable lower soil layers as would occur with a toothed excavator bucket. The licensee commits to the use of excavation safety and environmental control procedures to remediate radiologically contaminated soils. The licensee will also augment the excavation safety and environmental control procedures with procedural requirements to ensure the licensee maintains adequate erosion, sediment, and air emission controls during soil remediation.

Section 4.3, “Remediation Activities Impact on the Radiation Protection Program,” of the LACBWR LTP states that the radiation protection program approved for decommissioning is similar to the NRC approved program that was implemented during commercial power operation and the subsequent SAFSTOR period. During these periods, contaminated structures, systems, and components were decontaminated in order to perform maintenance or repair actions. These techniques are the same or similar to the radiological controls implemented at LACBWR during decommissioning to reduce personnel exposure to radiation and contamination and to prevent the spread of contamination from established contaminated areas.

The licensee provided its ALARA analysis process and conclusions for soil and remaining basement structures in Section 4.4, “ALARA Evaluation,” of the LACBWR LTP. The licensee’s formulas for calculating the remediation levels conform to the guidance provided in Appendix N, “ALARA Analyses,” of NUREG-1757, Volume 2, Revision 1, which describes acceptable methods for determining when further reduction of residual radioactivity is required to concentrations below the levels necessary to satisfy the 25 mrem/yr dose criteria. For soil, the licensee concluded that the cost of disposing of excavated soil as low-level radioactive waste is greater than the benefit of removing and disposing of soil with residual radioactivity concentrations less than the dose criterion. For the remaining basement structures in the reactor building and WGTV, the analysis showed that further remediation of concrete beyond that required to demonstrate compliance with the 25 mrem/yr dose criterion is not justified. The NRC staff evaluated the licensee's ALARA analyses for soils and remaining basement structures and concluded that they were acceptable for determining situations when the costs for additional dose reduction below the regulatory release criterion exceed the calculated benefit value, and therefore comply with the ALARA criteria of 10 CFR 20.1402.

3.4.2 Radiological Site Remediation Plan Conclusions

The NRC staff reviewed the information in the LACBWR LTP, Revision 1, for the LACBWR facility and site in accordance with Section 2.4, "Remediation Plans," of the NUREG-1700, Revision 2, SRP. As described therein, the purposes of the NRC staff's review are to ensure the LTP (1) addresses any changes in the radiological controls to be implemented to control radiological contamination associated with the remaining decommissioning and remediation activities; (2) discusses in detail how facility and site areas will be remediated to meet the proposed residual radioactivity levels (DCGLs) for license termination; and (3) includes a schedule that demonstrates how and in what time frame the licensee will complete the interrelated decommissioning activities.

The LACBWR LTP, Revision 1, discusses in detail how the licensee intends to remediate the LACBWR facility and site to meet the proposed residual radioactivity levels (DCGLs) for license termination, including a summary of the removal and remediation tasks planned for surface and subsurface soil and concrete structures at the site, as well as the techniques associated with these tasks. The LTP also includes a summary of the radiation protection methods and control procedures that will be employed during the remaining decommissioning activities. The LTP provides the details of the licensee's ALARA analyses to ensure compliance with the criterion specified in 10 CFR 20.1402. The LTP contains a schedule that demonstrates how the licensee intends to complete the interrelated decommissioning activities.

Therefore, the LACBWR LTP, Revision 1, meets the acceptance criteria as delineated in SRP Section 2.4. Based on this review, the NRC staff determined that the licensee has provided a sufficiently detailed discussion of its radiological site remediation plans for the remaining decommissioning activities, as required by 10 CFR 50.82(a)(9)(ii)(C) (requiring the LTP to include "[p]lans for site remediation").

3.5 Final Radiation Survey Plan

In accordance with the requirements of 10 CFR 50.82 (a)(9)(ii)(D) and the guidance of RG 1.179, Chapter 5, "Remediation Plan," of the LACBWR LTP, Revision 1, provides a description of the methods to be used in planning, designing, conducting, and evaluating the FSS at LACBWR. The FSS plan describes the final survey process that will be used to demonstrate that the LACBWR facility and site comply with the radiological criteria for unrestricted use specified in 10 CFR 20.1402. Additional regulations applicable to FSS are also found in Subpart F, "Surveys and Monitoring," of 10 CFR Part 20 at 10 CFR 20.1501(a) and (b).

3.5.1 Final Status Survey Plan Overview

The final status survey is the radiation survey performed after an area has been fully characterized and remediated and the licensee believes that the area is ready to be released.

The purpose of the final status survey is to demonstrate that the plant and site meet the radiological criteria for license termination in Subpart E of 10 CFR Part 20.

According to the guidance contained in RG 1.179, the licensee should include the following items, which are not meant to be all inclusive, in the final radiation survey plan:

a. Describe the methods proposed for surveying all equipment, systems, structures, and soils, as well as a method for ensuring that sufficient data are included for a meaningful statistical survey.

b. Describe the methods the licensee will use to establish background radiation levels. Include a discussion of variances in background radiation that can be expected (e.g., between structures constructed of different materials).

c. Describe the QA program to support both field survey work and laboratory analysis. Address the QA organization; training and qualification requirements; survey instructions and procedures, including water, air, and soil sampling procedures; document control; control of purchased items; inspections; control of survey equipment; handling, storage, and response checks; shipping of survey equipment and laboratory samples; disposition of nonconformance items; corrective action; QA records; and survey audits, including methods to be used for reviewing, analyzing, and auditing data.

d. Describe the verification surveys and evaluations used to support the delineation of radiologically affected (contaminated) areas and unaffected (uncontaminated) areas.

e. Identify the major radiological contaminants.

f. Discuss methods used for addressing hard-to-detect radionuclides.

g. Describe access control procedures to avoid recontamination of clean areas.

h. Identify survey units having the same area classification.

i. Describe scanning performed to locate small areas of elevated concentrations of residual radioactivity.

j. Discuss levels established for investigating significantly elevated concentrations of residual radioactivity.

k. Describe the reference coordinate system established for the site areas.

The NRC staff compared the information in the LACBWR LTP, Revision 1, for the LACBWR facility and site against the acceptance criteria in Section 2.5, “Final Radiation Survey Plan,” of the NUREG-1700, Revision 2, SRP. As described therein, the purposes of the NRC staff’s review are to ensure the LTP includes (1) the “Information To Be Submitted,” as described in Section 4, “Facility Radiation Surveys,” of NUREG-1757, Volume 2; (2) the following information: identification of the major radiological contaminants, methods used for addressing HTD radionuclides, access control procedures to control recontamination of clean areas, description of the QA program, and methods for surveying embedded and buried piping; and (3) a final survey plan that meets the evaluation criteria defined in Section 4 of NUREG-1757.

Chapter 5 of the LACBWR LTP also notes that in addition to RG 1.179, NUREG-1700, NUREG-1757, Volume 2, and NUREG-1575 (MARSSIM), NUREG-1505, "A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys," Revision 1, dated June 1998 (ADAMS Accession No. ML061870462), and NUREG-1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions," Revision 0, dated June 1998 (ADAMS Accession No. ML003676046), will be used to develop the LACBWR FSS plan.

The licensee generated site-specific, concentration based DCGLs in order to assess compliance with the 25 mrem/yr dose criteria for unrestricted use, as specified in 10 CFR 20.1402. These DCGLs were developed for soils, buried pipe, and basement structures (i.e., basements to be backfilled). As previously noted, the default screening values from NUREG-1757, Volume 2, Appendix H, Table H.1 will be applied to above grade structures that will remain on the LACBWR site at the time of license termination. If applicable, any screening values not addressed in Table H.1 will be based on values derived or taken from Table 5.19 of NUREG/CR-5512, "Residual Radioactive Contamination from Decommissioning," Volume 3, "Parameter Analysis," dated October 1999 (ADAMS Accession No. ML082460902). The concentrations listed in disintegrations per minute per 100 square centimeters (dpm/100 cm^2) in Table 5.19 are equivalent to a dose of 25 mrem/yr.

The scope of the LACBWR FSS plan includes the radiological assessment of all impacted backfilled structures, excavations created as a result of the removal of basement structures, buried piping, open land areas and above grade buildings that will remain following decommissioning. The licensee indicates in the LTP that it is their intention to release for unrestricted use the impacted open land areas, remaining backfilled structures, buried piping and above grade buildings from the 10 CFR Part 50 license, with the exception of the immediate area surrounding the ISFSI. The LACBWR FSS plan does not address non-impacted areas.

The backfilled structures that will remain at license termination and be subjected to FSS include the basements of the reactor building and the WGTV, which will be demolished and removed to a depth of at least 3 feet below grade. The waste treatment building (WTB), piping and ventilation tunnel, reactor / generator plant, the chimney foundation, and the turbine building (including the sump and the turbine pit) will be removed in their entirety. The resultant excavations will undergo FSS. All systems and components (associated with the structures) as well as all structures above the 636-foot elevation (with the exception of the buildings previously noted) will be removed during decommissioning and disposed of as a waste stream.

3.5.2 Radionuclides of Concern and Release Criteria

3.5.2.1 Radionuclides of Concern During Decommissioning

Section 5.1, "Radionuclides of Concern and Mixture Fractions," of the LACBWR LTP discusses the licensee's anticipated radionuclides of concern and mixture fractions to be encountered during decommissioning. A refined suite of ROCs was developed using the results of additional concrete core analyses from the reactor building and the WGTV, as well as surface and subsurface soil samples taken in each impacted open land survey unit (including soil beneath and adjacent to basements). The licensee determined several insignificant dose contributors based upon the guidance contained in Section 3.3, "Insignificant Radionuclides and Exposure Pathways," of NUREG-1757, Volume 2. The suite of dose significant ROCs at LACBWR for use during decommissioning is provided in Table 5-2, "Dose Significant Radionuclides and Mixture," of the LACBWR LTP, and includes Cesium-137 (Cs-137), Strontium-90 (Sr-90), Cobalt-60 (Co-60), Europium-152 (Eu-152), and Europium-154 (Eu-154). A detailed evaluation of the process used to derive the final suite of dose significant ROCs and eliminate insignificant dose contributors from the ROCs, as well as a discussion of the mixture fractions and surrogate ratios, is provided in Section 3.6, "Compliance with Radiological Criteria for License Termination," of this NRC safety evaluation report (SER).

Based on surface and subsurface soil characterization in the impacted area surrounding LACBWR, the licensee has stated that there is minimal residual radioactivity in soil. In addition, minimal contamination is expected in the buried piping that LACBWR plans to leave in place. However, the licensee has committed to characterizing previously inaccessible areas as part of the continuing characterization process as decommissioning progresses. In order to verify that the insignificant contributor (IC) dose[6] does not change prior to implementing the FSS, and to verify the HTD to surrogate radionuclide ratios used for the surrogate calculation are still valid, LS will obtain and analyze concrete core and soil samples during continuing characterization (including radiological assessments) and FSS within each individual survey unit or area.

3.5.2.2 Release Criteria for the LACBWR Facility and Site

Section 5.2, "Release Criteria," of the LACBWR LTP discusses the FSS criteria that will be used to demonstrate compliance with the radiological criteria for unrestricted use, as specified in 10 CFR 20.1402. Before the FSS process can proceed, the Base Case DCGLs that are used to demonstrate compliance with the 25 mrem/yr unrestricted release criterion must be established. The Base Case DCGLs are calculated by analysis of various pathways (direct radiation, inhalation, ingestion, etc.), media (concrete, soils, and groundwater) and scenarios through which exposures could occur. According to the LTP, each radionuclide-specific Base Case DCGL is equivalent to the level of residual radioactivity (above background levels) that could, when considered independently, result in a TEDE of 25 mrem/yr to an average member of the critical group (AMCG). To ensure that the summation of dose from each source term is 25 mrem/yr or less after all FSS is completed, the Base Case DCGLs are reduced based on an expected fraction of the 25 mrem/yr dose limit from each source term. The reduced DCGLs, or Operational DCGLs, can be related to the Base Case DCGLs as an expected fraction of dose based on an a priori assessment of what the expected dose should be based on the results of site characterization, process knowledge, and the extent of planned remediation. The Operational DCGL is then used as the DCGL for the FSS design of the survey unit (calculation of surrogate DCGLs, investigations levels, etc.). Details of the Operational DCGLs derived for each dose component and the basis for the applied a priori dose fractions are provided in ES TSD LC-FS-TSD-002, "Operational Derived Concentration Guideline Levels for Final Status Survey," Revision 2 (ADAMS Accession No. ML19007A037).

Compliance will ultimately be demonstrated through the summation of dose from five distinct source terms for the end-state (basements, soils, buried pipe, above ground structures, and groundwater), as shown in Equation 5-3 of the LACBWR LTP. When applied to backfilled basements below the 636 foot elevation, the DCGLs are expressed in units of activity per unit of area (picocuries per square meter [pCi/m^2]). When applied to soil, the DCGLs are expressed in units of activity per unit of mass (pCi per gram [pCi/g]). For above grade buildings that will remain and buried piping, the DCGLs are calculated and expressed in units of activity per

[6] The NRC staff considers radionuclides and exposure pathways that, in aggregate, contribute no greater than 10 percent of the dose criteria to be insignificant contributors. Therefore, the insignificant contributor dose is the dose associated with radionuclides that are undetected during radiological characterization activities, or present at such a low level that they contribute less than 10 percent of the overall dose criterion (i.e., up to 2.5 mrem of the 25 mrem/yr dose standard) even if assumed to be present at the minimum detectable concentrations.

surface area (dpm/100 cm^2). Operational DCGLs and Base Case DCGLs are provided in Section 5.2 of the LTP for basement surfaces, soils, buried piping, and above grade buildings.

The licensee has defined soils as a layer of soil beginning at the surface but extending to a depth of 1 meter (m) to allow for flexibility in demonstrating compliance if contamination deeper than 0.15m is encountered. Based on characterization data and historical information, the licensee does not expect to encounter a source term geometry that is comprised of a clean surface layer of soil over a contaminated subsurface soil layer. As the licensee plans conduct FSS of structures prior to surveying soils, there is an indication in the LACBWR LTP that once the FSS of structures is complete, the operational DCGLs for soils and buried piping may be revised by incorporating the difference between the assumed fraction of dose for the maximum basement and the actual fraction of dose for the maximum basement as measured by the FSS.

Since multiple ROCs exist at the LACBWR site, a sum-of-fractions (SOF) (unity rule) approach will be utilized for FSS to ensure that the total dose from all ROCs does not exceed the criterion for unrestricted release. The LTP also indicates that the Base Case DCGL, which is established for the average residual radioactivity in a survey unit, is equivalent to a $DCGL_W$ (as typically described in MARSSIM guidance). In that sense, the $DCGL_W$ can be multiplied times an area factor (AF) to obtain a Base Case DCGL that represents a dose of 25 mrem/yr to an individual as a result of a smaller area of contamination within a survey unit. This LTP defines this concept as the $DCGL_{EMC}$, which will only be applied to Class 1 open land soil survey units. The usage of area factors for soil is described in Section 5.2.1, "Soil Area Factors," and Section 6.19, "Soil Area Factors," of the LACBWR LTP. In addition, further discussion on the derivation of the licensee's release criteria using AFs is provided in Section 3.6 of the SER.

Section 5.2.9, "Surrogate Radionuclides," of the LACBWR LTP discusses the process used to develop a ratio between an easy to detect radionuclide and an HTD radionuclide for use in compliance measurements. Section 5.2.9 notes that "assuming gamma measurements are used for the survey, the concentrations of the HTD radionuclide(s) will be based on known ratio(s) of the HTD radionuclide(s) to beta-gamma radionuclide(s) when demonstrating compliance with the release criteria," and "this is accomplished through the application of a surrogate relationship." For FSS surveys, a modified DCGL is required as described in LACBWR LTP Equation 5-1 (per MARSSIM Section 4.3.2, "DCGLs and the Use of Surrogate Measurements"). A modified SOF (unity rule) approach is also required when multiple ROCs exist. The licensee notes in Section 5.2.10, "Sum-of-Fractions," of the LACBWR LTP that the use and application of the unity rule will be in accordance with MARSSIM Section 4.3.3, "Use of DCGLs for Sites with Multiple Radionuclides."

The licensee notes in Section 5.2.9 of the LACBWR LTP that Cs-137, which is a gamma emitter, will be used to detect the HTD radionuclide Sr-90. The licensee intends to infer HTD concentrations for Sr-90 during FSS using the surrogate approach. The licensee established a 95 percent upper confidence level (UCL) of the surrogate ratios for concrete core samples taken in the reactor building, tunnel, WGTV, and WTB during characterization, as presented in Table 5-11, "Final Sr-90 to Cs-137 Surrogate Ratios," of the LACBWR LTP. Section 5.2.9 of the LTP also indicates that the licensee will use the maximum ratios for FSS surrogate calculations unless area specific ratios are determined by continuing characterization. In Section 5.1 of the LACBWR LTP, the licensee indicates that survey unit-specific surrogate ratios, in lieu of the maximum ratios from Section 5.2.9, Table 5-11, may be used for compliance if sufficient radiological data exists to demonstrate that a different ratio is representative for the given survey unit, and that "in these cases, the survey unit-specific radiological data and the derived surrogate ratios will be submitted to the NRC for approval."

3.5.2.3 Radionuclides of Concern and Release Criteria Conclusions

The NRC staff evaluated the licensee's proposed radionuclides of concern and release criteria in accordance with the regulatory guidance and acceptance criteria contained in NUREG-1757, Volume 2, Revision 1, Section 4.1, "Release Criteria," and Section 2.5 of the SRP. Based on the discussion provided in this section of the SER, as well as additional details provided in Section 3.6 of the SER, the NRC staff finds that the ROCs are reasonable and appropriate for the LACBWR site and that the release criteria are adequate to demonstrate compliance with the radiological criteria for unrestricted use in accordance with 10 CFR 20.1402.

3.5.3 <u>Summary of Characterization Survey Methods and Results</u>

3.5.3.1 LACBWR Characterization Survey Methodology

Section 5.3, "Summary of Characterization Survey Results," of the LACBWR LTP provides a discussion of the characterization results as they relate to the LACBWR FSS plan, including assessments of the characterization data to demonstrate the acceptability of the data for use in decommissioning planning, initial area classification, remediation planning, and FSS planning. Since site-specific DCGLs were not established at the time the characterization survey was performed for LACBWR, the licensee used screening DCGLs as presented in NUREG-1757, Volume 2, Appendix H, Table H.2, "Screening Values (pCi/g) of Common Radionuclides for Soil Surface Contamination Levels," and the concentration values found in NUREG/CR-5512, Table 6.91, "Concentration (pCi/g) equivalent to 25 mrem/y for three values of P_{crit}" (P_{crit} = 0.10), as the action levels for impacted soils and open land areas. For impacted structures, a 7,100 dpm/100 cm^2 action level (which is the nuclide specific screening value for total gross beta-gamma surface activity of Co-60 from NUREG-1757, Appendix H, Table H.1) was used.

Section 5.3.3, "Summary of Survey Results," of the LACBWR LTP discusses surveys of impacted and non-impacted media and notes the results of the characterization of these survey units. Characterization of the impacted and non-impacted open land survey units designated in the LACBWR HSA, as well as the building basements that would remain and be subjected to FSS before backfill, was performed from October 2014 to August 2015. During this 11-month period, approximately 11,072 square meters (m^2) of surface soil was scanned, 85 surface soil samples were acquired and analyzed, 126 subsurface soil samples were acquired and analyzed, and 15 concrete core samples were acquired from subsurface basement structures. Additionally, between September 2017 and February 2018, continuing characterization was performed in previously inaccessible areas. An additional 18 concrete core samples were obtained in the reactor building and WGTV basements, and approximately 25 soil samples were obtained from locations beneath and adjacent to structure basements.

Chapter 2 of the LACBWR LTP provides a more extensive discussion of the previous characterization programs along with a discussion of the HSA and contamination history. The characterization survey design is discussed in Section 2.2.2, "Survey Design," of the LTP, and the licensee notes that a graded approach using DQOs was established for the design. The licensee used the MARSSIM DQO process to design each survey unit, and notes that "for example, an open land survey unit was designated as Class 1 because it may contain levels of radiological contamination greater than the unrestricted release criteria," and that "characterization surveys that were performed in a Class 1 survey unit focused on bounding the contamination where contamination was potentially present."

The survey design for areas classified as non-impacted, Class 2, or Class 3 included a combination of systematic and biased survey measurement locations and scan areas. Biased surveys were designed using known information to select locations for static measurements and/or samples, and systematic surveys were designed to select static measurement and/or sample locations at random or by using a systematic sampling design with a random start. The licensee used the DQO process to establish the appropriate design for each survey unit. The licensee notes that “a biased approach was warranted when the characterization effort was designed to delineate the extent of an area that requires remediation,” and “a systematic approach was warranted if the characterization effort was designed to verify the basis for the classification of a survey unit.”

Section 2.2.2.1, “Number of Static Measurements and/or Samples,” of the LTP discusses the licensee’s strategies for determining the number of characterization samples as follows:

- For the characterization of impacted Class 1 and Class 2 open land areas (paved and unpaved) that will be subjected to FSS, the licensee designed the minimum number of random or biased direct measurements and/or samples taken in the survey units to be commensurate with the probability of the presence of residual radioactive contamination in the survey unit.

- For the characterization of Class 1 basement structures that will remain and be subjected to FSS, the licensee designed the sample size based upon the necessary number of samples needed to assess the lateral and vertical extent of the contamination.

- For non-impacted and Class 3 open land survey units, the licensee designated the primary characterization DQO to validate the basis of the classification. Consequently, the licensee stated that the number of systematic static measurements and/or samples was sufficient to ensure with reasonable confidence that only trivial levels of plant generated radionuclides are present in Class 3 areas and no licensee generated radionuclides are present in non-impacted areas.

Section 2.2.2.3, “Scan Coverage,” and Section 5.6.4.4, “Scan Coverage,” of the LACBWR LTP discusses scan coverage and notes that survey units were scanned to the extent practical in accordance with their classification, and that emphasis will be placed on a higher frequency of scans in areas of higher risk. The scan coverage requirements that will be applied for scans performed in support of the FSS of open land and above grade structure survey units are:

- For Class 1 survey units, 100 percent of the accessible soil or structure surface will be scanned.

- For Class 2 survey units, between 10 percent and 100 percent of the accessible soil or structural surface will be scanned, depending upon the potential of contamination. The amount of scan coverage for Class 2 survey units will be proportional to the potential for finding areas of elevated radioactivity or areas close to the release criterion. Accordingly, the site will use the results of individual measurements collected during characterization to correlate this radioactivity potential to scan coverage levels.

- For Class 3 survey units, judgmental (biased) surface scans will typically be performed on areas with the greatest potential of contamination. For open land areas, this will include surface drainage areas and collection points. In the absence of these features the locations of these judgmental scans will at the discretion of the survey designer.

The amount of area to be covered by scan measurements is presented in Table 5-15, "Recommended Survey Coverage for Open Land Areas and Structures," of the LACBWR LTP, which is reproduced from a portion of MARSSIM Table 5.9, "Recommended Survey Coverage for Structures and Land Areas," and is provided as Table 1 of the SER below.

Table 1: Recommended Survey Coverage for Open Land Areas and Structures

Area Classification	Surface Scans	Soil Samples/Static Measurements
Class 1	100 percent	Number of sample / measurement locations for statistical test, additional sample / measurements to investigate areas of elevated activity
Class 2	10 percent to 100 percent, systematic and judgmental	Number of sample / measurement locations for statistical test
Class 3	Judgmental	Number of sample / measurement locations for statistical test

The types of characterization surveys for land areas and building surfaces are discussed in Section 2.2.2.4, "Types of Measurements and Samples," of the LACBWR LTP. These consisted of a combination of surface scans (beta and gamma), static beta measurements, and material samples / smears for building surfaces. For any concrete and/or asphalt-paved open land areas that will remain and be subjected to FSS, a combination of surface scans (beta and gamma), static beta measurements, and volumetric samples were performed. Surveys of open land areas consisted of gamma scans and the sampling of surface and subsurface soil, sediment, and surface water for isotopic analysis. Details on static measurements, beta surface scans, gamma surface scans, removable surface contamination, concrete core sampling, and material sampling were addressed in the subsections of Section 2.2.2.4 of the LTP.

The licensee performed static measurements to detect direct contamination levels on structural surfaces of buildings, or on concrete or asphalt paved areas; these were primarily performed using ~100 cm^2 or larger scintillation or gas-flow proportional detectors. Static measurements were conducted by placing the detector on or very near the surface to be counted and acquiring data over a pre-determined count time. Instrument count times were adjusted as appropriate to achieve an acceptable minimum detectable concentration (MDC) for static measurements.

The licensee performed beta scanning to locate areas of residual activity above the 7,100 dpm/100 cm^2 action level. Beta scans were performed over accessible structural surfaces including: floors, walls, ceilings, roofs, asphalt, and concrete paved areas. Floor monitors using large area gas-flow proportional detectors (typically 584 cm^2) were used to scan the basement floor in the WGTV. Hand-held beta scintillation and/or gas-flow proportional detectors were used for other areas, and the licensee performed beta scanning with the detector position maintained within 1 centimeter (cm) (0.4 inch [in]) of the surface, using a scanning speed of one detector active window per second. If scanning at the specified standoff distance was not possible because of surface conditions, the detection sensitivity for an alternate distance was determined, and the scanning technique adjusted accordingly. Scanning speed was calculated prior to the surveys to ensure that the MDC for scanning was appropriate for the stated objective of the survey. Technicians monitored the audible response of instruments when not affected by ambient noise and flagged areas of elevated contamination for additional investigation or decontamination.

The licensee performed gamma scans over open land surfaces, typically using 2 in by 2 in sodium iodide (NaI) gamma scintillation detectors. The response and scan MDC of the detectors to Co-60 and Cs-137 when used for scanning surface soils was described in ES TSD RS-TD-313196-006, “Ludlum Model 44-10 Detector Sensitivity” (ADAMS Accession No. ML19007A044). The licensee performed gamma scans by moving the detector in a serpentine pattern, while advancing at a rate not to exceed 0.5 m (20 in) per second. The distance between the detector and the surface was maintained within 15 cm (6 in) of the surface if possible. During the scans, technicians monitored both the audible and visual response of the instruments, and used visual response only when ambient noise could not be reduced. Areas of elevated activity were flagged for additional investigation or decontamination

The licensee performed removable beta and/or alpha contamination or smear surveys where applicable to verify that loose surface contamination is less than the action level of 1,000 dpm/100 cm^2. A smear for removable activity was usually taken at each direct measurement location on non-asphalt type surfaces. To accomplish this, the licensee sampled a 100 cm^2 surface area using a circular cloth or paper filter, under moderate pressure. These smears were analyzed for the presence of gross beta and/or gross alpha activity, as appropriate, using a proportional counting system or equivalent.

The licensee utilized concrete core boring and sampling to assess contamination in concrete walls and floors that will remain and be subjected to FSS. A diamond bit core drill was used for concrete sampling, and the sample was typically sliced into ½-inch wide “pucks” to assess contamination at depth. Static measurements were performed on the top and bottom of the pucks to determine contaminant intrusion depth and/or the activation of the concrete matrix. Concrete pucks were also pulverized and analyzed for isotopic content.

The licensee obtained samples of soil, sediment, and sludge from judgmental and systematic sample locations per survey designs, as well as other biased locations of elevated activity identified by scanning. Surface soil was collected using a split spoon sampling system, or by using hand trowels, bucket augers, or other suitable sampling tools, while subsurface soil was sampled by direct push sampling systems (e.g., GeoProbe®) or by use of manual hand augers.

Field instrumentation and sensitivities are discussed in Section 2.2.3, “Instrumentation Selection, Use and Minimum Detectable Concentrations,” and summarized in Section 5.3.2, “Laboratory Instrument Methods and Sensitivities,” of the LACBWR LTP. The licensee stated that in all cases, the field instruments and detectors selected for static measurements and scanning were capable of detecting the initial suite of potential ROCs at an MDC of 50 percent of the applicable action level, and that analytical methods were established to ensure that required MDC values are achieved. The analysis of radiological contaminants used standard approved and generally accepted methodologies or other comparable methodologies.

As part of the RAI response dated May 31, 2018 (ADAMS Accession No. ML18169A278), the licensee stated that LACBWR participates in an independent inter-laboratory comparison program with Eckert Ziegler, utilizing National Institute of Standards and Technology (NIST) traceable standards for gross alpha, gross beta, gamma spectroscopy, and liquid scintillation (H-3). LACBWR utilizes GEL Laboratories as their offsite laboratory. GEL Laboratories is required to maintain a National Environmental Laboratory Accreditation Conference (NELAC) certification. The NRC staff generally finds these types of accredited programs acceptable for laboratory analyses and the associated quality assurance measures.

Instrumentation and nominal MDC values that were employed during characterization activities at LACBWR are listed in Table 2-3, “Instrument Types and Nominal MDCs,” of the LACBWR LTP. Laboratory instrument methods and sensitivities are summarized in Section 5.3.2 and Section 2.2.4, “Laboratory Instrument Methods and Sensitivities,” of the LACBWR LTP. Table 2-4, “Off-Site Laboratory Analytical Methods and Typical MDCs,” of the LACBWR LTP lists typical analytical methods employed and the laboratory MDC achieved by the offsite vendor laboratories used during characterization activities. The licensee also noted in its RAI response that it utilizes 2π geometry for beta measurement instrument calibrations and meets the requirements of the American Nation Standards Institute (ANSI) Report N323A-1997, “Radiation Protection Instrumentation Test And Calibration,” for calibration procedures. The licensee also intends to use a surveyor efficiency of 0.5 for use in efficiency calculations.

3.5.3.2 LACBWR Characterization Survey Results

Section 5.3.3 of the LACBWR LTP discusses the results of the LACBWR site characterization activities. A review of the operating history of the facility, historical incidents, interviews with station personnel and operational radiological surveys was conducted as documented in the LACBWR HSA. Non-impacted areas were determined to not be impacted plant operation based on the location(s) of licensed operations, site use, topography, site discharge pathways, and other site physical characteristics. The non-impacted classification for much of the open land area surrounding the LACBWR site was supported by the Cs-137 results from characterization in the area, which were all within the range of natural background.

The licensee stated that extensive characterization and monitoring have been performed at the LACBWR site. Measurements and samples taken in each area, along with the historical information, provide a clear picture of the residual radioactive materials and its vertical and lateral extent at the site. Using the appropriate DQO, monitoring well water samples, surface soil, sediment, and sub-surface soil have been collected to provide the profile of residual radioactivity at the site. Samples have been analyzed for the applicable radionuclides with detection limits that provide the level of detail necessary for decommissioning planning. Based upon the volume of characterization data collected and an assessment of the characterization results, the licensee considers the characterization survey data adequate to demonstrate that it is unlikely that significant quantities of residual radioactivity have gone undetected.

3.5.3.3 Continuing Characterization Activities

The need for additional ongoing characterization has been identified as decommissioning activities progress at the LACBWR site. Section 5.1 of the LACBWR LTP notes that the characterization surveys of several inaccessible or not readily accessible subsurface soils or structural surfaces have been deferred until safe access is available. Additional details for the deferred areas were provided in Section 2.4, “Continuing Characterization,” and 5.3.3.4, “Inaccessible or Not Readily Accessible Areas,” of the LACBWR LTP. The licensee states that areas where characterization surveys were deferred will be surveyed in accordance with the LACBWR Characterization Survey Plan as they become accessible, or in some instances the areas will be incorporated into the FSS plan (such as soil beneath or adjacent to the WTB). In other areas (e.g., soil beneath slab-on-grade structures after the slab is removed), continuing characterization will be performed in accordance with ES Procedure LC-FS-PR-003, “Radiological Assessments and Remedial Action Support Surveys” (ADAMS Accession

No. ML19007A035), using the same processes, quality, instruments, plans, and procedures as described in Section 2.2, "Characterization Approach," of Chapter 2 of the LACBWR LTP.

Section 5.3.3.4 of the LACBWR LTP defines areas for deferred surveys of soils under structures, soils under concrete or asphalt covers, inaccessible concrete surfaces, and interiors of buried piping, including the WGTV interior structural surfaces, underlying concrete in the reactor building basement after liner removal, soil under the turbine building, and soil adjacent to and beneath basement structures. In the May 31, 2018, RAI response, the licensee stated that the only piping to be grouted at the LACBWR site is the Class 2 circulating water discharge pipe. The grouting is for structural integrity and not for contamination control. There is no dose subtraction or reduction credit taken in dose modeling or DCGL development.

The licensee has also committed to obtain and analyze concrete core and soil samples during continuing characterization (including radiological assessments) and FSS in order to verify that the dose from ICs does not change prior to FSS and to verify that surrogate ratios used for HTD radionuclide calculations are still valid. Section 5.1 of the LACBWR LTP describes the process that will be utilized to sample for HTDs during continuing characterization. This includes analyzing for HTDs in at least 10 percent of all media samples collected in a survey unit during continuing characterization; additionally, a minimum of one sample beyond the 10 percent will be selected at random and also analyzed for HTDs. The HTD analyses performed during continuing characterization will be for the full suite of radionuclides, as shown in Table 5-1, "Initial Suite of Radionuclides," of the LACBWR LTP.

The IC contribution will also be assessed for each individual sample result using the DCGLs from ES TSD RS-TD-313196-004, "LACBWR Soil DCGL, Basement Concrete DCGL, and Buried Pipe DCGL," Revision 4 (ADAMS Accession No. ML19007A042), from Table 4, "LACBWR Soil DCGLs Initial Suite of Radionuclides," for soils and Table 35, "Summed Basement DCGL ($DCGL_B$) for Initial Suite Radionuclides," for basement structures. The LTP notes that "if the IC dose calculated is less than the IC dose assigned for DCGL adjustment, then no further action will be taken," and that "if the actual IC dose calculated from the sample result is greater than the IC dose assigned for DCGL adjustment, then a minimum of five (5) additional investigation samples will be taken around the original sample location." The actual calculated maximum IC dose from an individual investigation sample would then be used to readjust the DCGLs in the respective survey unit, and if the maximum IC dose exceeds 10 percent, the additional radionuclides that were the cause of the IC dose exceeding 10 percent will be added as ROCs for that survey unit.

The licensee has additionally indicated in Section 5.1 of the LACBWR LTP that radiological assessment (RA) surveys will be performed in currently inaccessible soil areas that are exposed after removal of asphalt or concrete roadways and parking lots, rail lines, or building foundation pads (slab-on-grade). Section 5.4.1, "Radiological Assessment," of the LACBWR LTP indicates that radiological assessments of soil areas will rely principally on direct and scan radiation measurements using gamma sensitive instrumentation, as described in Table 5-18, "Typical FSS Survey Instrumentation," of the LTP, and samples will also be collected from potentially impacted soil, sediment and/or surface residues for laboratory analysis. In that case, the licensee commits in Section 5.1 of the LACBWR LTP to analyze 10 percent of any soil samples collected during the radiological assessment of a survey area (with a minimum of one sample) for the full initial suite of radionuclides. It is additionally noted in Section 5.1 that if levels of residual radioactivity in an individual soil sample exceed the SOF of 0.1 (using the Operational DCGL) then the sample(s) will be analyzed for the full initial suite of radionuclides.

3.5.3.4 Characterization Survey Methods and Results Conclusions

The NRC staff evaluated the licensee's characterization survey methods and results in accordance with the regulatory guidance and acceptance criteria contained in NUREG-1757, Volume 2, Revision 1, Section 4.2, "Scoping and Characterization Surveys," and Section 2.5 of the SRP. The NRC staff evaluated the completed characterization activities at the time the LACBWR LTP, Revision 1, was submitted. The NRC staff also acknowledges that certain areas of the site were inaccessible or not readily able to be characterized prior to remediation, or at the time of the LACBWR LTP submittal. In these cases, the licensee has proposed plans for continuing characterization, which were evaluated by the NRC staff.

Based on the discussion provided in this section of the SER, the NRC staff finds that the completed radiological characterization of the LACBWR site, as well as the proposed continuing characterization plans, are adequate to (1) permit planning for remediation activities that will be effective and will not endanger the remediation workers; (2) demonstrate that it is unlikely that significant quantities of residual radioactivity have gone undetected; and (3) provide information that will be used to design the final status survey for LACBWR. As such, the NRC staff finds that the licensee's site characterization methods are adequate to demonstrate compliance with 10 CFR 50.82(a)(9)(ii)(A) and 10 CFR 20.1501(a) and (b).

3.5.4 Decommissioning Support Surveys

3.5.4.1 Remedial Action Support, Contamination Verification, and Post-Demolition Surveys

Section 5.4, "Decommissioning Support Surveys," of the LACBWR LTP discusses decommissioning support surveys at LACBWR, including radiological assessment surveys (which were discussed in Section 3.5.3.3, "Continuing Characterization Activities," of the SER), remedial action support (in-process) surveys (RASS), contamination verification surveys (CVS), and post-demolition surveys. According to the LACBWR LTP, RASS will be conducted to guide remediation activities, determine when an area or survey unit has been adequately prepared for FSS, and provide updated estimates of the parameters (e.g., variability) to be used for planning the FSS. In a similar fashion to RA surveys, RASS will rely principally on direct and scan radiation measurements using gamma sensitive instrumentation (as described in Table 5-18 of the LACBWR LTP), and samples will also be collected from potentially impacted soil, sediment, and/or surface residues for laboratory analysis.

The licensee states that RASS of structural surfaces and systems that undergo remediation will be performed using surface contamination monitors, augmented with sampling for removable surface contamination. RASS surveys may also be performed using the in situ object counting system (ISOCS), especially where personnel safety is of concern. Examples include: overhead ceilings, upper walls, and cavity locations where the use of scaffolding and areal lifts is impractical. The NRC staff evaluated the use of ISOCS measurements to meet the guidance in the SRP and the interpretation of statistical tests results guidance in MARSSIM Section 5.5, "Final Status Surveys." The licensee submitted ES TSD LC-FS-TSD-001, "Use of ISOCS for FSS of End State Sub Structures at LACBWR" (ADAMS Accession No. ML19007A036), Table 2, "Comparison of the Circular Plane Model Cs-137 MDC to Sub Structure DCGLs," to demonstrate adequate ISOCS sensitivity when compared to the Cs-137 DCGL. The NRC staff determined that ISOCS measurements will be sufficient to meet the 100 percent Class 1 area scan requirement without relying on conventional measurement methods for inaccessible areas. In addition, the NRC staff reviewed licensee drawings that show ISOCS measurement locations and confirmed that there will be overlapping fields of view (FOVs).

Additional instrumentation and field screening methods for RASS are provided in Section 5.4.3, “Instrumentation for RA and RASS,” and Section 5.4.4, “Field Screening Methods for RASS During the Excavation of Soils,” of the LACBWR LTP. In these sections the licensee states that the analytical capability for soil sample analysis will supplement field scanning techniques to provide radionuclide-specific quantification, achieve lower MDCs, and provide timely analytical results. The on-site laboratory will include a gamma spectroscopy system calibrated for various sample geometries. The system will be calibrated using mixed gamma standards traceable to NIST standards and intrinsic calibration routines. Count times will be established such that the DQOs for MDC will be achieved. Gas proportional counting and liquid scintillation analysis will be performed by an approved vendor laboratory in accordance with approved laboratory procedures. The quality programs of any contracted off-site vendor laboratory that is used for the receipt, preparation, and analysis of RA and RASS samples will be confirmed to ensure the same level of quality as the on-site laboratory under the LACBWR QAPP.

In addition, the information obtained during the RA and RASS (scan results and the analytical data from any associated soil samples) will be used to determine if the remaining exposed soils:

- contain radioactivity concentrations above the applicable Operational DCGLs and require further excavation;
- contain radioactivity concentrations that are less than the Operational DCGLs but require removal in order to access additional soil / debris that potentially contains radioactivity concentrations above the applicable DCGL; or,
- contain radioactivity concentrations that are less than the Operational DCGLs, and not requiring removal.

The licensee further states that if the survey instrument scan MDC is less than the Operational DCGLs, then scanning will be the primary method for guiding the remediation. When the scan surveys, as well as the laboratory data obtained from any biased soil samples that may have been collected, indicate residual concentrations are less than the Operational DCGLs, the area will be considered suitable for FSS. If the scan MDC is greater than the Operational DCGLs, the gamma walk-over survey will still be used to initially guide remediation; however, as the levels are reduced to the range of the Operational DCGLs an additional number of biased soil samples will be taken to ensure that the area can be released as suitable for FSS.

Section 5.4.5, “Contamination Verification Surveys of Basement Structural Surfaces,” of the LACBWR LTP describes CVS of basement structural surfaces, which will be performed to identify areas requiring remediation to meet the open air demolition limits presented in ES TSD RS-TD-313196-005, “La Crosse Open Air Demolitions Limits” (ADAMS Accession No. ML19007A043). A CVS will be performed within any structure that contains, or previously contained, radiological controlled areas. These surveys will be performed using hand-held beta-gamma instrumentation as presented in Table 5-18 of the LACBWR LTP. The licensee will determine scan coverage based on the contamination potential of the structural surface being surveyed, and Class 1 survey units will require 100 percent scan coverage of all accessible surface area. The LACBWR LTP indicates that any areas identified in excess of the open air demolition limits will be earmarked for remediation. For structural surfaces below the 636-foot elevation (which will remain and be subjected to FSS), the licensee also commits to remediate areas to ensure that any individual ISOCS measurement will not exceed the Operational DCGLs, and to identify any area of elevated activity that could potentially approach the Operational DCGLs as a location for a judgmental ISOCS measurement during FSS.

Post-demolition surveys are described in Section 5.4.6, “Post-Demolition Survey,” of the LACBWR LTP as additional scan surveys that will be performed (following demolition) to ensure that any individual ISOCS measurement will not exceed the Operational DCGLs from Table 5-4, “Operational DCGLs for Basements,” of the LACBWR LTP during FSS. These will be performed using hand-held beta-gamma instrumentation as presented in Table 5-18 of the LTP.

3.5.4.2 Decommissioning Support Surveys Conclusions

The NRC staff evaluated the licensee’s decommissioning support survey methods in accordance with the regulatory guidance and acceptance criteria contained in NUREG-1757, Volume 2, Revision 1, Section 4.3, “Remedial Action Support Surveys,” and Section 2.5 of the SRP. Based on the discussion provided in this section of the SER, the NRC staff finds that the plans for decommissioning support surveys are consistent with the NRC’s guidance on remedial action support surveys, and that the plans are adequate to assist the licensee in determining when remedial actions have been successful and the FSS may commence. As such, the NRC staff finds that the licensee’s decommissioning support survey methods are adequate to demonstrate compliance with 10 CFR 50.82(a)(9)(ii)(D) and 10 CFR 20.1501(a) and (b).

3.5.5 Final Status Survey of Basement Structures

3.5.5.1 Basement FSS Design and Methodology

Section 5.5, “Final Status Surveys of Basement Structures,” of the LACBWR LTP discusses the process for conducting a final status survey on remediated basement structures to demonstrate that all floor and wall concrete surfaces are below the DCGL and all residual radioactivity is below the criteria for unrestricted use. After the licensee has remediated basement structures to ensure that the remaining floor and wall concrete surfaces are below the Operational DCGL for basements ($DCGL_B$), as measured by ISOCS, an FSS will be completed to demonstrate compliance with the 25 mrem/yr dose criteria for unrestricted release (per 10 CFR 20.1402).

Section 5.5.1, “Instruments Selected for Performing FSS of Basement Structures,” of the LACBWR LTP indicates that the Canberra ISOCS will primarily be used to perform FSS of basement surfaces, as “direct beta measurements taken on the concrete surface will not provide the data necessary to determine the residual radioactivity at depth in concrete and therefore, would have to be augmented with core sampling.” However, the licensee has committed to performing additional concrete core samples during additional characterization and during FSS, as discussed in Sections 5.1 of the LACBWR LTP. With regard to FSS, it is noted in Section 5.1 of the LACBWR LTP that “the number of cores collected and analyzed for ROC HTD will be ten percent (10%) of the FSS ISOCS measurements.”

According to Section 5.5.2, “Basement Structure FSS Units,” of the LACBWR LTP, the basement surface FSS units will be comprised of the combined wall and floor surfaces of each remaining building basement, which includes the reactor building and WGTV. Contamination potential is the prime consideration for grouping these FSS units; however, based on the results of concrete core sample analysis, the basements of the reactor building and WGTV were identified as being unique FSS units. Characterization data, radiological surveys performed to support commodity removal, and surveys performed to support structural remediation for open-air demolition will continue to be used to verify that the contamination potential within each FSS unit is reasonably uniform throughout all walls and floor surfaces.

FSS classification for basement surfaces is discussed in Section 5.5.2.1, “Classification and Areal Coverage for FSS of Basement Structures,” of the LACBWR LTP, where it is noted that the “the primary consideration for determining FSS classification and areal coverage in basement surfaces is the potential for an individual ISOCS measurement in a FSS unit to exceed the operational,” which will be “evaluated by the potential for an individual ISOCS measurement to exceed the Operational $DCGL_B$.” The licensee also commits in Section 5.5.2.1 of the LACBWR LTP that “the continuing characterization plans will be provided to the NRC for information and reports provided for evaluation.”

ISOCS areal coverage determination for basement surfaces is discussed in Section 5.5.2.1 of the LTP, where it is noted that the reactor building and WGTV basement FSS units are designated as Class 1 and the FSS areal coverage will be 100 percent. The licensee also refers to MARSSIM Table 5.9, which discusses recommended survey coverage for structures and land areas, in determining the ISOCS area coverage. As such, the ISOCS areal surveys will be used by the licensee in place of scanning surveys recommended by MARSSIM.

3.5.5.2 Survey Coverage for the LACBWR Basement Structures

The determination of FSS sample sizes is discussed in Section 5.5.2.2, “Sample Size Determination for FSS of Basement Structures,” of the LACBWR LTP. The licensee calculated minimum sample sizes for the Class 1 reactor building and WGTV basement survey areas based upon the quotient of the required areal coverage surface area divided by the ISOCS FOV (which will be 28 m^2 for the LACBWR basement structures). The results of this calculation are summarized in Table 5-13, “Number of ISOCS Measurements per FSS Unit Based on Areal Coverage,” of the LACBWR LTP, which presents the basement FSS units, the classification based on contamination potential, the surface area to be surveyed, and the minimum number of ISOCS measurements that will be required. According to Table 5-13, 19 ISOCS measurements are required for the reactor building basement (which has an area of 512 m^2) and 11 ISOCS measurements are required for the WGTV basement (which has an area of 311 m^2).

Additionally, although a sufficient number of ISOCS measurements will be obtained in the two Class 1 basement survey units to meet the 100 percent scan requirement, the number of ISOCS samples was further adjusted to ensure that the circular ISOCS FOVs overlap in order to confirm that there are no un-surveyed corners and gaps. Table 5-14, “Adjusted Minimum Number of ISOCS Measurements per FSS Unit,” of the LACBWR LTP presents the adjusted minimum number of ISOCS measurements in each of the basement FSS units to account for overlap of the ISOCS FOV. According to Table 5-14, 43 ISOCS measurements are required for the reactor building basement, and 22 ISOCS measurements are required for the WGTV basement to ensure full scan coverage an overlap of the ISOCS FOV.

Section 5.5.3, “Survey Approach for FSS of Basement Structures,” of the LACBWR LTP discusses the planning, design, implementation, and assessment processes that will be used for FSS of the basement structures at LACBWR. The licensee notes that this approach is the same as that specified for FSS in MARSSIM, and that if, during the course of performing an FSS, measurement results are encountered that are not as expected for the surface undergoing survey, an investigation will be performed to determine the cause of the discrepancy. Investigations will also be performed if the SOF for an individual measurement exceeds one.

3.5.5.3 Data Assessment and Analysis for the Basement Structures

A discussion on data assessment for basement surface FSS results is provided in Section 5.5.4, "Basement Structure FSS Data Assessment," of the LACBWR LTP. The licensee plans to utilize an SOF approach for each measurement by dividing the reported concentration of each ROC by the Operational $DCGL_B$ for each ROC, in order to calculate an individual ROC fraction. The SOF for gamma-emitting ROCs will be based on the measured activity (along with any other gamma emitting radionuclides positively detected by the ISOCS), and the SOF for HTD ROCs will be inferred utilizing the surrogate approach from Section 5.2.9 of the LACBWR LTP. Background will not be subtracted from any measurement. All individual ROC fractions will be summed to provide a total SOF value for each measurement.

Section 5.5.4 of the LACBWR LTP notes that the Sign Test will be used to evaluate the remaining residual radioactivity in each Class 1 survey area against the compliance dose criterion of 25 mrem/yr, and the SOF for each measurement will be used as the sum value for the Sign Test. The licensee further notes that "if the Sign Test demonstrates that the mean activity for each ROC is less than the Operational $DCGL_B$ at a Type 1 decision error of 0.05, then the mean of all the total SOFs for each measurement in a given survey unit is calculated," and that "if the Sign Test fails, or if the mean of the total SOFs in a basement exceeds one (using Operational DCGLs), then the survey unit will fail FSS."

Methods for evaluating elevated areas of activity in basements are also described in Section 5.5.4 of the LACBWR LTP. For building surfaces, the licensee defines areas of elevated activity as "any area identified by measurement / sample (systematic or judgmental) that exceeds the Operational DCGL but is less than the Base Case DCGL," and indicates that "any area that exceeds the Base Case DCGL will be remediated." Section 5.5.4 of the LACBWR LTP also notes that the "SOF (based on the Operational DCGL) for a systematic or a judgmental measurement / sample(s) may exceed one without remediation as long as the survey unit passes the Sign Test and, the mean SOF (based on the Operational DCGL) for the survey unit does not exceed one." If the Sign Test is passed, the mean radionuclide activity (in pCi/m^2) for each ROC from systematic measurements, along with any identified elevated areas from systematic and judgmental measurements, will be used with the Base Case DCGLs to perform the following equation (Equation 5-5 of the LACBWR LTP) and assess the SOF for basement structural surface survey units:

Equation 1: Sum of Fractions Calculation for Basement Structures

$$SOF_B = \sum_{i=1}^{n} \frac{Mean\ Conc_{B_{ROC_i}}}{Base\ Case\ DCGL_{B_{ROC_i}}} + \frac{\left(Elev\ Conc_{B_{ROC_i}} - Mean\ Conc_{B_{ROC_i}}\right)}{\left[Base\ Case\ DCGL_{B_{ROC_i}} \times \left(\frac{SA_{SU}}{SA_{Elev}}\right)\right]}$$

where:

SOF_B	=	SOF for structural surface survey unit within a basement using Base Case DCGLs
$Mean\ Conc_{B\ ROC_i}$	=	Mean concentration for the systematic measurements taken during the FSS of structural surface in survey unit for each ROC_i
$Base\ Case\ DCGL_{B\ ROC_i}$	=	Base case DCGL for structural surfaces ($DCGL_B$) for each ROC_i

Elev Conc$_{B\ ROCi}$	=	Concentration for ROC_i in any identified elevated area (systematic or judgmental)
SA_{Elev}	=	Surface area of the elevated area
SA_{SU}	=	Adjusted surface area of FSS unit for DCGL calculation

The SOF_B will then be multiplied by 25 mrem/yr in order to assign the dose from residual radioactivity to the FSS unit(s) for basement structures.

3.5.5.4 Final Status Survey of Basement Structures Conclusions

The NRC staff evaluated the licensee's final status survey methods for the basement structures at LACBWR in accordance with the regulatory guidance and acceptance criteria contained in NUREG-1757, Volume 2, Revision 1, Section 4.4, "Final Status Survey Design," and Section 2.5 of the SRP. Based on the discussion provided in this section of the SER, the NRC staff finds that the plans for conducting FSS of the reactor building and WGTV basement structures at LACBWR are consistent with the NRC's guidance and requirements, and that the plans are adequate to assist the licensee in determining when the FSS has been implemented. As such, the NRC staff finds that the licensee's FSS methods for the basement structures are adequate to demonstrate compliance with 10 CFR 50.82(a)(9)(ii)(D), 10 CFR 20.1501(a) and (b), and the radiological criteria for unrestricted use in accordance with 10 CFR 20.1402.

3.5.6 Final Status Survey Design

3.5.6.1 FSS Planning and Design

Section 5.6, "Final Status Survey Design," of the LACBWR LTP presents the LACBWR FSS design, where it is noted that the design discussion "pertains to open land survey units, above grade structures, and buried pipe," and includes sample plans that when implemented, demonstrate compliance with the dose-based unrestricted release criterion of 10 CFR 20.1402.

Survey planning is discussed in Section 5.6.1, "Survey Planning," of the LACBWR LTP, and the licensee indicates that the primary objectives of the FSS are to: verify survey unit classification, demonstrate that the potential dose from residual radioactivity is below the release criterion for each survey unit, and demonstrate that the potential dose from small areas of elevated radioactivity is below the release criterion for each survey unit. The LACBWR LTP also notes that the FSS process will include the following four principal elements: planning, design, implementation, and data assessment. The usage of the DQO and Data Quality Assessment (DQA) processes is additionally described in the LTP, including the establishment of ROCs, classification of survey units, turnover and control measures, survey implementation, use of QA measures, and the creation of survey packages. The licensee commits to utilizing the DQO process from MARSSIM Appendix D, which includes the following actions: state the problem, identify the decision, identify inputs to the decision, define the study boundaries, develop a decision rule, specify limits on decision errors, and optimize the design for obtaining data.

The licensee discusses the FSS design process in Section 5.6.4, "Final Status Survey Design Process," of the LACBWR LTP, and indicates that the concepts on sampling size determination and scanning coverage will be implemented as described in MARSSIM and NUREG-1757. The LACBWR LTP notes that decisions regarding whether a given survey unit meets the applicable release criterion are made based on the results of statistical tests. Scanning measurements are used to confirm the design basis for the survey by evaluating if any small areas of elevated radioactivity exist that would require reclassification, tighter grid spacing for the total surface contamination measurements, or both. In accordance with MARSSIM, the level of survey effort required for a given survey unit is determined by the potential for contamination as indicated by its classification. Class 3 survey units receive judgmental (biased) scanning and randomly located measurements or samples. Class 2 survey units receive scanning over a portion of the survey unit based on the potential for contamination, combined with total surface contamination measurements or sampling performed on a systematic grid. Class 1 survey units receive scanning over 100 percent of the survey unit combined with total surface contamination measurements or sampling performed on a systematic grid.

3.5.6.2 Statistical Considerations for FSS

In Section 5.6.4.1, “Sample Size Determination,” of the LACBWR LTP, the licensee discusses the use of MARSSIM and Appendix A, “Implementing the MARSSIM Approach for Conducting Final Radiological Surveys,” of NUREG-1757, Volume 2, to determine the number of sampling and measurement locations (sample size) necessary to ensure an adequate set of data that are sufficient for statistical analysis such that there is reasonable assurance that the survey unit will pass the requirements for release. The number of sampling and measurement locations is dependent upon the anticipated statistical variation of the final data set such as the standard deviation, the decision errors, and a function of the gray region, as well as the statistical tests to be applied. Decision errors are addressed in Section, 5.6.4.1.1, “Decision Errors,” of the LACBWR LTP, and the licensee commits to setting the Type I (release of a survey unit containing residual radioactivity above the release criterion, or false negative) and Type II (failure to release a survey unit when the residual radioactivity is below the release criterion, or false positive) decision errors as follows:

- the α value (probability of making a Type I error) will always be set at 0.05 (5 percent) unless prior NRC approval is granted for using a less restrictive value; and

- the β value (probability of making a Type II error) will also be initially set at 0.05 (5 percent), but may be modified, as necessary, after weighing the resulting change in the number of required sampling and measurement locations against the risk of unnecessarily investigating and/or remediating survey units that are truly below the established release criterion.

The licensee notes in Section 5.6.4.1.3, “Gray Region,” and Section 5.6.4.1.6, “Relative Shift,” of the LACBWR LTP that the gray region and relative shift calculations will utilize Operational DCGLs in planning the number of required FSS measurements. Section 5.6.4.2, “Statistical Test,” of the LACBWR LTP discusses statistical tests to evaluate FSS results, and the licensee indicates that “the Sign Test will be implemented using the unity rule, surrogate methodologies, or combinations thereof as described in MARSSIM” and Chapter 11, “Multiple Radionuclides,” and Chapter 12, “Multiple Surfaces,” of NUREG-1505.” The licensee also states that “the Sign Test will be applied when demonstrating compliance with the unrestricted release criteria without subtracting background.”

3.5.6.3 Areas of Elevated Activity and Scan Coverage

Small areas of elevated activity are discussed in Section 5.6.4.3, “Small Areas of Elevated Activity,” of the LACBWR LTP, and investigation levels are presented as a comparison to the $DCGL_{EMC}$ (a DCGL modified by an area factor to account for small areas of elevated activity). The licensee notes that “at LACBWR, the consideration of small areas of elevated radioactivity will only be applied to Class 1 open land (soil) survey units as Class 2 and Class 3 survey units should not have contamination in excess of the $DCGL_W$," and that "for basement structures, any residual radioactivity identified by an FSS measurement at concentrations in excess of the respective Base Case DCGL will be remediated." Section 5.6.4.3 of the LACBWR LTP proceeds to discuss the fact that statistical sampling sizes and measurement locations may need to be adjusted to ensure that FSS scan surveys are able to adequately detect the $DCGL_{EMC}$, and the licensee commits to using methods from MARSSIM Section 5.5.2.4, "Determining Data Points for Small Areas of Elevated Activity," for that purpose.

FSS scan coverage is discussed in Section 5.6.4.4, "Scan Coverage," of the LACBWR LTP, which states that the purpose of scan measurements is to confirm that the area was properly classified and that any small areas of elevated radioactivity are within acceptable levels (i.e., are less than the applicable $DCGL_{EMC}$). Depending on the sensitivity of the scanning method used, the number of total surface contamination measurement locations may need to be increased so the spacing between measurements is reduced. The licensee indicates that MARSSIM Table 5.9 was utilized to determine the recommended survey coverage, and the amount of area to be covered by scan measurements is provided in Table 5-15 of the LACBWR LTP. FSS scan coverage for open land areas and structures is also discussed in more detail in Section 3.5.3.1, "LACBWR Characterization Survey Methodology," of the SER.

3.5.6.4 FSS Preparation, Investigation Process, and Reclassification Activities

The licensee indicates in Section 5.6.4.5, "Reference Grid, Sampling, and Measurement Locations," of the LACBWR LTP that reference grids and systematic sampling and measurement locations will be developed in accordance with MARSSIM Section 4.8.5, "Reference Coordinate System," and Section 5.5.2.5, "Determining Survey Locations," and provides the methods which will be used to determine sampling locations during FSS activities.

The licensee's FSS investigation process is described in Section 5.6.4.6, "Investigation Process," of the LACBWR LTP, where it is noted that any areas of concern will be identified and investigated during FSS, and "this will include any areas as identified by the surveyor in real-time during the scanning of surface soils or structural surfaces, any areas identified during post-processing and reviewing of scan survey data, and any results of soil or bulk material analyses that exceed the DCGL." FSS investigation levels are presented in Table 5-16, "FSS Investigation Levels," of the LACBWR LTP, and is provided as Table 2 of the SER below.

Table 2: FSS Investigation Levels

Classification	Scan Investigation Levels	Direct Investigation Levels
Class 1	> Operational DCGL or > MDC_{scan} if MDC_{scan} is greater than Operational DCGL	> Operational $DCGL_W$
Class 2	> Operational DCGL or > MDC_{scan} if MDC_{scan} is greater than Operational DCGL	> Operational $DCGL_W$
Class 3	> Operational DCGL or > MDC_{scan} if MDC_{scan} is greater than Operational DCGL	> 0.5 Operational $DCGL_W$

Depending upon FSS results and the results of any investigations, there may be a need for remediation, reclassification, and resurvey of certain survey units; these concepts are described in Section 5.6.4.6.1, "Remediation, Reclassification and Resurvey," of the LACBWR LTP. The licensee notes that "if an area is remediated, then a RASS will be performed to ensure that the remediation was sufficient," and that "if an individual FSS survey measurement (ISOCS for basements, sample for soil, and instrument reading for buried pipe) in a Class 2 survey unit exceeds the Operational DCGL, the survey unit, or portion of the survey unit, will be investigated." The licensee also commits to reclassifying the survey unit (or portion thereof) to Class 1 if small areas of elevated activity exceeding the Operational DCGL are confirmed by additional investigations, or if the investigation suggests that there is a reasonable potential that contamination is present in excess of the Operational DCGL.

The LACBWR LTP further states that the DQO process will be used to evaluate the remediation, reclassification, and/or resurvey actions to be taken if an investigation level is exceeded. Reclassification of a survey unit from a less restrictive classification to a more restrictive classification may be done without prior NRC approval. However, reclassification to a less restrictive classification requires prior NRC approval. The required remediation, reclassification, and resurvey actions are further described in Table 5-17, "Remediation, Reclassification, and Resurvey Actions," of the LACBWR LTP.

3.5.6.5 Final Status Survey Design Conclusions

The NRC staff evaluated the licensee's final status survey design for LACBWR in accordance with the regulatory guidance and acceptance criteria contained in NUREG-1757, Volume 2, Revision 1, Section 4.4, and Section 2.5 of the SRP. Based on the discussion provided in this section of the SER, the NRC staff finds that the plans for conducting FSS are consistent with the NRC's guidance and requirements, and that the plans are adequate to assist the licensee in determining when the FSS has been implemented. As such, the NRC staff finds that the licensee's FSS methods are adequate to demonstrate compliance with 10 CFR 50.82(a)(9)(ii)(D), 10 CFR 20.1501(a) and (b), and the radiological criteria for unrestricted use in accordance with 10 CFR 20.1402.

3.5.7 <u>Final Status Survey Implementation</u>

3.5.7.1 FSS Methods and Measurements for Soils

Section 5.7, "Final Status Survey Implementation," of the LACBWR LTP describes FSS implementation and discusses the various FSS survey methods and measurements, including surface scanning, gamma spectroscopy of volumetric materials, and fixed gamma spectroscopy measurements. This includes surface soils, subsurface soils, excavated soils, clean fill, areas covered by asphalt or concrete, buried piping, groundwater, sediments, and surface water. The licensee notes that "the survey methods to be employed for FSS will consist of combinations of gamma scans and static measurements, soil and sediment sampling and ISOCS. Additional specialized methods may be identified as necessary between the time [the LTP] is approved and the completion of FSS activities. Any new technologies will meet the applicable DQOs of [the LTP], and the technical approach will be documented for subsequent regulator review."

Specific sampling strategies for surface and subsurface soils are provided in Sections 5.7.1.4, "Surface Soils," and Section 5.7.1.5, "Subsurface Soils," of the LACBWR LTP, respectively. The licensee defines surface soil as "soil located from the surface down to a depth of 1 m," and defines subsurface soil as "soil that resides at a depth greater than 1 m below the final configuration of the ground surface or soil that will remain beneath structures such as basement floors / foundations or pavement at the time of license termination." Surface soil samples will be taken for FSS of land areas at designated systematic locations and at areas of elevated activity identified by gamma scans. The licensee commits that "if levels of residual radioactivity in an individual soil sample exceed a SOF of 0.1, then the sample(s) will be analyzed for ROC HTD radionuclides." In addition, the LACBWR LTP notes that any soil excavation created to expose or remove a potentially contaminated subgrade basement structure will be subjected to FSS prior to backfill. The FSS will be designed as an open land survey using the classification of the removed structure, and the Operational DCGLs for soils as the release criteria.

Subsurface soils will be sampled during FSS in Class 1 open land areas at 10 percent of the systematic soil sampling locations, with the location(s) selected at random. No subsurface soil sample(s) will be taken as part of the LACBWR FSS plan in Class 2 and Class 3 open land survey units, because the LACBWR HSA and site characterization activities have shown that there is minimal residual radioactivity in subsurface soil. Section 5.7.1.5.2, "Sampling of Subsurface Soils During FSS," of the LACBWR LTP additionally notes that, for Class 1, 2, and 3 open land survey units, "if during the performance of FSS, the analysis of a surface soil sample, or the results of a surface gamma scan indicates the potential presence of residual radioactivity at a concentration of 75 percent of the soil Operational DCGL, then additional biased subsurface soil sample(s) will be taken within the area of concern as part of the investigation."

Sampling of subsurface soils below basement structure foundations is discussed in Section 5.7.1.5.3, "Sampling of Subsurface Soils below Structure Basement Foundations," of the LACBWR LTP. The licensee notes that for the foundation walls and basement floors of the reactor building and WGTV that will remain at the time of license termination, "continuing characterization surveys will be performed as necessary to ascertain the radiological conditions of these sub-slab soils," and "the continuing characterization plans and reports will be provided to the NRC for information and results for evaluation." The LACBWR LTP also discusses the potential for subsurface soil contamination under the turbine building as a result of suspected broken drain lines, and notes that after removal of the turbine building floor, additional judgmental samples will be obtained in areas specifically located under the suspect drain lines.

Strategies to sample subsurface soils below basement structures include soil borings or Geoprobe® sampling and will be biased to locations having a high potential for the accumulation and migration of radioactive contamination, including stress cracks, floor and wall interfaces, penetrations through walls and floors for piping, runoff from exterior walls, and leaks or spills in adjacent outside areas. The licensee also commits in Section 5.7.1.5.3 of the LACBWR LTP that "ten percent (10%) of any sub slab soil samples taken will be analyzed for the initial suite of HTD radionuclides as well as any individual sample where analysis indicates gamma activity in excess of a SOF of 0.1."

Section 5.7.1.6, "Excavated Soils and Clean Fill," of the LACBWR LTP states that LACBWR will not stockpile and store excavated soil for reuse as backfill; however, overburden soils excavated to expose buried components or install a new buried system may be replaced into the original excavation, as long as appropriate surveys are performed. The licensee presents survey strategies for overburden soils in Section 5.7.1.6 of the LACBWR LTP as follows:

> 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. In these cases, a RA will be performed. The footprint of the excavation will be scanned prior to the excavation. 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. Scanning will be performed in accordance with section 5.7.1.4.1 ["Gamma Scans of Surface Soils," of the LACBWR LTP]. A soil sample will be acquired at any

scan location that indicates activity in excess of 50 percent of the soil Operational DCGL. Any soil confirmed as containing residual radioactivity at concentrations exceeding 50 percent of the soil Operational DCGL will not be used to backfill the excavation and will be disposed of as waste.

During radiological assessment surveys of excavated soils, as well as the conduct of RAs on any offsite material introduced to the LACBWR site, the licensee would be expected to follow all commitments for radiological assessments, as described in Section 5.1 of the LACBWR LTP (and previously discussed in Section 3.5.3.3 of the SER), including HTD ROCs analyses.

3.5.7.2 FSS Methods and Measurements for Other Media

Additional survey strategies are discussed within Section 5.7 of the LACBWR LTP, including those for pavement covered areas, buried piping, groundwater, sediments, and surface water, and are discussed briefly in the following paragraphs.

Pavement covered areas will be incorporated into larger open land survey units and will be surveyed according to the classification of the survey units in which they are located. Surface soil DCGLs will be used for these surveys, and sample media will be pulverized and analyzed by gamma spectroscopy for comparison to the Operational DCGL. The licensee indicates in Section 5.7.1.7, “Pavement Covered Areas,” of the LACBWR LTP that if pavement exhibits residual radioactivity above the surface soil Base Case DCGL, then the pavement will be disposed of as radiological waste, and an investigation of underlying soil will be performed.

Section 5.7.1.8, “Buried Piping,” of the LACBWR LTP discusses buried piping surveys, and notes that designated sections of buried piping will be remediated in place and undergo FSS. The licensee provided an inventory of buried piping located below the 636 foot elevation that will remain and be subjected to FSS in TSD RS-TD-313196-004. The licensee also indicates that “compliance with the Operational DCGL values, as presented in Table 5-8 [“Operational DCGLs for Buried Piping,” of the LACBWR LTP], will be primarily demonstrated by measurements of total surface contamination and by the collection of sediment samples when available.”

Groundwater assessment is described in Section 5.7.1.9, “Groundwater,” of the LACBWR LTP, where it is noted that “assessments of any residual radioactivity in groundwater at the site will be via groundwater monitoring wells installed at LACBWR.” Section 3.7, “Hydrology and Groundwater,” of the SER discusses groundwater monitoring in more detail.

Sediments and surface water are addressed in Section 5.7.1.10, “Sediments and Surface Water,” of the LACBWR LTP, and the licensee notes that these samples will be evaluated against the site-specific soil Operational DCGLs for each of the potential ROCs, as shown in Table 5-2 of the LACBWR LTP. Section 5.7.1.10 of the LACBWR LTP also indicates that “the assessment of residual radioactivity levels in surface water drainage systems will be made through the sampling of sediments, total surface contamination measurements, or both, as appropriate, making measurements at traps and other appropriate access points where it is expected that radioactivity levels will be representative or bounding of the residual radioactivity on the interior surfaces.”

The licensee discusses considerations for buildings, structures, and equipment in Section 5.7.1.1, “Survey Considerations for Buildings, Structures and Equipment,” of the LACBWR LTP. The LTP indicates that all above grade buildings will be removed with the exception of those structures noted in Section 3.4.1, “LACBWR Remediation Plans,” of the SER (e.g., administration building, crib houses, backup control center, security station, and transmission sub-station switch house), which will be subjected to FSS using the screening values for building surface contamination from Table H.1 of NUREG-1757, Volume 2. The survey approach that will be used to radiologically assess the residual radioactivity in these above grade structures is presented in Section 5.6 of the LACBWR LTP.

3.5.7.3 Final Status Survey Implementation Conclusions

The NRC staff evaluated the licensee's plans for implementing the final status survey plan for LACBWR in accordance with the regulatory guidance and acceptance criteria contained in NUREG-1757, Volume 2, Revision 1, Section 4.4, and Section 2.5 of the SRP. Based on the discussion provided in this section of the SER, the NRC staff finds that the plans for implementing the LACBWR FSS are consistent with the NRC's guidance and requirements, and that the plans are adequate to assist the licensee in determining when the FSS has been completed. As such, the NRC staff finds that the licensee's FSS implementation plans are adequate to demonstrate compliance with 10 CFR 50.82(a)(9)(ii)(D), 10 CFR 20.1501(a) and (b), and the radiological criteria for unrestricted use in accordance with 10 CFR 20.1402.

3.5.8 Final Status Survey Instrumentation

3.5.8.1 FSS Instrument Selection, Calibration, and Sensitivity

Section 5.8, "Final Status Survey Instrumentation," of the LACBWR LTP discusses instrument selection, which is based on detection sensitivity, operating characteristics and expected performance in the field, and indicates that the DQO process will be utilized in selecting FSS instruments. With regard to instrument detection capability, the licensee notes that "for direct measurements and sample analyses, MDCs less than 10 percent of the Operational DCGL are preferable while MDCs up to 50 percent of the Operational DCGL are acceptable," and "instruments used for scan measurements in Class 1 areas are required to be capable of detecting radioactive material at the Base Case DCGL." Section 5.8.1, "Instrument Selection," of the LACBWR LTP additionally notes that the "target MDC for measurements obtained using laboratory instruments will be 10 percent of the applicable Operational DCGL."

The licensee's proposed FSS instrumentation is listed in Table 5-18 of the LACBWR LTP, and instrument MDCs are discussed in Section 5.8.4, "Measurement Sensitivity," of the LACBWR LTP, with nominal MDC values for the proposed instrumentation presented in Table 5-19, "Typical FSS Instrument Detection Sensitivities," of the LACBWR LTP. The licensee also indicates in Section 5.8.1 of the LTP that "other measurement instruments or techniques may be utilized," and "the acceptability of additional or alternate instruments or technologies for use in the FSS will be justified in a technical basis evaluation document prior to use." The licensee commits to developing technical basis evaluations for alternate final status survey instruments or techniques that will be provided for NRC review 30 days prior to use. The evaluation contained in the technical basis document will include the following:

- a description of the conditions under which the alternate method would be used;
- a description of the measurement method, instrumentation, and criteria;
- a justification that the alternative technique would provide the required sensitivity for the given survey unit classification; and,

- a demonstration that the instrument provides sufficient sensitivity for measurement.

The calibration of instrumentation used for FSS is discussed in Section 5.8.2, "Calibration and Maintenance," of the LACBWR LTP, where it is stated that "radioactive sources used for calibration will be traceable to NIST and have been obtained in standard geometries to match the type of samples being counted." Instrument response checks and measurement sensitivity are described in Section 5.8.3, "Response Checks," and Section 5.8.4 of the LACBWR LTP, respectively. Section 5.8.4 of the LTP also notes that the MDC is dependent upon the counting time, geometry, sample size, detector efficiency and background count rate, and describes the scan and static MDC calculations for FSS, which utilize guidance from NUREG-1507 and International Organization for Standardization (ISO) Standard 7503-1, "Evaluation of Surface Contamination," dated 1988. Scan MDC calculations for gamma scans of land areas are described in Section 5.8.4.4, "Gamma Scan Measurement Minimum Detectable Concentration," of the LACBWR LTP, along with a basic description of the scanning procedures that will be utilized for gamma walkover surveys of land areas. Section 5.8.4.4 of the LACBWR LTP also notes that TSD RS-TD-313196-006 derives the MDC for the radionuclide mixtures at various detector distances and scan speeds and provides MDC values for the expected LACBWR soil mixture based on detector background condition, scan speed, soil depth (15 cm), soil density (1.6 grams per cubic centimeter [g/cm^3]) and detector distance to the suspect surface.

Section 5.8.4.5, "[High Purity Germanium] HPGe Spectrometer Analysis," and Section 5.8.4.6, "Pipe Survey Instrumentation," of the LACBWR LTP address HPGe spectrometer analysis and pipe survey instrumentation, respectively. With regard to HPGe analysis, the licensee indicates that "the onsite laboratory at LACBWR maintains gamma isotopic spectrometers that are calibrated to various sample geometries," and "these systems are calibrated using a NIST traceable mixed gamma source." With regard to pipe survey instrumentation, the licensee provides detection sensitivities of approximately 350 dpm/100 cm^2 to 5,200 dpm/100 cm^2, and states that this level of sensitivity is adequate to detect residual radioactivity below the Operational DCGLs derived for the unrestricted release of buried pipe.

3.5.8.2 Final Status Survey Instrumentation Conclusions

The NRC staff evaluated the licensee's proposed radiation detection and measurement instrumentation for performing FSS in accordance with the regulatory guidance and acceptance criteria contained in NUREG-1757, Volume 2, Revision 1, Section 4.4, and Section 2.5 of the SRP. Based on the discussion provided in this section of the SER, the NRC staff finds that the proposed radiation detection and measurement instrumentation for performing FSS are consistent with the NRC's guidance and requirements. As such, the NRC staff finds that the licensee's FSS instrumentation is adequate to demonstrate compliance with 10 CFR 50.82(a)(9)(ii)(D), 10 CFR 20.1501(a) and (b), and the radiological criteria for unrestricted use in accordance with 10 CFR 20.1402.

3.5.9 <u>Quality Assurance</u>

3.5.9.1 LACBWR Decommissioning Quality Assurance Project Plan

The licensee's quality assurance program for decommissioning and completion of license termination activities at LACBWR is described in Section 5.9, "Quality Assurance," of the LACBWR LTP, which states that the QA program complies with the requirements set forth in Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing

Plants," of 10 CFR Part 50, Subpart H, "Quality Assurance," of 10 CFR Part 71, "Packaging and Transportation of Radioactive Material," and Subpart G, "Quality Assurance," of 10 CFR Part 72.

Project management and the LACBWR decommissioning organizational structure is described in Section 5.9.1, "Project Management and Organization," of the LACBWR LTP, and the licensee notes that further details on key positions are described in the project Quality Assurance Project Plan. The basic elements of the QAPP are described in Section 5.9.2, "Quality Objectives and Measurement Criteria," of the LACBWR LTP, and include: written procedures; training and qualifications; measurement and data acquisitions; instrument selection, calibration, and operation; chain of custody; control of consumables; control of vendor-supplied services; database control; and data management. The licensee states that the QA objectives for FSS are to ensure the survey data collected is of the type and quality needed to demonstrate, with sufficient confidence, that the site is suitable for unrestricted release. The objective is met through use of the DQO process for FSS design, analysis, and evaluation. Compliance with the QAPP ensures that the following items are accomplished: (1) the elements of the FSS plan are implemented in accordance with the approved procedures; (2) surveys are conducted by trained personnel using calibrated instrumentation; (3) the quality of the data collected is adequate; (4) all phases of package design and survey are properly reviewed, with QC and management oversight provided; and (5) corrective actions, when identified, are implemented in a timely manner and are determined to be effective.

Measurement and data acquisition is described in Section 5.9.3, "Measurement / Data Acquisition," of the LACBWR LTP, and the licensee lists the following quality control measures for use during decommissioning: replicated measurements and surveys; duplicate and split samples; field blanks and spiked samples; and QC investigations. The licensee's quality assurance assessment and oversight strategies are described in Section 5.9.4, "Assessment and Oversight," of the LACBWR LTP, which includes focused self-assessments; independent review of survey results; and the continued use of a sitewide corrective action process. Data validation is described in Section 5.9.5, "Data Validation," of the LACBWR LTP, where it is noted that survey data will be reviewed for completeness and for outliers. Comparisons to investigation levels will be performed, measurements exceeding the investigation levels will be evaluated, and procedurally verified data will be subjected to the Sign Test and the unity rule.

Section 5.9.6, "NRC and State Confirmatory Measurements," of the LACBWR LTP discusses the ability of the NRC and Wisconsin state regulatory agencies to take confirmatory measurements to assist in making a determination in accordance with 10 CFR 50.82(a)(11) that the FSS and associated documentation demonstrate the site is suitable for release in accordance with the criteria for decommissioning in 10 CFR 20.1402. Confirmatory measurements may include collecting radiological measurements for the purpose of confirming and verifying the adequacy of the LACBWR FSS measurements.

3.5.9.2 Quality Assurance Conclusions

The NRC staff evaluated the licensee's quality assurance program for the decommissioning of LACBWR in accordance with the regulatory guidance and acceptance criteria contained in NUREG-1757, Volume 2, Revision 1, Section 4.4, and Section 2.5 of the SRP, and well as the quality assurance requirements of 10 CFR Part 50, Part 71, and Part 72. Based on the discussion provided in this section of the SER, the NRC staff finds that the LACBWR quality assurance program assures that the design, procurement, construction, testing, operation, maintenance, repair, modification, dismantlement, and remediation of nuclear reactor components are performed in a safe and effective manner during decommissioning and license termination activities. These activities are consistent with the NRC's guidance and requirements, and as such, the NRC staff finds that the licensee's quality assurance program is adequate to demonstrate compliance with 10 CFR 50.82(a)(9)(ii)(D), 10 CFR 20.1501(a) and (b), and the radiological criteria for unrestricted use in accordance with 10 CFR 20.1402.

3.5.10 Final Status Survey Data Assessment

3.5.10.1 FSS Data Assessment and Validation using the DQA and DQO Process

FSS data assessment is described in Section 5.10, "Final Status Survey Data Assessment," of the LACBWR LTP, which states that the DQA approach being implemented at LACBWR is an evaluation method used during the assessment phase of FSS to ensure the validity of FSS results and demonstrate achievement of the survey plan objectives. The level of effort expended during the DQA process will typically be consistent with the graded approach used during the DQO process. The DQA process includes a review of the DQOs, survey plan design, and preliminary data; and will use appropriate statistical testing, verify the assumptions of the statistical tests, and draw conclusions from the data. The DQA process includes:

- Verification that the measurements were obtained using approved methods.
- Verification that the quality requirements were met.
- Verification that the appropriate corrections were made to any gross measurements and that the data is expressed in the correct reporting units.
- Verification that the measurements required by the survey design, and any measurements required to support investigation(s), have been included.
- Verification that the classification and associated survey unit design remain appropriate based on a preliminary review of the data.
- Subjecting the measurement results to the appropriate statistical tests.
- Determining if the residual radioactivity levels in the survey unit meet the applicable release criterion and if any areas of elevated radioactivity exist.

The licensee indicates in Section 5.10 of the LACBWR LTP that once the FSS data is collected, the information for each survey unit will be assessed and evaluated to ensure that it is adequate to support the release of the survey unit, and that simple assessment methods such as comparing the survey data mean result to the appropriate Operational DCGL will be performed first on the FSS results. An SOF will be calculated as several radioisotopes are measured, and a non-parametric statistical test (i.e., the Sign Test) will be applied to the final data set. In Class 1 soil areas, an EMC test may be performed if elevated activity is encountered. Once the assessment and evaluation is complete, conclusions will be made as to whether the survey unit meets the site release criteria or whether additional actions will be required.

Data validation is discussed in Section 5.10.2.1, "Data Validation," of the LACBWR LTP, and the licensee notes that, at a minimum, the following actions should occur:

- Ensure that the instrument calibration was current and traceable to NIST standards.

- Ensure that the instrumentation MDC for direct measurements and sample analyses was less than 10 percent of the Operational DCGL, which is preferable. MDCs up to 50 percent of the Operational DCGL are acceptable.

- Ensure that the field instruments used for FSS were source checked with satisfactory results before and after use each day that data were collected.

- Ensure that the MDCs and assumptions used to develop them were appropriate for the instruments and techniques used to perform the survey.

- Ensure that the survey methods used to collect data were proper for the types of radiation involved and for the media being surveyed.

- Ensure that the sample was controlled from the point of sample collection to the point of obtaining results.

- Ensure that the data set is comprised of qualified measurement results collected in accordance with the survey design which accurately reflect the radiological status of the facility.

- Ensure that the data have been properly recorded.

Graphical data analyses are discussed in Section 5.10.2.2, "Graphical Data Review," of the LACBWR LTP and will include, at a minimum, posting plots and frequency plots or histograms, while it is noted that additional data review methodologies are found in MARSSIM Section 8.2.2, "Conduct a Preliminary Data Review."

3.5.10.2 FSS Statistical Tests and Data Conclusions

The FSS statistical test (i.e., Sign Test) is provided in Section 5.10.3, "Applying Statistical Test," of the LACBWR LTP. The licensee notes that the SOF or unity rule will be applied to FSS data in accordance with the guidance contained in NUREG-1757, Volume 2, Section 2.7, "Sum of Fractions." The sum of fractions calculation will be based on the Operational DCGL, and if a surrogate DCGL is used, the "unity rule equivalents" will be calculated using the surrogate adjusted Operational DCGL as shown by the following equation demonstrating Cs-137 as a surrogate radionuclide for Sr-90 (Equation 5-13 of the LACBWR LTP).

Equation 2: Sum of Fractions Calculation for Surrogate Radionuclides

$$SOF \leq 1 = \frac{Conc_{Cs\text{-}137}}{DCGL_{Cs\text{-}137_s}} + \frac{Conc_{Co\text{-}60}}{DCGL_{Co\text{-}60}} + \ldots \frac{Conc_n}{DCGL_n}$$

where:

$Conc_{Cs\text{-}137}$	=	Measured mean concentration for Cs-137
$DCGL_{Cs\text{-}137s}$	=	Surrogate Operational DCGL for Cs-137
$Conc_{Co\text{-}60}$	=	Measured mean concentration for Co-60
$DCGL_{Co\text{-}60}$	=	Operational DCGL for Co-60
$Conc_n$	=	Measured mean concentration for radionuclide n
$DCGL_n$	=	Operational DCGL for radionuclide n

The process for an EMC evaluation is shown in Section 5.10.4, "Elevated Measurement Comparison Evaluation," of the LACBWR LTP. As previously noted, EMC is only applicable to Class 1 open land survey units. The $DCGL_{EMC}$, which is a Base Case DCGL modified by an area factor to account for small areas of elevated activity, will be used in accordance with MARSSIM Section 8.5.1, "Elevated Measurement Comparison," and Section 8.5.2, "Interpretation of Statistical Test Results." This analysis will use the Base Case DCGLs as presented in the following equation (Equation 5-14 of the LACBWR LTP).

Equation 3: EMC Evaluation Calculation

$$\frac{\delta}{DCGL_W}+\frac{\tau_1-\delta}{DCGL_{EMC_1}}+\frac{\tau_2-\delta}{DCGL_{EMC_2}}+\cdots\frac{\tau_n-\delta}{DCGL_{EMC_n}}<1$$

where:

δ	=	The survey unit average activity
$DCGL_W$	=	The survey unit Base Case DCGL concentration
τ_n	=	The average activity value of hot spot *n*
$DCGL_{EMCn}$	=	The $DCGL_{EMC}$ concentration of hot spot *n*

The fractions for all of the terms (including all elevated areas within a survey unit) will be summed and must be less than unity for the survey unit to pass the EMC evaluation.

Section 5.10.5, "Data Conclusions," of the LACBWR LTP indicates that the results of the statistical testing, including the application of the EMC, allow for one of two conclusions to be made. The first conclusion is that the survey unit meets the site release criterion, and the data provide statistically significant evidence that the level of residual radioactivity within the survey unit does not exceed the release criteria. The decision to release the survey unit will then be made with sufficient confidence and without any further analyses. The second conclusion that can be made is that the survey unit fails to meet the release criteria. The data may not be conclusive in showing that the residual radioactivity is less than the release criteria; as a result, the data will be analyzed to determine the reason for failure, including an evaluation of whether the number of measurements made and the standard deviation of the measurement data is adequate to ensure that the power of the statistical tests is sufficient.

3.5.10.3 Final Status Survey Data Assessment Conclusions

The NRC staff evaluated the licensee's FSS data assessment methods in accordance with the regulatory guidance and acceptance criteria contained in NUREG-1757, Volume 2, Revision 1, Section 4.4, and Section 2.5 of the SRP. Based on the discussion provided in this section of the SER, the NRC staff finds that the LACBWR FSS data assessment methods are consistent with the NRC's guidance and requirements. As such, the NRC staff finds that the FSS data assessment methods are adequate to allow the licensee to demonstrate compliance with 10 CFR 50.82(a)(9)(ii)(D), 10 CFR 20.1501(a) and (b), and the radiological criteria for unrestricted use in accordance with 10 CFR 20.1402.

3.5.11 <u>Final Status Survey Reporting</u>

Section 5.11, "Final Status Survey Reporting," of the LACBWR LTP discusses final radiation survey reporting, and Section 5.11.1, "FSS Release Records," and Section 5.11.2, "FSS Final

Reports," of the LACBWR LTP discuss survey unit release records and final FSS reports, respectively. The licensee indicates that these reports will be consistent with MARSSIM Section 8.6, "Documentation," and that an FSS release record will be prepared to provide a complete record of the as-left radiological status of an individual survey unit, relative to the specified release criteria, while an FSS final report will be prepared to provide a summary of the survey results and the overall conclusions which demonstrate that the site, or portions of the site, meets the radiological criteria for unrestricted use, including ALARA.

3.5.11.1 FSS Release Records

In Section 5.11.11 of the LACBWR LTP, the licensee indicates that the LACBWR FSS survey unit release records will include the following:

- Survey unit description, including unit size, descriptive maps, plots or photographs and reference coordinates.
- Classification basis, including significant HSA and characterization data used to establish the final classification.
- DQOs stating the primary objective of the survey.
- Survey design describing the design process, including methods used to determine the number of samples or measurements required based on statistical design, the number of biased or judgmental samples or measurements selected and the basis, method of sample or measurement locating, and a table providing a synopsis of the survey design.
- Survey implementation describing survey methods and instrumentation used, accessibility restrictions to sample or measurement locations, number of actual samples or measurements taken, documentation activities, QC requirements and scan coverage.
- Survey results including types of analyses performed, types of statistical tests performed, surrogate ratios, statement of pass or failure of the statistical test(s).
- QC results to include discussion of split samples and/or QC replicate measurements.
- Results of any investigations.
- Any remediation activities, both historic and resulting from the performance of the FSS.
- Any changes from the FSS survey design including field changes.
- DQA conclusions.
- Any anomalies encountered during performance of the survey or in the sample results.
- Conclusion as to whether or not the survey unit satisfied the release criteria and whether or not sufficient power was achieved.

3.5.11.2 FSS Final Reports

Section 5.11.2 of the LACBWR LTP notes that FSS final reports will be written, to the extent practical, as stand-alone documents that will usually incorporate multiple survey unit release records, and may be submitted in a phased approach. The licensee commits in Section 5.11.2 of the LACBWR LTP to include the following information in these FSS final reports:

- A brief overview discussion of the FSS program, including descriptions regarding survey planning, survey design, survey implementation, survey data assessment, and QA and QC measures.

- A description of the site, the applicable survey area(s) and survey unit(s), a summary of the applicable HSA information, conditions at the time of survey, identification of potential contaminants, and radiological release criteria.

- A discussion regarding the DQOs, survey unit designation and classification, background determination, FSS plans, survey design input values and method for determining sample size, instrumentation (detector efficiencies, detector sensitivities, instrument maintenance and control and instrument calibration), ISOCS efficiency calibration geometry, survey methodology, QC surveys, and a discussion of any deviations during the performance of the FSS from what was described in the LTP.

- A description of the survey findings including a description of surface conditions, data conversion, survey data verification and validation, evaluation of number of sample and measurement locations, a map or drawing showing the reference system and random start systematic sample locations, and comparison of findings with the appropriate Operational DCGL or action level, including statistical evaluations.

- Description of any judgmental and miscellaneous sample data collected in addition to those required for performing the statistical evaluation.

- Description of anomalous data, including any areas of elevated direct radiation detected during scanning that exceeded the investigation level or measurement locations in excess of the Operational DCGL.

- If a survey unit fails the statistical test, a description of any changes in initial survey unit assumptions relative to the extent of residual radioactivity, the investigation conducted to ascertain the reason for the failure, and the impact that the failure has on the conclusion that the facility is ready for final radiological surveys, as well as a discussion of the impact of the failure on survey design and results for other survey units.

- Description of how good housekeeping and ALARA practices were employed to achieve final activity levels.

3.5.12 <u>Surveillance Following Final Status Survey</u>

The licensee discusses surveillance following the FSS in Section 5.12, “Surveillance Following FSS,” of the LACBWR LTP, and notes that isolation and control measures will be implemented in accordance with approved LACBWR site procedures as described in Section 5.6.3, “Area Preparation: Turnover and Control Measures,” of the LACBWR LTP.

Section 5.12 of the LACBWR LTP also notes that documented surveillances of open land survey units will be performed to provide additional assurance that the survey units that have successfully undergone FSS remain unchanged until final site release. The licensee indicated that the routine surveillance activities will consist of the following:

- Review of access control entries since the performance of FSS or the last surveillance.
- A walk-down of the areas to check for proper postings.
- A check for materials introduced into the area or any disturbance that could change the FSS, including the potential for contamination from adjacent decommissioning activities.
- If evidence is found of materials that have been introduced into the survey unit or any disturbance that could change the FSS results, the licensee will perform and document a biased scan of the survey unit, focusing on access and egress points and any areas of disturbance or concern.
- These surveillance activities will be controlled and documented in accordance with the LACBWR QAPP and approved procedures.
- If routine surveillance results in physical observations or radiological scan measurements that require further investigation, the specific areas will be reinvestigated as appropriate, and the entire FSS may be repeated in the affected survey unit.

3.5.13 NRC Staff Evaluation and Conclusions for the Final Status Survey Plan

The NRC staff evaluated Chapter 5 (Final Status Survey Plan) of the LACBWR LTP, Revision 1, to ensure that the licensee's proposed decommissioning strategies will be consistent with, or comparable to, the NRC's applicable decommissioning guidance, including: NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM);" NUREG-1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions;" NUREG-1700, "Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans;" and NUREG-1757, Volumes 1 and 2, "Consolidated Decommissioning Guidance," in order to ultimately ensure that the licensee complies with the "radiological criteria for unrestricted use" as specified in 10 CFR 20.1402. The NRC staff provides evaluations with regard to the FSS plan and FSS strategies as follows.

3.5.13.1 Evaluation of Final Status Survey Approach for Basement Structures

With regard to FSS methodologies for basement structures, the licensee utilizes MARSSIM in the development of the FSS plans for basement structures, but there are deviations from the MARSSIM process that warrant elaboration. A typical MARSSIM process for surfaces utilizes gamma walkover scanning in conjunction with random / systematic sampling (or discrete measurements). Random / systematic sampling provides a non-biased and representative approach to determine the radiological status of a survey unit, while scanning is utilized for the purpose of locating and delineating any elevated areas of activity. The licensee proposes in the LACBWR LTP to use in situ gamma surveys (i.e., ISOCS) to accomplish both scanning and discrete sampling tasks for the basement surface surveys, and the licensee notes in Section 5.5.1 of the LACBWR LTP that "the surface area covered by a single ISOCS measurement is large (a nominal range of 10-30 m^2) which essentially eliminates the need for scan surveys."

However, the NRC staff notes that ISOCS should not arbitrarily be considered a replacement for gamma scanning to locate elevated areas of activity. This is because ISOCS results represent an average of all detectable radioactivity within the instrument's FOV, which can present challenges in delineating small areas of elevated activity within a relatively large FOV. The licensee discusses the detection of elevated areas in ES TSD LC-FS-TSD-001, "Use of ISOCS for FSS of End State Sub Structures at LACBWR," which was provided with the LTP. In that document, the licensee notes that an over or under estimate of activity can occur depending on the location of an elevated area relative to the center of the ISOCS FOV. The licensee concludes in the TSD that "the distribution and location of non-uniform elevated areas are expected to be randomly located with equal probability of being at any distance from the detector centerline," and makes no adjustment for potential non-uniform areal distribution. The licensee commits to using additional scan surveys and investigations to inform the FSS, and has noted in Section 5.5.2 of the LACBWR LTP that "characterization data, radiological surveys performed to support commodity removal, and surveys performed to support structural remediation for open-air demolition will continue to be used to verify that the contamination potential within each FSS unit is reasonably uniform throughout all walls and floor surfaces." The licensee has also revised the LACBWR LTP to require judgmental ISOCS measurement in any area that could potentially approach the Operational DCGLs. As such, NRC staff considers additional scan surveys a necessary part of the overall FSS process.

Additional factors considered in the NRC staff's evaluation of basement surface surveys include their context within the Basement Fill Model (BFM), and the currently proposed survey unit classification and investigation processes. The BFM is unique with regard to how overall residual radioactivity is assessed, which is discussed in greater detail in Section 6 of the SER. With regard to current survey unit classification, all LACBWR basement survey units are Class 1, which ensures greater overall survey coverage throughout the entire decommissioning process. With regard to investigation levels for basement surfaces, the ISOCS investigation levels (as shown in Table 5-16 of the LACBWR LTP and in Table 2 of the SER) are based on an Operational DCGL which is below the Base Case DCGL. This ensures that investigations will be triggered at lower levels (relative to the Base Case DCGL), but the NRC staff notes that if ISOCS surveys were performed for the sole purpose of locating small areas of elevated activity (as is the case using a typical MARSSIM scanning model), investigations may need to be designed differently. As a point of reference, the NRC staff notes that an NRC sponsored study was completed in 2006 titled "Spatially-Dependent Measurements of Surface and Near-Surface Radioactive Material Using In-situ Gamma Ray Spectrometry (ISGRS) For Final Status Surveys" (ADAMS Accession No. ML17284A121).

This study addressed various survey and investigation considerations when a discrete particle is located within a larger in situ FOV, and states the following with respect to investigation levels:

> It is important to understand that scanning is performed to identify or detect the presence of areas of elevated contamination, which may be discrete particles. The purpose of scanning is not to quantify the activity in the elevated area. The difference is one of detectability versus measurability. According to MARSSIM, "Scanning surveys are performed to locate radiation anomalies indicating residual gross activity that may require further investigation or action" (MARSSIM 2000). Therefore, it is necessary to define ISGRS investigation levels during scanning, and to specify the nature of the further investigation once the investigation level is triggered.

The 2006 ISGRS study goes on to note that if the investigation level is exceeded, then conventional scan surveys might be conducted to confirm and/or identify the location of the discrete particle. The LACBWR LTP does not specify that conventional scan surveys will be performed in the event that an ISOCS investigation level is exceeded, but rather seems to rely on preliminary demolition and characterization surveys to locate areas of elevated activity.

Based on its evaluation of the entire survey process for basement structures, the NRC staff finds the overall survey ISOCS methodology, as supplemented by the licensee's commitment to perform pre-FSS scanning surveys, adequate to meet the MARSSIM guidance regarding radiological sampling approach and detection of elevated areas. The ISOCS instrumentation and detection capabilities are adequate to quantify the average residual radioactivity within its field of view. The licensee's process for developing a sum of fractions result from basement surfaces based on the ISOCS measurements is acceptable to meet the MARSSIM process and demonstrate compliance with the unrestricted release dose criteria.

3.5.13.2 Evaluation of Final Status Survey Approach for Buried Piping

The NRC staff evaluated the licensee's plans for FSS of buried piping, as described in Section 5.7.1.8 of the LACBWR LTP, and as previously discussed in the SER. The survey methods and instrumentation proposed for buried piping surveys, including the usage of hand held portable detectors and push-pull methods, are adequate to ensure the buried piping can be sampled to an extent that will allow the licensee to demonstrate compliance with the unrestricted release dose criteria of 10 CFR 20.1402. In addition, the proposed strategies to maintain adequate survey coverage within piping are acceptable to ensure that the survey results fulfill the MARSSIM requirements and NUREG-1757 guidance associated with buried piping. As noted in Section 5.7.1.8 of the LACBWR LTP, "compliance with the [buried piping] Operational DCGL values … will be primarily demonstrated by measurements of total surface contamination and by the collection of sediment samples when available. … A conservative "area of detection" is assumed for each pipe size. It is also conservatively assumed that any activity is uniformly distributed in the area of detection." As such, the buried piping survey methodologies are acceptable and consistent with MARSSIM and NUREG-1757, Volume 2.

3.5.13.3 Evaluation of Final Status Survey Approach for Open Land Survey Areas and Soils

The NRC staff evaluated the licensee's final status survey approach for open land survey units, as provided in Section 5.7.1.4 of the LACBWR LTP, and as previously discussed in the SER. The NRC staff determined that the FSS design and usage of the DQO and DQA processes is consistent with MARSSIM and NUREG-1757, Volume 2. The proposed survey instrumentation and detection sensitivities are adequate. The scan coverage and systematic sampling strategies for open land areas are consistent with MARSSIM and NUREG-1757, and are therefore considered adequate. The sum of fractions and elevated measurements comparison methods, as presented in Equation 5-13 and Equation 5-14 of the LACBWR LTP, respectively, are acceptable and consistent with MARSSIM and NUREG-1757, Volume 2.

3.5.13.4 Evaluation of Final Status Survey Approach for Remaining Above Ground Structures

The NRC staff evaluated the licensee's final status survey approach for impacted above ground buildings, structures, and equipment that will remain after license termination, as provided in Section 5.7.7.1 of the LACBWR LTP, and as previously discussed in the SER. The NRC staff determined that an FSS design using the screening values for building surface contamination from Table H.1 of NUREG-1757 is appropriate and consistent with the applicable regulatory requirements and associated guidance provided in MARSSIM and NUREG-1757, Volume 2.

3.5.13.5 NRC Staff Conclusions on the Licensee's Final Status Survey Plan

The NRC staff evaluated the licensee's final status survey plans in accordance with the regulatory guidance and acceptance criteria contained in NUREG-1757, Volume 2, Revision 1, Section 4.4, and NUREG-1700, Revision 2, Section 2.5. Based on the discussion provided in Section 3.5.13 of the SER, the NRC staff finds that the FSS plans provide reasonable assurance that the licensee will be able to perform adequate surveys to demonstrate compliance with the radiological criteria for unrestricted use, as specified in 10 CFR 20.1402. Additionally, the staff finds that the licensee's FSS plans are adequate to demonstrate compliance with 10 CFR 50.82(a)(9)(ii)(D), and the requirements of 10 CFR 20.1501(a) and (b).

3.6 Compliance with Radiological Criteria for License Termination

Chapter 6, "Compliance with the Radiological Criteria for License Termination," of the LACBWR LTP describes the dose modeling and calculations used to establish the site-specific DCGLs that will be applied to the LACBWR site during final status surveys in order to demonstrate compliance with the radiological criteria for release for unrestricted use contained in 10 CFR 20.1402. Specifically, the residual radioactivity that is distinguishable from background levels must result in a TEDE to the average member of the critical group that does not exceed 25 mrem/yr, and the residual radioactivity must also be reduced to levels that are ALARA. In addition, the NRC staff is assessing the licensee's compliance with the requirements set forth in 10 CFR 50.82(a)(9)(ii)(D), which required the LTP to include detailed plans for the final radiation survey, because the DCGLs are used in the final radiation surveys.

The NRC staff compared the information in the LACBWR LTP, Revision 1, for the LACBWR facility and site against the acceptance criteria in Section 2.6, "Compliance with the Radiological Criteria for License Termination," of the NUREG-1700, Revision 2, SRP. The SRP refers to NUREG-1757, Volume 2, Section 5.2, "Scoping Surveys," and Appendix I, "Statistical Tables and Procedures," which describe, in part, the areas of review pertaining to unrestricted release using site-specific DCGLs. The findings and conclusions in this section of the SER are used to evaluate the LACBWR LTP's compliance with the requirements of 10 CFR 20.1402. The main areas of review include information on the licensee's methods for establishing the source term, exposure scenario(s), conceptual model(s), numerical analyses, and uncertainty analysis. This section of the SER is grouped according to the various sources contributing to the final dose on the site: soil, backfilled basements, buried piping, groundwater, and above grade structures.

3.6.1 <u>Source Term and Approach for Overall Dose Compliance</u>

Section 3.2.1, "Facility Radiological Status," of the SER establishes that two of the major objectives of site characterization activities are to provide information to develop specifications for FSS and to provide information for dose modeling that can be used to demonstrate compliance with the unrestricted release criteria. This section of the SER further reviews the LACBWR site characterization information related to these two objectives.

3.6.1.1 Methods for Establishing Source Term and DCGLs

The licensee developed site-specific DCGLs which will be used to demonstrate compliance with the dose-based release criteria for the soils, buried piping, and backfilled basements that will remain at the LACBWR site after license termination. The areas to be surveyed and sampled for unrestricted release within each backfilled basement are the wall and floor surfaces associated with each remaining building basement (i.e., reactor building and WGTV). DCGLs are the level of each ROC that would result in a dose equivalent to the regulatory dose limit (i.e., 25 mrem/yr) for each radionuclide within a survey unit. The licensee has termed these limits the Base Case DCGLs (BcDCGL). For soil, the BcDCGL is equivalent to the $DCGL_W$.

When more than one radionuclide is present in a survey unit, the sum of fractions rule will be applied to ensure that the total dose for a particular survey unit remains within the compliance limit. The SOF methodology takes the radionuclide concentration or activity for each radionuclide present and divides it by the BcDCGL of the same radionuclide for all of the ROCs, and then sums the ratios. The sum of the ratios of all the ROCs must be less than or equal to one in order for the survey unit to meet the dose based release criteria. The SOF for each LACBWR survey unit calculated using the BcDCGLs is termed the “BcSOF” by the licensee. In addition, the licensee must demonstrate that the total dose from all sources at the site meets the radiological criteria for license termination of 25 mrem/yr. The four source terms for the end state at LACBWR are as follows: soil, backfilled basements, buried piping, and groundwater.

The licensee will apply the following equation (Equation 5-3 of the LACBWR LTP) to determine overall compliance with the unrestricted release criteria of 25 mrem/yr from all sources at the site. The details of how the terms in Equation 4 are determined from sample measurement data are described in TSD LC-FS-TSD-002, which discusses the Operational DCGLs for FSS.

Equation 4: Compliance Dose Equation

$$\text{Compliance Dose} = (\text{Max BcSOF}_{\text{BASEMENT}} + \text{Max BcSOF}_{\text{SOIL}} + \text{Max BcSOF}_{\text{BURIED PIPE}} + \text{Max BcSOF}_{\text{AG BUILDING}} + \text{GW BcSOF}_{\text{BS OB}} + \text{GW BcSOF}_{\text{BPS OBP}} + \text{Max SOF}_{\text{EGW}}) \times 25 \text{ mrem/yr}$$

where:

Compliance Dose	=	Must be less than or equal to 25 mrem/yr
Max $\text{BcSOF}_{\text{BASEMENT}}$	=	Maximum BcSOF for the backfilled basements (mean of FSS systematic results plus the dose from any identified elevated areas) for either the reactor building or the WGTV
Max $\text{BcSOF}_{\text{SOIL}}$	=	Maximum BcSOF (mean of FSS systematic results plus the dose from any identified elevated areas) for open land survey units
Max $\text{BcSOF}_{\text{BURIED PIPE}}$	=	Maximum BcSOF (mean of FSS systematic results plus the dose from any identified elevated areas) from buried piping survey units
Max $\text{BcSOF}_{\text{AG BUILDING}}$	=	Maximum BcSOF (mean of FSS systematic results plus the dose from any identified elevated areas) from above grade (AG) standing building survey units
GW $\text{BcSOF}_{\text{BS OB}}$	=	Groundwater scenario dose from the “other basement” (OB) which is defined as the basement not used to generate the Max $\text{BcSOF}_{\text{BASEMENT}}$ term
GW $\text{BcSOF}_{\text{BPS OBP}}$	=	Groundwater scenario dose from the “other buried pipe” (OBP) which is defined as the buried pipe survey units not used to generate the Max $\text{BcSOF}_{\text{BURIED PIPE}}$ term

Max SOF_{EGW}	=	Maximum SOF from existing groundwater (EGW) based on the maximum concentration from all groundwater sampling wells collectively for each positively identified ROC in units of picoCuries per liter (pCi/L) within the most recent two years of sampling. (Note that this has the potential of combining results from various wells if different ROCs are positively identified in different wells)

Equation 1 of the SER (Equation 5-5 of the LACBWR LTP) will be used (with BcDCGLs) to assess the SOF_B for basement structural surface survey units. The dose from residual radioactivity assigned to the basement FSS survey unit(s) is the SOF_B multiplied by 25 mrem/yr. TSD LC-FS-TSD-002 also defines Operational DCGLs (OpDCGLs), which will be applied during FSS to help ensure that the dose from all source terms at the site remains below the dose criterion. The OpDCGLs are a fraction of the BcDCGLs, equivalent to the fraction which has been assigned to each source term. While compliance is not dependent on the specific Operational DCGL values as long as the overall dose is less than or equal to 25 mrem/yr, the concept of applying OpDCGLs is integral to ensuring compliance with Equation 4**Error! Reference source not found.** of the SER.

Because the licensee is applying OpDCGLs and has committed to remediating any area that exceeds the Base Case DCGLs, as well as areas where the SOF using the BcDCGLs is greater than one for some sources, the definition of "elevated area" for LACBWR is somewhat different from that used in MARSSIM guidance. For soil, the approach follows standard MARSSIM guidance where elevated areas of specific sizes above the BcDCGLs will be allowed as long as they are below the $DCGL_{EMC}$, which is discussed in Section 3.5.6.3, "Areas of Elevated Activity and Scan Coverage," of the SER. However, for basement surfaces, buried piping, and above grade buildings, elevated areas are defined differently. As shown in Equation 4, the BcSOF calculations for buried pipe and basements include the dose from non-elevated systematic samples, as well as elevated systematic and/or judgmental measurements, where "elevated" is defined as any measurement that exceeds the OpDCGLs.

Table 3 outlines the licensee's commitments in terms of remediating elevated areas, which are stated in Section 5.5.4 of the LACBWR LTP for backfilled basements and above grade buildings, and in Section 5.10.4 of the LACBWR LTP for soil survey units. Section 5.5.4 of the LACBWR LTP states that "for building surfaces, areas of elevated activity are defined as any area identified by measurement / sample (systematic or judgmental) that exceeds the Operational DCGL but is less than the Base Case DCGL. Any area that exceeds the Base Case DCGL will be remediated." In addition, TSD LC-FS-TSD-002, Section 3 states that "in basements and buried pipe, any areas of elevated residual radioactivity exceeding the Base Case $DCGL_B$ will be remediated … Any systematic and/or judgmental measurement in above grade buildings that exceeds the [Operational DCGL SOF] OpSOF will be remediated." Section 5.10.4 of the LACBWR LTP states that "any identified elevated areas [in soil] are each compared to the specific $DCGL_{EMC}$ value calculated for the size of the affected area. If the individual elevated areas pass, then they are combined and evaluated under the unity rule."

Table 3: Remediation of Elevated Areas

Survey Unit Type	OpDCGLs < Concentration < BcDCGLs	BcDCGLs < Concentration
Backfilled Basement Surfaces	Find the extent of contamination to bound the elevated area, and incorporate as an "elevated area" into the overall dose using Equation 5-5 of the LACBWR LTP	Remediate any areas where systematic or judgmental measurement concentrations are greater than the BcDCGLs
Buried Piping	Find the extent of contamination to bound the elevated area, and incorporate as an "elevated area" into the overall dose using Equation 4 from TSD LC-FS-TSD-002, Revision 2	Remediate any areas where systematic or judgmental measurement concentrations are greater than the BcDCGLs
Above Grade Buildings	Remediate any areas where systematic or judgmental measurement for above grade buildings exceed the OpDCGLs	Remediate any areas where systematic or judgmental measurement for above grade buildings exceed the OpDCGLs
	$DCGL_W$ < Concentration < $DCGL_{EMC}$	**$DCGL_{EMC}$ < Concentration**
Class 1 Soil Survey Units	Find the extent of contamination to bound the elevated area, and incorporate as an "elevated area" into the overall dose using Equation 5-14 of the LACBWR LTP	Remediate any areas where systematic or judgmental measurements exceed the $DCGL_{EMC}$ for soil

3.6.1.2 Radionuclides of Concern and Insignificant Radionuclide Contribution

TSD RS-TD-313196-001 established an initial suite of potential ROCs for LACBWR. To generate an initial suite of ROCs, the licensee reviewed (1) relevant regulatory and industry guidance; (2) a LACBWR spent fuel inventory assessment conducted in 1988 that was decay corrected to January 2015; and (3) several 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," waste stream analyses. The licensee reviewed potential radionuclides generated due to neutron activation of reactor components from the tables within NUREG/CR-3474, "Long-Lived Activation Products in Reactor Materials," dated August 1984 (available to the public online through the U.S. Department of Energy Office of Scientific and Technical Information). The licensee also reviewed data provided in NUREG/CR-4289, "Residual Radionuclide Concentration Within and Around Commercial Nuclear Power Plants: Assessment of Origin, Distribution, Inventory, and Decommissioning," dated February 1986 (ADAMS Accession No. ML061530019), regarding both fission and activation products in actual samples from seven nuclear power plants. Finally, the licensee reviewed the results of concrete core samples collected from the LACBWR waste treatment building, reactor building, and piping and ventilation tunnels.

The licensee eliminated noble gases from the initial suite of ROCs since they are not expected to be present at the time of FSS. The licensee also eliminated any radionuclide with a half-life less than two years, and theoretical neutron activation products that have calculated activity concentrations less than 0.0001 (0.01percent) of both the calculated activity concentrations of Co-60 and Nickel-63 (Ni-63) (the prominent activation products identified in the LACBWR 10 CFR Part 61 samples). The final initial suite of potential radionuclides, along with an assumed activity mixture fraction, is presented in Table 6-3, "Initial Suite of Potential Radionuclides and Mixture Fractions," of the LACBWR LTP. The final suite of dose significant ROCs at LACBWR for use during decommissioning is provided in Table 4 below.

Table 4: Significant Radionuclides of Concern for LACBWR

Radionuclide of Concern	Half-Life (in years)	Primary Form of Radiation Emitted
Co-60	5.27	Gamma
Sr-90	29.1	Beta
Cs-137	30	Gamma
Eu-152	13.3	Gamma
Eu-154	8.8	Gamma

To characterize source terms from concrete, the licensee derived the radionuclide mixture fractions using the results from 30 concrete core sample locations (38 total samples when considering samples from various depths at the same location) taken across the reactor building, WTB, and piping and ventilation tunnels. Specifically, the first half inch of each core sample was sent for analysis from the 30 locations. In addition, pucks representing the concrete radioactivity deeper than half an inch from four reactor building sample locations and two WTB sample locations were sent for isotopic analysis. As a result of questions raised by the NRC during the RAI process and the subsequent response from LACBWR, the licensee analyzed the reactor building and WGTV concrete core samples as two separate sample populations in order to recognize the potential that these populations may contain different radionuclide mixtures. The licensee also produced a mixture fraction using the combination of all 38 samples as a population in order to represent potential soil or buried pipe radionuclide mixtures, since the soil and buried piping samples taken to date did not contain sufficient quantities of residual radioactivity to allow for reliable quantification of mixture fractions.

As a result of the RAI process, the licensee also compared three alternative methods for deriving the radionuclide mixture percentages from the sample data. The third option, in which the licensee calculated the individual radionuclide ratios to Cs-137 (which is the predominant radionuclide at the LACBWR facility) for each sample, $R_{i,Cs\text{-}137,j}$, calculated the 75th percentile for the sample population, $R_{i,Cs\text{-}137,k,\ .75}$, and then renormalized the data to determine the activity fractions, $f_RA_{i,k,.75}$, was the most conservative approach, and therefore chosen to conservatively represent the overall nuclide mixtures for soil, the reactor building, and the WGTV. The soil mixture fractions are also applied to buried pipe and above grade buildings. The following equation demonstrates this calculation process (Equation 6-4 of the LACBWR LTP).

Equation 5: Relative Activity Fraction Calculation using 75th Percentile of Ratio to Cs-137

$$f_R A_{i,k,.75} = \frac{R_{i,Cs-137,k,.75}}{\sum(i) R_{i,Cs-137,k,.75}}$$

The final initial suite of potential radionuclides, along with an assumed activity mixture fraction as modified by the approach discussed above, as well as the dose fraction associated with each radionuclide is presented in the following table (note Rx Bldg represents the reactor building).

Table 5: Initial Suite of Potential Radionuclides and Radionuclide Activity Fractions

Nuclide	All Samples Activity Fractions	Rx Bldg Activity Fractions	WGTV Activity Fractions	All Samples Dose Fractions	Rx Bldg Dose Fractions	WGTV Dose Fractions
H-3	1.51E-01	2.36E-02	2.52E-01	8.27E-04	1.26E-04	2.33E-03
C-14	1.72E-03	1.27E-03	9.37E-03	6.69E-07	5.51E-05	9.61E-04
Fe-55	2.36E-02	1.40E-02	-8.13E-03	2.22E-07	1.46E-05	-1.91E-05
Ni-59	7.40E-04	2.48E-04	4.74E-02	2.72E-09	2.73E-08	1.24E-05
Co-60	**3.43E-02**	**4.58E-02**	**4.76E-03**	**2.55E-01**	**2.43E-01**	**4.05E-02**
Ni-63	2.64E-01	2.77E-01	1.89E-01	2.66E-06	8.35E-05	1.22E-04
Sr-90	**5.22E-02**	**7.59E-02**	**9.12E-03**	**7.57E-04**	**1.34E-01**	**4.24E-02**
Nb-94	1.68E-04	1.07E-04	1.01E-03	7.96E-04	3.51E-04	5.22E-03
Tc-99	2.06E-03	2.16E-03	6.91E-03	5.52E-04	4.72E-04	2.51E-03
Cs-137	**4.41E-01**	**4.92E-01**	**4.49E-01**	**7.25E-01**	**5.92E-01**	**8.70E-01**
Eu-152	**2.93E-03**	**1.84E-03**	**4.49E-03**	**9.82E-03**	**4.25E-03**	**1.63E-02**
Eu-154	**1.50E-03**	**2.49E-03**	**1.60E-03**	**5.42E-03**	**6.22E-03**	**6.29E-03**
Eu-155	2.08E-03	6.61E-04	4.56E-03	1.77E-04	3.96E-05	4.32E-04
Np-237	2.15E-06	2.17E-06	*	2.56E-04	4.06E-04	*
Pu-238	1.16E-03	2.27E-03	7.95E-04	6.65E-05	3.24E-03	2.46E-03
Pu-239/240	7.80E-04	3.17E-03	1.90E-04	4.98E-05	5.01E-03	7.15E-04
Pu-241	1.56E-02	4.58E-02	2.35E-02	4.08E-05	1.44E-03	1.64E-03
Am-241	3.56E-03	1.03E-02	3.25E-03	3.12E-04	9.27E-03	6.46E-03
Am-243	5.85E-04	6.18E-04	4.55E-04	2.99E-04	7.31E-04	1.15E-03
Cm-243/244	1.65E-04	1.58E-04	1.78E-04	5.48E-05	6.99E-05	1.46E-04
			Total	1.00	1.00	1.00
			ROC Dose Percent	99.7%	97.9%	97.6%
			IC Dose Percent	0.3%	2.13%	2.42%

* Note: the licensee calculated the Neptunium-237 (Np-237) activity fraction separately as a result of the RAI process, even though Np-237 was not detected in any of the 38 concrete core samples. The Np-237 value calculated was 7.3 percent using the maximum MDC for Np-237 of 0.239 pCi/g. The dose significant ROCs for LACBWR ROCs are shown in **bold**.

The activity mixture percentages (with the exception of Np-237 for the WGTV) shown in Table 5 are based on the inventories calculated for LACBWR, and decay corrected to March 1, 2020, since this is the earliest possible date for license termination. The licensee has chosen to define the dose significant radionuclides of concern as Co-60, Sr-90, Cs-137, Eu-152, and

Eu-154. The licensee used the applicable DCGLs for the full initial suite of radionuclides to calculate the relative dose fractions for the three sample populations. The results are shown in Table 6 below, which shows the DCGLs for the full initial suite of radionuclides that will be used in verifying the insignificant contributor doses for areas undergoing continuing characterization.

Table 6: Summed Basement DCGL ($DCGL_B$) and Soil DCGLs for Initial Suite ROCs

Radionuclide	Rx Bldg $DCGL_B$ (pCi/m^2)	WGTV $DCGL_B$ (pCi/m^2)	Soil DCGL (pCi/g)
H-3	6.54E+09	5.91E+09	1.746E+04
C-14	8.03E+08	5.33E+08	2.448E+05
Fe-55	3.35E+10	2.32E+10	1.018E+07
Ni-59	3.17E+11	2.09E+11	2.594E+07
Co-60	6.57E+06	6.42E+06	1.281E+01
Ni-63	1.16E+11	8.49E+10	9.478E+06
Sr-90	1.97E+07	1.18E+07	6.586E+03
Nb-94	1.06E+07	1.05E+07	2.018E+01
Tc-99	1.59E+08	1.50E+08	3.563E+02
Cs-137	2.90E+07	2.82E+07	5.812E+01
Eu-152	1.51E+07	1.51E+07	2.844E+01
Eu-154	1.40E+07	1.39E+07	2.636E+01
Eu-155	5.81E+08	5.77E+08	1.122E+03
Np-237	1.86E+05	1.51E+05	7.991E-01
Pu-238	2.44E+07	1.77E+07	1.660E+03
Pu-239	2.20E+07	1.46E+07	1.494E+03
Pu-240	2.20E+07	1.46E+07	1.496E+03
Pu-241	1.11E+09	7.81E+08	3.637E+04
Am-241	3.89E+07	2.75E+07	1.089E+03
Am-243	2.94E+07	2.16E+07	1.868E+02
Cm-243	7.89E+07	6.66E+07	2.884E+02
Cm-244	1.79E+08	1.34E+08	2.668E+03

Table 5 shows that the insignificant contribution dose (excluding the potential for an Np-237 dose contribution from the WGTV) ranges from approximately 0.3 percent to 2.42 percent (not including negative values) of the total dose. As a result of the RAI process, the licensee also calculated the potential contribution from Np-237 at its minimum detectible concentration. The adjusted IC dose, including Np-237 in the WGTV, calculated by the licensee ranged from 0.3 percent to 7.3 percent of the total dose. To provide additional margin and conservatism, the licensee assigned an IC dose of 10 percent to adjust the DCGLs for the ROCs in all media (soil, basements, buried pipe, and above grade buildings).

Section 2.4 of the LACBWR LTP describes the areas that will undergo continuing characterization as decommissioning activities progress at the LACBWR facility. The survey of the following specific inaccessible or not readily accessible subsurface soils or basement surfaces has or had been deferred as of writing of the SER:

- WGTV interior structural surfaces.
- Underlying concrete in the reactor building basement after liner removal.
- Soil under the turbine building (location of a suspected broken drain line).
- Soil adjacent to and beneath basement structures.
- Interior of buried pipe that may remain.

For these areas, the licensee has committed to verifying that the IC dose contribution remains below 10 percent as described in Section 5.1 of the LACBWR LTP, which is also discussed in Section 3.5.2.1, "Radionuclides of Concern During Decommissioning," of the SER. The licensee will use the continuing characterization data collected for these areas, along with the DCGLs shown in Table 6 of the SER, to verify the IC dose contribution of the initial suite of radionuclides is bounded by the 10 percent assumption.

3.6.1.3 NRC Staff Evaluation of Source Term and Approach for Overall Dose Compliance

The NRC staff reviewed the information provided in the LACBWR LTP pertaining to the licensee's assessment of the potential doses resulting from exposure to residual radioactivity remaining at the end of the decommissioning process according to NUREG-1757, Volume 2, Section 5.2. The findings and conclusions of the review evaluate the licensee's ability to comply with 10 CFR 20.1402 using the methods described in the LACBWR LTP. The NRC staff reviewed the assumptions used by the licensee to characterize the facility's source term of residual radioactivity for dose modeling purposes. The key areas of review for the source term assumptions are the potential radionuclides of concern, configuration, residual radioactivity spatial variability, and chemical form(s) of the source. The NRC staff also reviewed the determination that some of the potential radionuclides are insignificant contributors to dose. Given there are multiple sources of potential residual radioactivity at the site (soil, backfilled basements, buried piping, groundwater, and above grade structures), the NRC staff also reviewed the approach for demonstrating overall compliance from all sources.

The NRC staff reviewed the licensee's approach to developing a list of potential radionuclides for the LACBWR facility and their relative mixture percentages. The licensee has used operational histories, process knowledge, and the appropriate NRC guidance documents to develop the initial suite of radionuclides. The NRC staff also reviewed the licensee's approach to developing the radionuclide mixture fractions and corresponding relative dose contribution for these radionuclides. The licensee has created a unique radionuclide mixture for the major types of materials expected to remain on the site after remediation (reactor building concrete, waste gas tank vault concrete, soil, and buried piping). The NRC staff finds it appropriately conservative to use all of the concrete samples (38 cores) to inform the soil and buried piping mixture fractions because the actual soil samples taken for characterization did not have positive results for many of the initial suite of radionuclides. The NRC staff also finds it appropriate to assign a different mixture profile to the reactor building versus the waste gas tank vault in light of the different operational histories of the two buildings.

NUREG 1757, Volume 2, Section 3.3 provides guidance on conditions under which radionuclides or exposure pathways may be considered insignificant and eliminated from further consideration. Specifically, the NRC staff determined it is reasonable that radionuclides or pathways that are insignificant contributors to dose (less than 10 percent of the dose criteria, or 2.5 mrem/yr) may be eliminated from further detailed consideration. This is in accordance with NUREG 1757, Volume 2, Appendix O, "Lessons Learned and Questions and Answers to Clarify License Termination Guidance and Plans," Question 2, which states:

> When developing derived concentration guideline levels (DCGLs) for the FSS, which radionuclides can be deselected from further consideration?
>
> It is incumbent on the licensee to have adequate characterization data to support and document the determination that some radionuclides may be deselected from further detailed consideration in planning the Final Status Survey (FSS). Radionuclides that are undetected may also be considered insignificant, as long as the MDCs are sufficient to conclude that the dose contribution is less than 10 percent of the dose criterion (i.e., with the assumption that the radionuclides are present at the MDCs).

Given the discussion in NUREG-1757, the NRC staff finds the licensee's assignment of 10 percent to insignificant contributors reasonable given that the IC range estimated by the licensee (excluding Np-237) was well below 10 percent (0.3 percent to 2.42 percent). The NRC staff notes that Np-237 was not detected in any of the 38 concrete core samples, or any of the soil samples taken during characterization, and that the licensee will be verifying the insignificant contributor dose percentage in 10 percent of the continuing characterization samples for areas that have not yet been characterized. The licensee analyzed three methods for calculating the radionuclide mixture fractions for LACBWR, and went forward with using an approach that was based on the 75th percentile values across sample populations. Furthermore, the licensee calculated specific mixture percentages for the separate buildings (reactor building and WGTV) that will be subject to FSS given the different operating histories of the buildings. For the areas that have not yet been characterized, the NRC finds the licensee's approach of analyzing 10 percent of the samples within each survey unit for the full initial suite of ROCs in order to verify the IC dose appropriate. Furthermore, in the case that the assumed IC dose is exceeded, the NRC finds the licensee's approach for investigating the area of contamination and verifying the list of final ROCs to be appropriate.

The NRC staff notes that in December 2017 the licensee detected tritium (H-3) in the ice and snow melt impacted by the reactor building ventilation system during LACBWR reactor building demolition activities. Tritium levels were recorded up to 237,000 pCi/L, resulting in a maximum groundwater H-3 level of 24,200 pCi/L in Monitoring Well MW-203A. Survey Unit L1-010-102 (containing the turbine building slab, pit, and sump, and the reactor / generator and sump) is directly west of the reactor building, where the H-3 release occurred, and includes the soil beneath and adjacent to the LACBWR turbine building. The licensee analyzed 7 soil samples from the western portion of Survey Unit L1-010-102 for the full initial suite of ROCs and did not detect H-3 above the minimum detectable activity (MDA). (One additional sample from this portion of the survey unit was taken and only analyzed for Sr-90, which is discussed in further detail in LS's November 15, 2018, submittal.)

The eastern portion of the survey unit had not yet been sampled, or results had not yet been provided to the NRC, as of the finalization of the SER. However, the licensee indicated in both the May 31, 2018, and November 15, 2018, submittals that continuing characterization for the survey unit will be accomplished via sampling using GeoProbe® technology due to the intrusion of groundwater into the survey unit causing it to become inaccessible for gamma scanning. Specifically, for continuing characterization, soil sampling will be biased to areas closer to the location of the suspected broken drain lines under the turbine building (to the west within the survey unit) and the locations of potential H-3 contamination (to the east of the survey unit between the sump and the reactor building). In accordance with the LACBWR LTP, 10 percent of all samples collected in the survey unit will be analyzed for HTD radionuclides. In addition, a minimum of one sample beyond the 10 percent minimum will be selected at random, also for HTD radionuclide analysis. Additionally, if levels of residual radioactivity in an individual soil sample exceed an SOF of 0.1 (using Operational DCGLs), then the sample(s) will be analyzed for the HTD radionuclides. This same approach will be utilized in the FSS, with additional samples being used to augment the lack of available gamma scanning data.

As a result of the H-3 release, the NRC staff requested the licensee describe how the reactor building demolition activities may have impacted the radionuclide mixture assumptions or the established surrogate ratios for HTD radionuclides. In its response dated November 15, 2018, the licensee described the precautionary measures that are taken to minimize airborne particulate migration, such as the high efficiency particulate air filter (HEPA) ventilation system, and the corrective actions that were implemented, such as over excavating surfaces beside or beneath the reactor building concrete that was removed and sifting through soils to remove any concrete pieces that may be contaminated with H-3. The NRC staff finds that even with the release of H-3, it is still appropriate for H-3 to be designated as one of the insignificant radionuclides for soil and concrete because of its relatively low dose-to-source ratio, as well as the assumption by the licensee that insignificant radionuclides are contributing 10 percent of the overall dose. Furthermore, the licensee has committed to measuring for H-3 in groundwater and assigning a dose directly to H-3 using the separate groundwater exposure factors.

The NRC staff confirmed that the actual measurements, facility history, and planned remedial action(s) support the source term configuration used in the dose modeling assumptions by reviewing the information in the facility history, radiological status, and planned remedial action(s) portions of the LACBWR LTP. The NRC staff reviewed the provided information for both the areal extent of residual radioactivity and the depth (for soil or buildings) of the residual radioactivity. The information provided supports the configuration assumptions used in the exposure scenario and mathematical model (see Sections 3.6.2 – 3.6.5 of the SER).

Given that the licensee used dose modeling to develop DCGLs for LACBWR, instead of estimating final concentrations and then entering them into a code, the licensee does not need to specifically address the spatial variability of the residual radioactivity at this time. The licensee will provide this information as part of the FSS final report for NRC staff review. During review of the FSS report(s), the NRC staff will verify that the spatial variability is compatible with the assumptions made for dose modeling. In addition, the NRC staff reviewed the licensee's assumptions regarding the chemical form of the residual radioactivity and has found the assumptions to be appropriate in choosing the dose per unit intake in accordance with the information contained in the U.S. Environmental Protection Agency's (EPA's) Federal Guidance Report (FGR) Number 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," dated September 1988.

The NRC staff notes that the SER is approving the BcDCGLs for LACBWR. The specific OpDCGLs need not be approved, because to be in compliance with 10 CFR 20.1402 the licensee must only show overall compliance with the 25 mrem/yr dose limit from all sources, as opposed to showing that specific sources are within specific fractions of the 25 mrem/yr limit.

However, as specified in Section 3.5.6.4, “FSS Preparation, Investigation Process, and Reclassification Activities,” of the SER, the design of certain portions of the LACBWR FSS plan and investigation levels are based on OpDCGLs, and the licensee is applying the OpDCGLs for use in the Sign Test within each survey unit. Therefore, if the licensee desires to increase the OpDCGLs above what is specified in TSD LC-FS-TSD-002, Revision 2, the licensee will have to demonstrate to the NRC as part of the FSS final report that the FSS designs and investigation levels are adequately based on the final (adjusted) OpDCGLs which were used during the FSS.

The NRC staff reviewed the licensee’s approach for demonstrating compliance with the dose limit for unrestricted release using Equation 4. The NRC staff notes that in this equation, the BcSOF calculation for above grade buildings ($BcSOF_{AG\ BUILDING}$), groundwater pathway in the “other basement” (GW $BcSOF_{BS\ OB}$), and groundwater pathway in the “other buried pipe” (GW $BcSOF_{BPS\ OBP}$), do not include a term for elevated areas. The licensee has committed to remediate any areas where systematic and/or judgmental measurements in above grade buildings exceed the OpDCGLs, such that no elevated areas will exist in above grade buildings. The groundwater dose from the other buried pipe (GW $BcSOF_{BPS\ OBP}$) and other basement structure (GW $BcSOF_{BS\ OB}$) are based only on systematic measurements, and do not include a separate dose term for judgmental samples that may be above the OpDCGLs. The NRC staff finds this appropriate because the maximum doses from any elevated areas potentially within the basement and/or buried pipe survey units are already accounted for in the Max $BcSOF_{BASEMENT}$ and Max $BcSOF_{BURIED\ PIPE}$ terms. In addition, the systematic measurements in the other basement survey unit will adequately account for the total activity that could contribute to groundwater dose from that basement survey unit since it is classified as Class 1 and thus will require 100 percent coverage with the ISOCS systematic measurements.

3.6.2 Future Land Use and the Average Member of the Critical Group

Section 6.4, “Future Land Use Scenario and Average Member of the Critical Group,” of the LACBWR LTP provides a basis for the “reasonably foreseeable” future land use at the LACBWR site being an industrial use scenario. DPC owns the LACBWR site and operates the Genoa 3 coal power plant on the property, which is projected to continue operating for another 20-25 years. The licensee points to the fact that there are roughly 36 acres of closed coal ash landfills on the site to further support the assumption of no residential development in the foreseeable future. The licensee also states that there are more desirable tracts of land nearby that would be better suited for residential development. Given that the future land use scenario for the LACBWR site is industrial, the licensee defines the average member of the critical group (AMCG) for dose modeling assumptions as the industrial worker.

3.6.2.1 NRC Staff Evaluation of Future Land Use and the AMCG

Section I.3.3.3.1, “Land Use,” of NUREG-1757, Volume 2, provides the following guidance on reviewing land use assumptions:

> Licensees should base justifications of land use on (1) the nature of the land and reasonable predictions based on its physical and geologic characteristics, and (2) societal uses of the land based on past historical information, current uses of it and similar properties, and what is reasonably foreseeable in the near future.

The licensee has provided an adequate basis for the industrial use dose modeling scenario to be used at LACBWR to demonstrate compliance with the unrestricted release criteria of 10 CFR 20.1402. The site has been in continuous industrial use for 74 years, and DPC plans to continue this type of land use in the future. The LACBWR site is shared with a coal plant that will continue operation for another 20-25 years, and will likely have a new power station constructed on it as the property contains a transmission station and valuable infrastructure to support the site's future use for power supply. The licensee has justified the possible land use the site might experience in the future (next 100 years) and has developed exposure scenarios for the industrial worker consistent with these land uses. The licensee has adequately described the exposure pathways to which the industrial worker is or could be exposed.

In Section 6.5.7, "Alternate Scenarios," of the LACBWR LTP, the licensee has also identified what land uses are less likely but plausible for the site and evaluated scenarios consistent with these less likely but plausible land uses. The evaluation of the less likely but plausible alternative scenario is discussed in Section 3.6.8, "Alternate Scenario," of the SER.

3.6.3 Soil Dose Assessment and DCGLs

Section 6.5.2, "Soil," of the LACBWR LTP summarizes the soil conceptual model to be implemented at the LACBWR site. The licensee defines surface soil as the first 15 cm layer of soil and plans to perform FSS on the first 15 cm. For simplification and ease of implementation, the licensee chose to assume a contaminated zone thickness of 1 meter as opposed to 15 cm in deriving the soil DCGLs in case soil contamination is identified at LACBWR with a thickness greater than 15 cm up to 1 meter. In a revision to this section of the LACBWR LTP provided with the November 15, 2018, RAI response, the licensee committed to notifying the NRC in the unlikely event that geometries are encountered during continuing characterization or during FSS that are not bounded by the assumed 1 meter soil contamination thickness, which will need to be addressed by additional modeling. The licensee also committed to seek approval from the NRC before implementing any associated changes to the dose modeling assumptions.

3.6.3.1 Scenarios, Parameters, and Uncertainty Analysis for Soil DCGLs

According to the LACBWR LTP, site-specific DCGLs were developed for residual radioactivity in surface soil that represent the 10 CFR 20.1402 dose criterion of 25 mrem/yr. A DCGL was calculated for each initial suite radionuclide in order to provide an input to the determination of IC dose percentage and the final list of ROCs. The surface soil conceptual model assumes that the soil contamination is contained in a uniformly contaminated 1 meter layer of soil from the ground surface downward. There are no expectations that at the time of license termination, residual radioactivity will remain with a geometry consisting of a clean surface layer of soil over a contaminated subsurface soil layer with concentrations exceeding the surface soil DCGL.

Section 6.7.2, "Exposure Pathways and Critical Group," of the LACBWR LTP discusses the soil exposure pathways that are applicable to the soil model scenarios, which include: (1) direct exposure to external radiation; (2) inhalation of airborne radioactivity; (3) ingestion of soil; and (4) ingestion of water from an onsite well.

Section 6.8.1, "Parameter Selection Process," of the LACBWR LTP discusses the parameter selection process. Parameters are defined as either physical, behavioral, or metabolic. Physical parameters are specific to the site and the source term, behavioral parameters are defined by the receptor's behavior, and metabolic parameters are defined by the receptor's physiological characteristics. The licensee assigned metabolic and behavioral parameters (except for those otherwise noted) using the mean values from NUREG/CR-5512, Volume 3, Table 6.87, "Default values for residential scenario parameters…."

Physical parameters are ranked by priority as level 1, 2, or 3, as documented in Attachment B, "Selection of RESRAD[7] and RESRAD-BUILD Input Parameters for Detailed Distribution Analysis," to NUREG/CR-6697, "Development of Probabilistic RESRAD 6.0 and RESRAD-BUILD 3.0 Computer Codes," dated December 2000 (ADAMS Accession No. ML010090284). Since priority 1 and priority 2 parameters are more risk significant in terms of their potential impact on dose, they were either assigned site-specific deterministic values, or the mean, 25th, or 75th percentile of the parameter distribution, depending on how strongly they are correlated with dose. Priority 3 parameters were assigned either a site-specific value or the median values from the parameter distributions defined in NUREG/CR-6697.

Section 6.8.2, "RESRAD Parameter Selection for Uncertainty Analysis," of the LACBWR LTP discusses the parameter selection for the sensitivity analysis conducted by the licensee to determine the correlation with dose of parameters. For the sensitivity analysis, some site-specific parameters are deterministic, while others are assigned probability distributions.

The licensee used site-specific deterministic values for the hydrogeological parameters, taken from the LACBWR Hydrogeological Investigation Report, which was prepared by Haley & Aldrich, Inc., in January 2015 (ADAMS Accession No. ML19007A261). The NRC staff's review of the supporting bases for the site-specific hydrogeological parameter values is contained in Section 3.7.5, "Groundwater," and Section 3.7.6, "Groundwater Monitoring," of the SER. The deterministic values were applied to the following hydrogeological parameters:

- Contaminated Zone Hydraulic Conductivity (34822 m/yr (313 feet/day)).
- Soil Density (1.76).
- Soil Porosity (0.31).
- Soil Effective Porosity (0.28).
- Saturated Zone Hydraulic Gradient (0.0045).
- Saturated Zone Field Capacity (0.066).

The licensee selected a site-specific deterministic value for the Saturated Zone Field Capacity based on a similar calculation performed for a sand soil type at ZNPS (see Zion*Solutions*, LLC TSD 14-006, "Conestoga Rovers & Associates Report, Evaluation of Hydrological Parameters in Support of Dose Modeling for the Zion Restoration Project," Revision 5 (ADAMS Accession No. ML19007A241)). Note that the site-specific soil type for LACBWR is also mainly sand.

The licensee derived the inhalation rate for the industrial worker AMCG from NUREG/CR-5512, Section 5.3.4, "Breathing Rates for the Average Member of the Screening Group," which recommends an inhalation rate for workers in light industry of 1.4 cubic meters per hour (m^3/hr). The licensee assumed that 5 days a week and 50 weeks of the year (2190 hours) are spent working in the industrial use scenario to calculate the parameter as follows: inhalation rate (m^3/yr) = 1.4 m^3/hr*2190 hrs/yr = 3066 m^3/yr.

[7] The RESRAD family of computer codes is a tool for evaluating radioactively contaminated sites, specifically designed to help determine the allowable RESidual RADioactivity in site cleanup.

To determine the drinking water intake rate for the industrial worker, the licensee used the water intake rate of 478 L/yr (or 1.31 liters per day (L/dy)) for a residential user provided in NUREG/CR-5512, Table 6.87. The licensee assumed 250 work days out of the year for an industrial worker to calculate the parameter as follows: 1.31 L/dy * 250 work days/yr = 327 L/yr.

To determine the fraction of time out of the year spent indoors versus outdoors, the licensee assumed that 75 percent of work time is assumed to be indoors and 25 percent outdoors, consistent with Table 2-3, "Comparison of Key Parameters Used in the Resident Farmer, Suburban Resident, Industrial Worker, and Recreationist Scenarios," of the Argonne National Laboratory (ANL) Report "User's Manual for RESRAD Version 6," dated July 2001. The licensee assumed that 5 days a week, 8.75 hrs/dy, and 50 weeks of the year (2190 hrs) are spent working. The licensee calculated the indoor residence fraction as (2190*0.75)/(24*365) = 0.1875 and the outdoor fraction as (2190*0.25)/(24*365) = 0.0625.

The licensee assigned a site-specific parameter distribution for well pumping intake depth based on the two existing onsite industrial water supply wells at the LACBWR site. Since NUREG/CR-6697 does not provide a recommended value for well pumping rate due to high variability, the licensee developed a uniform distribution by assuming a minimum well pumping rate using a four worker scenario (NUREG/CR-6697, Table 3.10-1, "Example Calculations for Estimating the Well Pumping Rate," provides a sanitary and potable water usage rate for four persons of 328.7 m^3/yr); and a maximum well pumping rate is assumed based on supply to 20 workers, which equates to 1643.5 m^3/yr.

The licensee presents all parameters for the soil DCGL uncertainty analysis in Attachment 6-1, "RESRAD Input Parameters for LACBWR Soil DCGL Uncertainty Analysis," of the LACBWR LTP, which were selected in accordance with the process flow chart in Figure 6-7, "RESRAD Parameter Selection Flow Chart," of the LACBWR LTP, following the guidance in NUREG/CR-5512, Volume 3, and NUREG/CR-6697.

The results of the sensitivity analysis for the soil conceptual model are discussed in Section 6.8.3, "Soil DCGL Uncertainty Analysis Results," of the LACBWR LTP. Table 6-4, "Soil DCGL Uncertainty Analysis Results for K_d and Selected Deterministic Values," of the LACBWR LTP lists the uncertainty analysis results for distribution coefficients (K_ds) and the selected deterministic values based on the sensitivity results. For sensitive parameters, the licensee assigned either the 75th or 25th percentile values from the sand K_d distributions in Sheppard and Thibault's, "Default Soil / Solid / Liquid Partition Coefficients, K_ds, for Four Major Soil Types: A Compendium," dated 1990. For non-sensitive K_d parameters, the licensee assigned the mean deterministic values for sand as listed in NUREG/CR-6697, Table 3.9-2, "Comparison of the Mean K_d Values with Those from Other Sources." Table 6-5, "Soil DCGL Uncertainty Analysis Results for Non-Nuclide Specific Parameters and Selected Deterministic Values," in the LACBWR LTP lists the uncertainty results for other parameters (which are not nuclide-specific) and their selected deterministic values.

The base case soil DCGLs derived by the licensee and adjusted for insignificant contributor dose, as well as alternate scenario dose, are captured in Table 6-27, "Soil DCGLs for ROC Adjusted for Insignificant Contributor Dose and Alternate Scenario Dose," of the LACBWR LTP, and are reproduced in Table 7 below.

Table 7: Soil DCGL$_S$ Adjusted for IC Dose and Alternate Scenario Dose

ROC	Adjusted Soil DCGL (pCi/g)
Co-60	1.06E+01
Sr-90	5.47E+03
Cs-137	4.83E+01
Eu-152	2.36E+01
Eu-154	2.19E+01

3.6.3.2 Elevated Areas in Soils and Associated Area Factors

Section 6.19, "Soil Area Factors," of the LACBWR LTP discusses the area factors to be used to account for small areas of elevated activity in soil at LACBWR. The licensee derived area factors by varying the area of the contaminated zone from 1.0 m^2 to 100 m^2 in the same conceptual model that was used to calculate the soil DCGLs. The licensee then calculated area factors by dividing the output value (in pCi/g per 25 mrem/yr) from RESRAD for each smaller area by the unadjusted soil DCGLs for the full initial suite of radionuclides in Table 6-6, "LACBWR Soil DCGLs for Initial Suite Radionuclides," of the LACBWR LTP. The resultant area factors are presented in Table 6-34, "Surface Soil Area Factors," of the LACBWR LTP, and are reproduced in Table 8 below for contaminated zones of various sizes.

Table 8: Surface Soil Area Factors for LACBWR

Radionuclide	Area Factors				
	$1m^2$	$2m^2$	$5m^2$	$10m^2$	$100m^2$
Cs-137	9.44	5.56	3.07	2.04	1.19
Co-60	9.11	5.42	3.01	2.00	1.18
Sr-90	11.21	6.66	3.69	2.45	1.41
Eu-152	9.30	5.50	3.04	2.02	1.18
Eu-154	9.38	5.54	3.06	2.03	1.18

3.6.3.3 NRC Staff Evaluation and Independent Analysis of Soil DCGLs and Area Factors

The NRC staff reviewed the scenarios, parameters, and uncertainty analyses the licensee assumed to develop the soil conceptual model and site-specific soil DCGLs for the LACBWR site using Section 2.6 of NUREG-1700, which refers to NUREG-1757, Volume 2, Section 5.2 and Appendix I, and describes, in part, the areas of review pertaining to unrestricted release using site-specific DCGLs. Specifically, the NRC staff verified that the LACBWR site conditions are adequately addressed in the conceptual model and simplifying assumptions, and has confirmed that the licensee has used a mathematical model that is an adequate representation of the conceptual model using the industrial exposure scenario.

The NRC staff notes that the conceptual model for the soil DCGLs assumes contamination exists up to 1 meter deep, but not at greater depths. The NRC staff has reviewed the characterization data which supports the licensee's assumption that contamination does not exist at lower depths at the LACBWR site.

Section 5.2.3 of the LACBWR LTP states the following:

> Dose assessment in soils will be performed using the soil DCGLs in Table 5-5. However, administrative action levels will be set for soils to ensure that the mean soil concentrations at license termination are less than the values in Table H-2 of NUREG-1757, Appendix H.

Section 6.5.2 of the LACBWR LTP states the following:

> In the unlikely event that geometries are encountered during continuing characterization or during FSS that are not bounded by the assumed 1 m soil contamination thickness, the discovered geometries will be addressed by additional modeling. LS will seek approval from the NRC before implementing the change.

The NRC staff finds this approach acceptable because the discovery of subsurface soil contamination that is not bounded by the assumed conceptual model geometry for the soil DCGLs would trigger the LACBWR LTP change criteria. The LTP change criteria states that prior NRC review and approval is needed for activities that "change the approach used to demonstrate compliance with the dose criteria (e.g., change from demonstrating compliance using derived concentration levels to demonstrating compliance using a dose assessment that is based on final concentration data)." The sampling beneath the basement structures is described in Section 5.7.1.5 of the LACBWR LTP. In this section the licensee states that "no residual radioactivity was identified at concentrations greater than the generic screening values ($DCGL_W$) from NUREG-1757, Appendix H for each of the potential ROC."

Section 5.7.1.5 of the LACBWR LTP states that the licensee will be comparing results for subsurface soils with the DCGLs for soils up to 1 meter deep as the release criteria. The NRC staff notes that the soil DCGLs are conservative for this application with the exception of Sr-90 because the key pathway for Sr-90 is water dependent and placing it closer to the water table would increase its dose to source ratio. Therefore, while the soil DCGLs are conservative for Cs-137 and Co-90, they are not bounding if Sr-90 contamination is discovered in the subsurface soils (for example, beneath the basement slabs). In that case, a geometry would be encountered that is not bounded by the soil DCGL conceptual model, and the licensee would be required to seek NRC approval before implementing an alternative DCGL for Sr-90. In summary, the NRC staff concludes that the licensee's conceptual model, which assumes contaminated soil up to 1 meter in depth from the surface, is appropriate because the licensee would be required to seek NRC approval for changes in their approach if contamination is found at depths not bounded by the assumed 1 meter depth used to generate the soil DCGLs.

The licensee has adequately justified the parameter values or ranges assumed in the soil conceptual model for LACBWR. The NRC staff has reviewed the licensee's discussion of the uncertainty resulting from the physical parameter values chosen for use in the analysis. The NRC staff finds the assumptions for deriving the inhalation rate, drinking water intake rate, and fraction of time spent outdoors for the industrial worker to be appropriate. The licensee assumes 250 work days per year for the industrial worker, which is equivalent to 5 days per week for 50 weeks, which is reasonable for an industrial worker. The EPA considers water ingestion for the suburban resident and industrial worker; the EPA "Exposure Factors Handbook" recommends an average drinking water intake of 1.4 L/dy for an industrial worker. This is only slightly higher than the 1.3 L/dy assumed by the licensee; the licensee's approach is therefore acceptable. The fraction of time out of the year spent indoors versus outdoors for the industrial worker chosen by the licensee is consistent with the ANL RESRAD User's Manual, Table 2.3, "Comparison of Key Parameters Used in the Resident Farmer, Suburban Resident, Industrial Worker, and Recreationist Scenarios," which has a value for indoor fraction as 0.17 and outdoor fraction as 0.06, and is therefore acceptable. The site-specific deterministic values used for the hydrogeological parameters are evaluated in detail in Section 3.7 of the SER.

During the RAI process, the NRC staff noted that in Revision 0 of the LACBWR LTP, as implemented for the WGTV, the lower distribution coefficients (K_ds) used in the analysis of the contaminated zone led to higher leach rates from the source area, thereby pushing more radionuclides to the unsaturated and saturated zones where the larger distribution coefficients caused radionuclides to sorb to the solids rather than stay in the water phase. Therefore, the selected set of distribution coefficients led to non-conservative assumptions for both the soil inhalation / ingestion rate and groundwater pathways in the soil conceptual model. The licensee corrected this issue in Revision 1 of the LACBWR LTP by revising the sensitivity analysis, correlating the K_d values for the contaminated, saturated, and unsaturated zones with a Rank Correlation Coefficient of 0.99. This approach eliminated the inconsistent K_d sensitivity results.

The NRC staff notes that at the time of writing the SER, the licensee was still conducting continuing characterization for the soil beneath the turbine building, as well as soil adjacent to and beneath basement structures, because these areas were previously inaccessible. The NRC staff finds the licensee's commitments for verifying the insignificant contribution dose and the surrogate ratios acceptable for these areas as is discussed in Section 3.6.1.3, "NRC Staff Evaluation of Source Term and Approach for Overall Dose Compliance," of the SER. For the reasons described in this section of the SER, the NRC staff finds reasonable assurance that the site-specific DCGLs to be used in the LACBWR FSS for soil are adequate to demonstrate compliance with the unrestricted release criteria specified in 10 CFR 20.1402.

3.6.4 Backfilled Basements Dose Assessment and DCGLs

Section 6.5.1, "Backfilled Basements," of the LACBWR LTP provides an overview of the dose model used to derive DCGLs for the backfilled basements that will remain at the LACBWR site after license termination. The conceptual dose model for the backfilled basements assumes that all structures are removed to a depth of three feet below grade (i.e., to an elevation of 636 foot), and then backfilled with clean fill dirt. The LACBWR LTP further states that all impacted systems, components, and structural surfaces above the 636 foot elevation in Class 1 buildings will be removed during the decommissioning process and disposed of as waste.

3.6.4.1 Scenarios, Parameters, and Uncertainty Analysis for Backfilled Basements

Section 6.10.2, "[Basement Fill Model] BFM Exposure Pathways," of the LACBWR LTP describes the basement fill model scenarios and pathways. The BFM includes two exposure scenarios: in situ and excavation. The BFM in situ scenario includes two exposure pathways: ingestion of drinking water from an onsite well and direct exposure to drilling spoils that are assumed to be brought to the surface during the installation of the onsite well. The BFM excavation scenario assumes large scale industrial excavation of some or all of the backfilled concrete and spreading the concrete over a 1 meter layer on the ground surface. The dose from the in situ and excavation BFM scenarios are summed in the DCGL calculation. Given that it is possible that a portion of the remaining backfilled structures could be excavated, while a portion could simultaneously remain in the ground, the final backfilled basement dose for demonstrating compliance includes the sum of the in situ and excavation doses.

Section 6.10, “BFM Insitu Scenario,” of the LACBWR LTP provides details of the in situ scenario. In the in situ BFM scenario for LACBWR, the receptor assumed in the dose model drinks well water contaminated as a result of leaching of the residual radioactivity from the backfilled concrete surfaces into the fill material, and is also assumed to be exposed to drilling spoils that are brought to the surface during the hypothetical installation of an onsite water supply well. For calculating the groundwater concentration, 100 percent of the residual radioactivity in floors and walls is assumed to be instantly released to water existing in the pore space of the basement fill materials through leaching into water that comes into contact with the concrete surfaces after the basements are backfilled. The extent to which the contamination mixes with the basement fill is an uncertain variable and is discussed later in this section. The basement fill is treated as contaminated soil and modeled using RESRAD Version 7.0 to provide the dose from the well water. The licensee used Microsoft Excel datasheets to calculate the dose from the drilling spoils in conjunction with RESRAD modeling. The well installation is assumed to occur before any leaching from concrete occurs, thereby taking no credit for the decay or other forms of dilutions of the residual radioactivity remaining in the basement structures. The residual radioactivity in the basement floor concrete that is contacted by the borehole during installation of the well is assumed to be mixed with the fill material above the floor surface, brought to the ground surface, and spread over a 15 cm thick layer.

Section 6.12, “BFM Excavation Scenario,” of the LACBWR LTP provides the details of the excavation scenario. The excavation DCGLs are calculated to ensure that the average radionuclide concentrations in the excavated, mixed, and sized concrete from the basement structures do not exceed the soil DCGLs. In one type of excavation scenario, the licensee assumes the soil DCGL concentrations in pCi/g at the surface, finds the total curies associated with the total volume of concrete in the basement, and then converts those values to pCi/m^2 by dividing by the surface area of the basement. In this way, the conversion from pCi/g to pCi/m^2 depends on the ratio of the surface area to volume of the concrete exhumed. As a result of the RAI process, in Revision 1 of the LACBWR LTP the licensee also considered a scenario in which the basement walls with the minimum thickness (0.75 feet for both the LACBWR reactor building and WGTV) were independently excavated, as opposed to the entire volume of concrete for the basement. This approach maximized the surface area to volume ratio and resulted in the maximum assumed concentration in the excavated concrete. Because the second scenario resulted in more conservative excavation DCGLs, the licensee adopted this scenario over the scenario in which all the concrete is extracted.

The LACBWR LTP states that the parameter set developed to perform the soil DCGL uncertainty analysis is applicable to the groundwater portions of the BFM uncertainty analysis with changes to account for the geometries of the backfilled basement structures. The affected RESRAD geometry parameters are cover depth, area of contaminated zone, thickness of contaminated zone, length parallel to aquifer flow, unsaturated zone thickness, and fraction of contaminated zone below the water table. The following exposure pathways are applicable to both of the LACBWR basement fill model scenarios:

- Ingestion of water from onsite well.
- Direct exposure, inhalation dose and ingestion dose from contaminated drilling spoils brought to the surface during installation of the onsite well into the fill material.
- Direct exposure, inhalation dose and ingestion dose from concrete that is brought to the surface by excavation.

Because each of the two basements to remain at the LACBWR site have separate geometries, they are modeled with separate configurations. For example, the reactor backfilled basement is modeled as a contaminated zone with an area of 262 m^2 (2820 square feet [ft^2]) and a thickness of 7.32 m (24 feet [ft]), which is the depth of the filled portion of the backfilled reactor building basement beneath the 0.91 m (3 ft) cover. The water table elevation is assumed to be 629 feet above mean sea level (AMSL), the floor elevation of the reactor building is 621 feet AMSL, and the ground surface is 639 feet AMSL. These values are used to derive the thickness of the contaminated zone, as well as the fraction of the contaminated zone that is below the water table. RESRAD is used to derive dose-to-source ratios (DSRs) in pCi/g, which the licensee converts to pCi/m^2 by multiplying the DSR by the concentration (pCi/g) in the fill per unit area (pCi/m^2) of concrete between the 636 foot and 612 foot elevation. A similar approach is taken for modeling the WGTV backfilled basement using the specific geometry of that building. The conceptual models for both basement structures assume full mixing of the contamination over the fill volume in deriving the conversion factor between pCi/g and pCi/m^2.

The conceptual model applied to derive the DSRs assumes full mixing of the residual radioactivity over the entire fill volume in the backfilled basement structures both above and below the groundwater elevation. Full mixing may be reasonable below the groundwater elevation, but the degree of surface contamination mixing into the basement fill is more uncertain for the portion above the groundwater. Therefore, the licensee performed a sensitivity analysis to assess “mixing sensitivity,” or the impact on dose from various assumptions regarding contamination mixing depth. Section 6.15, “BFM Groundwater Scenario Mixing Volume Sensitivity Analysis for ROC,” of the LACBWR LTP discusses the results of this sensitivity analysis. The impact of contamination mixing distance on dose was evaluated by calculating the ratio of the dose factor (mrem/yr per pCi/m^2) for each partial mixing distance (1, 2, and 3 meters) to the dose factor under the full mixing assumption. To incorporate uncertainty in contamination mixing depth into the DCGLs, the licensee reduced the in situ groundwater DCGL values calculated for each ROC under the full mixing assumption by the ratios developed in the sensitivity analysis.

The DCGLs to be used for compliance during FSS of the LACBWR basements (the MARSSIM $DCGL_W$ value) are designated as the Operational DCGL for basement structural surfaces ($DCGL_B$) and represent the summation of the dose from the three BFM scenarios (in situ groundwater, in situ drilling spoils, and excavation). For conservatism, the $DCGL_B$ is used for FSS, which is the concentration that leads to a dose of 25 mrem/yr under the assumption that all three exposure scenarios occur simultaneously, which is not physically possible.

Section 6.16,”BFM DCGLs for ROC Adjusted for Insignificant Contributor Dose and Mixing Sensitivity,” of the LACBWR LTP summarizes the adjustments to the Base Case DCGLs for basement surfaces to account for the insignificant contributor dose, mixing sensitivity, and to account for the alternate scenario dose (see Section 3.6.8, “Alternate Scenario,” of the SER). As stated in Section 6.14.1, “Insignificant Contributor Dose and Radionuclides of Concern,” of the LACBWR LTP, as well as Section 3.6.1.2, “Radionuclides of Concern and Insignificant Radionuclide Contribution,” of the SER, the licensee assigned an insignificant dose percentage of 10 percent to adjust the DCGLs for the ROCs in all media (soil, basements, buried pipe, and above grade buildings) to account for the dose from the insignificant contributor radionuclides. The adjustments to the BFM DCGLs for basement surfaces in the reactor building to account for the insignificant contributor dose, mixing sensitivity, and the alternate scenario dose are presented in Table 6-24, “Reactor Building BFM DCGLs for ROC Individual BFM Scenarios ($DCGL_{BS}$) Adjusted for Insignificant Contributor Dose Fraction, Mixing Sensitivity, and Alternate Scenario Dose,” of the LACBWR LTP, and provided as Table 9 of the SER below.

Table 9: Adjusted Reactor Building BFM DCGLs by ROC for Individual BFM Scenarios

ROC	Reactor Building Adjusted BFM $DCGL_{BS}$ (pCi/m^2)		
	Insitu GW	Insitu Drilling Spoils	Excavation
Co-60	1.21E+08	4.75E+08	5.45E+06
Sr-90	1.46E+07	2.70E+11	2.80E+09
Cs-137	1.98E+08	1.94E+09	2.47E+07
Eu-152	2.73E+09	1.00E+09	1.21E+07
Eu-154	1.88E+09	9.43E+08	1.12E+07

The adjustments to the BFM DCGLs for basement surfaces in the WGTV to account for the insignificant contributor dose, mixing sensitivity, and the alternate scenario dose are presented in Table 6-25, "WGTV BFM DCGLs for ROC Individual BFM Scenarios ($DCGL_{BS}$) Adjusted for Insignificant Contributor Dose Fraction, Mixing Sensitivity, and Alternate Scenario Dose," of the LACBWR LTP, and provided as Table 10 of the SER below.

Table 10: Adjusted WGTV BFM DCGLs by ROC for Individual BFM Scenarios

ROC	WGTV Adjusted BFM $DCGL_{BS}$ (pCi/m^2)		
	Insitu GW	Insitu Drilling Spoils	Excavation
Co-60	6.23E+07	3.86E+08	4.43E+06
Sr-90	6.42E+06	2.20E+11	2.28E+09
Cs-137	1.52E+08	1.58E+09	2.01E+07
Eu-152	2.28E+09	8.16E+08	9.84E+06
Eu-154	1.57E+09	7.67E+08	9.12E+06

The licensee summed the adjusted dose values from the in situ and excavation scenarios BFM to derive the DCGLs to be used for compliance during the FSS of basements at the LACBWR site (the MARSSIM $DCGL_w$ value). The results are presented in Table 6-26, "BFM $DCGL_B$ Values for ROC Adjusted for Insignificant Contributor Dose Fraction, Mixing Sensitivity, and Alternate Scenario Dose," of the LACBWR LTP, and provided as Table 11 of the SER below.

Table 11: BFM $DCGL_B$ Adjusted for Mixing Sensitivity, IC, and Alternate Scenario Dose

ROC	Adjusted Reactor Building $DCGL_B$ (pCi/m^2)	Adjusted WGTV $DCGL_B$ (pCi/m^2)
Co-60	5.16E+06	4.10E+06
Sr-90	1.45E+07	6.40E+06
Cs-137	2.17E+07	1.76E+07
Eu-152	1.19E+07	9.69E+06
Eu-154	1.10E+07	8.97E+06

3.6.4.2 *Backfilled Basements and Elevated Area Consideration*

Instead of calculating area factors to be applied in cases where elevated areas of residual radioactivity are encountered in the backfilled basement structures, the licensee has committed to remediating any areas that are in excess of the Base Case DCGLs. Therefore, an elevated area for the purposes of the SER is defined as any area identified by measurement or samples (systematic or judgmental) that exceeds the Operational DCGL but is less than the Base Case DCGL. The licensee will use Equation 5-5 in the LACBWR LTP (Equation 1 of the SER) to incorporate dose from elevated areas into the calculation of the mean SOF for the affected survey unit. Further details regarding this approach during FSS of the LACBWR basement structures is described in Section 3.5.5.3, "Data Assessment and Analysis for the Basement Structures," and Section 3.5.6.3, "Areas of Elevated Activity and Scan Coverage," of the SER.

3.6.4.3 *NRC Staff Evaluation and Independent Analysis of DCGLs for Backfilled Basements*

The NRC staff reviewed the scenarios, parameters, and uncertainty analyses the licensee assumed to develop the BFM and DCGLs for backfilled basements at the LACBWR site using Section 2.6 of NUREG-1700, which refers to NUREG-1757, Volume 2, Section 5.2 and Appendix I, and describes, in part, the areas of review pertaining to unrestricted release using site-specific DCGLs. Specifically, the NRC staff verified that the LACBWR site conditions are adequately addressed in the conceptual model (BFM) and simplifying assumptions, and has confirmed that the licensee has used a mathematical model that is an adequate representation of the conceptual model using the industrial exposure scenario.

Summing the doses from the BFM in situ scenarios and the BFM excavation scenario in order to establish site-specific basement structure DCGLs is reasonably conservative because these two scenarios will not occur simultaneously. Furthermore, the dose adjustments made for mixing sensitivity in the in situ groundwater scenario adequately incorporate the uncertainty of the mixing depth assumption in the BFM. The NRC staff notes that the licensee reduced the in situ groundwater BFM DCGL values calculated for each ROC under the full mixing assumption by the ratios developed in the sensitivity analysis, but did not adjust the drilling or excavation scenario BFM DCGLs. It is not necessary to reduce the drilling scenario and excavation scenario values according to the mixing volume ratios because these scenarios assume that the contamination remains on the concrete surface, not mixed into the surrounding fill material. The NRC staff consider the minimum wall thickness (0.75 feet for both the reactor building and WGTV) assumed to be excavated (as opposed to the entire volume of concrete from the basement) to be appropriate because it maximizes the surface area to volume ratio and results in more conservative excavation DCGLs. It is also more realistic that part of a basement be excavated as opposed to the entire basement. Based on these considerations, the NRC staff concludes that the licensee has adequately justified the parameter values or ranges assumed in the BFM. The NRC staff has reviewed the licensee's discussion of the uncertainty resulting from the physical parameter values used in the analysis.

For the reasons described in this section of the SER, the NRC staff finds reasonable assurance that the site-specific DCGLs to be used in the LACBWR FSS for backfilled basements that will remain at the site after license termination are adequate to demonstrate compliance with the unrestricted release criteria specified in 10 CFR 20.1402.

3.6.5 Buried Piping Dose Assessment and DCGLs

Section 6.3, "Basements, Structures and Piping to Remain after License Termination (End State)," of the LACBWR LTP discusses the buried piping that will remain in the end state of the site, as detailed in Table 6 2, "Buried Piping to Remain in LACBWR End State," of the LTP. For the purpose of the LACBWR LTP, the licensee defined buried piping as that contained in soil, and notes that the design of the LACBWR plant precludes the need for penetrations or embedded piping. As such, none are present at the LACBWR facility.

3.6.5.1 Scenarios, Parameters, and Uncertainty Analysis for Buried Piping DCGLs

Section 6.20, "Buried Piping Dose Assessment and DCGL," of the LACBWR LTP describes the buried piping dose model scenarios and pathways. Similar to the BFM, the conceptual model for buried piping at the LACBWR facility includes two scenarios: in situ and excavation. Because the geometry of the circulating water discharge pipe is significantly different from other buried pipes at LACBWR, it is modeled separately. In the in situ buried piping scenario, the licensee models the residual radioactivity on the internal surfaces of the buried pipe as a thin 2.54 cm layer of soil in an area equal to the internal surface area of the pipe that is to remain underground. The depth of the contaminated layer in the in situ buried piping scenario is set to the lowest pipe elevation of 625 feet AMSL for the majority of the buried pipe group, and to 630.5 feet AMSL for the circulating water discharge pipe. For the excavation buried piping scenario, the residual radioactivity within the pipe is assumed to be brought to the surface and mixed within the first 15 cm of soil with no cover.

The industrial worker AMCG is exposed to dose from the in situ and excavated soil in the buried piping conceptual model via the same pathways applicable to the BFM and soil dose assessment scenarios. The licensee used RESRAD modeling in conjunction with Microsoft Excel spreadsheets to calculate buried pipe DCGLs in units of dpm/100 cm^2. The licensee summed the dose from the in situ and excavation scenarios to derive the final buried pipe DCGLs in order to account for the fact the scenarios may both occur.

The adjustments to the summed buried pipe DCGLs to account for the insignificant contributor dose are presented in Table 6-38, "Summed Buried Pipe DCGLs for ROCs adjusted for Insignificant Radionuclide Fractions," of the LACBWR LTP, and provided as Table 12 below.

Table 12: Buried Pipe $DCGL_{BP}$ Adjusted for IC Dose

ROC	Other Buried Pipe Group $DCGL_{BP}$ (dpm/100 cm^2)	Circulating Water Discharge $DCGL_{BP}$ (dpm/100 cm^2)
Co-60	7.50E+04	7.75E+04
Sr-90	5.16E+05	7.55E+05
Cs-137	3.18E+05	3.30E+05
Eu-152	1.64E+05	1.67E+05
Eu-154	1.52E+05	1.56E+05

3.6.5.2 Buried Piping and Elevated Area Consideration

Instead of calculating area factors to be applied in cases where elevated areas of residual radioactivity are encountered in the buried piping, the licensee has committed to remediating any areas that are in excess of the Base Case DCGLs. Therefore, an elevated area for the purposes of the SER is defined as any area identified by measurement or samples (systematic or judgmental) that exceeds the Operational DCGL but is less than the Base Case DCGL. The licensee will use Equation 5-5 in the LACBWR LTP (Equation 1 of the SER) to incorporate dose from elevated areas into the calculation of the mean SOF for the affected survey unit. Further details regarding this approach during the final status survey of the LACBWR buried piping is described in Section 3.5.7.2, "FSS Methods and Measurements for Other Media," and Section 3.5.6.3, "Areas of Elevated Activity and Scan Coverage," of the SER.

3.6.5.3 NRC Staff Evaluation and Independent Analysis of Buried Piping DCGLs

The NRC staff reviewed the scenarios, parameters, and uncertainty analyses the licensee assumed to develop the buried piping dose model and DCGLs at the LACBWR site using Section 2.6 of NUREG-1700, which refers to NUREG-1757, Volume 2, Section 5.2 and Appendix I, and describes, in part, the areas of review pertaining to unrestricted release using site-specific DCGLs. Specifically, the NRC staff verified that the LACBWR site conditions are adequately addressed in the buried piping conceptual model and simplifying assumptions, and has confirmed that the licensee has used a mathematical model that is an adequate representation of the conceptual model using the industrial exposure scenario.

The NRC staff notes that as part of the RAI process, a typo in Section 6.20.1, "Source Term and Radionuclide Mixture," of the LACBWR LTP, Revision 1, was identified regarding the results of continued characterization of buried piping. This typo was corrected in the page changes provided with the licensee's November 15, 2018, supplemental submittal, and states:

> As discussed in LTP Chapter 5, if continuing characterization is performed for buried pipe and the results indicate that the buried piping dose could exceed 10 percent of the 25 mrem/yr dose criterion, then samples will be analyzed for HTD radionuclides and additional assessments performed.

The licensee has adequately justified the parameter values or ranges assumed in the buried piping conceptual model for LACBWR. The NRC staff has reviewed the licensee's discussion of the uncertainty resulting from the physical parameter values chosen for use in the analysis. The NRC staff notes that the buried piping in situ dose is driven by the groundwater pathway, such that using the minimum distance to the water table is a conservative assumption.

In addition, the NRC staff notes that, on behalf of the NRC, the Oak Ridge Institute for Science and Education (ORISE) performed an independent confirmatory survey of the interior of the LACBWR circulating water discharge piping during the period of April 24 - 26, 2018 (ADAMS Accession No. ML19007A032). According to the ORISE report, "the confirmatory survey consisted of gamma scans and surface activity measurements for gamma and beta radiation to independently assess the final radiological status of the circulating water discharge piping interior relative to the release criterion. None of the collected surface activity measurements – based on either gamma or beta radiation – were above the operational gross activity derived concentration guideline level (which corresponds to a dose of approximately 5.3 mrem/yr). Based on the confirmatory survey data, it is the opinion of ORISE that residual radiation levels in the circulating water discharge piping interior are less than the release criterion." These results further support the licensee's assertion that the LACBWR circulating water discharge piping has minimal further contamination potential as remaining buried piping.

For the reasons described in this section of the SER, the NRC staff finds reasonable assurance that the site-specific DCGLs to be used in the LACBWR FSS for buried that will remain at the site after license termination are adequate to demonstrate compliance with the unrestricted release criteria specified in 10 CFR 20.1402.

3.6.6 Groundwater Dose Approach

Section 6.21, "Existing Groundwater Dose," of the LACBWR LTP discusses the licensee's approach to calculating groundwater dose. The licensee calculated groundwater exposure factors for the ROCs and H-3 directly using the FGR-11 ingestion dose conversion factors and the assumed industrial worker AMCG drinking water intake rate of 327 L/yr. The groundwater exposure factors are captured in Table 6-39, "Groundwater Exposure Factors for a Water Concentration of 1 pCi/L," of the LACBWR LTP and are reproduced in Table 13 below.

Table 13: Exposure Factors for Groundwater Contamination

ROC	GW Exposure Factor (mrem/yr per pCi/L)
Co-60	8.80E-03
Cs-137	1.64E-02
Sr-90	4.64E-02
H-3	2.09E-05
Eu-152	2.12E-03
Eu-154	3.12E-03

3.6.6.1 NRC Staff Evaluation of Groundwater Dose Approach

The NRC staff reviewed the exposure factors for groundwater the licensee assumed at the LACBWR site using Section 2.6 of NUREG-1700, which refers to NUREG-1757, Volume 2, Section 5.2 and Appendix I, and describes, in part, the areas of review pertaining to unrestricted release using site-specific DCGLs. Specifically, the NRC staff notes that the groundwater exposure factors will be multiplied by the maximum concentration (in units of pCi/L) from all groundwater sampling wells collectively for each positively identified ROC (including H-3) within the most recent two years of sampling. This has the potential of combining results from various wells if different ROCs are positively identified in different wells.

The NRC staff also notes that the licensee identified elevated levels of H-3 beginning in December 2017, with a maximum concentration of 24,200 pCi/L of H-3 identified in February 2018 in LACBWR Monitoring Well 203A. The dose for H-3 associated with a concentration of 24,200 pCi/L, using the exposure factors in Table 13, is 0.5 mrem/yr. The licensee has been monitoring the conditions of the H-3 release using the existing LACBWR groundwater monitoring well network by sample collection and analysis, following the discovery of impacted groundwater during the December 2017 sampling exercise. Additional samples were collected in February, April, June, and July of 2018, and will continue to be collected on an approximately monthly basis. Because the licensee will be sampling for H-3 in the groundwater, the dose from H-3 will be accounted for based on the commitment to multiply the maximum concentration from groundwater sampling by the associated exposure factors.

The NRC staff additionally notes that the potential groundwater dose from the radionuclides demarcated as insignificant contributors must also be accounted for in demonstrating overall compliance. Table 2-19, "2014 Groundwater Monitoring Results (pCi/L)," of the LACBWR LTP shows the groundwater monitoring samples analyzed for the full initial suite of ROCs in 2014. During the June 2014 sampling event, H-3 and Sr-90 were detected; Carbon-14 (C-14), Technetium-99 (Tc-99), Eu-152, Plutonium-239 and 240 (Pu-239/240), and Americium-241 (Am-241) were also positively detected at low concentrations in several wells. During the September 2014 sampling event, Co-60, Ni-63, Cs-137, Eu-152, Eu-154, Pu-239/240, and Am-241 were also positively detected at low concentrations in several wells in addition to Sr-90. The NRC staff notes that the licensee sampled for and detected some of these radionuclides in years after 2014, as shown in the monitoring data provided as an attachment to the November 15, 2018, supplemental submittal to the LACBWR LTP, Revision 1. However, the detected concentrations were not significantly different than those presented in Table 2-19 of the LACBWR LTP and are not anticipated to have additional impact on groundwater.

In its November 15, 2018, supplemental submittal, the licensee estimated the dose from insignificant contributor radionuclides in groundwater, and H-3 in particular. The maximum dose calculated by the licensee, using the FGR-11 ingestion dose conversion factors, from the identified positive detections in the June 2014 groundwater sampling event was 0.471 mrem/yr from Monitoring Well DW7 associated with a positive detection of Pu-239. The licensee assigned a total dose from groundwater of 3.25 mrem in TSD LC-FS-TSD-002 (which discusses the Operational DCGLs for FSS) corresponding to a total dose fraction of 0.13 from groundwater. Reducing 3.25 mrem by 0.471 mrem yields a remaining dose 2.779 mrem. Hypothetically attributing this dose to H-3 would corresponds to an H-3 concentration of over 110,000 pCi/L. Given that this concentration is significantly higher than the any observed H-3 concentration in groundwater at LACBWR since January 2018, the licensee concluded that inclusion of the positive detections from the 2014 groundwater sampling event results does not change the conservative assumption in TSD LC-FS-TSD-002 that the total groundwater dose from positive detections will not exceed 3.25 mrem/yr.

For the reasons described in this section of the SER, the NRC staff finds reasonable assurance that the approach to assessing groundwater dose is adequate to demonstrate compliance with the unrestricted release criteria specified in 10 CFR 20.1402.

3.6.7 Above Grade Structure Radiological Screening Values

Section 6.5.5, "Remaining Above Grade Buildings," of the LACBWR LTP discusses the release criteria that will be applied for the remaining above grade structures at LACBWR, which include:

- LACBWR Administration Building
- Genoa 3 Crib House
- LACBWR Crib House
- Transmission Sub-Station Switch House

- Genoa 1 Crib House
- Barge Wash Break Room
- Back-up Control Center
- Security Station

The licensee will apply the screening values from Table H.1, "Acceptable License Termination Screening Values of Common Radionuclides for Building-Surface Contamination," in NUREG-1757 to the FSS for above grade buildings. These screening values for the impacted above grade structures to remain at LACBWR are captured in Table 14 below.

Table 14: Base Case DCGLs for Above Grade Buildings ($DCGL_{AGB}$)

ROC	NUREG-1757, Table H.1 Screening Values (dpm/100cm^2)
Co-60	7100
Cs-137	28000
Sr-90	8700
H-3	120000000
Eu-152	12700
Eu-154	11500

3.6.7.1 NRC Staff Evaluation of Above Grade Structure Screening Values

NUREG-1757, Volume 2, Revision 1, Table H.1 contains the regulatorily acceptable license termination for unrestricted release screening values of common radionuclides for building surface contamination. The screening values in NUREG-1757 Table H.1 and Table H.2, "Screening Values (pCi/g) of Common Radionuclides for Soil Surface Contamination Levels," are intended for single radionuclides. For radionuclides in mixtures, the sum of fractions rule shall be used. The NRC staff finds the use of the NUREG-1757 Table H.1 screening values for the above grade buildings that will remain at LACBWR after license termination acceptable.

The NRC staff notes that Eu-152 and Eu-154 screening values are not provided in NUREG-1757 Table H.1. The values for these radionuclides are taken from NUREG-5512, Volume 3, Table 5.19, which are equivalent to 25 mrem/yr. The licensee has committed to including Eu-152 and Eu-154 as ROCs for all media including above grade buildings. The NRC staff finds this approach, coupled with use of the screening values, acceptable for demonstrating compliance with the unrestricted release criteria specified in 10 CFR 20.1402.

3.6.8 <u>Alternate Scenario</u>

In Section 6.18, "Alternate Land Use Scenario Dose," of the LACBWR LTP the licensee considered two alternate "less likely but plausible" land use scenarios for the LACBWR site after license termination for unrestricted use: resident gardener with onsite well and recreational use with onsite well. The licensee did not quantitatively assess the recreational use scenario since it is bounded by the resident gardener and industrial use scenarios, due to the fact that the occupancy time and well water intake rate would be less for a recreational user of the site.

The licensee included the following pathways for the resident gardener: (1) direct dose; (2) inhalation; (3) soil ingestion; and (4) fruit and vegetables from an onsite garden. It was considered highly unlikely that livestock would be raised on the LACBWR site, so the meat and milk pathways were inactive in the alternate scenario (resident gardener) dose model.

The licensee separately calculated the resident gardener dose from residual radioactivity in soil, for residual radioactivity left on concrete surfaces of the two backfilled basements at LACBWR, and for the excavation of contaminated concrete and soil. The licensee took credit for 30 years of decay assuming that a resident gardener could not plausibly occupy the LACBWR site until after the Genoa 3 coal power plant ceased operation and was decommissioned. The full initial suite of radionuclides was evaluated to determine the dose from the IC radionuclides specifically for the resident gardener scenario, and the alternate scenario dose was calculated using the ROCs after adjusting the ROCs for the resident gardener specific IC dose.

3.6.8.1 Dose Assessment for the Alternate Scenario

In order to estimate the alternate scenario dose for soils, the licensee had to assume a “maximum hypothetical concentration” of residual radioactivity that could be left in the soil at the LACBWR site. The licensee accomplished this by deriving a normalized dose activity fraction starting with the 75th percentile activity fractions that are described in Section 6.6.2, “Radionuclide Mixture Fractions,” of the LACBWR LTP, and then scaling down the DCGLs according to these fractions such that that the entire dose was equal to 25 mrem/yr. Table 15 below shows the assumed hypothetical maximum concentrations for each ROC applied in the licensee’s analysis, as well as the assumed dose contribution associated with those concentrations and how they add up to 25 mrem/yr. Note that the Industrial Use Adjusted Soil DCGLs in the first column in Table 15 of the SER do not exactly match those in Table 7 of the SER (giving the adjusted soil DCGLs for LACBWR). The values in the first column of Table 15 constitute starting assumptions that do not include adjustments for the alternate scenario or the insignificant dose contribution (or the mixing sensitivity in the case of the Basement DCGLs). Also note that most of the residual activity at the LACBWR site is assumed to be from Cs-137.

Table 15: Assumed Hypothetical Maximum ROC Concentrations Applied in the Licensee's Analysis of Resident Gardener Dose

ROC	Industrial Use Adjusted Soil DCGLs (pCi/g) Equivalent to 25 mrem/yr per ROC	Assumed Normalized Dose Fraction Derived from Activity Fractions	Radionuclide Concentrations (pCi/g) Resulting in a Total of 25 mrem/yr using the Industrial Use Soil DCGLs and Dose Fractions	Industrial Use Soil Dose Check Calculation (mrem/yr)
Co-60	11.53	25.62%	2.95	6.41
Sr-90	5927.40	0.08%	4.50	0.019
Cs-137	52.31	72.77%	38.07	18.19
Eu-152	25.60	0.99%	0.25	0.25
Eu-154	23.72	0.54%	0.13	0.14
		100.00%	Sum:	25

Table 16 below shows the dose-to-source ratios the licensee estimated using RESRAD for the resident gardener alternate scenario at LACBWR. The RESRAD model was similar to that used for developing the industrial use DCGLs, but with certain parameters changed to reflect the resident gardener scenario. As a part of the RAI process, the licensee also conducted a separate sensitivity analysis to ensure that the correct values were assumed for the sensitive parameters in the resident gardener scenario. The licensee multiplied the DSRs by the hypothetical maximum concentrations established in Table 15 to estimate the alternate scenario resident gardener doses, and then decayed the doses by 30 years. The licensee calculated a hypothetical soil dose of 27 mrem for the alternate scenario using this approach.

Table 16: Hypothetical Doses to the Resident Gardener Resulting from Assumed Hypothetical Maximum Concentrations Applied in the Licensee's Analysis per ROC

ROC	Alternate Scenario Resident Gardener Soil Dose to Source Ratio (mrem/yr per pCi/g)	Radionuclide Concentrations (pCi/g) Resulting in a Total of 25 mrem/yr using the Industrial Use Soil DCGLs and Activity Fractions	Alternate Scenario Resident Gardener Soil Dose (mrem/yr)	Alternate Scenario Resident Gardener Soil Dose (mrem/yr) Decayed 30 years
Co-60	5.06	2.95	14.93	0.29
Sr-90	1.45	4.50	6.51	3.16
Cs-137	1.23	38.07	46.75	23.47
Eu-152	2.31	0.25	0.58	0.13
Eu-154	2.48	0.13	0.32	0.03
			Sum:	27.07

The licensee also calculated a resident gardener dose for LACBWR using the backfilled reactor building and WGTV basement concrete as the source term. Similar to the conceptual model for the industrial scenario, the licensee included the three BFM dose scenarios: in situ groundwater, in situ drilling spoils, and excavation. The licensee summed the doses from these three scenarios for each basement to arrive at a dose estimate of 28.4 mrem/yr for the reactor building basement and 34.9 mrem/yr for the WGTV basement. The majority of the dose was attributed to the excavation scenario for either basement. A similar approach was used for the basement alternate scenarios as the soil alternate scenario in that the hypothetical maximum concentrations assumed were derived using the activity mixture fractions in Table 5 of the SER (giving the initial suite of ROCs and the associated activity fractions). The licensee chose to adjust the industrial scenario DCGLs by the difference between 25 mrem/yr and the estimated dose from the alternative scenario. For example, given that the licensee's estimated dose for soil under the alternative scenario was 27.07 rmrem/yr, the industrial scenario soil DCGLs were adjusted by multiplying them by a factor 25 divided by 27.07. The licensee made corresponding adjustments for the basement DCGLs based on the estimated doses of 28.4 mrem/yr and 34.9 mrem/yr for the reactor building basement and WGTV basement, respectively.

3.6.8.2 NRC Staff Evaluation of the Alternate Scenario

The NRC staff reviewed the information provided in the LACBWR LTP pertaining to the licensee's assessment of the potential doses resulting from exposure to residual radioactivity remaining at the end of the decommissioning process, including the potential for alternative land uses of the LACBWR site in the future. This review was conducted in accordance with NUREG-1757, Volume 2, Section 5.2, which states the following with regard to dose from "less likely but plausible land uses" that may be used at the LACBWR site:

> If the licensee evaluated scenarios based on reasonably foreseeable land uses, the licensee needs to provide either a quantitative analysis of or a qualitative argument discounting the need to analyze all scenarios generated from the less likely but plausible land uses. The results of these analyses will be used by the staff to evaluate the degree of sensitivity of dose to overall scenario assumptions (and the associated parameter assumptions). The reviewer will consider both the magnitude and time of the peak dose from these scenarios. If peak doses from the less likely but plausible land use scenarios are significant, the licensee would need to provide greater assurance that the scenario is unlikely to occur, especially during the period of peak dose.

As a result of the RAI process, the licensee performed an uncertainty analysis specifically for the resident gardener scenario, which included all radionuclides in the initial suite. The licensee performed a separate uncertainty analysis for each radionuclide, thereby eliminating any potential impact of an assumed radionuclide mixture fraction on which dose calculation parameters were deemed sensitive. This approach ensured that all potentially sensitive parameters were identified, regardless of the activity mixture that is actually present.

As part of its August 4, 2017, RAI letter, the NRC staff asked the licensee to provide additional technical basis to support the hypothetical maximum radionuclide concentrations assumed from the Resident Gardener Scenario. The NRC staff requested this information because one of the key assumptions in the licensee's analysis of the resident gardener alternate dose scenario is that the concentration of Sr-90 in relation to Cs-137 at any given location will be relatively small, and therefore due to the sum of fractions rule, only a small fraction of the Sr-90 DCGL will be allowed in comparison to the Cs-137 DCGL. The hypothetical maximum concentration which the licensee assumed for Sr-90 is limited by the mixture ratios in Table 5 of the SER, forcing the hypothetical maximum concentration to be 4.5 pCi/g, which is magnitudes of order below the derived concentration limit for Sr-90 (5927.40 pCi/g; see Table 15 of the SER). Because the NRC staff is evaluating DCGLs for *each* radionuclide following a sum of fractions approach, as opposed to limiting the individual fractions allowed for each radionuclide, the Sr-90 levels in the soil must be bounded by the DCGL in the absence of all other radionuclides.

Table 17 below compares the hypothetical dose to the resident gardener from all the LACBWR ROCs at concentrations equivalent to their respective industrial use DCGLs when accounting for 30 years of decay. Table 17 evaluates which radionuclides could drive dose for the alternate scenario given the potential upper limit of concentration for the industrial scenario. Based on Table 17, the two radionuclides driving the dose are Cs-137 and Sr-90. The industrial use scenario DCGL for Sr-90 is high compared to what it would be for the residential scenario, which is to be expected due to many of the water dependent pathways being excluded in the industrial scenario but included in the resident gardener scenario. While Sr-90 industrial concentration limits result in an apparently significant dose for the alternate scenario, both the half-life and the expected relative concentration of Sr-90 to Cs-137 are considered as part of the evaluation. The half-life of Sr-90 is 28 years, so the NRC staff notes that if 100 years of decay were assumed (which is the time frame expected for reasonably foreseeable future land use), the Sr-90 dose would be lower by a factor of approximately five. In addition, the site-specific characterization data support the assumption that the ratio of Sr-90 is expected to be small in relation to the Cs-137. It is important to note that the alternative resident gardener scenario for LACBWR is not being used for compliance, and is instead being evaluated to inform the overall review of the LACBWR LTP. The use of the industrial scenario is not unprecedented. The NRC has previously approved DCGLs based on the industrial scenario for the Rancho Seco Nuclear Generating Station, with a similar dose value assumed for Sr-90 (see ADAMS Accession No. ML072070291 for additional information).

Table 17: Hypothetical Doses to the Resident Gardener Resulting from Hypothetical Maximum Concentrations Applied in the Licensee's Analysis and DCGLs per ROC

ROC	Alternate Scenario Resident Gardener Soil Dose from Hypothetical Maximum Concentration (pCi/g per 25 mrem/yr)	Alternate Scenario Resident Gardener Soil DSR (mrem/yr per pCi/g)	Industrial Use Adjusted Soil DCGLs (pCi/g per 25 mrem/yr)	Alternate Scenario Resident Gardener Soil DSR Multiplied by Industrial DCGL (mrem/yr)	Alternate Scenario Resident Gardener Soil DSR Multiplied by Industrial DCGL (mrem/yr) Decayed 30 Years
Co-60	4.95	5.055E+00	11.53	58.28	1.13
Sr-90	17.29	1.446E+00	5,927.40	8572.75	4163.31
Cs-137	20.36	1.228E+00	52.31	64.24	32.24
Eu-152	10.85	2.305E+00	25.60	59.00	12.70
Eu-154	10.08	2.481E+00	23.72	58.85	5.54

The characterization data from the soil and concrete cores taken at the LACBWR facility support the ROC mixture ratios and activity fractions assumed by the licensee in Table 5 of the SER. The NRC staff notes that assuming a mixture ratio in the dose analysis is appropriate because the licensee will be obligated to follow a sum of fractions approach for each radionuclide. The licensee will be using a surrogate ratio for Sr-90 / Cs-137 (see Table 5-11 of the LACBWR LTP) of 0.502 in the soil and concrete final status surveys, so for every 1 pCi/g of Cs-137 detected, the licensee assumes 0.502 pCi/g of Sr-90. This amount is significantly higher than the ratio of Sr-90 to Cs-137 in Table 5, so the amount of remaining Sr-90 will likely be overestimated using this approach. Furthermore, the licensee has committed to measuring for Sr-90 in 10 percent of the LACBWR FSS samples to verify that the assumed Sr-90 / Cs-137 surrogate ratio is bounding, as described in Section 5.2.9 of the LACBWR LTP. In addition, the licensee has committed to measuring for Sr-90 in groundwater samples and calculating a groundwater dose using the exposure factors as described in Section 3.6.6 of the SER and Section 6.22, "Demonstrating Compliance with Dose Criterion," of the LACBWR LTP. For these reasons, the NRC staff notes that the dose contribution from Sr-90 will be appropriately limited by the approach presented in the LACBWR LTP.

The licensee's estimated dose from the less likely but plausible scenario of residential gardener use of the LACBWR site at some point in the future, assuming the mixture fractions supported by the characterization data, is not significantly more than the 25 mrem/yr dose criteria for unrestricted release. The licensee has chosen to adjust the site-specific LACBWR industrial DCGLs to account for the fact that the estimates for the alternate scenario dose were slightly higher than 25 mrem/yr. This is not required because the residential use scenario is not used for compliance purposes, but is a conservative approach for the licensee. The NRC staff notes that while the dose from concentrations at the full Sr-90 industrial DCGL would potentially be significant for the resident gardener, there is substantial evidence that the LACBWR soil or concrete will contain both Sr-90 and Cs-137, and therefore the ultimate amount of Sr-90 allowed to be left at the site will be limited based on the sum of fractions approach for multiple radionuclides and multiple sources. Furthermore, the half-life of Sr-90 will limit the length of time for which it will pose a dose risk. Thus, the dose estimate presented in Table 17 of the SER for the alternate scenario is considered conservative, and is not a realistic estimate of the potential dose in a residential gardener scenario.

3.6.9 NRC Staff Evaluation for Compliance with Radiological Criteria for License Termination

The NRC staff reviewed the information provided in the LACBWR LTP pertaining to the licensee's assessment of the potential doses resulting from exposure to residual radioactivity remaining at the end of the LACBWR decommissioning process. This review was conducted in accordance with Section 2.6 of NUREG-1700, which refers to NUREG-1757, Volume 2, Section 5.2 and Appendix I, in order to support a conclusion that the LACBWR LTP is in compliance with the unrestricted release criteria specified in 10 CFR 20.1402.

To summarize, the NRC staff has reasonable assurance of the following:

- The licensee has adequately characterized and applied its source term for LACBWR.

- The licensee has analyzed the appropriate dose scenario(s), and the exposure group(s) adequately represents a critical group.

- The mathematical method and parameters used are appropriate for the dose scenario(s), and parameter uncertainty has been adequately addressed.

- The peak annual dose to the average member of the critical group for the appropriate exposure scenario(s) was used to calculate the Base Case DCGLs.

- The licensee has committed to using radionuclide-specific DCGLs for LACBWR, and will ensure that the total dose from all radionuclides and all sources (soil, backfilled basements, buried piping, and remaining above ground structures) will meet the requirements of Subpart E of 10 CFR Part 20 using the sum of fractions approach and the compliance dose equation (Equation 4 of the SER).

3.7 Hydrology and Groundwater

In accordance with the requirements of 10 CFR 50.82(a)(9)(ii)(A), as well as the guidance contained in NUREG-1757 and the NUREG-1700, Revision 2, SRP, this section of the SER describes and evaluates the geologic and hydrologic conditions at the LACBWR site. The SRP guidance indicates that a review of the LACBWR site hydrogeological information is needed because the licensee proposed site-specific DCGLs in the in the LACBWR LTP. The SRP goes on to state that the hydrogeological information will likely be required to support portions of the site-specific dose assessment as described in NUREG-1757. The materials reviewed, and the NRC staff's evaluation of those materials, is based on the information provided in the LACBWR LTP, supporting documents referenced in the LTP, and the NRC staff's independent assessment of the LACBWR LTP, supporting documents, and general literature.

The NRC staff evaluated the geologic and hydrogeological conditions at LACBWR to determine whether operations or decommissioning activities have resulted in radiological impacts within the groundwater. Groundwater levels and flow beneath the LACBWR site depend on the (1) geology of the site; (2) infiltration and recharge which depend on meteorological conditions; (3) river stage that influences water levels under the plant site; and (4) flow from the upgradient groundwater system from below the plateau and bluffs to the east of the site. The LACBWR hydrogeological information is utilized in Section 3.6.6 of the SER to support the site conceptual groundwater flow model implemented as part of the dose assessment for groundwater using the associated site-specific hydrogeological input parameter values.

3.7.1 Geology

Section 1.3.4, "Geology and Seismology," Section 6.2.1, "Site Geology," and Section 8.5.3, "Topography, Geology and Seismology," of the LACBWR LTP provides information on the general geology of the area surrounding the LACBWR site. The site is on the east bank of the Mississippi River in a relatively flat area of the valley that is bounded by steep bluffs further to the east. The hydraulic fill emplaced during construction of the LACBWR site overlies a 100 to 130 foot (30 to 40 m) thickness of glacial outwash and fluvial sediments. The unconsolidated sediments are underlain by sandstones and shales of the Dresbach Group that regionally dip less than 20 degrees. The Dresbach Group overlies crystalline Precambrian rocks, which are found at depths greater than 650 feet (198 m) below the site.

The NRC staff notes that the groundwater that is at the most risk for contamination from activities at the plant site is located in the upper portion of the unconsolidated sediments. The groundwater in the upper portion of the unconsolidated sediments likely seeps directly into the river. Therefore, the unconsolidated sediments, particularly the shallow portions, are the focus of the discussion below. To assess the possibility of contamination reaching the lower portion of the aquifer in the unconsolidated sediments, the licensee continues to collect water quality samples from the deeper wells at the LACBWR site, and stated in the November 15, 2018, supplemental RAI response that the effect of well pumping will be included in a future analysis of the 2017-2018 tritium release resulting from the reactor building demolition activities.

3.7.2 Stratigraphy

Sections 1.3.4 and 6.2.1 of the LACBWR LTP provide descriptions of the unconsolidated sediments at the site. The unconsolidated sediments below the LACBWR site are of primary interest because these sediments encompass the groundwater system of principal concern for potential contamination by plant activities.

A layer of approximately 15 to 20 feet (4.6 to 6.1 m) of hydraulic fill dredged from the Mississippi River was used to elevate and level the LACBWR site to approximately 639.2 feet (195 m) above mean sea level during plant construction, which started in 1965. The hydraulic fill elevation is slightly above the 100-year flood level. The record flood stage of 638 feet (194 m) AMSL occurred in 1965. The fill extended the river bank of the LACBWR site westward into the existing river. The constructed sloped river bank was protected from river erosion by riprap.

Below the hydraulic fill is a thickness of 100 to 130 feet (30.5 to 40 m) of unconsolidated glacial outwash and fluvial deposits. The unconsolidated sediments are predominantly fine to medium sand with some gravelly portions. Clay and silt fines are generally less than five percent. Based on sample borings in the area of the LACBWR site, thin layers (1 to 2 feet (0.3 to 0.6 m) thick) of finer material described as silty sand or silty clay are generally found between 22 and 27 feet (6.7 and 8.2 m) below the ground surface. The LACBWR Hydrogeological Investigation Report (prepared by Haley & Aldrich, Inc., in January 2015) interpreted the thin clayey layers as historic flood events. The bedrock of sandstone and shale below the unconsolidated sediments slopes from an elevation of 509 feet (155 m) AMSL below the reactor building to 501 feet (153 m) AMSL near the river channel.

The NRC staff evaluated the information provided by the licensee and concluded that the LACBWR LTP and supporting documents provide an adequate level of stratigraphy detail to support development of a site conceptual model to implement in the overall dose assessment.

3.7.3 Meteorology and Climate

Section 1.3.3, “Meteorology and Climatology,” and Section 8.5.2, “Climate,” of the LACBWR LTP describes the temperatures experienced at the LACBWR site as typical of a continental climate, with cold winters and warm summers. Average temperatures in the winter are below freezing. Winds are influenced by channeling due to the steep bluffs along the Mississippi River valley. Meteorological data are available from a weather station that is 0.75 miles (1.2 kilometers (km)) north of the site at the dam near the town of Genoa, Wisconsin, as well as a weather station that is 23 miles (37 km) north of the site at the airport in the town of La Crosse, Wisconsin. Both weather stations are in the valley of the Mississippi River. Section 8.5.2 of the LACBWR LTP reported annual precipitation of 35.2 inches (0.89 m) for Genoa, Wisconsin.

The dose assessment model described in Chapter 6 of the LACBWR LTP uses an annual value of 30.7 inches (0.78 m) for precipitation in La Crosse, Wisconsin based on NUREG/CR-6697, Table 4.1-1, “Precipitation Data for 273 U.S. Weather Recording Stations.” Based on data from the National Weather Service (NWS), the NRC staff confirmed that the Genoa, Wisconsin annual precipitation average was 33.1 inches (0.84 m) for the period from 1937 to 2016, and the La Crosse, Wisconsin annual average was 31.5 inches (0.80 m) for the period from 1939 to 2016. Seasonal precipitation and snowmelt lead to higher precipitation and river water levels in the spring and early summer, and lower precipitation and river levels in the fall through winter. Therefore, the NRC staff concludes that use of 30.7 inches (0.78 m) for the precipitation parameter in the overall dose assessment is reasonable based on data readily available for the Genoa and La Crosse, Wisconsin areas. The NRC staff further notes that the annual precipitation amount is not a sensitive parameter input in the dose assessment models.

3.7.4 Surface Water

The LACBWR site is bounded on the west and north by the Mississippi River. The mean daily discharge of the river in the area of the LACBWR site varies from approximately 50,000 to 80,000 cubic feet per second in the spring and early summer months, to approximately 20,000 to 30,000 cubic feet per second in the fall and winter months, based on daily data collected by the Wisconsin Department of Natural Resources (WDNR) from 1959 to 2014. The river provided water for circulation in the cooling water system during plant operation via an intake pipe at the LACBWR site boundary at the river bank. In addition to a description of the characteristics of Mississippi River, Section 1.3.5, "Surface Water Hydrology," of the LACBWR LTP describes the surface water runoff across the LACBWR site derived from upgradient portions of the watershed as being significantly reduced by two engineered channels to the east of the site that divert water to the north and to the south.

The NRC staff notes that the stage of the Mississippi River sets the groundwater level at the river bank and thus directly influences the groundwater levels below the LACBWR site. The LACBWR Hydrogeological Investigation Report provided three river stage data points, though two of the data values are separated by only two days. No source for the data is described in the report or the LACBWR LTP, but the NRC staff established that the values are similar to river stage measurements from the dam near Genoa, Wisconsin, which is 0.75 miles (1.2 km) upstream of the LACBWR site, using data from the U.S. Army Corps of Engineers (USACE) Water Levels of Rivers and Lakes website.

The NRC staff also reviewed records from the downstream side of the Genoa dam. River stage levels can vary by more than a foot in a day, which complicates direct comparison with water levels in wells near the river. In addition, the river stage at the Genoa dam should be slightly higher than those at the LACBWR site. Using an average river gradient of 0.5 foot per mile (0.1 m/km) for the Mississippi River in this region, in accordance with "The Streams and Rivers of Minnesota" publication provided by the University of Minnesota, dated 1977, the river stage at the LACBWR site would be approximately 0.3 foot (0.09 m) lower than the stage below the Genoa dam. The river stage below the Genoa dam varied from approximately 620 feet (189 m) AMSL to 633 feet (193 m) AMSL during the period of 2010 to 2015, based on data from the USACE. The records exhibit a strong seasonal difference, with lower stages generally in the fall and winter and higher stages generally in the spring and summer. Historically, the minimum river stage on record of 615 feet (187.5 m) AMSL occurred in the 1930s, and the maximum stage of 638 feet (194.5 m) AMSL occurred in 1965.

The NRC staff evaluated the information provided by the licensee, analyzed the information provided by other sources, and concluded that the LACBWR LTP and supporting documents provide an adequate level of detail regarding the surface water characteristics to support development of a site conceptual model to implement in the overall dose assessment.

3.7.5 Groundwater

Section 1.3.6, "Ground Water Hydrology," of the LACBWR LTP describes the groundwater as being encountered at depths ranging from 15 to 25 feet (4.5 to 7.6 m) in the highly permeable unconsolidated sediments, and generally flowing westward from the bluffs toward the Mississippi River. The NRC staff notes that the influence over the groundwater levels at the LACBWR site is derived from vertical recharge, upgradient contributions from groundwater flowing from the bluffs, and changes in river stage levels. The LACBWR LTP suggests that the groundwater flow path bends downstream as it approaches and then discharges into the Mississippi River, although at high river stage levels the gradient may reverse in a zone along the river bank. Hydrogeological conditions and soil properties across the LACBWR site are used directly as parameter inputs into the overall dose models, or to support the site conceptual and numerical flow models. The attachments to Chapter 6 of the LACBWR LTP, which capture the input parameters for the uncertainty analyses associated with the soil, BFM, and alternate scenario dose models, list the hydrogeological parameter values for site-specific properties used in the dose assessment, including hydraulic conductivity, hydraulic gradient, soil density, porosity, effective porosity, and field capacity.

The licensee describes the unconsolidated sediments as highly permeable with hydraulic conductivities in the range of 10^{-5} to 10^{-1} centimeter per second (0.03 to 280 feet per day) with the range based on variations of soil types at the site. Section 2.3.7.2, "Groundwater Flow," of the LACBWR LTP provides a representative value of hydraulic conductivity of 313 feet per day (34822 meters per year), which is a representative value based on an average from slug tests as reported in the LACBWR Hydrogeological Investigation Report.

The LACBWR Site Investigation Report indicates that the horizontal groundwater gradient for the site is in the range of 0.004 to 0.005 for the shallower portions of the unconsolidated sediments. The LACBWR LTP and Hydrogeological Investigation Report describe several features of the water table topology that are relevant to estimation of the site groundwater gradient. Based on water table data from the site, the gradient often varies across the site and over time, as would be expected based on the effects of varying upgradient watershed contributions to the east of the site, river stage levels to the west of the site, and interactions with building supports beneath the site. For the latter, Section 2.3.7.2 of the LACBWR LTP suggests that soil compression from the buildings and pilings at the site may reduce permeability of the soil by one to two orders of magnitude, as well as reduce porosity, which would cause changes in the gradient and may cause diversions of the groundwater flow. The LACBWR Hydrogeological Investigation Report indicates that water level data appear to support the flattening of the groundwater gradient, in addition to the possible diversion suggested in the LACBWR LTP. In addition, gradient reversals often occur on the western portion of the site, which the licensee describes as likely tied to rapid increases and decreases in the river stage. Lastly, based on the monitoring data from paired wells, the licensee describes vertical groundwater gradients as having little or no consistent trend for changes upward and downward, though a link to the variations in the river stage is postulated.

For the remaining hydrologic parameters in the dose assessment model, the attachments to Chapter 6 of the LACBWR LTP list the site-specific hydrogeological parameter values for LACBWR as: (1) soil density of 1.76 g/cm^3; (2) porosity of 0.31: (3) effective porosity of 0.28; and (4) field capacity of 0.066.

The NRC staff reviewed the values of the hydrogeological parameters used in the dose assessment model. The hydraulic conductivity and gradient for LACBWR are combined to form an estimate of groundwater flux. The NRC staff finds the value of hydraulic conductivity and gradient used in the dose assessment model acceptable because it is an average from field scale hydraulic tests at the LACBWR site's monitoring wells. The attachments to Chapter 6 of the LACBWR LTP indicate that this representative value is used for contaminated zone, unsaturated zone, and saturated zone hydraulic conductivity. Based on an independent review and analysis of the overall groundwater monitoring data set from the LACBWR site, the NRC staff finds that a representative horizontal groundwater gradient of 0.0045 from the east and toward the river is a reasonable representation of the long term behavior needed for input into the dose assessment model. Based on knowledge and experience for similar soils, the NRC staff finds that the values for density, porosity, effective porosity, and field capacity are adequate for the dose assessment models. The staff expects that a reasonable range reflecting uncertainty for these last four parameters would not likely change the dose assessment results.

For the reasons stated above, the NRC staff finds the licensee's site-specific hydrogeological parameter values acceptable for development of a site-specific dose assessment model. Hydrogeological inputs to the numerical groundwater flow model used for estimating peak concentrations related to an H-3 release that occurred during the decommissioning process, however, are evaluated in Section 3.7.8.2 of the SER.

3.7.6 Groundwater Monitoring

Section 2.3.7.3, "Previous Investigations," of the LACBWR LTP describes five sets of paired monitoring wells that were sited in and around the LACBWR licensed area during 2012, with the siting locations stated to be chosen based on known groundwater contamination events or possible transport paths. Paired monitoring wells refer to two wells co-located within several feet that are screened at different depths such that that vertical groundwater gradients can be quantified. The Haley & Aldrich, Inc., "Site Investigation Report - La Crosse Boiling Water Reactor," dated November 2018 (ADAMS Accession No. ML18331A029), provides a summary of the measurement sets of groundwater levels taken from the paired monitoring wells (MW) from November 2012 to September 2018. Fourteen to sixteen measurement sets at different frequencies were made during this period, with an emphasis on 2018 (6 measurements) and none in 2014. In addition, older paired monitoring well sets were installed over the larger area encompassing the LACBWR site, Genoa 3 coal plant, and ISFSI pad, including one well set immediately to the east of the plant buildings (wells B11A/B11AR). At the LACBWR site, the paired monitoring wells in approximate order of west (river) to east are:

- MW-200A/B are closest to the river.
- MW-201A/B and MW202A/B are further from the river but on the east side of the plant buildings; well MW202A was damaged in 2017 and replaced in 2018.
- MW-203A/B are on the south side of the LACBWR turbine building.
- MW-204A/B and B11A/B11AR are on the eastern side of the plant buildings furthest upgradient and furthest from the river.

In accordance with the LACBWR Hydrogeological Investigation Report, all the monitoring wells are screened at shallow levels in the aquifer of the unconsolidated sediments. The upper well of each pair is screened from depths of 15 to 25 feet (4.6 to 7.6 m) and the lower well of each pair is screened from depths of 45 to 55 feet (13.7 to 16.8 m). With predominantly horizontal groundwater flow, the portion of the aquifer represented by the paired wells likely discharges directly to the Mississippi River. In addition, three deeper wells at the LACBWR site supply potable water for the overall DPC site (LACBWR and Genoa 3), and were screened at depths of 116 and 129 feet (35.3 and 39.3 m), which may be below the depth of the river.

Because of the strong hydraulic connection between the Mississippi River and the monitoring wells closest to the river, the variations in river stage, although slightly shifted in time and damped in magnitude, likely also track the variations in groundwater level beneath the LACBWR site, particularly at wells closest to the river on the western side of the site. Wells on the eastern side of the site are more influenced by upgradient watershed contributions to the groundwater levels, rather than the river contributions. Data from the five paired monitoring wells vary from approximately 621 to nearly 630 feet (189 to 192 m) AMSL during the period of late 2012 through mid-2018. The available river stage data from below the Genoa dam exhibits seasonal variations of approximately 624 to 633 feet (190 to 193 m) AMSL for the spring and summer, and approximately 620 to 624 feet (189 to 190 m) AMSL for the fall and winter. For reference, the base of the LACBWR reactor building basement at 607.5 feet (185.2 m) AMSL and the turbine building sump at 618 feet (188.4 m) AMSL are both in the saturated zone. The other basements, floors, and piping tunnels at the site are higher, and thus fall in the zone that varies from saturated to unsaturated as groundwater levels rise and fall throughout the year.

The important and quantitatively sensitive inputs in the dose assessment model are the transport length in the unsaturated zone and the fraction of contaminated zone in the saturated zone, which are derived directly from the depth of the water table and the relative position with respect to the depths of the structures and buildings. Based on the analysis in the previous paragraphs, the NRC staff requested justification for the water table elevation used to derive the associated inputs in the dose assessment model. As a result, in its RAI response dated May 31, 2018, the licensee changed the water table elevation from 619 to 629 feet (188 to 192 m) AMSL for use as an input to the dose assessment model. Based on the full range and seasonal variations of both groundwater level and the river stage at the LACBWR site, the NRC staff finds the latter elevation acceptable for use in the dose assessment modeling.

3.7.7 Groundwater Sampling and Analysis for Radionuclides of Concern

Section 2.3.7.3, Section 2.3.7.4, "On-Going Investigations," and Section 2.3.7.5, "Summary of Groundwater Analytical Results," of the LACBWR LTP summarize the previous and ongoing groundwater monitoring programs. The data collected from the LACBWR monitoring wells will be used to ensure that the concentration of residual radioactivity in the well water available, based upon the well supply requirements assumed for the resident gardener (i.e., the resident gardener's well) in Chapter 6 of the LACBWR LTP, is below the EPA's maximum contaminant levels (MCLs) (e.g., 20,000 pCi/L for H-3). This will ensure that the dose contribution from groundwater is a small fraction of the unrestricted release limit in 10 CFR 20.1402.

Section 2.3.7.3 of the LACBWR LTP notes that the single round of groundwater measurements taken in 2012, and two rounds taken in 2013, included a short list of radionuclides for additional radiological analysis (i.e., H-3, Sr-90, Cs-137, and Co-60). In 2014, a much larger suite of radionuclides was measured in a third and fourth round of groundwater sampling that included HTD and transuranic radionuclides. In addition to sampling from the five paired wells installed in 2012, sampling for the extended list of radionuclides also included four of the older wells and four potable water wells in the LACBWR ISFSI and Genoa 3 plant areas. Starting in 2014, Eu-152 and Eu-154 were added to the groundwater measurements, which together with Co-60, Sr-90, and Cs-147 comprise the radionuclides of concern listed in Section 6.14, "Insignificant Dose Contributors, Radionuclides of Concern and Surrogate Ratio," of the LACBWR LTP.

Section 2.3.7.5 of the LACBWR LTP describes the analytical results for radionuclides identified in groundwater at the LACBWR site for 2012, 2013, and 2014. The Haley & Aldrich, Inc., annual groundwater monitoring reports contain results and summaries for the 2015 and 2016 groundwater data. For the years 2012 through 2016, there were occasional groundwater monitoring results that reached the MDC levels. The licensee described these as residual concentration levels only, and noted that there were no trends or patterns. In late 2017, H-3 levels in the upper well of the paired set on the south side of the LACBWR turbine building footprint recorded H-3 levels above the EPA drinking water standard. This event is described in detail in Section 3.7.8.2 of the SER.

According to the LACBWR annual monitoring reports, samples of water are collected, managed, transported, and analyzed in accordance with approved procedures following EPA methods. Sample locations, sample collection frequencies, and analytical frequencies are controlled in accordance with approved procedures. Analytical laboratories are subject to internal quality assurance programs, industry crosscheck programs, as well as nuclear industry audits. LACBWR personnel review and evaluate all analytical data deliverables as data is received, and the analytical data results are reviewed by both site personnel and an independent hydrogeologist for adverse trends or changes to the hydrogeological conditions. Potential groundwater impacts will continue to be monitored by routine sampling of the onsite paired monitoring wells. The NRC staff expects that during decommissioning, the licensee has and will continue to implement a radiation protection program, as discussed in Section 4.3 of the LACBWR LTP, which will maintain compliance with the LACBWR license conditions, technical specifications, and the requirements of 10 CFR Part 20.

3.7.8 Liquid Radiological Spills, Leaks, and Releases

The LACBWR LTP describes two release events that led to known radionuclide contamination plumes in the groundwater system. The first was a suspected pipe leak in 1983 originating from the LACBWR turbine building. The second event was H-3 released during demolition activities related to the LACBWR reactor building in 2017 and 2018.

3.7.8.1 1983 Leak – Turbine Building

Section 2.3.7.3 and Section 6.5.4, "Existing Groundwater," of the LACBWR LTP describe a suspected spill and pipe leak that occurred in 1983. This incident concerned the potential leakage of radioactive liquids from suspected broken drain lines in the LACBWR turbine building to sub-building soils. A temporary well point was established to the south of the turbine building, and the groundwater was sampled once, on May 3, 1983, before the well point was abandoned. Results from the single groundwater sample were reported in Table 2-17, "1983 Groundwater Analysis from Temporary Well-Point South of Turbine Building," of the LACBWR LTP at activities of 21.7 pCi/L for Cs-137 and 508 pCi/L for Co-60. Other radionuclides with elevated concentrations were also identified, but the activity levels and the decay half-life would make them insignificant dose contributors 35 years after the suspected leak.

The LACBWR LTP provides no supporting basis that the concentrations recorded in Table 2-17 reflect the extent of the plume or the maximum concentrations in the groundwater. As such, the NRC staff estimated soil concentrations for Cs-137 and Co-60, projected for 2018, which reflect equilibrium conditions between soil and water and the appropriate decay half-lives. The resulting 2018 predicted soil concentration for Cs-137 is 34 pCi/g, assuming a bounding value for the sorption coefficient based on loam, or 5.1 pCi/g, assuming a reasonable value for the sorption coefficient based on sand. Similarly, the analogous Co-60 hypothetical soil concentrations are 4.1 pCi/g or 0.12 pCi/g. The sorption coefficients were obtained from ANL's "Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil and Building Structures." These estimates may be overestimates because the effect of groundwater flushing is neglected. Conversely, they may be underestimates because the temporary well point may not have been in the center of the plume (i.e., at the location of the maximum groundwater contamination). Because the LACBWR LTP states that the MW-203A/B well was installed near, but upgradient, of the likely location for the abandoned well point used to monitor for turbine building groundwater contamination, sampling during the 2012 to 2018 period could not preclude the possibility of continued contamination of the groundwater from the 1983 leak. In addition, characterization of soils closer to the source of the possible location of the 1983 turbine building drain line leak would be difficult to analyze during characterization and final status survey activities because of the original plan to leave the cement foundation in place (see LACBWR LTP, Revision 0, Chapter 2).

As a result of questions raised by the NRC staff during the RAI process and the subsequent response from LACBWR, the licensee provided clarification on the siting of the MW-203A well, as well as the capability of the characterization and final status surveys to identify potential remaining contamination from the 1983 turbine building drain line leak release. The licensee stated that MW-203A was installed downgradient of the potential floor drain leaks; i.e., possibly closer to the release source. In addition, part of the characterization survey described in the RAI response included angled coring and sampling at three locations under the south side of the turbine building in 2015, which did not identify any soil contamination.

In February 2018 the cement foundation of the LACBWR turbine building, which was originally slated to remain in place, was removed entirely in accordance with the updated dismantlement and site remediation plans described in Revision 1 of the LACBWR LTP. Because the LACBWR turbine building foundation was excavated, thus exposing the soil beneath the building, 100 percent soil scanning and random and biased soil sampling during FSS activities became feasible for this Class 1 area. This newly excavated area is closer to the contamination source than the temporary well point established in 1983 that confirmed the initial release to the groundwater system. If no soil contamination is found in the soil closer to the original source, then the NRC staff would not expect subsurface soil to be contaminated near the 1983 well point or other points beneath and away from the building footprint.

Prior to completing the FSS of the eastern half of the LACBWR turbine building, the excavation was partially filled with clean sediment to facilitate demolition of the reactor building. To compensate for the inability to complete a 100 percent scan of the eastern half of the building footprint, the licensee is developing a plan for additional soil sampling of the layer at and immediately below the excavated surface. If neither Co-60 nor Cs-137 soil contamination are identified in the eastern half of the turbine building footprint, particularly in the soil beneath the footprint of the drain lines, the NRC staff expects that no groundwater contamination would remain present because both radionuclides exhibit a large propensity to sorb to soils. The FSS soil sampling of the Class 1 area encompassing the eastern half of the LACBWR turbine building survey unit is scheduled to occur in April 2019, at which time the presence and possible extent of relict groundwater contamination from the leak identified in 1983 can be evaluated.

3.7.8.2 2017-2018 Tritium Release

In December 2017 the licensee detected elevated levels of H-3 in the groundwater, as well as in the ice and snow melt impacted by the reactor building ventilation system that was used during LACBWR reactor building demolition activities. In its November 15, 2018, supplemental submittal, the licensee hypothesizes that during rain events or prominent snow melt periods, tritiated water flowed along the ground surface around the perimeter of the reactor building to the turbine building eastern sump pit, where it entered the groundwater system. The sump pit was reported to be at an elevation below the water table. Tritium levels in the surface water samples were recorded up to 237,000 pCi/L (8770 Becquerels per liter (bq/L)). A portion of the H-3 reached monitoring wells MW-203A, located approximately 60 feet (18 m) downgradient, and MW-202A/202AR, located approximately 215 feet (65.5 m) downgradient. A maximum groundwater H-3 level of 24,200 pCi/L (895 bq/L) was measured in the MW-203A well in February 2018. The November 15, 2018, supplemental submittal provides the results of analyses of samples collected in April, June, July, August, and September of 2018 that reflect a decreasing trend of H-3 in the groundwater. These results indicate that the concentrations have decreased to background levels at well MW-203A, and to approximately 10 percent of the peak value at well MW-202AR, but still above background levels. Based on sampling results from other monitoring wells on the LACBWR site, the licensee concluded that the H-3 contamination remained solely in the shallowest portion of the aquifer. The bounding time frame for the H-3 release was reported to be from November 2017, when the LACBWR reactor building demolition started, to March 2018, when the exhaust ventilation system was modified to eliminate the source of the H-3 contamination.

In July 2018, the licensee began a dye tracer test injection at the sump area to confirm the site groundwater conceptual model; specifically, to provide support for the transport pathway for the H-3 release. The licensee's supplemental letter and the Haley & Aldrich, Inc., LACBWR Site Investigation Report, both prepared in November 2018, state that the dye tracer test results confirmed that the transport pathway remained in the upper part of the shallow aquifer and flowed generally westward toward the Mississippi River. The dye tracer material only reached well MW-203A, for which the licensee states that the tracer levels had stabilized by the time the last measurement set was taken in October 2018.

The licensee's supplemental letter and the Haley & Aldrich, Inc., LACBWR Site Investigation Report both also provide a description of a numerical flow and transport model focusing on the region between the sump and the river. The need for numerical modeling analysis arose because the licensee did not use measurements to characterize the magnitude and extent of the H-3 plume. Two sets of flow and transport simulations were documented; one set to calibrate the model to the dye tracer test results, and one set to predict the maximum H-3 concentrations in the groundwater. For the first set, the groundwater model was calibrated using the dye tracer test results from the closest well, MW-203A. For the second set, the calibrated groundwater model was used to estimate the maximum H-3 concentration in the groundwater based on measured H-3 concentrations from the more distant well, MW-202AR. The licensee reports the model had difficulties in matching measured values of H-3 at the closer monitoring well, MW-203A. The calibrated numerical model has a gradient of 0.002 with a fixed, hypothetical value for the river stage, a hydraulic conductivity of 350 feet per day, an anisotropy ratio of 5:1 horizontal to vertical, and an effective porosity of 0.25. The licensee states that an estimated peak concentration of 60,000 pCi/L of H-3 in the groundwater is predicted by using the LACBWR groundwater model with conservative[8] estimates of inputs.

The NRC staff reviewed the information provided by the licensee on the H-3 and dye tracer data and analysis to ascertain the reasonableness of the maximum estimated H-3 concentration in the groundwater system. The licensee's analysis did not reconcile the different descriptions of hydrogeological conditions given between the LACBWR LTP, the supplemental material provided, and the Haley & Aldrich, Inc., LACBWR Site Investigation Report. These hydrogeological conditions are reflected in the 2012 to 2018 monitoring well data and include variations in gradient direction as well as magnitude, and perturbations due to facility structures. The licensee's flow model was calibrated to the first peak of the dye tracer data and ignored a second peak that was still increasing at the last measurement in October 2018. The NRC staff notes that the meaning of the double peaked dye tracer test results may be understood by taking into consideration (1) the effect of variations in river stage levels on the groundwater flow direction beneath the western portion of the facility, and (2) the potential for multiple groundwater pathways caused by compression of soils due to buildings and pilings. Both of these factors are mentioned in the LACBWR LTP, but are not incorporated into the site conceptual model used for the numerical groundwater model.

Based on the NRC staff's judgement and experience, for the purposes of estimating a maximum H-3 concentration, a dilution factor of two is considered bounding for the contaminated surface water (at a concentration of 237,000 pCi/L of H-3) mixing with the groundwater in the highly permeable sediments at the site with the observed groundwater gradients. The dilution factor is the ratio of the groundwater flux to the infiltration flux associated with the H-3 release. A factor of two is considered reasonably bounding because of the high flow rates for the groundwater system compared to the likely much lower infiltration rates during the winter of 2017/2018. The licensee is not required to identify the precise concentration of H-3, but instead may account for the potential dose from H-3 by using a reasonably bounding concentration. Therefore, in the LACBWR LTP, the licensee allotted a remaining radiological dose of 2.779 mrem/yr (of the 3.25 mrem/yr total dose for groundwater) for the hypothetical maximum allowable H-3 concentration in groundwater (see Section 3.6.6 of the SER), which corresponds to 110,000 pCi/L of H-3. Given the approximate nature of the factor of two due to the fluxes in the groundwater versus the possible contaminated influx, the NRC staff considers 110,000 pCi/L of H-3 sufficiently close to half the source concentration. As such, the NRC staff concludes that the use of an estimated maximum H-3 concentration of 110,000 pCi/L is sufficient to demonstrate compliance. For a value of H-3 concentration less than 110,000 pCi/L to be incorporated into the FSS, additional support reconciling site observations with the numerical modeling would be needed.

3.7.9 Groundwater Use

Section 1.3.6 of the LACBWR LTP states that there are five domestic wells east of Highway 35 and south of the plant site. The groundwater flow direction from the LACBWR site is westward and discharges into the Mississippi River. Thus, the domestic wells east and south of the site would not be impacted by contaminants in the groundwater below the plant site. Section 8.5.1, "Geography and Demography," of the LACBWR LTP describes the uses of the river near the site as recreational boating and fishing and commercial barge and shipping. No communities

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8 Conservative, as used by the licensee, refers to the use of high or low values for parameter inputs such that the estimate of the compliance criteria parameter (concentration of H-3 in this case) is expected to be higher than actually exists, thus accounting for any uncertainty of the model input values.

for 40 miles (64 km) downstream used the river as a potable water source; rather, potable water is obtained from groundwater wells.

3.7.10 NRC Staff Conclusions for Hydrology and Groundwater

Section 3.7 of the SER describes the site characteristics provided in the LACBWR LTP that are important for the development of a site conceptual groundwater flow model and parameter inputs for the dose assessment model. The NRC staff finds that the licensee's geological and hydrogeological site characterization is sufficiently detailed to fulfill the site characterization requirement of 10 CFR 50.82(a)(9)(ii)(A) and the guidance contained in NUREG-1757 and the NUREG-1700, Revision 2, SRP. The NRC staff finds that the hydrology and groundwater description for the LACBWR site is adequate because observations and measurements taken at the site are generally consistent with the site conceptual flow model. Where observations and measurements are not consistent with the implemented site conceptual flow model, and reconciliation was not provided, conservative input values were or will be used. In addition, the NRC staff found that the properties of the site that support the groundwater dose assessment input parameters adequately represent site conditions, or that sensitivity analyses were performed or conservative values were or will be selected to address any significant uncertainty.

The LACBWR LTP identified radiological spills, leaks, and releases with the potential of impacting groundwater. The NRC staff notes that the identified spills, leaks, and releases that resulted in impacts to the groundwater were or are being addressed in the development of the FSS. While detectable concentrations of radionuclides have been reported within the groundwater of the LACBWR site footprint, concentrations for radiological constituents likely have fallen below EPA MCLs for drinking water, pending confirmation by FSS measurements. No imminent threats to human health or the environment due to radiological constituents in the groundwater have been identified, although additional assessments, i.e., groundwater monitoring, during the remainder of decommissioning will be ongoing.

The information provided as part of additional characterization and final status surveys, as well as during ongoing groundwater monitoring at the LACBWR site, will allow the NRC staff to determine the extent and range of any remaining radiological contamination to the groundwater prior to license termination. In addition, as part of independent confirmatory survey activities during license termination, the NRC, in conjunction with ORISE, may obtain split samples from the groundwater monitoring wells prior to license termination. The samples may be analyzed for all the primary constituents of concern identified in the LACBWR LTP.

3.8 Site Specific Cost Estimate

In accordance with the requirements of 10 CFR 50.82(a)(9)(ii)(F) and the guidance of RG 1.179, Chapter 7, "Update of the Site-Specific Decommissioning Costs," of the LACBWR LTP, Revision 1, provides an updated site specific estimate of remaining decommissioning costs to complete the dismantlement and decontamination activities at the LACBWR site. This portion of the LTP is intended to estimate the decommissioning costs remaining at the time of LTP submittal and compare the estimated remaining costs with the present funds set aside for decommissioning. If there is a deficit in present funding, then the LTP will indicate the means for ensuring adequate funds to complete the decommissioning activities.

3.8.1 Financial Requirements and Cost Estimate Criteria

The LACBWR LTP includes provisions for funding plans and an updated estimate of remaining decommissioning costs. Specifically, the licensee provided financial provisions for completing the LACBWR decommissioning activities, which include: (1) cost assumptions used, including contingency factors; (2) major decommissioning activities and tasks; (3) unit cost factors; (4) estimated costs for decontamination and removal of equipment and structures; (5) estimated costs for waste disposal, including disposal site surcharges; (6) estimated final status survey costs; and (7) estimated total costs. The cost estimate focuses on the remaining work at the LACBWR site and provides details for each activity associated with decommissioning, including the costs of labor, materials, equipment, energy, and services. The cost estimate is based on credible engineering assumptions that are related to all remaining major decommissioning activities and tasks. The cost estimate also includes the cost of the planned remediation actions, the cost of transportation and disposal of the waste generated by the actions, and other costs that are appropriate for the planned decommissioning actions.

According to the LACBWR LTP, the site-specific decommissioning cost estimate (DCE) presents a breakdown of all costs associated with completing the decommissioning activities and being approved for unrestricted release of the LACBWR site, other than the area bounded by the ISFSI. The estimate includes the costs required to accomplish unrestricted release and restore the site to a safe and stable condition, as well as operation of the ISFSI until the LACBWR site and remaining ISFSI are transferred back to DPC, which will be accomplished after license termination is complete.

3.8.2 Evaluation of the Updated Site-Specific Decommissioning Cost Estimate

As required by 10 CFR 50.82(a)(9)(ii)(F), LS estimated the remaining decommissioning costs associated with the termination of the LACBWR license and release of the site for unrestricted use, including contingency, and provided them as proprietary information in the LACBWR LTP. The remaining decommissioning scope of work included in the LACBWR cost estimate includes completion of the removal, transportation, and disposal of major components; completion of the removal, transportation, and disposal of remaining equipment; decontamination and/or bulk demolition of radiologically impacted structures, and transportation and disposal of the resulting radioactive wastes; and performance of the FSS and associated license termination activities.

The estimated decommissioning costs include the labor, equipment, materials, services, and fees needed to conduct the work. Consistent with the remaining work required at LACBWR, the estimated costs also include all of the program support activities and services necessary to manage and safely carry out a large-scale dismantlement and demolition project. The cost estimate includes provisions for cost escalation based on the “Consumer Price Index for all Urban Customers - U.S. City Average All Items, Not Seasonally Adjusted,” as provided by the U.S. Bureau of Labor Statistics. The cost estimate includes Class A radioactive waste management costs, which are covered by existing fixed-price contracts with Energy*Solutions*. The cost estimate does not include management or disposition of Class B or C radioactive waste, as all such materials were previously removed by DPC. Lastly, the licensee estimated no additional costs for spent fuel management because all spent nuclear fuel elements from LACBWR were transferred to dry cask storage in the ISFSI, which is retained by DPC. DPC will provide operations, maintenance, access control, and security services to and for the LACBWR ISFSI site, and DPC is also responsible for the costs relating to the ISFSI.

3.8.3 Evaluation of the Decommissioning Funding Plan

In addition to the requirement to provide an updated site-specific estimate of remaining decommissioning costs for the evaluation of the LACBWR LTP, LS is also required to provide annual decommissioning funding status reports for LACBWR.

Specifically, pursuant to 10 CFR 50.82(a)(8)(v):

> After submitting its site-specific decommissioning cost estimate required by paragraph (a)(4)(i) of this section, and until the licensee has completed its final radiation survey and demonstrated that residual radioactivity has been reduced to a level that permits termination of its license, the licensee must annually submit to the NRC, by March 31, a financial assurance status report.
>
> The report must include the following information, current through the end of the previous calendar year:
>
> (A) The amount spent on decommissioning, both cumulative and over the previous calendar year, the remaining balance of any decommissioning funds, and the amount provided by other financial assurance methods being relied upon;
>
> (B) An estimate of the costs to complete decommissioning, reflecting any difference between actual and estimated costs for work performed during the year, and the decommissioning criteria upon which the estimate is based;
>
> (C) Any modifications occurring to a licensee's current method of providing financial assurance since the last submitted report; and
>
> (D) Any material changes to trust agreements or financial assurance contracts.

Accordingly, on March 31, 2017, LS submitted the 2017 LACBWR Annual Decommissioning Funding Status (DFS) Report (ADAMS Accession No. ML17100A312). The subsequent NRC staff analysis of the annual DFS report was based on a decommissioning trust fund (DTF) balance of $64.4 million as of December 31, 2016, together with the $17 million Surety Bond payable to the DTF. The NRC staff applied a real rate of return of 2.0 percent to funds within the DTF during its analysis of funding through the expected license termination year of 2019. According to the LACBWR Annual DFS Report, the estimated cost to complete the radiological decommissioning of the LACBWR facility and site is $54.7 million as of December 31, 2016.

The NRC staff concludes that the updated site-specific cost estimate for the remaining radiological decommissioning activities at the LACBWR facility and site appears reasonable, and that the DTF balance as of December 31, 2016, will be sufficient to fund the remaining radiological decommissioning expenses and complete license termination.

3.8.4 Site Specific Cost Estimate Conclusions

The NRC staff reviewed the decommissioning cost information in the LACBWR LTP, Revision 1, for the LACBWR facility and site in accordance with Section 2.7, "Update of the Site Specific

Decommissioning Costs," of the NUREG-1700, Revision 2, SRP. As described therein, the purposes of the NRC staff's review are to ensure that:

(1) The LTP focuses on detailed activity by activity cost estimates.

(2) The LTP compares the funds available for decommissioning with the calculated total cost from the licensee's detailed cost analysis. In addition, RG 1.159, "Assuring the Availability of Funds for Decommissioning Nuclear Reactors," Revision 1, dated October 2003 (ADAMS Accession No. ML032790365), explains methods for estimating decommissioning costs, as well as accepted financial assurance mechanisms.

(3) The LTP cost estimate includes the cost of the remediation action being evaluated, the cost of transportation and disposal of the waste generated by the action, and other costs that are appropriate for the specific case. The current version of NUREG-1307, "Report on Waste Burial Charges: Changes in Decommissioning Waste Disposal Costs at Low-Level Waste Burial Facilities," Revision 16, dated March 2017 (ADAMS Accession No. ML17060A362), provides guidance on estimating waste disposal costs.

Based on the discussion provided in this section of the SER, the NRC staff finds that the decommissioning cost estimate and decommissioning funding plan associated with the LACBWR LTP are adequate and provide sufficient details associated with the funding mechanisms needed to complete dismantlement and decontamination activities at the LACBWR site. As such, the NRC staff finds that the licensee's updated site specific decommissioning cost estimate is adequate to demonstrate compliance with 10 CFR 50.82(a)(9)(ii)(F) (requiring the LTP to include "[a]n updated site-specific estimate of remaining decommissioning costs").

3.9 Environmental Report and Partial Site Release Considerations

In accordance with the requirements of 10 CFR 50.82(a)(9)(ii)(G), the licensee is required to provide a supplement to the environmental report, pursuant to 10 CFR 51.53, describing any new information or significant environmental changes associated with the licensee's proposed license termination activities. The licensee asserted that Chapter 8, "Supplement to the Environmental Report," of the LACBWR LTP, Revision 1, fulfilled this requirement, including (1) a detailed description of the impact of the site-specific license termination activities; (2) a comparison of the impact with previously analyzed license termination activities; and (3) an analysis of the environmental impact of the site-specific activities. See Section 5, "Environmental Consideration," of the SER for details concerning the NRC staff's environmental review of the La Crosse Boiling Water Reactor License Termination Plan.

In accordance with the requirements of 10 CFR 50.82(a)(9)(ii)(H), the licensee is required to identify parts, if any, of the facility or site that were released for use before approval of the LTP. On April 12, 2017 (ADAMS Accession No. ML16250A200), the NRC staff approved the release of approximately 88 acres of the 163 acre LACBWR site, which were classified as radiologically non-impacted, from LACBWR's Possession Only License No. DPR-45. This action was taken in response to the licensee's request dated June 27, 2016 (ADAMS Accession No. ML16181A068), in accordance with the provisions of 10 CFR 50.83, "Release of part of a power reactor facility or site for unrestricted use," which requires written approval from the NRC prior to release for unrestricted use of any part of a site at a nuclear power plant before receiving approval of a license termination plan. The licensee's application contained: (1) the results of evaluations performed to determine the effect of releasing the property, including dose to the public, effluent release, and environmental monitoring; (2) a description of the land to be released; (3) a schedule for release of the property; (4) results of the 10 CFR 50.59 evaluation performed; and (5) environmental impact conclusions.

In accordance with 10 CFR 50.83, the NRC staff reviewed the overall effects that the early release of the property would have on the remaining radiological doses and whether the classification of the release as non-impacted was justified. The NRC also held a public meeting in the vicinity of LACBWR on September 20, 2016, to obtain public comments associated with the partial site release (see public meeting summary dated October 17, 2016, at ADAMS Accession No. ML16286A050). The NRC staff conducted a review of the operating history of the facility, historical incidents, and operational radiological surveys as documented in the LACBWR HSA, as well as additional site characterization surveys performed in 2015 by the licensee to support the non-impacted classification of the 88 acre area, and in November 2016 by ORISE to support the NRC's review of the partial site release.

Based on this review, the NRC staff determined that the open land areas and buildings to be released were not impacted by previous licensed activities or materials, or by ongoing decommissioning activities. The NRC staff's review also indicated that: (1) the property has not been used for plant operations; (2) the property has not been used for storage or burial of any radioactive material or waste; and (3) there are no event records that any spills, leaks, or uncontrolled release of radioactive material have ever occurred on the property, either reportable or non-reportable. Therefore, the NRC staff determined that the "non-impacted" classification for the 88 acres of the LACBWR site to be released was appropriate, and the details of the subsequent partial site release were adequately captured in the environmental report and other documentation supporting the LACBWR LTP, Revision 1.

3.10 LACBWR LTP Change Procedure

The licensee has proposed that it be authorized to make certain changes to the NRC-approved LACBWR LTP without prior NRC approval, in a similar fashion to the process outlined in 10 CFR 50.59, if these changes do not:

(1) Require Commission approval pursuant to 10 CFR 50.59;

(2) Result in the potential for significant environmental impacts that have not previouslybeen reviewed;

(3) Detract or negate the reasonable assurance that adequate funds will be available for decommissioning;

(4) Decrease a survey unit area classification (i.e., impacted to not impacted; Class 1 to Class 2; Class 2 to Class 3; or Class 1 to Class 3) without providing the NRC a minimum 14 day notification prior to implementing the change in classification;

(5) Increase the derived concentration guideline levels and related minimum detectable concentrations for both scan and fixed measurement methods - if MDCs are increased (relative to what was approved) the licensee should request NRC approval;

(6) Increase the radioactivity level, relative to the applicable DCGL, at which an investigation occurs;

(7) Change the statistical test applied to a test other than the Sign test or Wilcoxon Rank Sum test;

(8) Increase the probability of making a Type I decision error above the level stated in the LACBWR LTP;

(9) Change the approach used to demonstrate compliance with the dose criteria (e.g., change from demonstrating compliance using DCGLs to demonstrating compliance using a dose assessment that is based on final concentration data); or

(10) Change parameter values or pathway dose conversion used to calculate the dose, such that the resultant dose is lower than in the approved LTP and if a dose assessment is being used to demonstrate compliance with the dose criteria.

The licensee will submit changes to the LACBWR LTP not requiring prior NRC approval as an update to the final safety analysis report, which for LACBWR is considered to be the PSDAR / D-Plan, in accordance with 10 CFR 50.71(e). The NRC staff concludes that authorizing the licensee to make certain changes to the LACBWR LTP during the final site remediation process, without prior NRC approval, is acceptable, subject to the above listed conditions.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Wisconsin State official, Mr. Paul Schmidt, Manager of the Radiation Protection Section at the Bureau of Environmental and Occupational Health, in the Division of Public Health for the Wisconsin Department of Health Services, was notified of the proposed issuance of the amendment on February 4, 2019 (ADAMS Accession No. ML19036A897). The State official supplied no comments.

5.0 ENVIRONMENTAL CONSIDERATION

Pursuant to 10 CFR 51.21 (stating criteria for and identification of licensing and regulatory actions requiring environmental assessments), 10 CFR 51.32 (addressing a finding of no significant impact), and 10 CFR 51.35 (proving the requirement to publish finding of no significant impact, and limiting pre-publication of Commission actions), an environmental assessment and finding of no significant impact was published in the *Federal Register* on May 21, 2019 (84 FR 23083). Accordingly, based upon the environmental assessment, the Commission has determined that issuance of this amendment will not have a significant effect on the quality of the human environment.

6.0 CONCLUSIONS

The NRC has concluded, based on the considerations discussed above, that there is reasonable assurance that the remainder of the decommissioning activities at LACBWR, as described in the LTP (1) will be performed in accordance with the regulations in 10 CFR Part 50; (2) will not be inimical to the common defense and security or to the health and safety of the public; and (3) will not have a significant effect on the quality of the environment.