UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

U.S. NUCLEAR REGULATORY COMMISSION

EVALUATION BY THE OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS

OF THE CLASS 1 FINAL STATUS SURVEY REPORTS, LICENSE TERMINATION

ACTIVITIES AT THE REACTOR SITE, AND PARTIAL SITE RELEASE

FOR POSSESSION ONLY LICENSE NO. DPR-45

LACROSSE*SOLUTIONS*, LLC

LA CROSSE BOILING WATER REACTOR

DOCKET NO. 50-409

1.0 INTRODUCTION

By letters dated September 11, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19261A344), December 13, 2019 (ML20006D756), and January 28, 2020 (ML20031C839), as supplemented by letter dated November 2, 2020 (ML20356A041), LaCrosse*Solutions*, LLC (LS, the licensee) requested U.S. Nuclear Regulatory Commission (NRC) review of the Final Status Survey Report (FSSR) for the La Crosse Boiling Water Reactor (LACBWR). These submittals support the LACBWR partial site release request received on February 14, 2020 (ML20052D015), as supplemented by letter dated December 14, 2021 (ML21350A014), which would remove a 36.5 acre portion of the site from the LACBWR Possession Only License No. DPR-45, which was issued pursuant to Part 50, “Domestic Licensing of Production and Utilization Facilities,” of Title 10 of the *Code of Federal Regulations* (10 CFR). The proposed action would effectively terminate the LACBWR 10 CFR Part 50 license outside the footprint for the remaining onsite Independent Spent Fuel Storage Installation (ISFSI), which encompasses approximately 39 acres.

The LS letter dated December 14, 2021, requested that the NRC staff expedite review of the FSSR documentation related to the LACBWR Class 2 and Class 3 survey units and approve the release of those survey units from the 10 CFR Part 50 license in advance of the Class 1 survey units. The Class 2 and Class 3 survey units consisted of eight above grade building survey units, seven open land survey units, and nine buried piping survey units for a total of 24 survey units. The NRC staff also evaluated one Class 1 buried piping survey unit as part of the review in order to be able to include all of the LACBWR buried piping survey units as part of this initial partial site release. The release of these 25 survey units from LACBWR’s Possession Only License No. DPR-45 was approved in an NRC letter dated May 24, 2022 (ML22122A230).

The sixteen remaining LACBWR Class 1 survey units consist of two basement survey units and fourteen land survey units (including seven below grade excavation survey units). The removal of these survey units from the LACBWR 10 CFR Part 50 license will represent the completion of decommissioning activities at the LACBWR reactor site, until such time as the ISFSI is no longer needed for the storage of spent fuel and subsequently decommissioned. The FSSR associated with these survey units is the documentation that demonstrates completion of the activities described in the LACBWR License Termination Plan (LTP), which was submitted by letter dated June 27, 2016 (ML16200A095), as supplemented by letter dated December 1, 2016 (ML16347A025), May 31, 2018 (ML18169A271 and ML18169A235), and November 15, 2018 (ML18331A023). The LACBWR LTP was approved by the NRC on May 21, 2019 (ML19008A079). References from the LTP safety evaluation are also available (ML19007A031).

The LACBWR LTP provided 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 described how the licensee will confirm the extent and success of remediation through radiological surveys, as captured in the FSSR, 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.

The NRC staff has completed its review of the portions of the LACBWR FSSR associated with sixteen Class 1 survey units: two basement survey units and fourteen land survey units. The staff's review considered if the FSSR for these survey units meets the criteria in 10 CFR 50.82(a)(11): whether the remediation of these survey units is in accordance with the approved LTP and whether these survey units meet the criteria for unrestricted release in Subpart E, "Radiological Criteria for License Termination," of 10 CFR Part 20, "Standards for Protection Against Radiation." The licensee's Final Status Survey (FSS) design criteria, implementation of the Data Quality Objectives (DQO) process, and survey approach/methods included in the FSSR were also reviewed, and results were assessed against the approved release criteria from the LACBWR LTP. The radiological dose contributions associated with the sixteen LACBWR Class 1 survey units were evaluated in aggregate with the 25 LACBWR Class 1, 2, and 3 survey units previously released to ensure that the site, as a whole, meets the criteria for unrestricted release. Based on this review, the NRC determined that the remaining LACBWR Class 1 survey units meet the criteria in 10 CFR 50.82(a)(11).

2.0 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 powerplant that is slated for decommissioning beginning in 2023. 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 (ML17080A423).

LACBWR permanently ceased operations on April 30, 1987 (ML17080A422), and the final reactor defueling was completed on June 11, 1987 (ML17080A420). In a letter dated August 4, 1987 (ML17080A393), the NRC terminated DPC's authority to operate LACBWR under Provisional Operating License No. DPR-45 and granted the licensee's request to amend the license to a possess-but-not-operate status. By letter dated August 18, 1988 (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 Paragraphs (a)(1)(iii) and (a)(2) in 10 CFR 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 (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." This document is also considered the Final Safety Analysis Report and Defueled Safety Analysis Report 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 ISFSI under the provisions of 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 (ML12290A027).

By order dated May 20, 2016 (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 order was published in the *Federal Register* (FR) on June 2, 2016 (81 FR 35383). The transfer assigned DPC's licensed possession, maintenance, and decommissioning authorities for LACBWR to LS to implement expedited decommissioning at the LACBWR site. LS commenced decommissioning of the site effective June 1, 2016, and completed all activities necessary to terminate the license and propose release of the majority of the site for unrestricted use as an industrial site, as documented in the associated LACBWR FSSR, except for a small area surrounding the ISFSI until final disposition and removal of the spent nuclear fuel.

By order dated September 24, 2019 (ML19008A393), the NRC approved the transfer of Possession Only License No. DPR-45 for LACBWR from LaCrosse*Solutions* back to the Dairyland Power Cooperative and approved a conforming license amendment. The transfer order will be implemented upon completion of decommissioning activities at the LACBWR site and is currently effective through March 24, 2023 (42 months from issuance, with extensions). Specifically, by letter dated June 24, 2020 (ML20188A228), LS submitted a request to extend the effectiveness of the order by six months. By order dated September 1, 2020 (First Extension Order) (ML20195A846), the NRC extended the transfer order's expiration date to March 24, 2021. Subsequently, by letter dated February 2, 2021 (ML21036A055), LS submitted a second request to extend the effectiveness of the order by an additional six months. By order dated March 9, 2021 (Second Extension Order) (ML21050A299), the NRC extended the transfer order's expiration date to September 24, 2021. On August 17, 2021 (ML21230A330), LS submitted a third request to extend the effectiveness of the order by an additional 12 months. By order dated August 30, 2021 (Third Extension Order) (ML21228A105), the NRC extended the license transfer order's expiration date to September 24, 2022. Subsequently, by letter dated August 16, 2022 (ML22230A801), LS submitted a fourth request to extend the effectiveness of the order by an additional three months. By order dated September 9, 2022 (Fourth Extension Order) (ML22235A792), the NRC extended the order's expiration date to December 24, 2022. Subsequently, by letter dated November 23, 2022 (ML22335A085), LS submitted a fifth request to extend the effectiveness of the order by an additional three months. By order dated December 8, 2022 (Fifth Extension Order) (ML22321A309), the NRC extended the order's expiration date to March 24, 2023. The previously approved conforming license amendment will be issued and made effective when the license transfer is complete.

3.0 TECHNICAL EVALUATION

3.1 Applicable Requirements

Section 5.11, “Final Status Survey (FSS) Reporting,” of the LACBWR LTP describes the licensee’s approach to license termination and FSSR documentation as follows:

> Documentation of the FSS will be contained in two types of reports and will be consistent with Section 8.6, “Documentation,” of NUREG-1575, “Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),” Revision 1, dated August 2000 (ML082470583). 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. Survey Unit Release Records will be made available to the NRC for review as appendices to the appropriate FSS Final Report. An FSS Final Report, which is a written report that is provided to the NRC for its review, 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 the as low as reasonably achievable (ALARA) criterion.
>
> It is anticipated that the FSS Final Report will be provided to the NRC in phases as remediation and FSS are completed with related portions of the site. The phased approach for submittal is intended to provide the NRC with detailed insight regarding the remediation and FSS activities early in the process, to provide opportunities for improvement based on feedback, and to support a logical and efficient approach for technical review and independent verification.

Additionally, the licensee indicated that it may seek approval to remove areas from the LACBWR license once decommissioning and remediation tasks are complete and the FSSR can demonstrate that release of the area(s) and any associated basement structures, above grade buildings, or buried piping will have no adverse impact on the ability of the site in aggregate to meet the 10 CFR Part 20, Subpart E, criteria for unrestricted release at the time of the final license termination decision. Because the approved LACBWR LTP includes the phased FSSR documentation process set forth above, as well as the fact that removal from the LACBWR 10 CFR Part 50 license of the remaining Class 1 survey units, is taking place after NRC approval of the LTP, the 10 CFR 50.83, “Release of part of a power reactor facility or site for unrestricted use,” partial site release requirements are not applicable to the current review for unrestricted release. However, it should be noted that on April 12, 2017 (ML16250A200), the NRC approved the partial site release of approximately 88 acres of non-impacted land from the LACBWR license, leaving approximately 75.5 acres under the subsequent LACBWR license.

In accordance with 10 CFR 50.82(a)(11), the LACBWR License Termination Plan, and the NRC safety evaluation dated May 21, 2019, the NRC staff has reviewed the applicable LACBWR FSS release records to ensure that the proposed action will have no impact on the ability of the site in aggregate to meet the unrestricted release criteria in 10 CFR 20.1402, “Radiological criteria for unrestricted use.” In the LACBWR LTP, the licensee establishes site-specific Base

Case Derived Concentration Guideline Levels (DCGLs) for each radionuclide of concern that are each equivalent to a total effective dose equivalent of 25 millirem per year (mrem/yr). To ensure that when all the separate source terms are considered jointly, the dose remains below 25 mrem/yr, the licensee assigned a fraction of the 25 mrem/yr dose to each type of source term (i.e., above ground buildings, below grade excavations, buried piping, soil, etc.). The Operational DCGLs (OpDCGLs) represent the site-specific Base Case DCGLs reduced by the appropriate fraction for each type of source term and are used in the LACBWR FSS design.

3.2 Area to be Released

When the sixteen remaining Class 1 survey units are combined with the 25 Class 1, 2, and 3 survey units released from the LACBWR license on May 24, 2022, the total area the licensee intends to release from the 10 CFR Part 50 license consists of 41 survey units. These 41 survey units encompass 36.5 acres (approximately 22 percent (%)) of the original licensed site area of 163.5 acres, which will leave only the land area associated with the ISFSI within the remaining 10 CFR Part 50 license (approximately 39 acres). An FSS was performed for each of these impacted survey units in accordance with the LACBWR LTP, MARSSIM, and numerous LACBWR implementing procedures. The licensee stated that "an FSS release record was prepared for each survey unit to provide complete and unambiguous records of the as-left radiological status. Sufficient data and information are provided in each release record to enable an independent recreation and evaluation of both the survey activities and the derived results."

The FSSR was written consistent with the guidance provided in NUREG-1757, "Consolidated Decommissioning Guidance," Volume 2, "Characterization, Survey, and Determination of Radiological Criteria, Final Report," Revision 1, dated September 2006 (ML063000252), and provided in three phases. The Phase 1 LACBWR FSSR (ML19261A344) was submitted on September 17, 2019, and includes four sub-grade excavation survey units, three open land survey units, and two basement survey units. The Phase 2 LACBWR FSSR (ML20006D756) was submitted on December 16, 2019, and includes eight above grade building survey units and ten buried piping survey units. The Phase 3 LACBWR FSSR (ML20031C839) was submitted on January 28, 2020, and includes three sub-grade excavation survey units and 11 open land area survey units. Note that each FSSR phase consisted of Class 1, Class 2, and Class 3 survey units, but this evaluation discusses primarily the sixteen Class 1 survey units that currently remain in the LACBWR 10 CFR Part 50 license.

The Phase 3 LACBWR FSSR also provided an overview of existing groundwater conditions and the methods used for calculating the dose from groundwater. In addition, the Phase 3 FSSR includes a description of how dose compliance is demonstrated through the summation of the five distinct source terms for the LACBWR end state (i.e., basements, soil, buried piping, above-grade structures, and groundwater), which demonstrates that the LACBWR site, as a whole, meets the 25 mrem/yr unrestricted release criterion established in 10 CFR 20.1402. The NRC staff reviewed the FSSR in its entirety for consistency with the LACBWR LTP and to verify that the summation dose meets the unrestricted release criteria, as discussed below.

The NRC staff reviewed the LACBWR Class 2 and Class 3 survey units prior to the Class 1 survey units and released the Class 2 and Class 3 survey units for unrestricted use by letter dated May 24, 2022 (ML22122A230). The NRC staff's conclusions associated with the remaining LACBWR Class 1 survey units are documented in this report. The NRC staff requested supplemental information associated with several survey units in a request for additional information (RAI) dated August 19, 2020 (ML20195A272). The licensee responded to this request on November 2, 2020 (ML20356A041). The NRC staff also held several teleconferences with the licensee to seek clarifications associated with the LACBWR FSSR RAI response (ML22277A350). These teleconferences were held in June through November 2022 to discuss the Class 1 survey units and resulted in the NRC staff requesting confirmatory information by letter dated October 12, 2022 (ML22278A027). As a result of these interactions the licensee provided supplemental information on July 28, September 7, October 20, and November 11, 2022 (ML22223A088, ML22269A395, ML22297A004, and ML22321A014 respectively), which revised the release records for the Waste Treatment Building Excavation and the Stack, Pipe Tunnel, and Reactor Plant Generator Plant Area Excavation survey units, among other clarifications and discussion regarding the Class 1 survey units to be released.

The NRC staff compared the licensee's decommissioning and FSS activities to applicable decommissioning guidance. This decommissioning guidance includes: MARSSIM; NUREG-1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions," Revision 0, dated June 1998 (ML003676046), and Revision 1, dated August 2020 (ML20233A507); NUREG-1700, "Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans," Revision 1, dated April 2003 (ML031270391), and Revision 2, dated April 2018 (ML18116A124); and NUREG-1757, Volumes 1 and 2, "Consolidated Decommissioning Guidance." For Class 1 survey units, MARSSIM specifies that 100% of the surface be scanned in order to support the statistical test for releasing the area for unrestricted use. The NRC staff evaluated the associated portions of the LACBWR FSSR for each type of Class 1 survey unit (basement survey units, land survey units, and below grade excavation survey units) in order to ultimately ensure that release of these survey units will have no adverse impact on the ability of the site in aggregate to meet the 10 CFR Part 20, Subpart E, criteria for unrestricted release. The sixteen LACBWR FSSR Class 1 survey units are summarized in Table 1 below.

Table 1. LACBWR FSSR Class 1 Survey Units (16 Total Survey Units)

Survey Unit	Type	Survey Unit Description	Class
L1-SUB-DRS	Excavation	Radiologically Controlled Area North Excavation	1
L1-SUB-TDS	Excavation	Turbine Building, Sump, and Pit Diesel Excavation	1
L1-SUB-LES	Excavation	Low Specific Activity (LSA) Building, Eat Shack, and Septic Excavation	1
L1-010-101C	Excavation	Waste Treatment Building (WTB) Excavation	1
B1-010-004	Basement	Waste Gas Tank Vault (WGTV) Basement	1
B1-010-001	Basement	LACBWR Reactor Building Basement	1
L1-010-101	Open Land	LACBWR Reactor Building, WTB, WGTV, and Ventilation Stack Grounds	1
L1-010-102	Open Land	Turbine Building, Turbine Office Building, and 1B Diesel Generator Building Grounds	1
L1-010-103	Open Land	LSA Building, Maintenance, and Eat Shack Grounds	1
L1-010-104	Open Land	North LSE Grounds	1
L1-010-105	Open Land	North Interim Debris Storage Area	1
L1-010-106	Open Land	North Loading Area	1
L1-010-107	Open Land	Outside East LSE Area	1
L1-SUB-CDR	Excavation	Stack, Pipe Tunnel, and Reactor Plant Generator Plant Area (RPGPA) Excavation	1
L1-SUB-TDS A	Excavation	Eastern Portion of the Turbine Building, Sump, Pit, and Diesel Excavation	1
L1-SUB-TDS B	Excavation	RPGPA Excavation	1

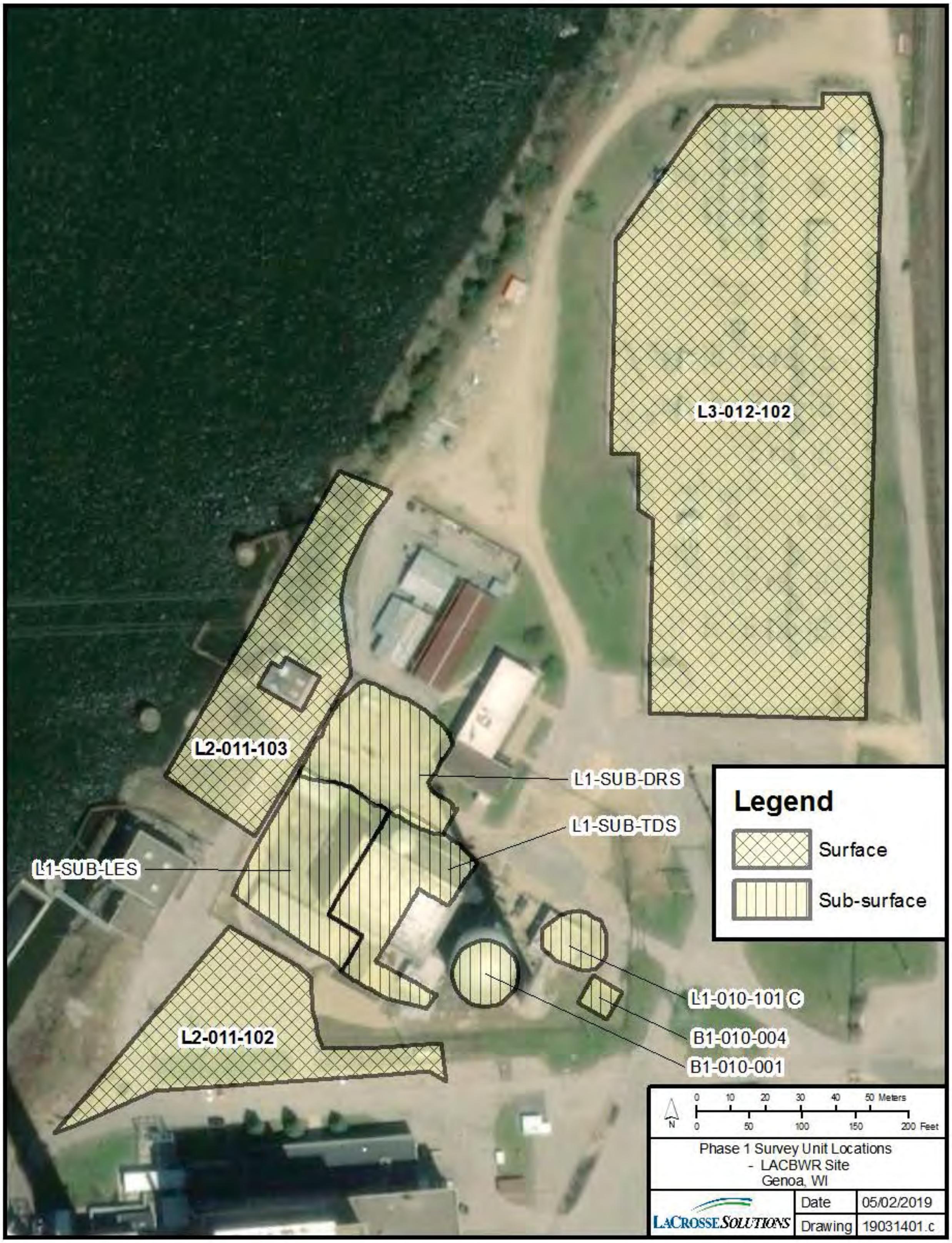


Figure 1. LACBWR FSSR Phase 1 Survey Unit Locations

Figure 2. LACBWR FSSR Phase 2 Survey Unit Locations

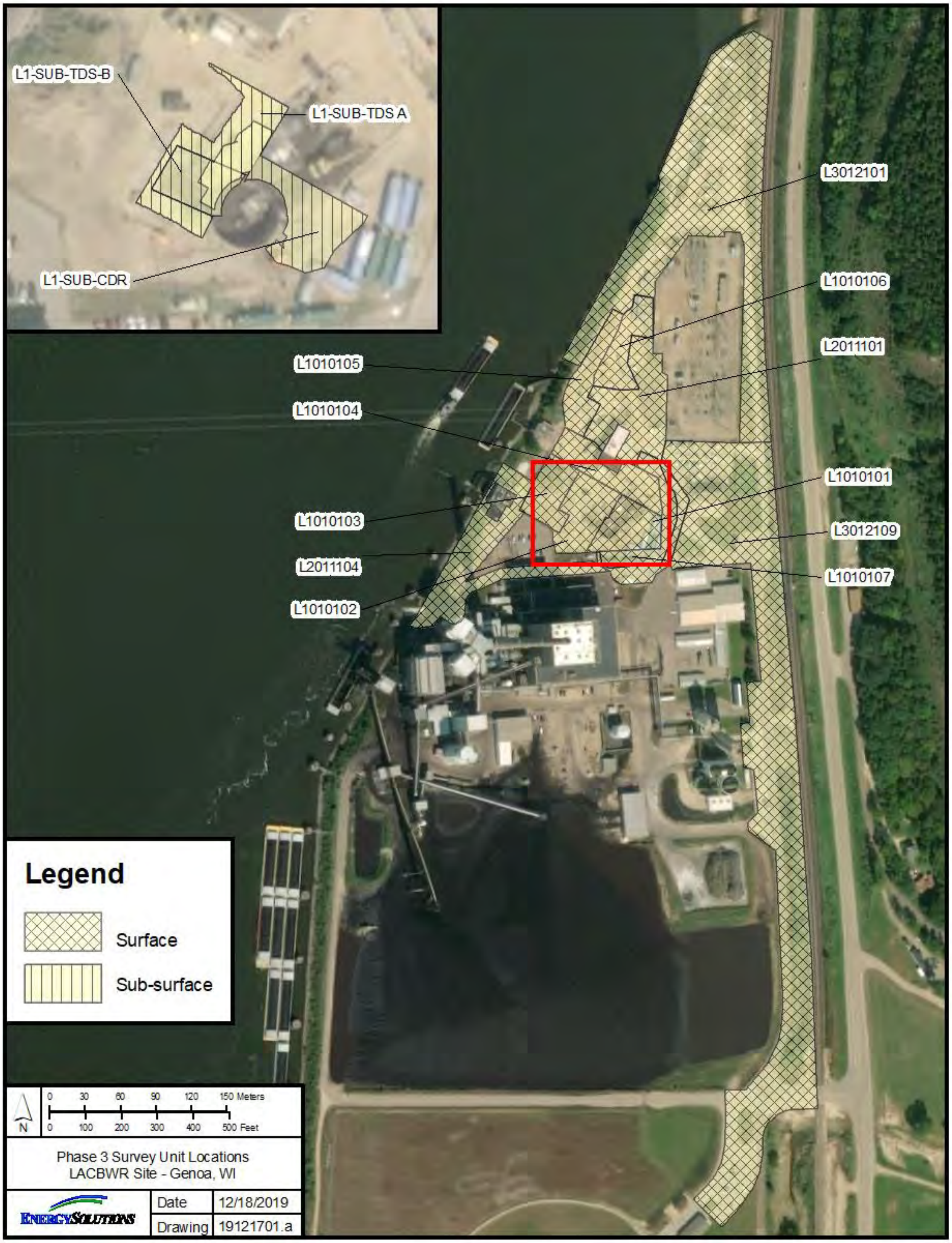


Figure 3. LACBWR FSSR Phase 3 Survey Unit Locations

3.3 Class 1 Excavation Survey Units

3.3.1 Description of the Excavation Survey Units

The LACBWR site consists of seven Class 1 excavation survey units, as summarized below.

Table 2. Class 1 Excavation Survey Units

Survey Unit	Type	Survey Unit Description	Phase	Class
L1-010-101C	Excavation	WTB Excavation	1	1
L1-SUB-CDR	Excavation	Stack, Pipe Tunnel, and RPGPA Excavation	3	1
L1-SUB-TDS	Excavation	Turbine Building, Sump, and Pit Diesel Excavation	1	1
L1-SUB-TDS A	Excavation	Eastern Portion of the Turbine Building, Sump, Pit, and Diesel Excavation	3	1
L1-SUB-TDS B	Excavation	RPGPA Excavation	3	1
L1-SUB-LES	Excavation	LSA Building, Eat Shack, and Septic Excavation	1	1
L1-SUB-DRS	Excavation	Radiologically Controlled Area North Excavation	1	1

3.3.1.1 Survey Unit L1-010-101C, Waste Treatment Building Excavation

Survey Unit L1-010-101C consists of the underlying soil post-removal of the WTB. The surface area of the survey unit is 87.8 square meters (m^2), and the survey unit is located below open land Survey Unit L1-010-101 for the LACBWR reactor building, WTB, WGTV, and ventilation stack grounds. The licensee performed FSS of this survey unit by conducting a 100% gamma walkover scan and collecting the 15 systematic soil samples required by the survey plan.

However, this survey unit required additional remediation as an outcome of the results of verification surveys conducted by NRC inspectors, as described in the associated inspection report dated February 12, 2018 (ML18043B109). After additional remediation was completed (Figure 4), the licensee conducted a 100% gamma scan of the excavation before backfilling. The remediation and additional excavation in the survey unit invalidated 11 of the original 15 systematic soil samples, but the survey unit had already been backfilled when the licensee recognized this situation. As a result the licensee collected 15 new systematic soil samples via GeoProbe[1] technology (Figure 5), which is capable of collecting samples at depth.

The mean sum of fractions (SOF) for the applicable radionuclides of concern (ROCs) when applying the respective Base Case DCGLs for soil is 0.0144 in Survey Unit L1-010-101C. This SOF equates to a dose for the survey unit of 0.3597 mrem/yr.

[1] GeoProbe® is a registered trademark of Kejr, Inc. in Salina, Kansas.

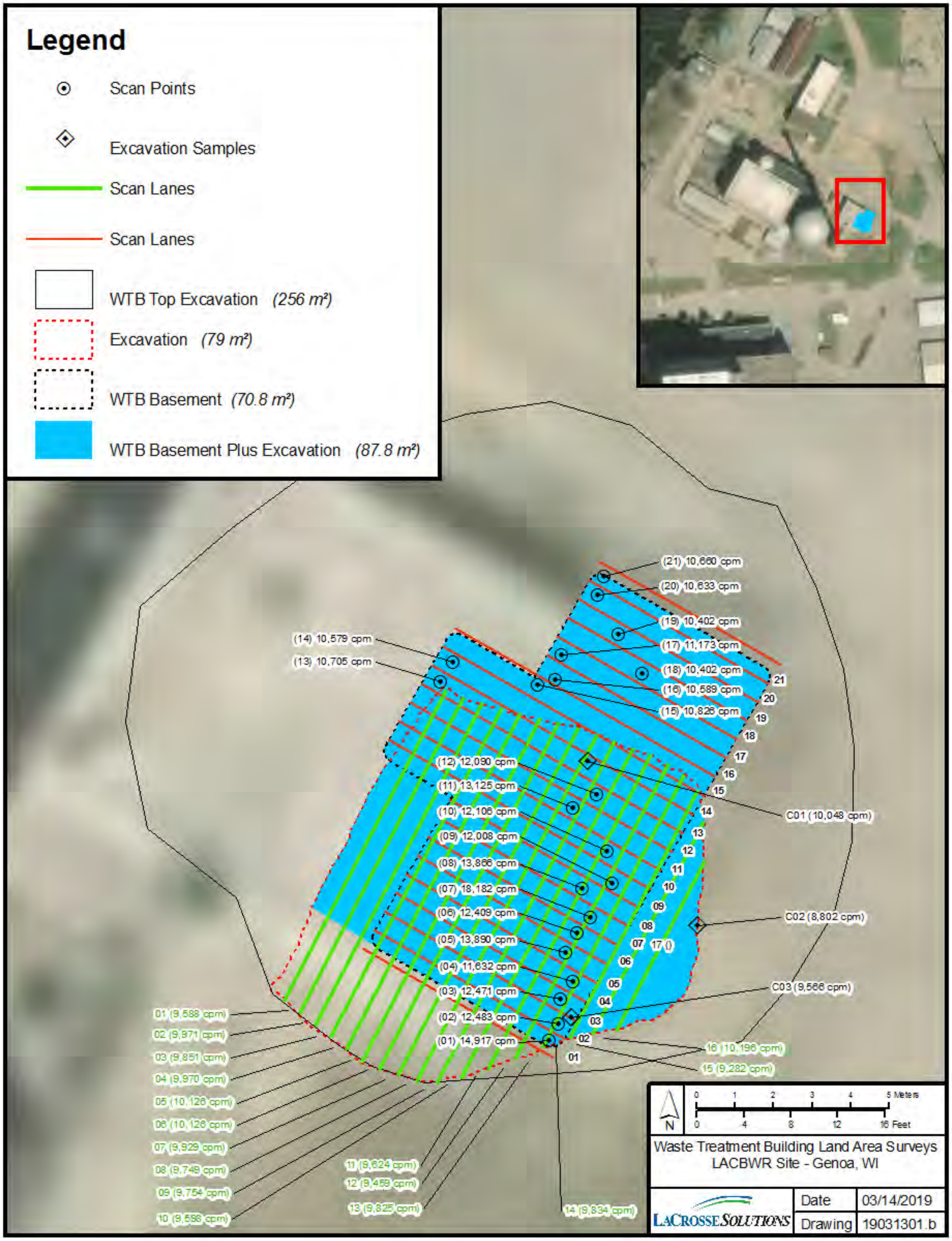


Figure 4. Remediation/Excavation Area Within Survey Unit L1-010-101C

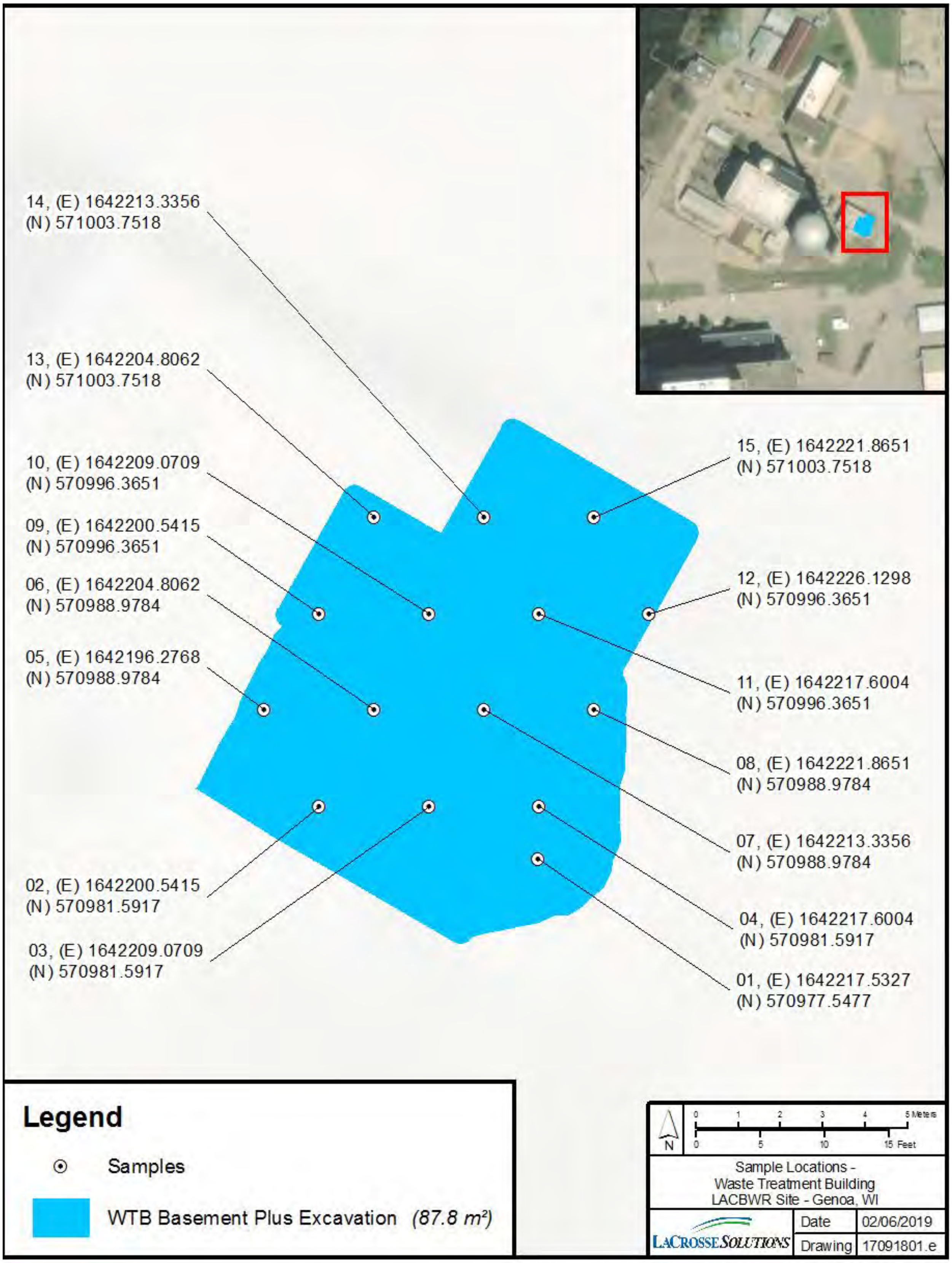


Figure 5. Survey Unit L1-010-101C GeoProbe Systematic Sample Locations

3.3.1.2 Survey Unit L1-SUB-CDR, Stack, Pipe Tunnel, and RPGPA Excavation

Survey Unit L1-SUB-CDR consists of the underlying soil post-removal of the stack, pipe tunnel and reactor plant generator plant area foundations. The surface area of the survey unit is 431 m^2 and is within open land Survey Unit L1-010-101.

The licensee performed FSS of this survey unit by conducting a 100% gamma walkover scan and collecting the 14 systematic soil samples required by the survey plan (Figure 6). Six investigational samples were collected at locations that produced scan alarms in the gamma scanning lanes. Five samples were selected for hard-to-detect (HTD) radionuclide analysis, four of which were chosen because the sample SOF was greater than 10% of the OpDCGL threshold, an HTD selection process which is described in the approved LACBWR LTP.

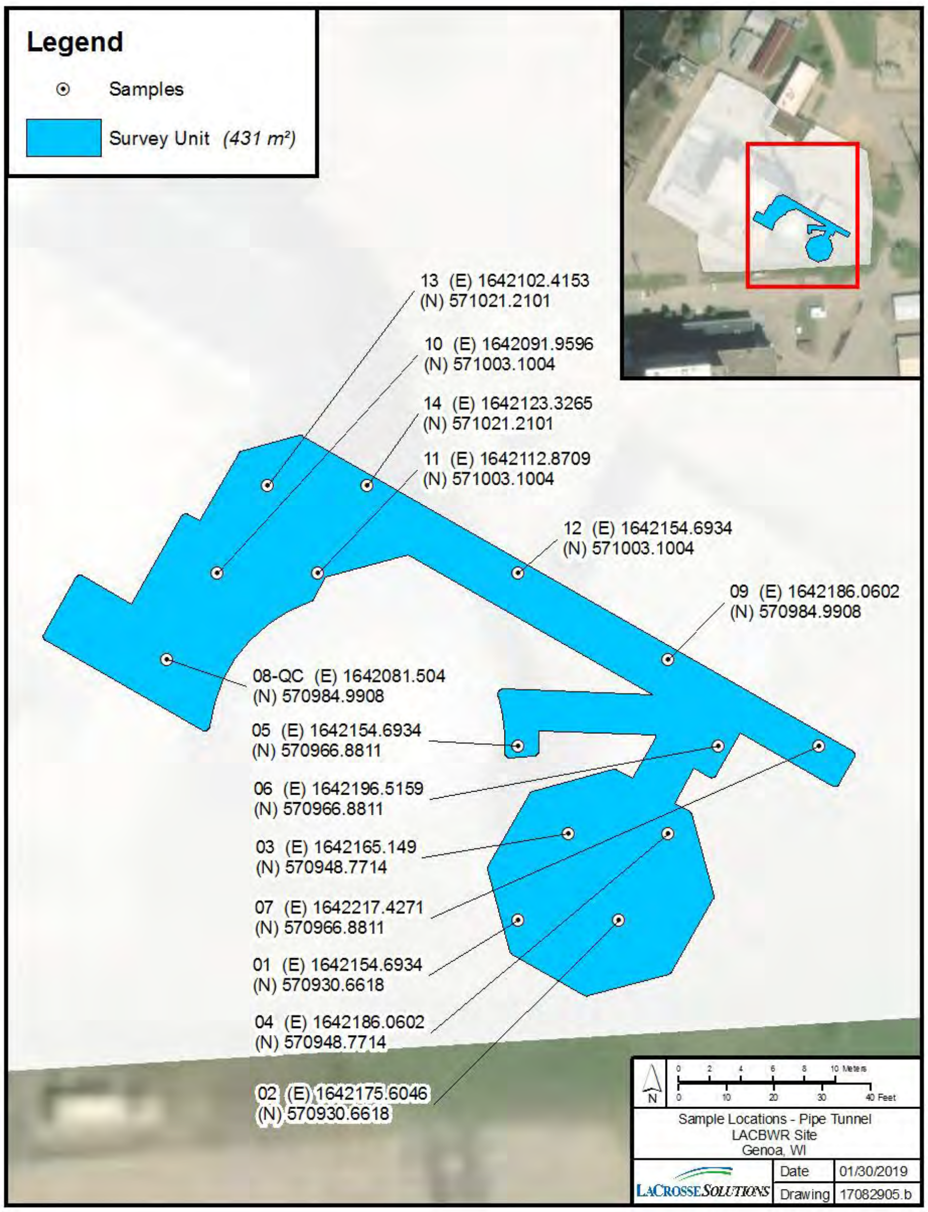


Figure 6. Survey Unit L1-SUB-CDR Systematic Samples

As shown in Figure 7 below, Survey Unit L1-SUB-CDR partially overlaps with both Survey Unit L1-SUB-TDS A and Survey Unit L1-SUB-TDS B, although at slightly different elevations due to the excavations associated with these survey units. Specifically, Survey Unit L1-SUB-TDS A was at a higher elevation than Survey Unit L1-SUB-CDR, while Survey Unit L1-SUB-TDS B was at a lower elevation than Survey Unit L1-SUB-CDR. Survey Unit L1-SUB-TDS A and Survey Unit L1-SUB-TDS B received FSS after Survey Unit L1-SUB-CDR. Excavation and demolition of the structures in Survey Unit L1-SUB-CDR was conducted throughout August and September 2017. Backfill of the survey unit was completed from September 20-26, 2017, except for the RPGPA sump area, which was backfilled on April 18, 2019.

Figure 7. Survey Units L1-SUB-TDS A, L1-SUB-TDS B, and L1-SUB-CDR Overlap

As shown in Figure 8 and Figure 9, the RPGPA sump area is at a lower elevation than Survey Unit L1-SUB-CDR, with the bottom of the sump trench box within Survey Unit L1-SUB-TDS B at an elevation of 618 feet. Therefore, the soil that had been scanned and sampled in the portion of Survey Unit L1-SUB-CDR that overlapped with Survey Unit L1-SUB-TDS B was later remediated and sampled as part of the Survey Unit L1-SUB-TDS B activities. In addition, Survey Unit L1-SUB-TDS A was at a higher elevation (636 feet – 639 feet) than Survey Unit L1-SUB-CDR (627 feet), and therefore the soil and samples that were taken in Survey Unit L1-SUB-CDR prior to the Survey Unit L1-SUB-TDS A activities remained at an elevation that was under the backfill that was initially used to fill in Survey Unit L1-SUB-CDR.

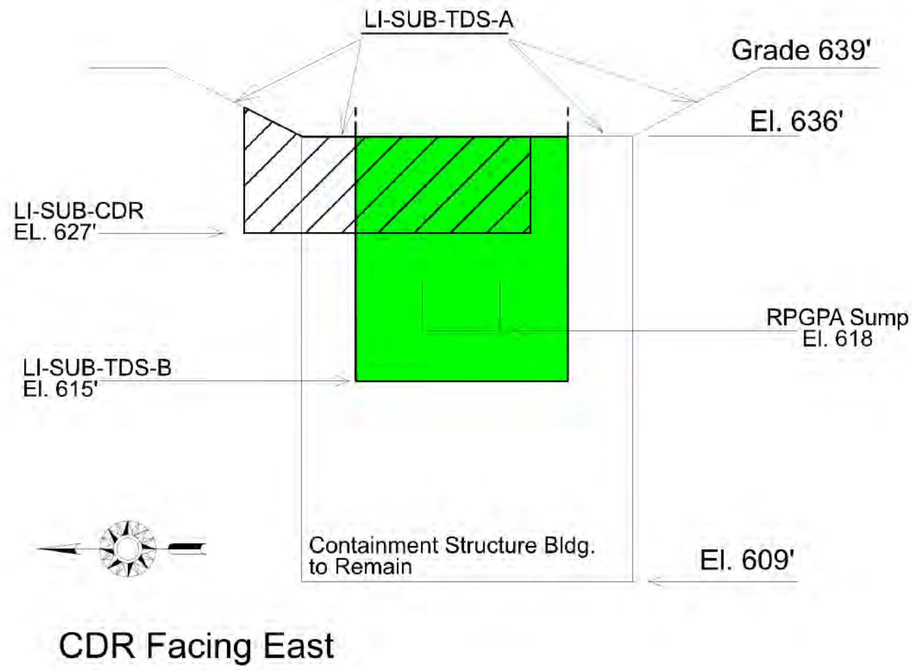


Figure 8. Cross Section East View of L1-SUB-CDR, L1-SUB-TDS B, and L1-SUB-TDS A

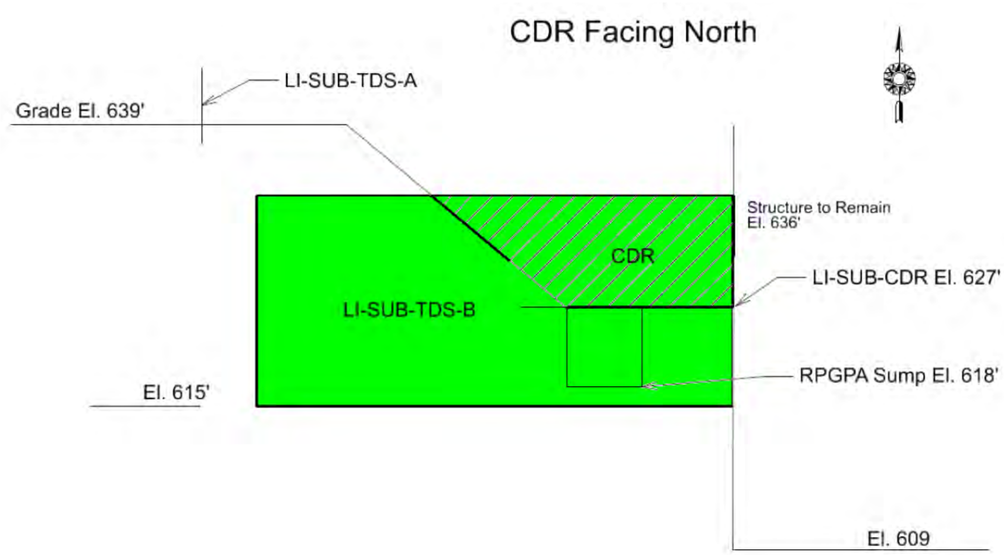


Figure 9. Cross Section North View of L1-SUB-CDR, L1-SUB-TDS B, and L1-SUB-TDS A

The licensee clarified that there was some disturbance of the backfill over Survey Unit L1-SUB-CDR during the subsequent activities associated with Survey Unit L1-SUB-TDS A, but that the disturbance never reached to the elevation of Survey Unit L1-SUB-CDR. As seen in Figure 10 below, portions of Survey Unit L1-SUB-TDS B (at the top of the photo) were excavated for proper sloping as indicated by the darker fill material. The licensee confirmed that these disturbances did not reach the elevation of the bottom of Survey Unit L1-SUB-CDR (ML22269A395, ML22297A004, and ML22321A014). Note that in Figure 10, Survey Unit L1-SUB-TDS B is the light tan rectangular area, which had been backfilled to an elevation of 636 feet prior to sampling with the GeoProbe equipment.

Figure 10. Survey Unit L1-SUB-TDS B (RPGPA Sump) at time of GeoProbe Sampling from June 26, 2019, to July 12, 2019

The mean SOF for the applicable ROCs when applying the respective Base Case DCGLs for soil is 0.0408 in Survey Unit L1-SUB-CDR. This SOF equates to a dose for the survey unit of 1.0190 mrem/yr. Note that Survey Unit L1-SUB-CDR was the survey unit with the maximum dose contribution and is therefore used in the final dose summation.

3.3.1.3 Survey Unit L1-SUB-TDS, Turbine Building, Sump, and Pit Diesel Excavation

Survey Unit L1-SUB-TDS consists of the underlying soil post-removal of the LACBWR turbine building, turbine building offices, and 1B diesel generator building, as well as associated system lines. The surface area of the survey unit is 1,185.5 m^2. This survey unit includes only the western portion of the original area covered by Survey Unit L1-SUB-TDS. The eastern portion of the original survey unit did not undergo FSS along with the western portion because of high background radiation readings emanating from the LACBWR reactor building at the time the

FSS was conducted. The eastern portion of the turbine building excavation is documented in the release records for Survey Unit L1-SUB-TDS A and Survey Unit L1-SUB-TDS B.

The Oak Ridge Institute of Science and Education (ORISE) conducted a confirmatory survey of this excavation soil survey unit from January 15-18, 2018. The results of the confirmatory survey concluded that that the licensee's FSS design and implementation were appropriate and reported results were acceptable for demonstrating compliance with the release criteria given that all the concentrations in measurements obtained during the confirmatory survey were at least an order of magnitude less than the respective OpDCGLs (ML20296A507).

The ORISE survey report also stated that the post-survey review of the gamma walkover maps showed a discrepancy between the planned boundary for Survey Unit L1-SUB-TDS and the physical boundary observed in the field (Figure 11). Therefore, the NRC staff asked the licensee to confirm that the boundaries of the survey units surrounding Survey Unit L1-SUB-TDS share physical boundaries such that 100% of the soil area was investigated during FSS. The licensee confirmed that 100% of Survey Unit L1-SUB-TDS received a gamma walkover scan in the supplemental information provided in response to a clarification teleconference on July 7, 2022. Specifically, the licensee reviewed the FSS field logs for Survey Unit L1-SUB-TDS and confirmed that the areas not scanned by ORISE were scanned by LaCrosse*Solutions* survey technicians during FSS of the survey unit (ML22269A392).

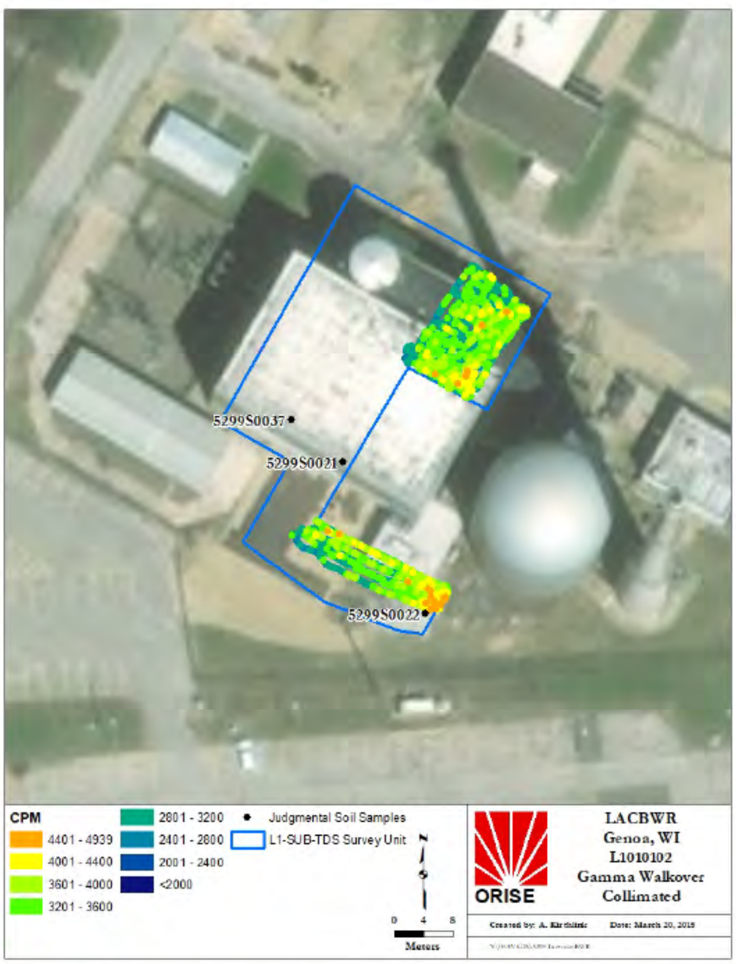


Figure 11. Survey Unit L1-SUB-TDS ORISE Confirmatory Survey Physical Boundary

The licensee performed FSS of this survey unit by conducting a 100% gamma walkover scan and collecting the 14 systematic soil samples required by the survey plan. Ten judgmental soil samples were collected (Figure 12) to investigate locations where scanning revealed higher readings and for continuing characterization as required by Section 5.3.3.4, “Inaccessible or Not Readily Accessible Areas,” of the LACBWR LTP. One sample was selected for HTD radionuclide (Strontium-90 (Sr-90)) analysis, and seven additional samples were selected for analysis of the full initial suite of radionuclides for continuing characterization purposes.

The mean SOF for the applicable ROCs when applying the respective Base Case DCGLs for soil is 0.0125 in Survey Unit L1-SUB-TDS. This SOF equates to a dose for the survey unit of 0.3115 mrem/yr.

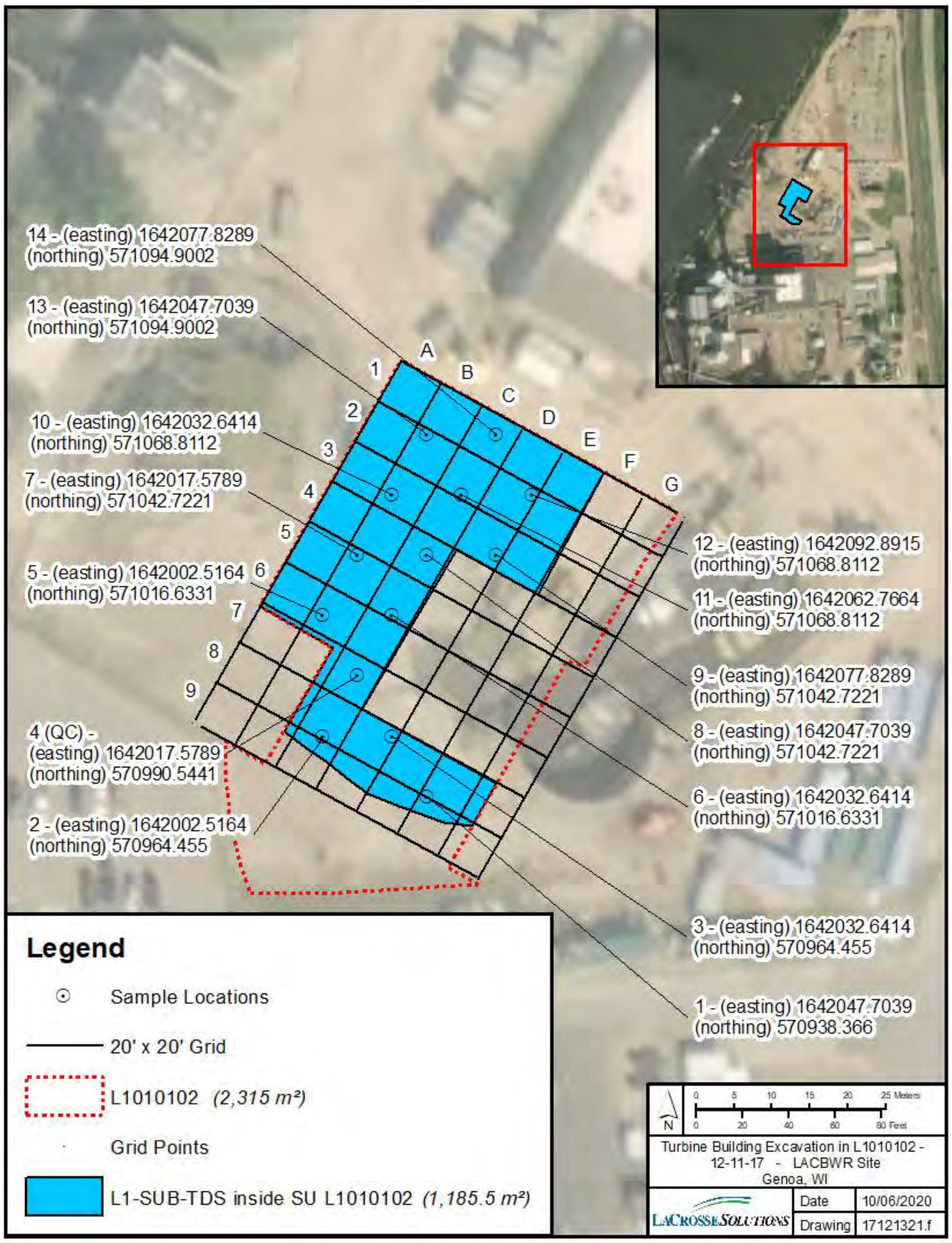


Figure 12. Survey Unit L1-SUB-TDS Systematic and Judgmental Sample Locations

3.3.1.4 Survey Unit L1-SUB-TDS A, Eastern Portion of the Turbine Building, Sump, Pit, and Diesel Excavation

Survey Unit L1-SUB-TDS A consists of the eastern portion of the underlying soil post-removal of the LACBWR turbine building, turbine building offices, and 1B diesel generator building, as well as associated system lines. The surface area of the survey unit is 476 m^2 and is within open land Survey Unit L1-010-102. The eastern portion of the original turbine building survey unit (Survey Unit L1-SUB-TDS) did not undergo FSS along with the western portion because of high background radiation readings emanating from the LACBWR reactor building and surrounding environs at the time the FSS was conducted.

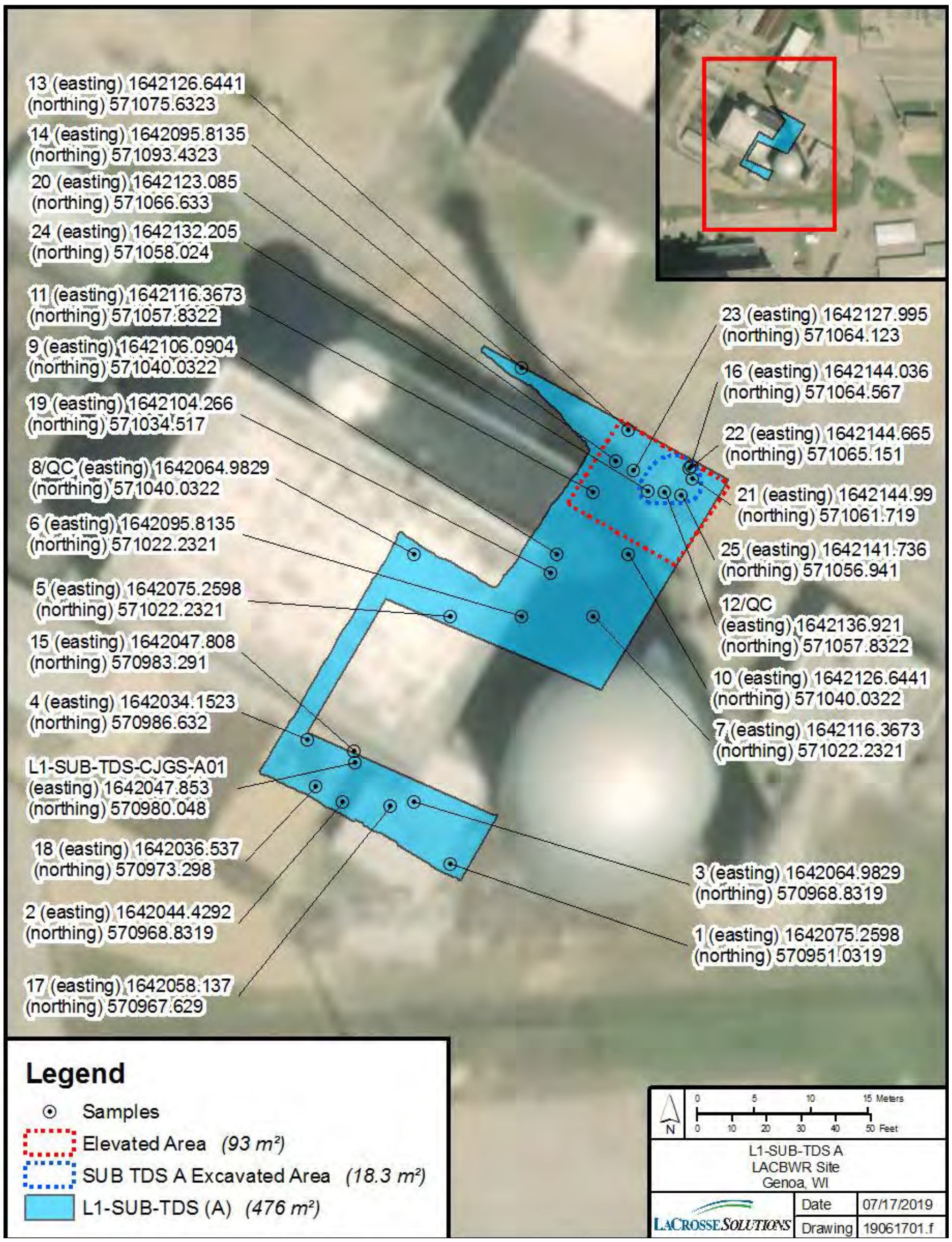


Figure 13. Survey Unit L1-SUB-TDS A Systematic and Judgmental Sample Locations

The licensee performed FSS of this survey unit by conducting a 100% gamma walkover scan and collecting the 14 systematic soil samples required by the survey plan. Four judgmental samples were obtained (Figure 13 above) to investigate locations where scanning revealed higher readings that caused scan alarms. This surpassed the minimum survey plan requirement of collecting one judgmental sample in this survey unit. Three samples were selected for HTD radionuclide (Sr-90) analysis.

The mean SOF for the applicable ROCs when applying the Base Case DCGLs for soil is 0.0141 in Survey Unit L1-SUB-TDS A. This SOF equates to a dose for the survey unit of 0.3526 mrem/yr.

3.3.1.5 Survey Unit L1-SUB-TDS B, RPGPA Excavation

Survey Unit L1-SUB-TDS B consists of part of the eastern portion of the underlying soil post-removal of the LACBWR turbine building, turbine building offices, and 1B diesel generator building, as well as associated system lines. The surface area of the survey unit is 259 m^2 and is within open land Survey Unit L1-010-102. The survey unit consists of the sloped boundaries of the excavation area and the 39 m^2 location of the former RPGPA sump. The maximum depth of the excavation in Survey Unit L1-SUB-TDS B is at the 618-foot elevation, which is 21 feet below grade (639-foot elevation). Note that in Figure 14 below, the blue shaded area is of the western portion of the LACBWR turbine building, while this survey unit (indicated by the red outline) is a small part within the eastern footprint of the turbine building.

During decommissioning activities at LACBWR, the RPGPA sump experienced groundwater intrusion due to rising Mississippi River water levels that caused it to become inaccessible. As a result, the licensee backfilled the excavation area before FSS was conducted. The backfilled RPGPA sump area subsequently underwent FSS via the use of GeoProbe technology. Surface scan measurements of the bottom of the excavation were not performed because the area had been backfilled prior to FSS. However, the licensee did perform gamma scans of the soil sample tubes as they were being collected using the GeoProbe technology.

As part of this effort, 28 systematic sample locations were selected, and the licensee collected soil samples in four strata at each location via GeoProbe technology. The licensee also obtained GeoProbe samples at eight judgmental soil sample locations consisting of four strata. The maximum activity reading within the four stratum for each GeoProbe sample was reported as part of the release record. All 36 samples were sent offsite and analyzed for both Sr-90 and tritium (H-3). Figure 14 shows the systematic and judgmental locations of the GeoProbe samples. The NRC staff notes that two soil samples (labeled Sump Area #1 and Sump Area #2) from the sump area in this survey unit were collected prior to the GeoProbe campaign in Survey Unit L1-SUB-TDS B, during the FSS of a different survey unit (Survey Unit L1-SUB-CDR), and were subsequently remediated as part of the remediation of the RPGPA sump.

The mean SOF for the applicable ROCs when applying the respective Base Case DCGLs for soil is 0.0385 in Survey Unit L1-SUB-TDS B. This SOF equates to a dose for the survey unit of 0.9613 mrem/yr.

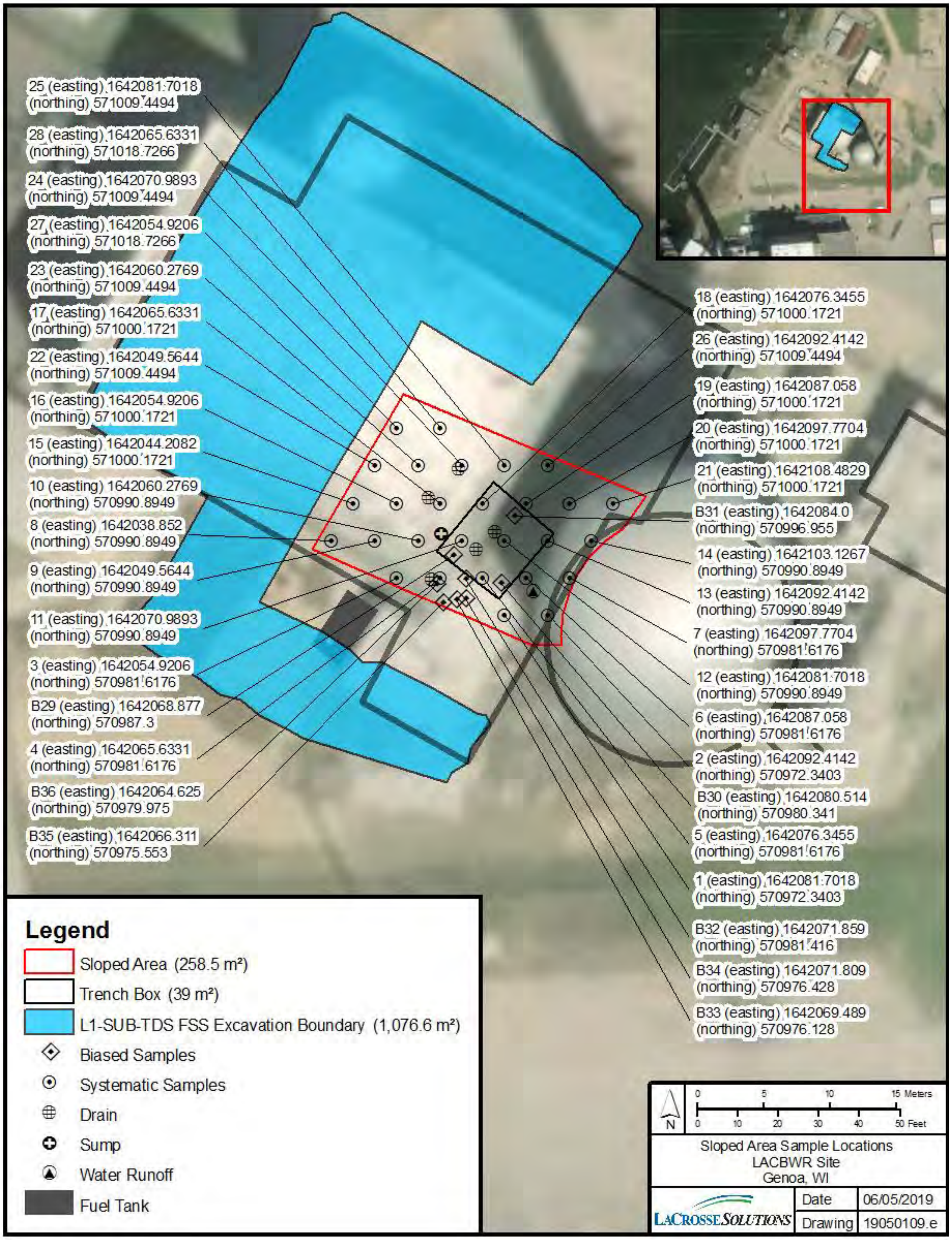


Figure 14. Survey Unit L1-SUB-TDS B Systematic and Judgmental Sample Locations

3.3.1.6 Survey Unit L1-SUB-LES, LSA Building, Eat Shack, and Septic Excavation

Survey Unit L1-SUB-LES consists of the underlying soil post-removal of the LSA building, septic tank, maintenance eat shack foundation, oily water tank, circulating water intake and discharge piping, and main transformer substation, as well as associated system lines. The surface area of the survey unit is 1,336 m^2 and is within open land Survey Unit L1-010-103.

The licensee performed FSS of this survey unit by conducting a 100% gamma walkover scan and collecting the 14 systematic soil samples required by the survey plan. One judgmental sample was obtained (Figure 15), which met the minimum requirement of the survey plan. Two samples were selected for HTD radionuclide (Sr-90) analysis. Zero investigational samples were triggered due to scan alarms during the gamma walkover scan.

The mean SOF for the applicable ROCs when applying the respective Base Case DCGLs for soil is 0.01 in Survey Unit L1-SUB-LES. This SOF equates to a dose for the survey unit of 0.2495 mrem/yr.

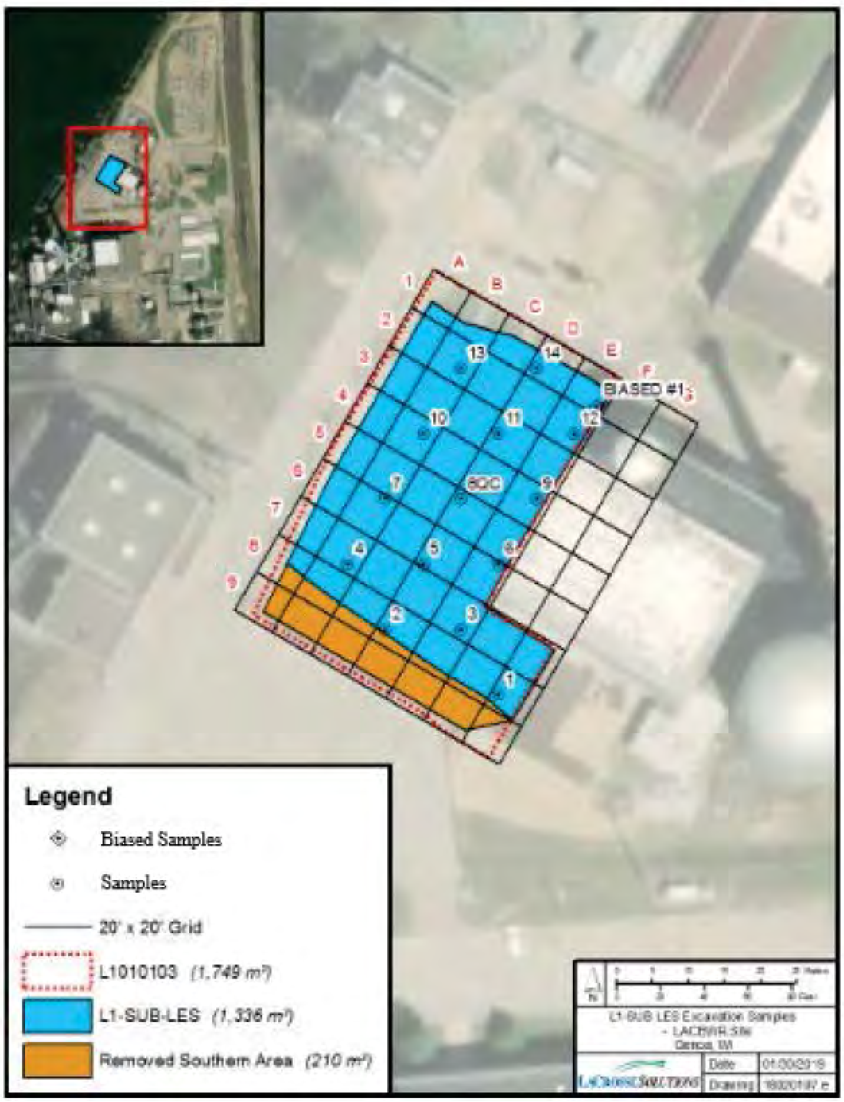


Figure 15. Survey Unit L1-SUB-LES Systematic and Judgmental Sample Locations

3.3.1.7 Survey Unit L1-SUB-DRS, Radiologically Controlled Area North Excavation

Survey Unit L1-SUB-DRS consists of the underlying soil post-removal of the radiologically controlled area roadway, rail lines, storm drains, high pressure service water lines, low pressure service water lines, and well water lines. The surface area of the survey unit is 1,125 m^2 and is within open land Survey Unit L1-010-104 (west).

The licensee performed FSS of this survey unit by conducting a 100% gamma walkover scan and collecting the 14 systematic soil samples required by the survey plan. Six judgmental samples were collected (Figure 16) during implementation of the FSS, and two samples were selected for HTD radionuclide (Sr-90) analysis, which met the minimum requirements of the survey plan for judgmental sampling and HTD radionuclide analysis.

The mean SOF for the applicable ROCs when applying the respective Base Case DCGLs for soil is 0.0105 for Survey Unit L1-SUB-DRS. This SOF equates to a dose for the survey unit of 0.2620 mrem/yr.

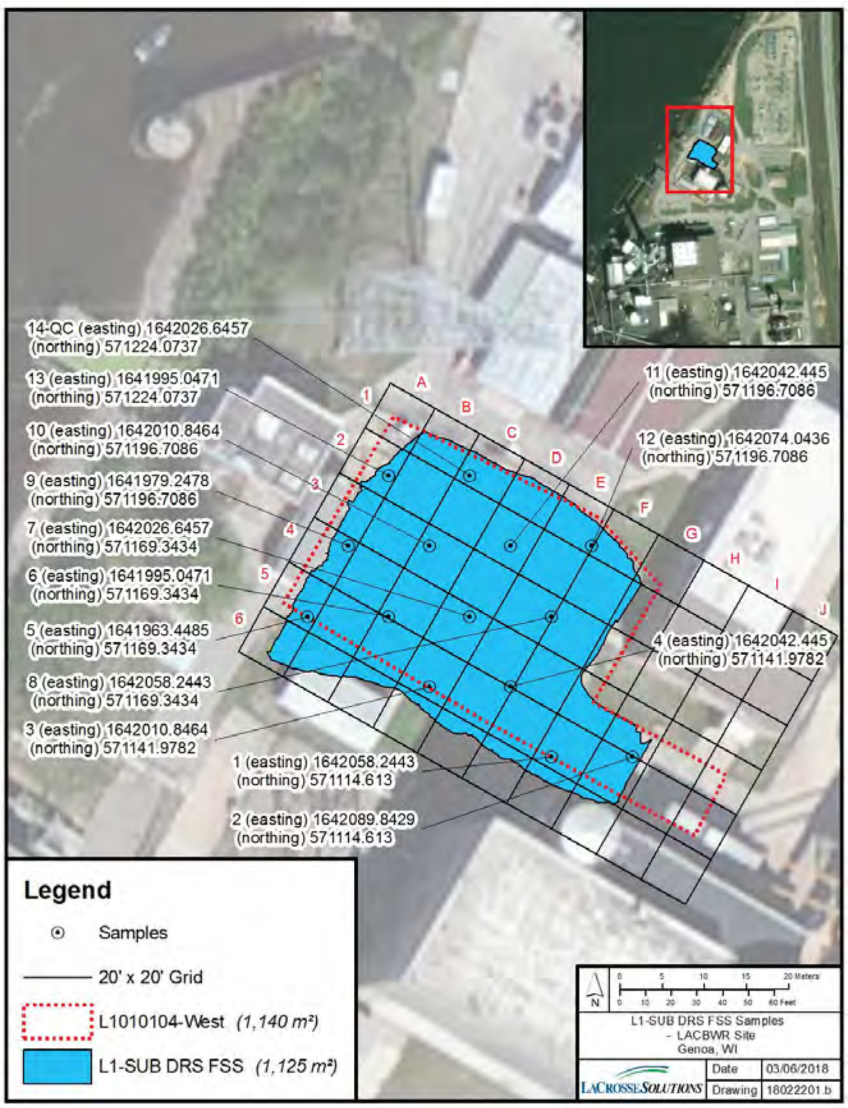


Figure 16. Survey Unit L1-SUB DRS Systematic and Judgmental Sample Locations

3.3.2 NRC Evaluation of the Excavation Survey Units

3.3.2.1 Number of Systematic Samples

Section 5.6.4.1, “Sample Size Determination,” of the LACBWR LTP specifies 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 - N) necessary to ensure sufficient data for statistical analysis, such that there is reasonable assurance that the survey unit will pass the requirements for release. Table 5.5, “Values of N for Use with the Sign Test,” of MARSSIM provides guidance on determining the minimum number of survey samples to be taken based on Sign Test results, acceptable 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 error rates, and outlines the appropriate method for calculation of the relative shift.

The relative shift (Δ/σ) is defined as shift (Δ), which is the upper boundary of the gray region (UBGR), or the DCGL for average concentrations over a wide area (DCGLw), minus the lower boundary of the gray region (LBGR), divided by sigma (σ), which is the standard deviation of the dataset used for survey design. The largest value the relative shift can be set to is three. For all the LACBWR Class 1 survey units, the relative shift the licensee calculated was greater than three. As a result a value of three was used for the relative shift based on the applicable MARSSIM guidance. Because there is more than one radionuclide, the UBGR or DCGLw becomes the unity SOF of one. The LBGR is set at the expected median concentration of the contaminant, but the LACBWR LTP states that “if no other information is available regarding the survey unit, the LBGR may be initially set equal to 0.5 times the OpDCGLw.” The licensee set the LBGR to 0.5 times the OpDCGLw for most of the LACBWR Class 1 excavation survey units.

The guidance in MARSSIM recommends that for survey units that have been remediated, the site-specific parameters used during FSS planning (e.g., standard deviation of the radionuclide concentration and expected median concentration) should be re-established following remediation. Obtaining updated values for these parameters should be considered when planning a remedial action support survey. Proper characterization after remediation is especially important for soil that was underlying former buildings, where contamination in the subsurface beneath a cleaner layer of soil may exist. Section 2.4, “Continuing Characterization,” of the LACBWR LTP discusses the continuing characterization of several specific inaccessible or not readily accessible subsurface soils in the LACBWR Class 1 open land areas that were previously located beneath buildings. The LTP describes that after remediation is completed, a “turnover assessment” will be performed to collect additional survey data prior to conducting the FSS. One objective of the turnover assessment is to ensure appropriate sample collection and analysis to determine spatial variability and variability in radionuclide ratios.

For LACBWR Class 1 survey units L1-SUB-DRS, L1-SUB-TDS, L1-SUB-LES, L1-010-101C, and L1-SUB-CDR, the dataset used for the survey design, as described in the associated FSS release records, is from the characterization of the Class 1 open land survey units prior to the buildings being removed. The four LACBWR Class 1 open land survey units are show in red in Figure 17 below, which is reproduced from Figure 2-1, “LACBWR Site Map – Open Land Survey Units and Classification,” of the LACBWR LTP. The characterization data for the Class 1 open land survey areas is in Table 2-10, “Impacted Class 1 Open Land Survey Units – Characterization Survey Summary,” of the LACBWR LTP.

Most of the characterization subsurface samples were taken at a depth of one meter and the buildings were obstructing the ability to characterize the soil beneath the buildings. Section 2.3.4.1, “Class 1 Open Land Areas,” of the LACBWR LTP states that “the assessment of potential subsurface soil contamination in the Class 1 open land areas is not currently complete. Soil in difficult to access areas such as under building foundations and surrounding buried structures and piping has been deferred until later in the decommissioning process, when access will be more readily available.” Therefore, the characterization data for the land survey areas prior to removal of the buildings may not be representative of the median radionuclide concentration or the standard deviation of the excavation soil after the removal of the buildings and remediation of the underlying soil. For these survey units, the licensee set the LBGR equal to 0.5 times the OpDCGLw. Assigning a value of 0.5 times the OpDCGLw for the LBGR is conservative if the expected median contaminant concentration is lower than 0.5 of the SOF. When the median contaminant concentration is lower than 0.5 of the SOF, it will result in a higher calculated relative shift, and therefore a lower number of required samples.

As part of the supplemental information provided in support of the clarification teleconferences to discuss the LACBWR FSSR RAI response (ML22223A088), the licensee reviewed the release records for survey units L1-SUB-DRS, L1-SUB-LES, and L1-SUB-TDS and acknowledged that remedial action support surveys (RASS) were performed as part of the turnover assessment process. The relative shifts for these survey units should have been calculated using the RASS datasets rather than the characterization data for the land survey areas prior to removal of the buildings. As such, the licensee performed an assessment to calculate the relative shift using the Cesium-137 (Cs-137) values from the RASS for median radionuclide concentration and standard deviation, in order to ensure that the correct sample size (N) was collected during the FSS for survey units L1-SUB-DRS, L1-SUB-LES, and L1-SUB-TDS. In all cases, the survey units had the appropriate sample sizes in accordance with Table 5.5 of MARSSIM. Note that the revised calculated relative shifts based on the RASS data for survey units L1-SUB-DRS, L1-SUB-LES, and L1-SUB-TDS, which were provided in the supplemental information from the licensee, are shown below in Table 3 as opposed to the calculated relative shifts in the original FSS release records.

The supplemental information also confirmed that “the relative shifts for the FSSs of survey units L1-010-101C and L1-SUB-CDR were calculated using subsurface soil data (Cs-137 and Cobalt-60 (Co-60)) from the characterization of the top-side soil survey unit.” For survey units L1-SUB-TDS A and L1-SUB-TDS B, the licensee used the radiological assessment (RA) dataset for calculating the relative shift. These survey units utilize the median contaminant concentration and standard deviation of the samples taken during the RA survey of the excavation just prior to FSS, which is a more representative dataset for the survey unit after removal of the buildings. For these survey units, the calculated relative shift was also greater than three, so the licensee assigned a value of three in accordance with MARSSIM guidance.

The effect of underestimating the median radionuclide concentration and variability is that the required number of samples associated with a given Type II error may be underestimated. Since the licensee used Scenario A from MARSSIM, this means there was a greater risk that the survey unit would have failed FSS when it could have passed with additional samples. The Scenario A null hypothesis in MARSSIM states that the concentration of residual radioactive material in the survey unit exceeds the release criteria. This framing of the null hypothesis places the burden of proof for demonstrating compliance with the release criteria on the licensee. Further, if the median radionuclide concentration and variability were underestimated, this would result in a larger relative shift and the statistical power would decrease. The statistical power (i.e., the probability of rejecting the null hypothesis) depends on the variability in the

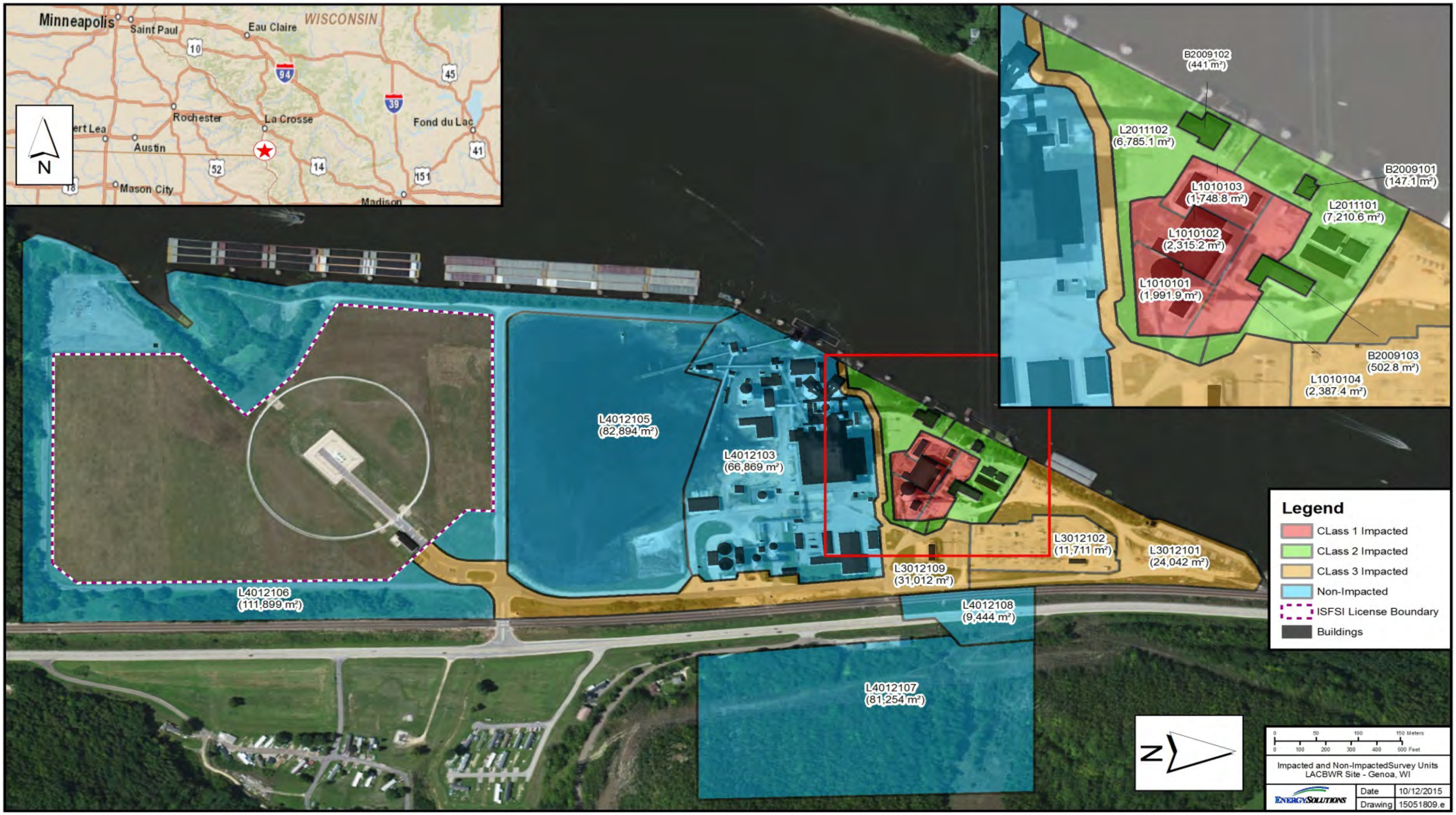


Figure 17. LACBWR Site Map – Open Land Survey Units and Classification

survey unit and the tolerable Type II error probability (i.e., β). Under Scenario A, this type of decision error can result in deciding that a survey unit does not meet the release criteria when it would have passed with more data. In other words, if the licensee underestimated the number of required samples there is a greater probability that the survey unit would fail the statistical test and not meet the release criteria when it is in fact "clean," which is a conservative approach for addressing failure of the statistical test. However, in these instances all of the LACBWR Class 1 excavation survey units passed the Sign Test (the null hypothesis was rejected) with the number of samples required by the survey design in each survey unit.

Table 3. LACBWR Class 1 Excavation Survey Unit Characterization Data

Survey Unit	Survey Unit Description	Characterization, RASS, or RA Samples	Median Cs-137 in picoCuries per gram (pCi/g)	Standard Deviation of Characterization Samples (σ) (pCi/g)	Calculated Relative Shift
L1-010-101C	WTB Excavation	18 subsurface samples from Survey Unit L1-010-101 (only Cs-137 detected)	0.054	0.035	$\Delta/\sigma = (1-0.5) / 0.03 = 16.67$
L1-SUB-CDR	Stack, Pipe Tunnel, and RPGPA Excavation	18 subsurface samples from Survey Unit L1-010-101 (only Cs-137 detected)	0.054	0.035	$\Delta/\sigma = (1-0.5) / 0.03 = 16.67$
L1-SUB-TDS	Turbine Building, Sump, and Pit Diesel Excavation	RASS	0.274	0.262	$\Delta/\sigma = (17.4-0.274) / 0.262 = 65.3$
L1-SUB-TDS A	Eastern Portion of the Turbine Building, Sump, Pit, and Diesel Excavation	9 samples during RA	0.043	0.025	$\Delta/\sigma = (1 - 0.043) / 0.025 = 38.3$
L1-SUB-TDS B	RPGPA Excavation	7 samples during RA	0.1	0.14	$\Delta/\sigma = (1 - 0.1) / 0.14 = 6.43$
L1-SUB-LES	LSA Building, Eat Shack, and Septic Excavation	RASS	0.318	0.479	$\Delta/\sigma = (17.4-0.318) / 0.479 = 35.6$
L1-SUB-DRS	Radiologically Controlled Area North Excavation	RASS	0.287	0.632	$\Delta/\sigma = (17.4-0.287) / 0.632 = 27$

3.3.2.2 Scanning, Investigation Levels, and GeoProbe Samples

In Section 5.6.4.5, "Reference Grid, Sampling and Measurement Locations," of the LACBWR LTP, the licensee commits to performing 100% gamma walkover scans of Class 1 survey units. Furthermore, Section 5.6.4.6, "Investigation Process," of the LACBWR LTP states that survey areas where radioactivity is identified in excess of the given investigation levels will be "addressed by further biased surveys and sampling as necessary" according to the investigation levels in Table 5-16, "FSS Investigation Levels," of the LTP. The NRC staff evaluated the surface scan coverage and process for investigating areas of elevated contamination for each of the LACBWR Class 1 excavation survey units to determine whether the provisions of the LACBWR LTP, the guidance in MARSSIM, and the 10 CFR 20.1402 criterion were met.

The FSS investigation levels for each class of survey unit are presented in Table 5-16 of the LACBWR LTP, and are provided as Table 4 below. This table also corresponds to Table 5.8, "Example Final Status Survey Investigation Levels," of MARSSIM, which provides example investigation levels. Table 5-16 of the LACBWR LTP states that for Class 1, Class 2, or Class 3 survey areas the scan investigation level will be the OpDCGL or the scan minimum detectable concentration (MDC_{scan}) if the scan MDC is greater than the OpDCGL.

Table 4. 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
Class 2	>Operational DCGL or >MDC_{scan} if MDC_{scan} is greater than Operational DCGL	>Operational DCGL
Class 3	>Operational DCGL or >MDC_{scan} if MDC_{scan} is greater than Operational DCGL	>0.5 Operational DCGL

The LACBWR OpDCGLs for soil are reproduced in Table 5 below. Note that Table 5.8 of MARSSIM indicates that the $DCGL_W$ may be used for the scan investigation level for Class 1, Class 2, and Class 3 survey units, and that a DCGL for small areas of elevated activity ($DCGL_{EMC}$) may be used for the scan investigation level for Class 1 survey units. The LACBWR LTP indicated that the licensee planned to use the OpDCGL for the scan investigation level, which is much lower than the $DCGL_W$ or a $DCGL_{EMC}$ for the LACBWR Class 1 survey units.

Table 5. Soil Operational and Base Case DCGLs

Radionuclide	OpDCGL (pCi/g)	Base Case DCGL (pCi/g)
Co-60	3.83	10.6
Sr-90	1970.45	5470
Cs-137	17.39	48.3
Europium-152 (Eu-152)	8.51	23.6
Europium-154 (Eu-154)	7.89	21.9

In accordance with the approved LACBWR LTP, a surrogate adjusted DCGL for Cs-137 was calculated to be 17.31 pCi/g, according to Equation 1 below, and based on the assumed ratio of Sr-90 to Cs-137 of 0.502. This surrogate adjusted OpDCGL for Cs-137 was applied by the licensee as the soil investigational action level, as shown in Table 6, and is the basis for the scanning action levels applied in the LACBWR Class 1 survey units during FSS activities.

Equation 1

$$Surrogate_{DCGL(Cs-137)} = \frac{1}{\left[\left(\frac{1}{17.39_{(Cs-137)}}\right) + \left(\frac{0.502}{1970.45_{(Sr-90)}}\right)\right]} = 17.31 pCi/g$$

Table 6. Soil Direct Investigation Levels for LACBWR Class 1 Survey Units

Radionuclide	OpDCGL (pCi/g)
Co-60	3.83(1)
Cs-137	17.31(2)
Eu-152	8.51(1)
Eu-154	7.89(1)

(1) Based on the OpDCGL
(2) Based on the surrogate adjusted DCGL of Cs-137 while inferring Sr-90

The LACBWR FSS reports state that the scan MDCs were sufficient to detect the surrogate adjusted OpDCGL for Cs-137 of 17.31 pCi/g. Given that the background radiation values varied across the LACBWR Class 1 survey units, the NRC staff verified that the scan MDC was sufficient to detect 17.31 pCi/g of Cs-137 by following Equation 6.11 in NUREG-1507, Revision 1, which is reproduced below in Equation 2. As indicated in NUREG-1507, Revision 1, this method of estimating the scan MDC “depends on the surveyor’s technique (e.g., scan rate) and ability to decide whether the signal represents only the background count response, or more generally, whether detector response in counts per minute (cpm) represents residual contamination in excess of noise (i.e., the background detector response).”

Equation 2

$$Scan\ MDC\left(\frac{pCi}{g}\right) = \left(\frac{MDCR}{\sqrt{p} * CPMR * ERC}\right)$$

where:

$MDCR$	is the minimum detectable (net) count rate in units of cpm
p	is unitless and is the surveyor efficiency of 0.5
$CPMR$	is the count-rate-to-exposure-rate ratio in units of cpm per microroentgen per hour (μR/hr)
ERC	is the exposure-rate-to-concentration ratio in units of μR/h per pCi/g

The MDCR, which is dependent on background radiation levels, is calculated following Equation 6.2 in NUREG-1507, Revision 1, which is reproduced below in Equation 3.

Equation 3

$$MDCR = s_i * \left(\frac{60}{i}\right) = d' * \sqrt{b_i} * \left(\frac{60}{i}\right)$$

where:

$MDCR$	is minimum detectable (net) count rate for the ideal observer in cpm
s_i	is the minimum detectable number of net source counts in the observation interval
d'	is the index of sensitivity (set to 1.38)
b_i	is the number of background counts in the observation interval
i	is the observational interval (in seconds), based on the scan speed and areal extent of the contamination, which was one second

As described in NUREG-1507, Revision 1, when surveyors are instructed simply to collect the data for a survey unit without listening to the audible detector response, the contamination detection decisions are made during the data assessment phase of a decommissioning project (*a posteriori*). In this scenario, the sensitivity (d') of the surveyor is not relevant for making assessment phase decisions. Section 6.3, "*A Posteriori* Decisions Using an Investigation Level," of NUREG-1507, Revision 1, describes methods for estimating an investigation level based on the *a posteriori* (assessment phase) approach when data analysts, not surveyors, make contamination detection decisions based on a review of processed survey data.

In the case of LACBWR scan surveys, the LTP specified that the surveyor listen to the audible output of the scan instrument and respond accordingly to make contamination detection decisions based on the radiation detector's audible output. Therefore, the *a priori* (estimating the scan MDC during the planning phase of a decommissioning project) method for estimating the scan MDC is appropriate. Section 5.7.1.1, "Scanning," of the LACBWR LTP states:

> Technicians will respond to indications of elevated areas while surveying. Upon detecting an increase in visual or audible response, the technician will reduce the scan speed or pause and attempt to isolate the elevated area. If the elevated activity is verified to exceed the established investigation level, the area will be bounded (e.g., marked and measured to obtain an estimated affected surface area). If surface conditions prevent scanning at the specified distance, the detection sensitivity for an alternate distance will be determined and the scanning technique adjusted accordingly. Whenever possible, surveyors will monitor the visual and audible responses to identify locations of elevated activity that require further investigation and/or evaluation.

To determine the scan action level in units of cpm, the licensee used Equation 4 below to determine the count rate equivalent to the adjusted surrogate OpDCGL for Cs-137 and then added that count rate to the background radiation level.

Equation 4

$$Count\ Rate\ Equivalent\ OpDCGL\ (cpm) = Surrogate\ Adjusted\ OpDCGL\ \left(\frac{pCi}{g}\right) * ERC\left(\frac{\mu R/hr}{pCi/g}\right) * CPMR\ \left(\frac{cpm}{\mu R/hr}\right)$$

where:

$Surrogate\ Adjusted\ OpDCGL\ \left(\frac{pCi}{g}\right)$	is 17.31 pCi/g for Cs-137, which the licensee rounded down to 17 pCi/g
$ERC\left(\frac{\mu R/hr}{pCi/g}\right)$	is the MicroShield exposure-to-concentration ratio of 0.2206, assuming (1) 100% Cs-137, (2) three inches between detector endcap and soil, and (3) a scan speed of 0.5 meters per second (m/s), which is documented in Energy*Solutions* (ES) Technical Support Document (TSD) RS-TD-313196-006, "Ludlum Model 44-10 Detector Sensitivity" (ML19007A044)

$CPMR\ \left(\frac{cpm}{\mu R/hr}\right)$ is the empirically derived count-rate-to-exposure-rate ratio of 940 cpm per μR/hr, which is documented in RS-TD-313196-006

Applying Equation 4 with these values for the LACBWR site yields a Count Rate Equivalent OpDCGL result of 3,525 cpm for Cs-137, as shown in Equation 5 below.

Equation 5

$$3{,}525\ (cpm) = 17.31\left(\frac{pCi}{g}\right) * 0.2206\left(\frac{\frac{\mu R}{hr}}{\frac{pCi}{g}}\right) * 940\ \left(\frac{cpm}{\frac{\mu R}{hr}}\right)$$

The licensee determined the count rate equivalent to the surrogate adjusted OpDCGL assuming 100% Cs-137. Since Co-60 may have also been present, ideally the count rate equivalent would have been calculated using a representative ratio of Cs-137 to Co-60. Hypothetically, assuming 5% of the gamma radiation is Co-60 and 95% of the gamma radiation is Cs-137, while keeping the scan speed of 0.5 m/s and the detector end cap three inches above the soil surface, the ERC would be equal to 0.2544 in accordance with ES TSD RS-TD-313196-006. In addition, the CPMR would be a weighted average of the Cs-137 value of 940 cpm per μR/hr and the Co-60 value of 430 cpm per μR/hr, or 914.5 cpm per μR/hr. Therefore, the OpDCGL above background that the licensee used for its action level would also change from 17.31 pCi/g to a gross OpDCGL that also accounts for Co-60, or 14.72 pCi/g using Equation 6 below.

Equation 6

$$Gross_{DCGL} = \frac{1}{\left[\left(\frac{.95}{17.31_{Cs-137}}\right) + \left(\frac{.05}{3.83_{Co-60}}\right)\right]} = 14.72\ pCi/g$$

Applying Equation 4 with these values for the LACBWR site yields a Count Rate Equivalent OpDCGL result of 3,424 cpm, as shown in Equation 7 below. This is only slightly lower than the count rate equivalent value of 3,525 cpm that was applied for most of the LACBWR Class 1 survey units and therefore would not have impacted the scan action level in a significant way.

Equation 7

$$3{,}424\ (cpm) = 14.72\left(\frac{pCi}{g}\right) * 0.2544\left(\frac{\frac{\mu R}{hr}}{\frac{pCi}{g}}\right) * 914.5\ \left(\frac{cpm}{\frac{\mu R}{hr}}\right)$$

The licensee added the 3,525 cpm count rate equivalent to the background radiation value measured in each survey unit to determine the scan action level that would be used to trigger investigation samples. Because the LACBWR LTP did not discuss how background radiation was planned to be measured in each survey unit, the NRC staff asked the licensee for additional information on how background radiation was determined for the scan surveys. The licensee clarified that the process for acquiring background radiation measurements for scanning of excavations and open land survey areas was not procedurally established at LACBWR. Rather, background radiation measurement collection requirements were denoted in the instructions of the FSS sample plan for each survey unit, with more detailed instruction provided through technician training and field supervisor instruction. The licensee's approach to background radiation measurements for most of the excavation survey units was to enter the area to be surveyed and obtain five, one-minute radiation measurements at various locations within the area at a detector height of six inches. This resulted in a background radiation measurement that varied throughout each of the excavation and Class 1 open land survey units.

As part of the evaluation of background radiation measurements for the LACBWR Class 1 excavations, the NRC staff notes that ideally the ambient background scan measurements would be taken from a conservative reading in the area bounded by the sample locations to verify that the background readings are indeed from ambient radiation as opposed to elevated radiation areas. The surveyors would investigate areas with higher scan log readings. If there are relatively larger portions of the survey area with higher scan log readings, and if the readings are confirmed to be background radiation by investigative sampling, the surveyor would assign a new background at a higher level for that portion of the survey unit.

In some of the LACBWR Class 1 excavation survey units the background radiation was measured in the licensee's environmental lab room as opposed to the survey unit itself. The licensee later revised those background radiation measurements to be higher, arguing that the environmental lab was not an accurate representation of ambient background for survey units with higher ambient background levels. The NRC staff agrees that the environmental lab may not be representative of the ambient background radiation in a particular survey unit. It may be appropriate for the ambient background to be measured directly within the survey unit that is being scanned, or in an adjacent clean survey area; however, the approach should be consistently followed and ideally approved as part of the LTP phase to avoid issues during FSS.

The NRC staff also noted during its review that the count rate equivalent to the surrogate adjusted OpDCGL for Cs-137 was not applied consistently across the LACBWR Class 1 excavation survey units (see Table 7 below), and that investigational samples were not always collected as per the LACBWR LTP commitments. Therefore, as part of the RAI process and during subsequent clarification discussions, the NRC requested additional details regarding the process the license followed for determining when further biased surveys and sampling were deemed necessary. These inconsistencies and their implications for the LACBWR FSSR are discussed in more detail for each LACBWR Class 1 excavation survey unit below.

Table 5-16 of the LACBWR LTP states that the FSS scan investigation level is the OpDCGL or the scan MDC if the scan MDC is greater that the OpDCGL (for Class 1, Class 2, or Class 3 survey areas). Given that the scan MDC was lower than the OpDCGL for the LACBWR Class 1 excavation survey units, the scan investigation level is expected to be the OpDCGL plus background radiation in all survey units. However, as can be seen in Table 7 below, the licensee did not consistently apply the same scan investigation action level above background radiation to all the LACBWR Class 1 excavation survey units.

For example, in survey units L1-SUB-TDS, L1-010-101 C, and L1-SUB-CDR the surface scan alarm set points were much higher than the alarm set points established for the FSS activities performed in other survey units subsequent to these three survey units. In Survey Unit L1-SUB-TDS A, the licensee applied a scan investigation action level that was background radiation plus 50% of the OpDCGL instead of 100% of the OpDCGL (which the NRC staff notes is a conservative scan investigation action level). In Survey Unit L1-010-101C, the excavation of the WTB, the scan investigation action level was set to background radiation plus 22,140 cpm, which the FSS release record stated is equivalent to the scanning instrument response to a concentration of 12 pCi/g of Cs-137. The NRC staff asked the licensee about the basis for using 22,140 cpm during one of the clarification teleconferences on the LACBWR Class 1

FSSR (ML22277A350). As part of the supplemental information provided in support of the teleconference (ML22223A088), the licensee clarified that the value of 22,140 cpm is the level of background radiation that would equate to a scan MDC of 10.85 pCi/g of Cs-137 using the following factors in Equation 2 and Equation 3:

Scan Speed – 0.5 m/s
Index of Sensitivity d' – 1.38
Surveyor Efficiency p – 0.5
CPMR – 940 cpm per µR/hr
ERC at three inches from the soil surface – 0.2206 µR/hr per pCi/g

Applying Equation 3 with these values yields an MDCR of 1,591 cpm, as shown in Equation 8.

Equation 8

$$Scan\ MDC\ \left(\frac{pCi}{g}\right) = \left(\frac{MDCR}{\sqrt{p} * CPMR * ERC}\right)$$

$$10.85\ \left(\frac{pCi}{g}\right) = \left(\frac{1{,}591}{\sqrt{0.5} * 940 * \ 0.2206}\right)$$

Applying Equation 2 with these values yields a number of background counts in the observation interval (b_i) of 369 counts in one second, as shown in Equation 9 below.

Equation 9

$$MDCR = \ s_i * \left(\frac{60}{i}\right) = d' * \sqrt{b_i} * \left(\frac{60}{i}\right)$$

$$1{,}591\ cpm = \ s_i * \left(\frac{60}{1}\right) = 1.38 * \sqrt{369} * \left(\frac{60}{1}\right)$$

Converting 369 counts per second to cpm yields 22,140 cpm, which is the value the FSS release records for survey units L1-010-101C and L1-SUB-CDR used for background radiation. The licensee acknowledged that the statement in the FSS release records that an instrument response level of 22,140 cpm is equivalent to 12 pCi/g of Cs-137 is an error; instead, as shown in the equations above, the scan MDC associated with that background radiation level is 10.85 pCi/g. As a result, the NRC staff notes that the licensee incorrectly added 22,140 cpm to the background radiation values in survey units L1-010-101C and L1-SUB-CDR when determining the scan investigation action level. Instead, the correct value to add to background radiation for these survey units was 3,525 cpm as discussed above. This means that the scan investigation action levels for survey units L1-010-101C and L1-SUB-CDR were set significantly higher than they should have been set, which is a variance from the approved LACBWR LTP. The impact of this variance on the scan investigation action levels is further discussed below for each LACBWR Class 1 excavation survey unit.

Although the licensee intended to use the OpDCGL for the scan investigation action level in accordance with the approved LACBWR LTP, the NRC staff notes that Table 5.8 of MARSSIM indicates that the $DCGL_W$, and even the $DCGL_{EMC}$, may be used as the scan investigation action level for Class 1 survey units. Using this scenario and applying Equation 4 above, the count rate equivalent value to the Cs-137 Base Case $DCGL_W$ of 48.3 pCi/g is 11,550 cpm (Equation 10). This is a general estimate because it assumes 100% Cs-137 as opposed to a mixture of plant-derived gamma emitters, but it provides a generic sense of how high the allowable scan investigation action level could have been set using guidance in MARSSIM. Furthermore, the $DCGL_{EMC}$ for a 5 m^2 elevated radiation area would have been three times the Base Case $DCGL_W$ for Cs-137 (three times 48.3 pCi/g), which is equivalent to 34,650 cpm (three times 11,550 cpm) for the scanning instrument and height. Both of these values provide context for the relative impact of adding 22,140 cpm to the background radiation values in survey units L1-010-101C and L1-SUB-CDR when determining the scan investigation action level.

Equation 10

$$11{,}550\ (cpm) = 48.3\left(\frac{pCi}{g}\right) * 0.2544\left(\frac{\frac{\mu\text{R}}{\text{hr}}}{\frac{pCi}{g}}\right) * 940\left(\frac{cpm}{\frac{\mu\text{R}}{\text{hr}}}\right)$$

Table 7. Scan Action Levels and Scan Minimum Detectable Concentration

Survey Unit	Survey Unit Description	Count Rate Added to Background to Determine Action Level	Scan Action Level Range (cpm)	Background Range (cpm)	MDC_{scan}[a] of Cs-137 (Assuming Maximum Background Radiation)
L1-010-101C	WTB Excavation	22,140 cpm	20,000 - 27,235[b]	5,004 - 5,095 (lab background) 6,129 - 7,385 (nearby field)	5.204 pCi/g (lab) 6.26 pCi/g (nearby field)
L1-SUB-CDR	Stack, Pipe Tunnel, and RPGPA Excavation	22,140 cpm	27,135 - 27,781	4,995 - 5,641 (lab)	5.47 pCi/g (lab)
L1-SUB-TDS	Turbine Building, Sump, and Pit Diesel Excavation	1,906 cpm	33,706	31,800 (anticipated) 7,263 - 8,891 (actual)	13 pCi/g (anticipated) 6.9 pCi/g (actual)
L1-SUB-TDS A	Eastern Portion of the Turbine Building, Sump, Pit, and Diesel Excavation	1,762 cpm	5,344 - 11,059	3,582 - 9,297	7.03 pCi/g
L1-SUB-TDS B	RPGPA Excavation	N/A	None	2,806 - 4,623	N/A
L1-SUB-LES	LSA Building, Eat Shack, and Septic Excavation	3,525 cpm	7,874 - 10,438	4,349 - 6,913	6.3 pCi/g
L1-SUB-DRS	Radiologically Controlled Area North Excavation	3,525 cpm	10,882 - 15,672	7,357 - 11,975	7.99 pCi/g

[a] Detector endcap is three inches above soil surface and scan speed is 0.5 m/s
[b] For part of this scan the action level was set to 20,000 cpm and for the other part of the scan 22,140 cpm was added to the background radiation value

The NRC staff's evaluation of the scanning and investigation process for each LACBWR Class 1 excavation survey unit is discussed in depth below due to the deviations from the approved LACBWR LTP process for survey scans and investigations. As a high level summary, in survey units L1-010-101 C and L1-SUB-CDR, there existed several locations where scan alarms would have occurred had the licensee used the appropriate investigation levels and, in turn, these alarms would have triggered investigations. In Survey Unit L1-SUB-TDS, several scan alarms would have occurred had the actual background radiation value been used instead of an anticipated one. In several other excavation survey units, the NRC staff asked for additional information about scan alarms that did occur and the associated investigations. In Survey Unit L1-SUB-TDS B, the licensee was unable to perform a scan survey because the excavation had already been backfilled at the time the FSS was performed. In Survey Unit L1-010-101C, some scanning was performed after remediation and prior to backfill, but no systematic sampling occurred, so in both survey units L1-SUB-TDS B and L1-SUB-101-C, survey samples were collected via GeoProbe after backfilling. The impact of these variances on the approved release criteria from the LACBWR LTP are described below.

3.3.2.2.1 *<u>Survey Unit L1-010-101C, Waste Treatment Building Excavation</u>*

The FSS field activities for the WTB excavation (Survey Unit L1-010-101C) commenced on September 12, 2017. The survey design called for 15 systematic samples, which were originally collected while the excavation was still open, and the initial FSS results indicated that the survey unit would have passed the FSS and met the criteria for unrestricted release. However, during an NRC inspection in September 2017 (ML18043B109), it was determined that additional remediation was required to remove buried contamination in a portion of the survey unit. This additional remediation activity invalidated the original FSS samples.

The WTB excavation survey unit consisted of the soil that was underlying the former Waste Treatment Building. During the June 7, 2022, clarification teleconferences on the LACBWR Class 1 FSSR (ML22277A350), the NRC staff asked the licensee about the original WTB excavation sample results to better understand why the initial survey indicated the survey unit passed the FSS and met the criteria for unrestricted release. As part of the supplemental information provided in support of the teleconference (ML22223A088), the licensee provided the results for the samples from the original FSS performed in Survey Unit L1-010-101C. The licensee also provided scan data from the excavation sloping, which was performed on September 12, 2017 (Figure 21). The original FSS scan lanes are shown in red in Figure 20.

From review of the original WTB excavation FSS scan data, it is apparent that the scan investigation action levels that were applied during the initial FSS were not sufficient to indicate the presence of the slightly buried contamination discovered in September 2017. The highest scan reading was from scan lane 7 (18,182 cpm), which was surrounded by lower scan readings in scan lane 5 (12,409 cpm) and scan lane 8 (13,866 cpm). This should have been an indication of the need to conduct an additional investigation in scan lane 7, but an investigation was not performed due to the use of the higher scan action level.

A systematic soil surface sample was not taken from scan lane 7, as shown in Figure 18. The NRC staff notes that even if a surface sample were taken, it may not have revealed the slightly buried contamination in that area of the survey unit due to the design of the FSS. Specifically, Section 6.5.2, "Soil," of the LACBWR LTP states that "there is low potential for significant subsurface contamination to remain in the end state with a geometry comprised of a clean soil layer over a contaminated soil layer at depth." The LACBWR LTP defines surface samples as consisting of samples taken from the first 15 centimeters (cm) of soil and subsurface samples as consisting of samples taken between 15 cm and one meter deep. However, the MARSSIM approach is not designed to be able to detect contamination that is buried under clean soil at the surface, and the LACBWR LTP did not anticipate this contamination potential. Therefore, the FSS was not designed to detect subsurface contamination under relatively clean cover.

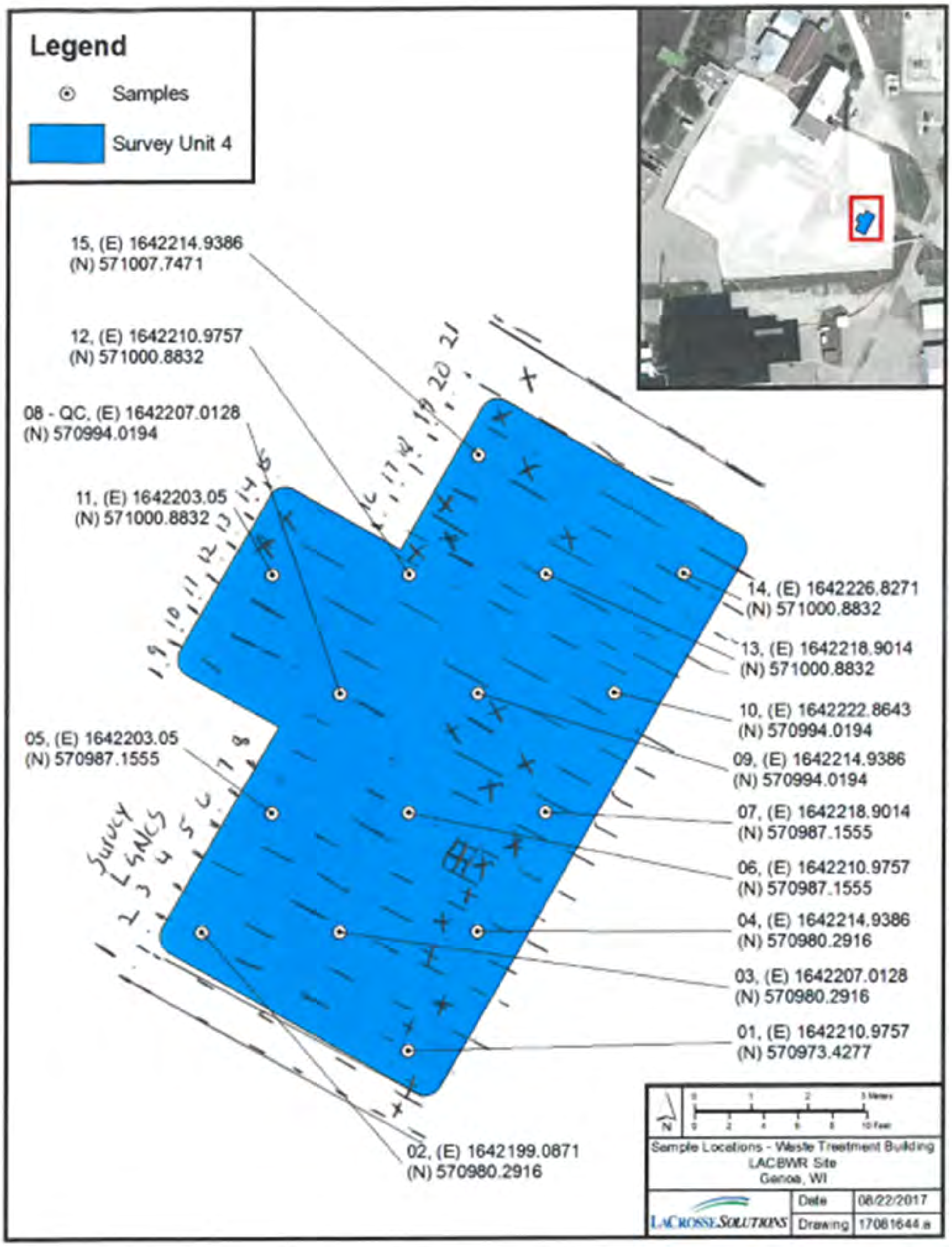


Figure 18. WTB Original FSS Scan Lanes and Systematic Sample Locations

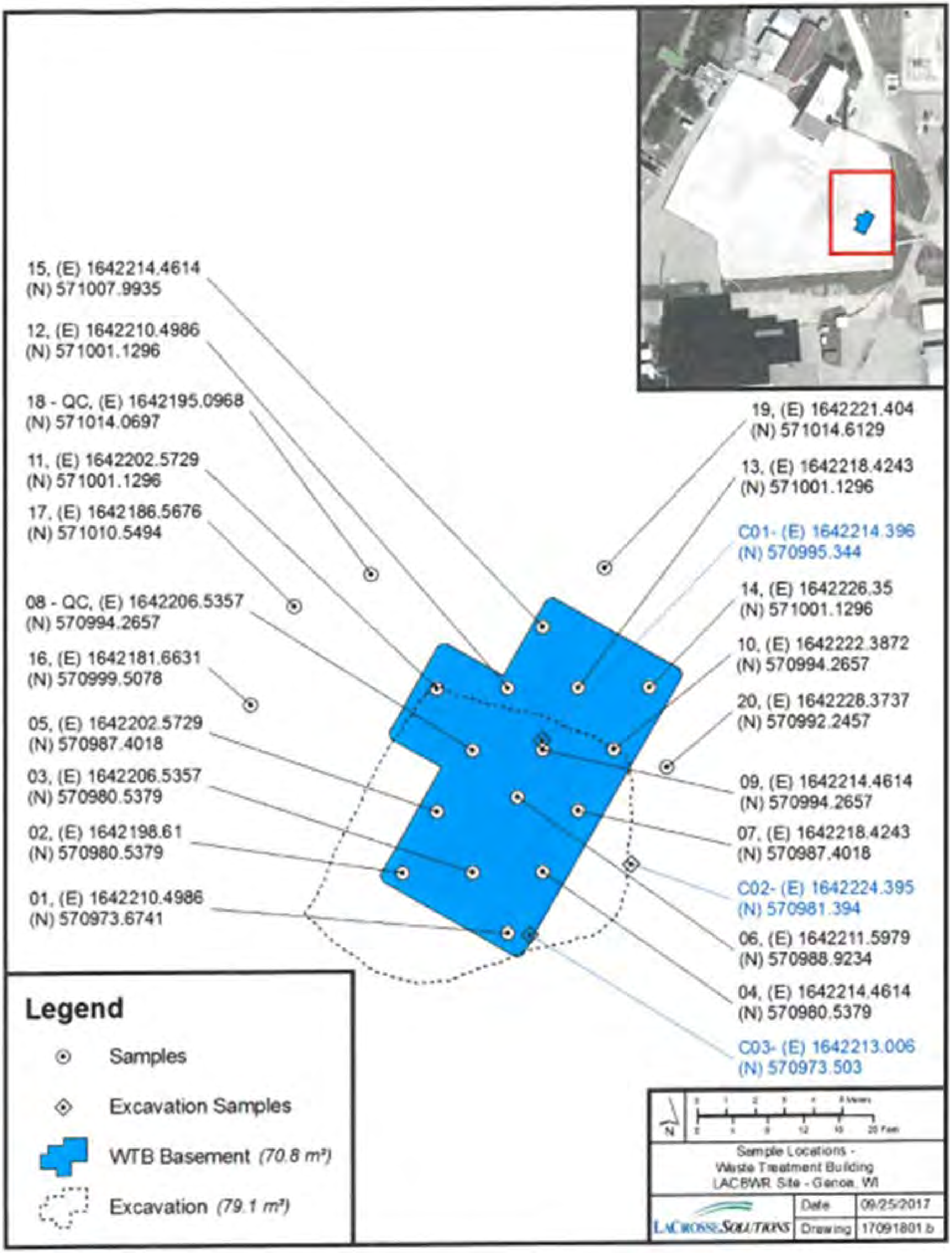


Figure 19. Original WTB FSS Systematic, Judgmental, and Composite Sample Locations

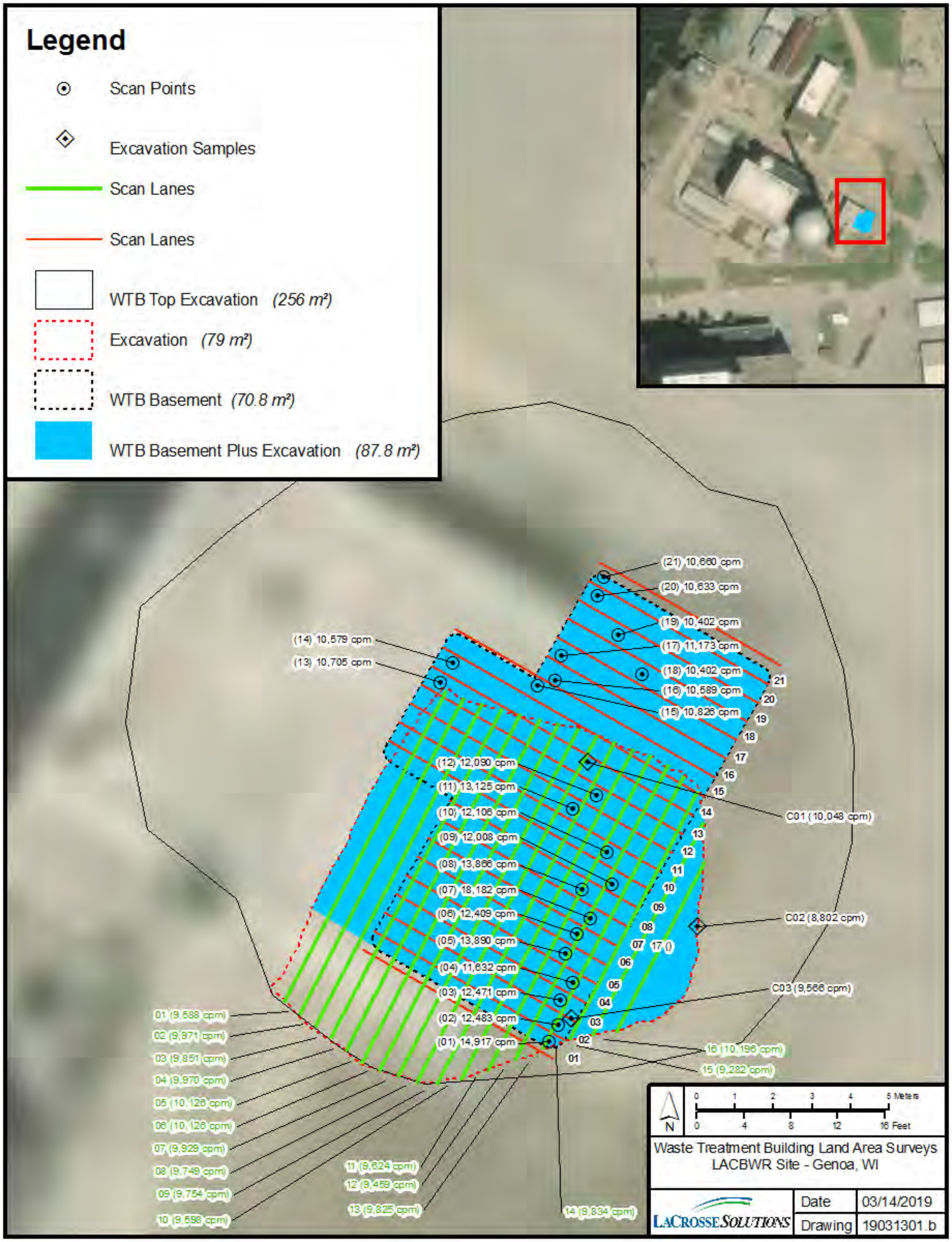


Figure 20. WTB Excavation Scan Post-Remediation

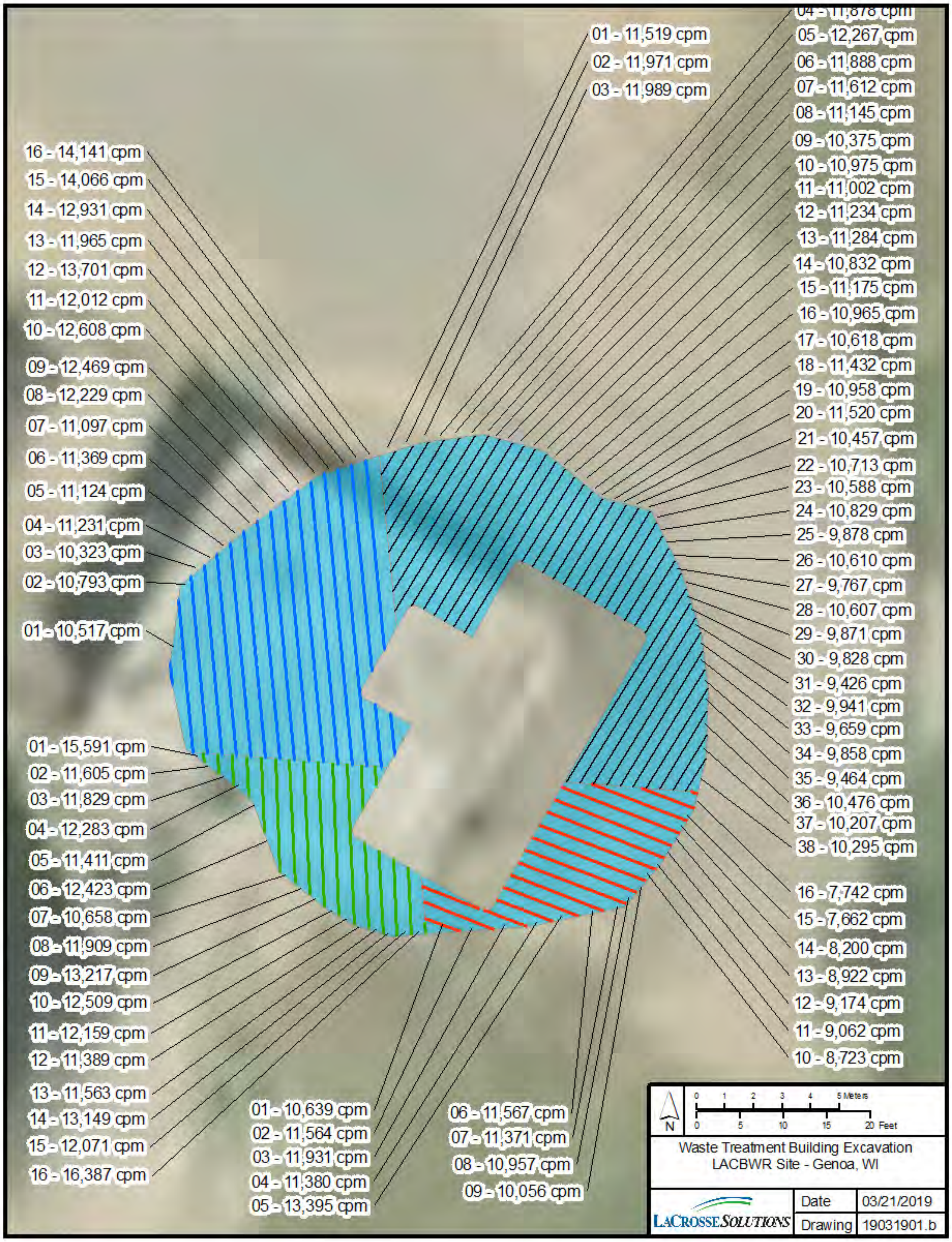


Figure 21. WTB Excavation Original Scan of Sloped Sidewalls

Section 5.7.1.5, “Subsurface Soils,” of the LACBWR LTP describes sampling of subsurface soils during FSS and discusses how the licensee’s RASS scans are expected to provide a high degree of confidence that the excavation meets the criterion for unrestricted release. The LTP also states that “soil samples will be collected to depths at which there is high confidence that deeper samples will not result in higher concentrations. Alternatively, a sodium iodide (NaI) detector or intrinsic germanium detector of sufficient sensitivity to detect residual radioactivity at the OpDCGL can be used to scan the exposed soils in an open excavation to identify the presence or absence of soil contamination, and the extent of such contamination. If the detector identifies the presence of contamination at a significant fraction of the OpDCGL, additional confirmatory investigation and analyses of soil samples of the suspect areas will be performed.”

Furthermore, Section 5.7.1.5.2, “Sampling of Subsurface Soils During FSS,” of the LACBWR LTP requires that a subsurface soil sample be taken at 10% of the systematic surface soil sample locations in the survey unit with the location(s) selected at random. In addition, if the analysis of an FSS surface soil sample, or the results of a surface gamma scan, indicate the potential presence of residual radioactivity at a concentration of 75% of the soil OpDCGL, then additional biased subsurface soil sample(s) will be taken within the area of concern as part of the investigation. As discussed above, depending on background radiation levels in the area of the survey unit, the results of the original gamma surface scan during the initial FSS of the WTB excavation could have triggered biased subsurface soil sampling in accordance with the LACBWR LTP. In regard to the initial WTB excavation FSS systematic soil sample results, there were no surface soil samples with concentrations greater than 75% of the OpDCGL. The maximum concentration in a surface soil sample for the WTB excavation was 3.55 pCi/g of Cs-137, which was associated with Sample L1-010-101-FSGS-C04-SB.

As documented in an NRC Inspection Report dated February 12, 2018 (ML18043B109), the NRC inspectors identified elevated readings in the WTB basement foundation cap during a verification survey after the licensee had completed FSS. Based on their observations, the NRC inspectors identified a violation of 10 CFR 20.1501, “General,” for the licensee’s failure to perform necessary surveys during the demolition of the WTB foundation that may be needed for the licensee to ensure compliance with 10 CFR 20.1402. As a result, the NRC issued a Severity Level IV Non-Cited Violation (NCV) in accordance with Section 2.3.2, “Noncited Violation,” of the NRC's Enforcement Policy (ML21323A042).

In response to this inspection finding, the licensee conducted further remediation of the WTB excavation survey unit. During the remediation activities, additional areas with elevated radiological contamination were identified, the highest of which registered approximately 1.4 million cpm. This reading was associated with concentrations of Cs-137, Co-60, and Americium-241 (Am-241) of approximately 210 pCi/g, 24 pCi/g, and 2.6 pCi/g, respectively. Identification of these areas of elevated contamination in the WTB excavation resulted in the licensee excavating additional concrete debris and approximately 70 cubic yards of soil, of which approximately 4 to 5 cubic yards exceeded the OpDCGL.

As part of the discussions regarding the WTB excavation and subsequent remediation activities, the licensee concluded that an equipment operator inadvertently had not removed all contaminated concrete and foundation material during the original demolition of the WTB foundation. After the additional remediation, the licensee performed 100% gamma scans of the remediated portion of the survey unit and took 3 one-meter-deep core samples. The NRC inspectors verified that the scan results did not exceed the background radiation level and that the three core samples contained a concentration of less than 0.2 pCi/g of Cs-137.

Specifically, as part of the supplemental information provided in support of the clarification teleconferences to discuss the LACBWR FSSR (ML22223A088), the license described how contaminated material became buried in the WTB excavation, as well as the corrective actions which would prevent it from occurring in other excavation survey units. The response states:

> The contaminated concrete was buried beneath the surface of the excavation floor primarily by two methods. First, during the demolition and excavation of the WTB concrete, a corner of the foundation became tilted and eventually became buried within the excavation. This was not noticed because the equipment operator was inattentive, and there was a general lack of oversight. Secondly, the excavator hammer used to demolish the WTB concrete foundation had a pin approximately three feet in length. This hammer/pin drove residual pieces of concrete into the soil to the depth of the pin. Work packages were revised to require the measurement and documentation of the depths of excavations. A requirement was added to dig out/sift at a minimum of three feet below the bottom of the concrete slab being removed.

As part of the corrective actions following this event, the licensee revised procedure ES TSD LC-FS-PR-008, "Final Status Survey Data Assessment," Revision 4 (ML23023A148). Specifically, the following note was included as part of the data validation section:

> When performing an FSS in an excavation, the individual performing data validation shall be cognizant of data anomalies that may be indicative of a source term at a greater depth than the excavation. For example, if all scan readings are in the 10k cpm to 13k cpm range but an area shows 20k cpm, although the 20k cpm may be below the investigation levels, the anomalous reading may warrant an investigation to verify there is no source term at a greater depth.

In addition, the licensee revised procedure ES TSD LC-FS-PR-010, "Isolation and Control for Final Status Survey," Revision 2 (ML23024A139), in order to further address the conditions of this event and prevent recurrence. Specifically, the revised procedure indicated that:

> If the physical configuration and/or radiological conditions in a survey area change where FSS activities are active or have been completed, regardless if the change was due to remediation or for other reasons, then the [Radiation Protection] RP/FSS Manager shall be notified.

The 100% gamma scans performed by the licensee after the additional remediation of the WTB excavation were only conducted within the remediated area using a scan alarm action level ranging from 20,000 cpm to 27,235 cpm. The gamma scans did not produce any scan alarms at this setpoint; therefore, the licensee proceeded to backfill the WTB excavation survey unit. During subsequent discussions regarding the WTB excavation and remediation activities, the licensee acknowledged that the scan alarm action level was incorrect; had the correct action level been added to background radiation there would have been multiple scan alarms.

The NRC staff also notes that the FSS release record for Survey Unit L1-010-101C states that the background radiation applied to the scan alarm action level should have been higher. Specifically, the FSS release record for the WTB excavation survey unit states:

> Evaluating the logged scan data to the correct and current action levels based on the OpDCGL shows that nearly all the scan measurements from the E, EX, and

> N grids would have produced alarms, and in turn would have triggered the collection of investigational soil samples. It was discovered that background values for the scan grids (E, EX, and N) for this survey unit were erroneously collected in the environmental lab and were not representative of actual background levels. The lab backgrounds ranged from 5,004 cpm to 5,095 cpm. The background values for the scan measurements at the sample locations (measurements labeled with SP) were collected in a field near a non-impacted survey unit that had little influence or “shine” from the reactor building and ranged from 6,129 cpm up to 7,385 cpm. Both sets of backgrounds are lower than the activity of scan measurements collected for FSS, which ranged from 8,449 cpm to 16,110 cpm (as shown in Table 7-1 [of the Release Record] above), though the backgrounds collected for the sample locations are a closer representation of true background in the survey unit. If the average background for the sample locations (6,824 cpm) was applied to the scan grids, and the scan data was evaluated against the current action levels based on the OpDCGL, only two locations would have produced alarms. Because 100% of the soil in the survey unit was scanned and no soil samples collected for FSS resulted in ROC concentrations above the OpDCGLs, the probability of discovering an elevated soil sample is very low, even had investigational samples been collected.

While the licensee could not reproduce a map of the scan lanes denoted as “E” and “N” in the FSS release record for the WTB excavation, a figure from the field logs was provided that depicts the general location and orientation of the “E” and “N” scan lanes but does not specifically show how each lane is demarcated. Figure 22 below shows a photograph of the scan coverage for lanes in the “E” and “N” survey areas, which consisted of the sidewall of the WTB excavation. In addition, Figure 20 above denotes the area (shown with a red dotted line) that was remediated via additional excavation due to areas with elevated radiological contamination being identified during the NRC inspection verification survey. Figure 20 also shows the scan lanes (shown in solid green) that are labeled as “EX” in the FSS release record. The “EX” scans were collected on September 14, 2017, and the licensee clarified that these scan lanes covered the remediated portion of the WTB excavation but not the entire survey unit. The 21 scan lanes identified by solid red lines in Figure 20 are the original scan lanes from the survey scan performed in the WTB excavation prior to remediation on September 12, 2017.

The logged gamma scan data results for the WTB excavation with two new scan alarm action levels, as described by the licensee in the supplemental information provided in support of the clarification teleconferences to discuss the LACBWR FSSR, are shown in Table 8 for the scan lanes from the excavation after remediation but before backfill, which are labeled “E,” “EX,” and “N.” The NRC staff notes that the scan areas labeled as “SP” in the FSS release record for the WTB excavation are not scan lanes, rather they denote the 1 m^2 surface scan area around each soil sample location. The first scan alarm action level corresponds to 3,525 cpm (equivalent to a concentration of 17 pCi/g of Cs-137) plus the background radiation values presented in Table 7-1, “Synopsis of Scan Results,” of the associated FSS release record. The second scan alarm action level is associated with a background radiation level measured in a nearby field.

Table 8 reflects that nearly all the scan locations in the WTB excavation would have alarmed (i.e., exceeded the action level) using the environmental lab background radiation values of 5,004 cpm or 5,095 cpm plus the revised scan alarm action level value of 3,525 cpm. However, only two grid locations within the “E,” “EX,” or “N” scan lanes (E08 and N05) of the remediated area would have alarmed when assuming the average of the background radiation values from the nearby field (the average of background measurements for locations SP1 through SP13 is

6,489 cpm) plus 3,525 cpm, which gives a scan alarm action level of 10,349 cpm. The two locations that alarmed in this scenario (E08 and N05) were only slightly higher than the revised scan alarm action level when using the background radiation value from the nearby field. The NRC staff notes that several of the 1 m^2 areas around the GeoProbe sample locations, demarked (SP), were higher than the scan alarm action level, but these scan readings were of the clean fill and not part of the data that represents the end state of the subsurface soil.

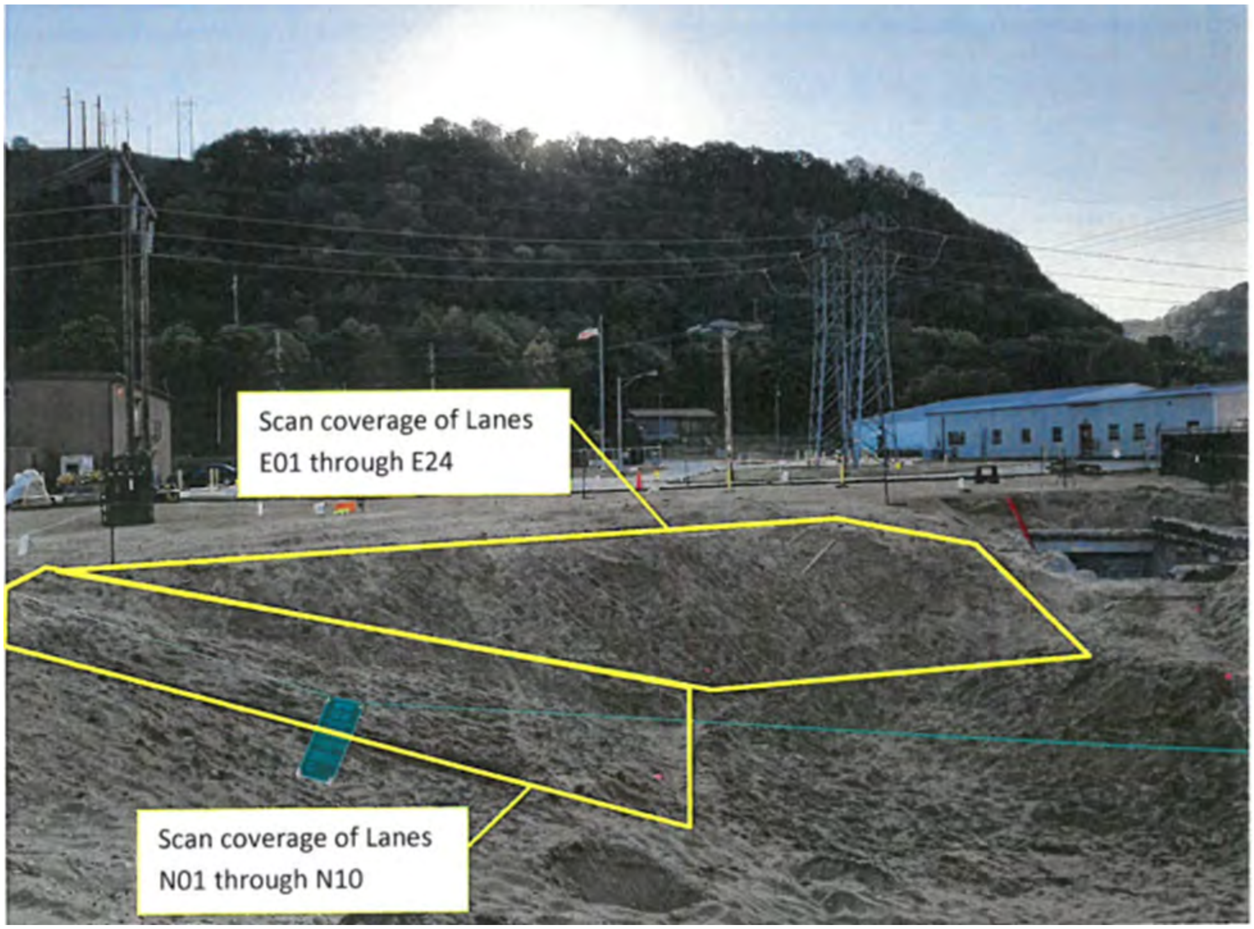


Figure 22. WTB Scan Lane Coverage for Scan Lanes "E" and "N"

Section 5.7.1.11, "Survey Considerations for Buildings, Structures and Equipment," of the LACBWR LTP states the following about scanning: "Scan surveys that identify locations where the magnitude of the detector response exceeds an investigation level indicate that further investigation is warranted to determine the amount of residual radioactivity. The investigation levels will be based on the OpDCGL, a fraction of the OpDCGL, or the $DCGL_{EMC}$ for Class 1 soils." The LACBWR LTP commits to using a scan investigation level that is based on the OpDCGL, but it does not describe how the background radiation value was planned to be established for each survey unit. Section 4.5, "Select Background Reference Areas," of MARSSIM discusses selecting background reference areas and states the following:

> A site background reference area should have similar physical, chemical, geological, radiological, and biological characteristics as the survey unit being evaluated. Background reference areas are normally selected from non-impacted

areas, but are not limited to natural areas undisturbed by human activities. In some situations, a reference area may be associated with the survey unit being evaluated, but cannot be potentially contaminated by site activities. For example, background measurements may be taken from core samples of a building or structure surface, pavement, or asphalt. This option should be discussed with the responsible regulatory agency during survey planning. Generally, reference areas should not be part of the survey unit being evaluated.

For the WTB excavation survey unit, the second set of background radiation values was obtained in a soil and grass area adjacent to the LACBWR Backup Control Center Building, which is the area referred to as a nearby field. The NRC staff agree with the licensee's statement that the background radiation values obtained adjacent to the Backup Control Center are considered more representative of background radiation at the survey unit than those in the environmental lab, due to the material composition (grass and soil in the field instead of concrete in the environmental lab) and the increased exposure to cosmic radiation. In addition, the selection of a nearby field to represent background radiation more closely follows the guidance in MARSSIM Section 4.5 for selecting a background reference area.

Table 8. Survey Unit L1-010-101C Scan Data with Various Scan Action Levels

Scan Location	Scan Logged Result (cpm)	"Lab" Background (cpm)	Action Level Based on 3,525 cpm + Lab Background (cpm)	Scan Alarm Based on 3,525 cpm + Lab Background	Scan Alarm Based on Action Level of 10,349 cpm
E01	9,886	5,095	8,620	**1**	0
E02	9,858	5,095	8,620	**1**	0
E03	9,806	5,095	8,620	**1**	0
E04	9,889	5,095	8,620	**1**	0
E05	9,731	5,095	8,620	**1**	0
E06	9,794	5,095	8,620	**1**	0
E07	9,755	5,095	8,620	**1**	0
E08	10,691	5,095	8,620	**1**	**1**
E09	9,093	5,095	8,620	**1**	0
E10	9,349	5,095	8,620	**1**	0
E11	8,862	5,095	8,620	**1**	0
E12	9,349	5,095	8,620	**1**	0
E13	8,463	5,095	8,620	0	0
E14	8,692	5,095	8,620	**1**	0
E15	8,835	5,095	8,620	**1**	0
E16	8,933	5,095	8,620	**1**	0
E17	8,869	5,095	8,620	**1**	0
E18	8,449	5,095	8,620	0	0
E19	8,878	5,095	8,620	**1**	0
E20	9,505	5,095	8,620	**1**	0

Scan Location	Scan Logged Result (cpm)	"Lab" Background (cpm)	Action Level Based on 3,525 cpm + Lab Background (cpm)	Scan Alarm Based on 3,525 cpm + Lab Background	Scan Alarm Based on Action Level of 10,349 cpm
E21	8,597	5,095	8,620	0	0
E22	8,500	5,095	8,620	0	0
E23	9,615	5,095	8,620	**1**	0
E24	8,837	5,095	8,620	**1**	0
EX01	9,588	5,004	8,529	**1**	0
EX02	9,971	5,004	8,529	**1**	0
EX03	9,851	5,004	8,529	**1**	0
EX04	9,970	5,004	8,529	**1**	0
EX05 & EX06	10,126	5,004	8,529	**1**	0
EX07	9,929	5,004	8,529	**1**	0
EX08	9,749	5,004	8,529	**1**	0
EX09	9,754	5,004	8,529	**1**	0
EX10	9,598	5,004	8,529	**1**	0
EX11	9,624	5,004	8,529	**1**	0
EX12	9,459	5,004	8,529	**1**	0
EX13	9,825	5,004	8,529	**1**	0
EX14	9,384	5,004	8,529	**1**	0
EX15	9,282	5,004	8,529	**1**	0
EX16	10,196	5,004	8,529	**1**	0
N01	9,947	5,095	8,620	**1**	0
N02	10,036	5,095	8,620	**1**	0
N03	10,145	5,095	8,620	**1**	0
N04	10,276	5,095	8,620	**1**	0
N05	10,757	5,095	8,620	**1**	**1**
N06	9,671	5,095	8,620	**1**	0
N07	10,200	5,095	8,620	**1**	0
N08	9,812	5,095	8,620	**1**	0
N09	9,966	5,095	8,620	**1**	0
N10	9,212	5,095	8,620	**1**	0

After backfilling the WTB excavation, the licensee realized that because of the additional remediation in the survey unit that occurred in late 2017, the original systematic soil samples for the FSS were invalidated and would need to be retaken. However, although the post-remediation surface scan only covered the remediated portion of the survey unit, and the survey unit was backfilled without redoing the FSS for the WTB excavation as a whole, the licensee is relying on the surface scan data that was collected prior to backfilling to fulfill the requirements of the FSS surface scan. The associated FSS release record for the WTB excavation states:

> The scan measurements collected post-remediation of the survey unit were still valid for FSS because they represented the end state condition of the excavation. Although not required, additional scanning was performed during the collection of the new soil samples; a 1 m^2 area at each sample location and, in some cases, scans of the actual samples in a low-background area, were scanned using the Ludlum 2350-1 paired with a Model 44-10 2"x 2" NaI detector. Background measurements for the sample location scans were collected in a field near a non-impacted survey unit that had little influence or "shine" from the reactor building and ranged from 6,129 cpm up to 7,385 cpm.

In order to address the invalidated systematic soil samples in the WTB excavation, and because the area was already backfilled, the licensee took the 15 systematic samples via GeoProbe technology. As part of a request for confirmatory information (ML22278A027), the NRC requested verification that the GeoProbe sampling technique was adequate to meet the systematic sampling requirements of the survey design and provide a reasonable level of confidence that the GeoProbe samples were capturing native soil and not backfill material. In response to this request and as part of the supplemental information provided in support of the clarification teleconferences to discuss the LACBWR FSSR, the licensee stated that Survey Unit L1-010-101C was backfilled with soil from the adjacent Genoa 3 coal-fired powerplant, which was much darker than the soil at the bottom of the WTB excavation (native soil), and therefore a difference in soil color was noticeable when collecting the GeoProbe samples. Accordingly, the licensee sampled to a depth where the excavation/backfill interface was encountered, with the excavation soils collected for the systematic GeoProbe sample.

Based on the above considerations, the NRC staff finds that the licensee's approach to scanning and investigation sampling for Survey Unit L1-010-101C is adequate. Although the licensee did not follow the scan investigation action level criteria in Table 5-16 of the LACBWR LTP, the licensee's revised background radiation value for the WTB excavation is reasonable, and, considering the revised background, few scan alarms would have occurred during the surface scan of the survey unit. The scan locations that would have caused alarms were only slightly higher than the revised scan investigation action level. For the portion of the survey unit that was not rescanned after remediation, the NRC staff is relying on information from the scan that was performed on the WTB excavation and sidewalls during the original FSS, which was before the additional remediation was conducted. The majority of the scan data results from the original FSS of the WTB excavation are also close to the revised scan investigation action level. Finally, in accordance with Table 5.8 of MARSSIM, the licensee could have set the scan investigation action level at the $DCGL_W$ or the $DCGL_{EMC}$ for Class 1 survey units, which would have easily encompassed the majority of the surface scan results. Therefore, the investigation sampling and scanning for the survey unit is acceptable.

3.3.2.2.2 Survey Unit L1-SUB-CDR, Stack, Pipe Tunnel, and RPGPA Excavation

Table 7-1 and Table 16-1, "Survey Unit L1-SUB-CDR Complete Scan Data," of the FSS release record show that eight scan alarms were triggered during the surface scan of Survey Unit L1 -SUB-CDR, which resulted in the collection of six investigational samples. The associated release record describes how "the background was established as the average of five one-minute static measurements, while maintaining the detector 6 inches from the soil. In Survey Unit L1-SUB-CDR, background ranged from 4,995 cpm up to 5,641 cpm."

As summarized previously in Table 7 of this safety evaluation, the value the licensee added to background radiation to determine the scan investigation action level for this survey unit is 22,140 cpm. If a value of 3,525 cpm had instead been added to the background radiation values shown in the Survey Unit L1-SUB-CDR release record, then almost every scan location would have alarmed. However, the licensee also stated that the background radiation values were too low and should be revised. Specifically, the FSS release record states:

> Evaluating the logged scan data to the correct and current action levels based on the OpDCGL shows that nearly all the scan measurements would have produced alarms, and in turn would have triggered the collection of additional investigational soil samples. It was discovered that background values for the scan grids for this survey unit were erroneously collected in the environmental lab and were not representative of actual background levels. The lab backgrounds ranged from 4,995 cpm to 5,641 cpm. These backgrounds are lower than the activity of scan measurements collected for FSS, which ranged from 4,529 cpm to 48,247 cpm.

The Survey Unit L1-SUB-CDR release record goes on to describe that if a background radiation value of 17,440 cpm (which is the average of the actual scan readings for the survey unit) were applied to the scan grids, only the eight alarms from the original survey would be reproduced.

The statement in the FSS release record that the background radiation count was collected in an environmental lab seems to contradict the statement that it was measured 6 inches above the soil in the survey unit. Accordingly, the NRC staff requested additional information on this topic in the FSSR RAIs (ML20195A272), as well as during follow up calls in June 2022 and July 2022, which led to the licensee providing supplemental information (ML22223A088 and ML22269A395). During these information exchanges, the licensee described how the LACBWR reactor building was contributing radioactive shine to the area of Survey Unit L1-SUB-CDR during the time the FSS surface scan was being performed.

The NRC staff acknowledges that radioactivity coming from the LACBWR reactor building during this timeframe could have contributed to the scan logged results for the FSS of Survey Unit L1-SUB-CDR, and therefore a lab measured background radiation level of approximately 5,000 cpm would not be an accurate representation of the ambient background. The NRC staff does not, however, agree with using the average or median values of the actual scan readings for the survey unit as an estimate for the background radiation value. Given the difficulties in assessing the actual background radiation for Survey Unit L1-SUB-CDR at the time of the FSS surface scan, it is not possible to evaluate whether the licensee took an adequate number of investigational samples. In this case, the NRC staff must rely on information from the investigational samples that were collected at the locations with the highest scan readings within Survey Unit L1-SUB-CDR, and then use those results to risk inform whether there were elevated areas of contamination within the survey unit that were not investigated.

Table 9. Survey Unit L1-SUB-CDR Scan Data with Corrected Investigation Action Levels

Scan Area	Highest Logged Reading (cpm)	Action Level (cpm)	Corrected Action Level Based on 3,525 cpm (cpm)	# of Scan Alarms with the Original Action Level	Investigation Samples	Corrected # of Scan Alarms with Adjusted Action Level
CDR01	18,429	27,196	8,308	0	0	1
CDR02	17,420	27,196	8,308	0	0	1
CDR03	16,956	27,196	8,308	0	0	1
CDR04	18,267	27,196	8,308	0	0	1
CDR05	17,404	27,196	8,308	0	0	1
CDR06	17,423	27,196	8,308	0	0	1
CDR07	19,271	27,196	8,308	0	0	1
CDR08	18,921	27,196	8,308	0	0	1
CDR09	16,520	27,196	8,308	0	0	1
CDR10	12,365	27,196	8,308	0	0	1
CDR11	4,845	27,196	8,308	0	0	0
CDR12	5,149	27,196	8,308	0	0	0
CDR13	4,529	27,196	8,308	0	0	0
CDR14	30,902	27,196	8,308	1		1
CDR15	35,749	27,196	8,308	1		1
CDR16	38,108	27,196	8,308	1	3	1
CDR17	46,676	27,196	8,308	1		1
CDR18	48,247	27,196	8,308	1		1
CDR19	12,203	27,196	8,308	0	0	1
CDR20	11,497	27,196	8,308	0	0	1
CDR21	12,321	27,196	8,308	0	0	1
CDR22	12,103	27,196	8,308	0	0	1
E01	10,325	27,423	8,535	0	0	1
E02	11,475	27,423	8,535	0	0	1
E03	9,392	27,423	8,535	0	0	1
E04	10,213	27,423	8,535	0	0	1
E05	10,154	27,423	8,535	0	0	1
E06	10,211	27,423	8,535	0	0	1
E07	10,541	27,423	8,535	0	0	1
E08	10,554	27,423	8,535	0	0	1
E09	10,566	27,423	8,535	0	0	1
E10	11,682	27,423	8,535	0	0	1
E11	11,012	27,423	8,535	0	0	1

Scan Area	Highest Logged Reading (cpm)	Action Level (cpm)	Corrected Action Level Based on 3,525 cpm (cpm)	# of Scan Alarms with the Original Action Level	Investigation Samples	Corrected # of Scan Alarms with Adjusted Action Level
E12	12,262	27,423	8,535	0	0	1
E13	11,733	27,423	8,535	0	0	1
E14	12,026	27,423	8,535	0	0	1
E15	12,594	27,423	8,535	0	0	1
E16	18,572	27,423	8,535	0	0	1
E17	15,775	27,423	8,535	0	0	1
E18	13,118	27,423	8,535	0	0	1
E19	13,103	27,423	8,535	0	0	1
E20	13,015	27,423	8,535	0	0	1
E21	12,904	27,423	8,535	0	0	1
E22	11,783	27,139	8,251	0	0	1
E23	12,448	27,139	8,251	0	0	1
E24	12,350	27,139	8,251	0	0	1
E25	14,924	27,139	8,251	0	0	1
E26	14,183	27,139	8,251	0	0	1
E27	15,003	27,139	8,251	0	0	1
E28	13,785	27,139	8,251	0	0	1
E29	13,991	27,139	8,251	0	0	1
E30	15,243	27,139	8,251	0	0	1
E31	15,963	27,139	8,251	0	0	1
E31 QC	15,709	27,781	8,893	0	0	1
E32	20,983	27,139	8,251	0	0	1
E32 QC	16,641	27,781	8,893	0	0	1
E33	21,026	27,139	8,251	0	0	1
E33 QC	19,820	27,781	8,893	0	0	1
E34	19,800	27,139	8,251	0	0	1
E34 QC	20,269	27,781	8,893	0	0	1
E35	16,245	27,139	8,251	0	0	1
W01	14,744	27,139	8,251	0	0	1
W01 QC	12,971	27,781	8,893	0	0	1
W02	13,623	27,139	8,251	0	0	1
W02 QC	14,665	27,781	8,893	0	0	1
W03	15,236	27,139	8,251	0	0	1
W03 QC	15,339	27,781	8,893	0	0	1

Scan Area	Highest Logged Reading (cpm)	Action Level (cpm)	Corrected Action Level Based on 3,525 cpm (cpm)	# of Scan Alarms with the Original Action Level	Investigation Samples	Corrected # of Scan Alarms with Adjusted Action Level
W04	17,457	27,139	8,251	0	0	1
W04 QC	15,495	27,781	8,893	0	0	1
W05	14,765	27,234	8,346	0	0	1
W06	23,801	27,139	8,346	0	0	1
W07	15,830	27,139	8,251	0	0	1
W08	20,737	27,139	8,346	0	0	1
W09	26,142	27,139	8,251	0	0	1
W10	26,458	27,139	8,346	0	0	1
W11	36,821	27,139	8,251	1	1	1
W12	19,633	27,234	8,346	0	0	1
W13	26,792	27,234	8,251	0	0	1
W14	24,176	27,234	8,346	0	0	1
W15	23,172	27,234	8,346	0	0	1
W16	29,183	27,234	8,251	1	1	1
W17	30,449	27,234	8,346	1	1	1
W18	23,237	27,234	8,251	0	0	1
W19	20,961	27,234	8,346	0	0	1
W20	16,876	27,234	8,346	0	0	1
W21	17,718	27,234	8,346	0	0	1
W22	15,917	27,234	8,346	0	0	1
W23	14,901	27,234	8,346	0	0	1
W24	16,234	27,135	8,346	0	0	1
W25	18,184	27,135	8,346	0	0	1
W26	18,609	27,135	8,346	0	0	1
W27	18,213	27,135	8,346	0	0	1
W28	18,088	27,135	8,346	0	0	1
W29	17,300	27,135	8,346	0	0	1
W30	17,452	27,135	8,346	0	0	1
W31	16,810	27,135	8,247	0	0	1
W32	16,995	27,135	8,247	0	0	1
W33	15,805	27,135	8,247	0	0	1
W34	16,613	27,135	8,247	0	0	1
W35	16,549	27,135	8,247	0	0	1
W36	18,195	27,423	8,247	0	0	1

Scan Area	Highest Logged Reading (cpm)	Action Level (cpm)	Corrected Action Level Based on 3,525 cpm (cpm)	# of Scan Alarms with the Original Action Level	Investigation Samples	Corrected # of Scan Alarms with Adjusted Action Level
W37	18,677	27,423	8,247	0	0	1
W38	17,445	27,423	8,247	0	0	1
W39	20,117	27,423	8,247	0	0	1
W40	20,136	27,423	8,247	0	0	1
W41	21,127	27,423	8,247	0	0	1
W42	21,625	27,423	8,247	0	0	1
W43	21,518	27,423	8,535	0	0	1

The FSS release record for Survey Unit L1-SUB-CDR also states that "six investigational samples were collected at locations of scanning alarms in scan lanes CDR14 through CDR18 and W11, W16, and W17. Inadvertently, the investigational samples were not labeled correctly, the coordinates were not collected, and the locations were not marked on the survey maps. The six investigational samples were labeled CDR #4 through CDR-NRC #9." In the FSSR RAI response (ML20356A041), the licensee explained that the six investigational samples were collected during an NRC inspection and were labeled in the order collected. Although the investigational samples were not labeled in accordance with procedure, the field notes indicate that the samples were collected in response to scan alarms in Survey Unit L1-SUB-CDR. Table 10 below shows that the highest gamma spectroscopy results in the six investigational samples taken within Survey Unit L1-SUB-CDR were 0.0768 pCi/g of Co-60 from sample CDR #4, and 1.57 pCi/g of Cs-137 from sample CDR-NRC #9. Ideally, the NRC staff would be able to determine the location of these investigational samples and verify that they were taken at the locations of the scan lanes with the highest readings. However, given that the investigational sample locations were not marked on the survey maps, verification of the location is not possible, so the licensee confirmed that the samples were collected at the scan alarm locations in Survey Unit L1-SUB-CDR (ML22223A088 and ML22269A395).

Table 10. Summary of Gamma Spectroscopy Results for RPGPA Investigational Samples

Sample ID	Co-60 (pCi/g)	Cs-137 (pCi/g)	Eu-154 (pCi/g)	Sr-90 (pCi/g)
CDR #4	***7.68E-02***	***1.52E+00***	1.78E-02	7.63E-01
CDR-NRC #5	***8.11E-02***	***7.16E-01***	1.58E-02	3.59E-01
CDR-NRC #6	***4.80E-02***	***7.31E-01***	8.92E-03	3.67E-01
CDR-NRC #7	1.06E-02	***3.87E-02***	2.59E-02	1.94E-02
CDR-NRC #8	0.00E+00	***1.59E-01***	7.94E-04	7.98E-02
CDR-NRC #9	***7.29E-02***	***1.57E+00***	2.32E-02	7.88E-01

Note: Bold and italic values indicate concentrations greater than MDC.

In addition, Attachment 8 of Revision 2 of the FSS release record for Survey Unit L1-SUB-CDR (ML22269A391) shows that a soil sample collected in 2017, labeled sample NRC #4, was analyzed for the full suite of radionuclides and contained concentrations above MDC for several radionuclides (i.e., Cs-137, Co-60, Nickel-63 (Ni-63), Sr-90, Technetium-99 (Tc-99), Plutonium-238 (Pu-238), Plutonium-239 (Pu-239), Plutonium-240 (Pu-240), Plutonium-241 (Pu-241), Am-241, Americium-243 (Am-243), Curium-243 (Cm-243), and Curium-244 (Cm-244)). The NRC staff notes that the Operational SOF of this sample is 14.74, and the SOF when compared to the Soil Initial Suite Base Case DCGLs is 4.44 (see Table 11 and ES TSD RS-TD 313196-001, "Radionuclides of Concern During LACBWR Decommissioning" (ML19007A040)). Both of these considerations could have a negative impact on the ability of Survey Unit L1-SUB-CDR to pass the FSS and meet the criteria for unrestricted release.

However, as part of the supplemental information provided in support of the clarification teleconferences to discuss the LACBWR FSSR (ML22269A395), the licensee confirmed that sample NRC #4, along with the Sump #1 and Sump #2 samples, were taken from the portion of the RPGPA excavation that was later split apart from Survey Unit L1-SUB-CDR to be further remediated. Specifically, the response states that sample NRC #4 is "not a part of the excavation subjected to the L1-SUB-CDR FSS. Materials associated with this sample were remediated and the associated land area was subjected to FSS as survey unit L1-SUB-TDS B."

Table 11. Sample NRC #4 Base Case and Operational SOF Considerations

Radionuclide	NRC #4 Concentration pCi/g	Soil DCGLs pCi/g	Base Case SOF*	OpDCGL pCi/g	OpDCGL SOF
Co-60	18.8	1.28E+01	1.47E+00	3.83	4.91
Ni-63	50.4	9.48E+06	5.32E-06		
Sr-90	3.55	6.59E+03	5.39E-04	1970	0.00
Nb-94		2.02E+01	0.00E+00		
Tc-99	7.92	3.56E+02	2.22E-02		
Cs-137	171	5.81E+01	2.94E+00	17.39	9.83
Eu-152		2.84E+01		8.51	
Eu-154		2.64E+01		7.89	
Eu-155		1.12E+03			
Np-237		7.99E-01			
Pu-238	0.622	1.66E+03	3.75E-04		
Pu-239/240	0.615	1.49E+03	4.12E-04		
Pu-241	0.615	3.64E+04	1.69E-05		
Am-241	2.03	1.09E+03	1.86E-03		
Am-243	0.137	1.87E+02	7.33E-04		
Cm-243/244	0.0482	2.88E+02	1.67E-04		
	SOF TOTAL		**4.44**		**14.74**

*SOF compared to Soil Initial Suite Base Case DCGLs (ES TSD RS-TD 313196-001)

GEL Laboratories analyzed sample NRC #4 and the Sump #1 sample. The Sump #1 sample resulted in a Cs-137 concentration of 193 pCi/g according to the GEL Laboratories report. The NRC #4 sample resulted in a Cs-137 concentration of 171 pCi/g according to the GEL

Laboratories report. In addition, the Sump #1 sample had a Cs-137 concentration of 105 pCi/g, while the Sump #2 sample had a Cs-137 concentration of 200 pCi/g during the licensee's gamma spectroscopy scans. Therefore, it is reasonable to assume, based on the similar Cs-137 concentration magnitudes, that sample NRC #4 was from the RPGPA sump area, or a split sample from the one of the sump samples, and part of a portion of the RPGPA excavation survey unit that was later remediated and subject to a separate FSS (see Survey Unit L1-SUB-TDS B) to determine that the area met the criteria for unrestricted release.

Based on the above considerations, the NRC staff finds that the licensee's approach to scanning and investigation sampling for Survey Unit L1-SUB-CDR is adequate. The licensee did not follow the scan investigation action level criteria in Table 5-16 of the LACBWR LTP, and the background radiation value is difficult to assess for this survey unit. Therefore, the NRC staff is relying on the measured radionuclide concentrations of the investigational samples that were collected at the locations with the highest scan readings. The licensee confirmed to the NRC that these samples were collected at the highest scan alarm locations and the measured results are a small fraction of the OpDCGL. In addition, in accordance with Table 5.8 of MARSSIM, the licensee could have set the scan investigation action level at the $DCGL_W$ or the $DCGL_{EMC}$ for Class 1 survey units, which would have encompassed the majority of the surface scan results. Further, the licensee confirmed to the NRC that the samples labeled NRC #4, Sump #1, and Sump #2, which contained elevated concentrations of Cs-137 and appear in Attachment 8 of the FSS release record for Survey Unit L1-SUB-CDR, were collected in the RPGPA sump area that was further remediated and surveyed as Survey Unit L1-SUB-TDS B. Therefore, the investigation sampling and scanning for the survey unit is acceptable.

3.3.2.2.3 *<u>Survey Unit L1-SUB-TDS, Turbine Building, Sump, and Pit Diesel Excavation</u>*

In Survey Unit L1-SUB-TDS, the licensee collected 14 systematic soil samples in accordance with the survey plan, as well as 10 judgmental soil samples. As a result of the FSSR RAIs (ML20356A041), the licensee revised Figure 16-1, "L1-SUB-TDS Systematic Sample Locations Map," and Figure 16-2, "L1-SUB-TDS Judgmental Sample Locations," of the FSS release record to show the scan grids overlaid onto the systematic and judgmental sample locations. In the revised Figure 16-1 (reproduced in Figure 12 of this safety evaluation) and Figure 16-2 (reproduced in Figure 23 below), it is shown that systematic soil samples (abbreviated S) or judgmental soil samples (abbreviated J) were taken within the scan grids that would have triggered scan alarms in all instances except for scan location G9 and scan location E8.

The surface scan data from Table 7-1 of the FSS release record for Survey Unit L1-SUB-TDS is reproduced below in Table 12 with a corrected scan alarm action level of background radiation plus 3,525 cpm to reflect the 14 scan measurements that would have caused scanning alarms. Scan grid cells A1 through G9 are shown in Figure 23. Scan locations JSP1 through JSP10 are the scans performed around the judgmental soil sample locations. Scan locations SP1 through SP114 are the scans performed around the systematic soil sample locations. Scan location QC is the scan performed at the quality control (QC) sample location.

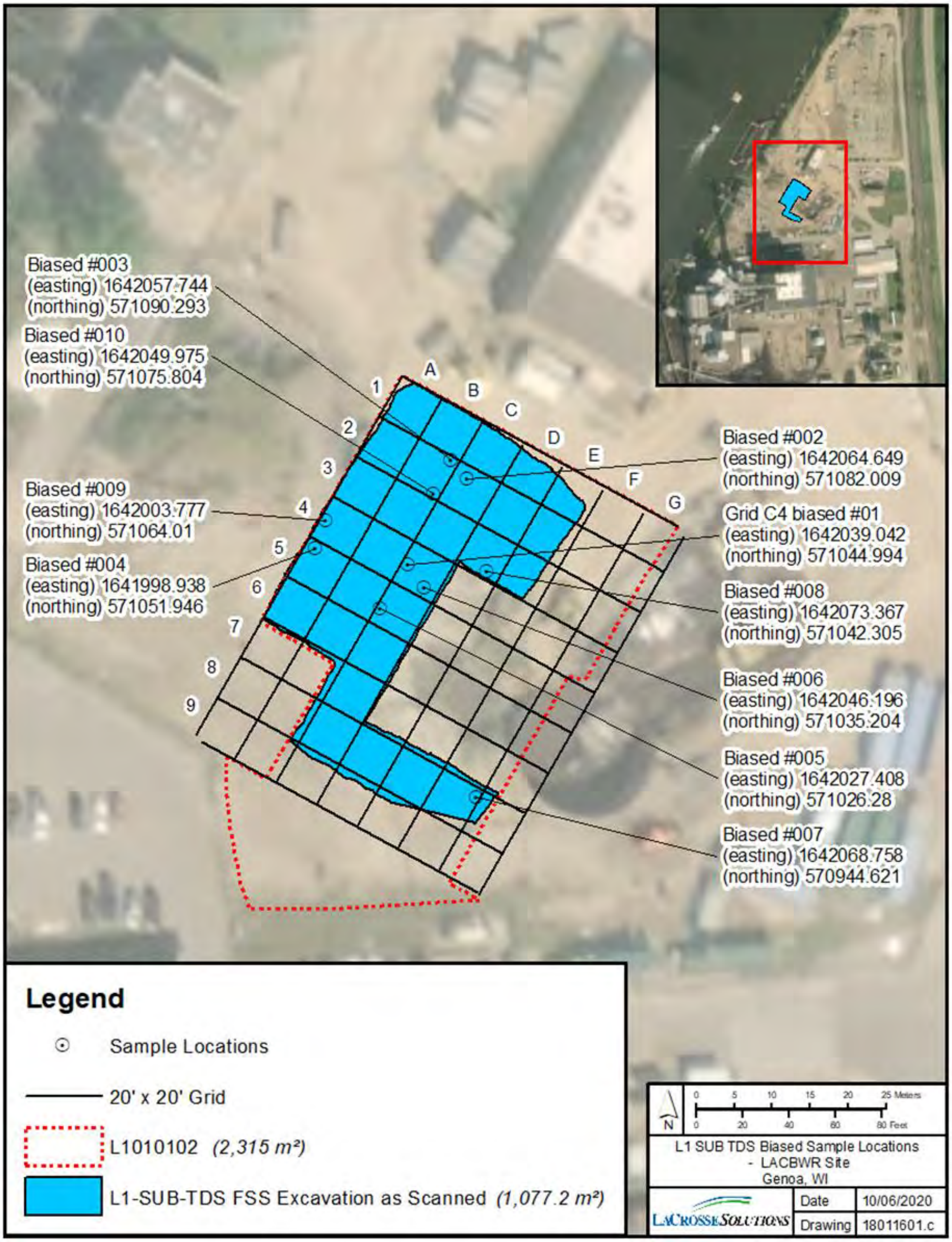


Figure 23. Survey Unit L1-SUB-TDS Judgmental Sample Locations

The sample results for the judgmental and systematic soil samples collected from the scan lanes in Survey Unit L1-SUB-TDS were below 50% of the OpDCGL. Further, the maximum surface scan reading for this survey unit was 16,975 cpm at scan location C4. Subtracting the average background radiation at this location of 7,812 cpm, leaves 9,163 cpm. As shown below in Equation 11, this corresponds to a concentration of 44.2 pCi/g of Cs-137 if only Cs-137 were present, which is still below the Base Case DCGL for Cs-137 of 48.3 pCi/g. In conclusion, although the licensee did not fully adhere to the process outlined in the approved LACBWR LTP for collecting investigation samples for this survey unit due to an inaccurate scan alarm action level setting, because the majority of the systematic and judgmental soil samples were collected near the areas with the highest surface scan results, and those scan values are sufficiently low, adequate information is available for the NRC staff to reach reasonable assurance that areas of elevated contamination above the unrestricted release criteria do not remain in the survey unit.

Equation 11

$$\frac{9{,}163\ (cpm)}{\left(0.2206\left(\frac{\mu\text{R/hr}}{pCi/g}\right) * 940\ \left(\frac{cpm}{\mu\text{R/hr}}\right)\right)} = 44.2\left(\frac{pCi}{g}\right)$$

Table 12. Survey Unit L1-SUB-TDS Scan Data with Scan Alarms

Scan Location	Scan Logged Result (cpm)	Average Background (cpm)	Corrected Action Level (cpm)	Revised Scan Alarms
A1	8757	7263	10788	0
A2	9075	8082	11607	0
A3	8879	7263	10788	0
A4	9613	7812	11337	0
A5	9230	7482	11007	0
A6	10041	7482	11007	0
A7	9130	7482	11007	0
B1	8767	7263	10788	0
B2	9005	8082	11607	0
B3	9938	7263	10788	0
B4	9160	7812	11337	0
B5	10039	7482	11007	0
B6	10422	7482	11007	0
B7	9762	7482	11007	0
B8	8514	7812	11337	0
C1	8514	7263	10788	0
C2	13403	8082	11607	**1**
C3	8747	7263	10788	0
C4	11957	8891	12416	0
C4	16975	7812	11337	**1**
C4	9878	7812	11337	0
C5	10934	7482	11007	0

Scan Location	Scan Logged Result (cpm)	Average Background (cpm)	Corrected Action Level (cpm)	Revised Scan Alarms
C5QC	12588	8899	12424	**1**
C6	12495	7482	11007	**1**
C7	10676	7482	11007	0
C8	8914	7812	11337	0
C9	7435	7482	11007	0
D1	9244	7263	10788	0
D2	9297	8082	11607	0
D3	9148	7263	10788	0
D8	14449	8891	12416	**1**
D8	10462	7812	11337	0
D9	7695	7482	11007	0
E1	9676	7263	10788	0
E2	9570	8082	11607	0
E3	10641	7263	10788	0
E8	11516	7812	11337	**1**
E9	8950	7482	11007	0
F8	13054	7482	11007	**1**
F9	11309	7482	11007	**1**
G8	13320	7482	11007	**1**
G9	14024	7482	11007	**1**
JSP10	7297	7889	11414	0
JSP10	7263	7889	11414	0
JSP2	13088	7889	11414	**1**
JSP2	8948	7889	11414	0
JSP3	8209	7889	11414	0
JSP3	7755	7889	11414	0
JSP4	8217	7889	11414	0
JSP4	9009	7889	11414	0
JSP5	6870	7889	11414	0
JSP5	7229	7889	11414	0
JSP6	9185	7889	11414	0
JSP6	8796	7889	11414	0
JSP7	12527	7889	11414	**1**
JSP7	12952	7889	11414	**1**
JSP8	8715	7889	11414	0
JSP8	8995	7889	11414	0
JSP9	8131	7889	11414	0
JSP9	8344	7889	11414	0
QC4	9047	8201	11726	0
SP1	13778	7988	11513	**1**

Scan Location	Scan Logged Result (cpm)	Average Background (cpm)	Corrected Action Level (cpm)	Revised Scan Alarms
SP10	8736	7748	11273	0
SP11	8211	7748	11273	0
SP12	8835	7748	11273	0
SP13	7724	7748	11273	0
SP14	8498	7748	11273	0
SP2	7649	7988	11513	0
SP3	9322	7988	11513	0
SP4	9708	7988	11513	0
SP5	9710	7748	11273	0
SP6	8338	7748	11273	0
SP7	8358	7748	11273	0
SP8	8667	7748	11273	0
SP9	8715	7748	11273	0

Based on the above considerations, the NRC staff finds that the licensee's approach to scanning and investigation sampling for Survey Unit L1-SUB-TDS is adequate. Although the licensee did not follow the scan investigation action level criteria in Table 5-16 of the LACBWR LTP, the licensee collected the systematic and judgmental soil samples from the highest scan alarm locations and the measured results are a small fraction of the OpDCGL. In addition, in accordance with Table 5.8 of MARSSIM, the licensee could have set the scan investigation action level at the $DCGL_W$ or the $DCGL_{EMC}$ for Class 1 survey units, which would have encompassed the majority of the surface scan results. Therefore, the investigation sampling and scanning for the survey unit is acceptable.

3.3.2.2.4 *Survey Unit L1-SUB-TDS A, Eastern Portion of the Turbine Building, Sump, Pit, and Diesel Excavation*

In Survey Unit L1-SUB-TDS A, the licensee assumed a scan investigation action level that was equivalent to background radiation plus the cpm equivalent to 50% of the OpDCGL (1,762 cpm) as opposed to the full OpDCGL equivalent value of 3,525 cpm. Per the scan investigation action level criteria in Table 5-16 of the LACBWR LTP, it would also have been acceptable to add the 3,525 cpm value to background radiation. In addition, in accordance with Table 5.8 of MARSSIM, the licensee could have set the scan investigation level at the $DCGL_W$ or the $DCGL_{EMC}$ for Class 1 survey units. Therefore, for Survey Unit L1-SUB-TDS A the licensee was using a scan investigation action level lower (more conservative) than what was required per the approved LACBWR LTP or in accordance with the guidance contained in MARSSIM.

Given that additional remediation was conducted in Survey Unit L1-SUB-TDS A during FSS, the NRC staff requested that the licensee clarify the extent of the remediation, the location of the investigational soil samples, and the location of the judgmental soil samples. Specifically, the NRC requested a map of the surface scan locations in conjunction with the soil sample locations, and a clearer explanation of the investigations, remediation, and resurvey performed in Survey Unit L1-SUB-TDS A. The soil sample locations are indicated in Figure 13 of this safety evaluation. The surface scan locations for this survey unit are shown in Figure 24 below.

In response, the licensee revised the FSS release record for Survey Unit L1-SUB-TDS A to correct certain errors and provide additional clarification. The scan data in Table 7-1 of the FSS release record show that there were alarms for scan lanes 9, 22, 28, 29, 30, 31, 73, and 79. The revised release record clarifies that scan alarms triggered the collection of four investigational soil samples - one sample in scan lane 9, one sample for scan lanes 29 through 31, one sample in scan lane 73, and one sample in scan lane 79. The FSS release record states that in scan lane 22 and scan lane 28, the alarm was inadvertently logged since the field log states no alarm was produced on rescan and identifies that the licensee grouped certain scan lanes together with one investigational sample. As shown by the overlay of the surface scan lanes on the sample locations in Figure 25, the scan lanes with the highest survey readings in Survey Unit L1-SUB-TDS A correspond to investigational samples as matched in Table 13. In addition, the gamma spectroscopy results revealed that Cs-137 was positively identified in sample A19 (which was collected in scan lane 31) and sample A20 (which was collected in scan lane 9).

Table 13. Survey Unit L1-SUB-TDS A Scan Lane Corresponding to Investigation Samples

Scan Lane	Highest Logged Reading (cpm)	Background (cpm)	Scan Action Level (cpm)	Investigation Sample ID	Sample Gamma Spec Cs-137 Result (pCi/g)
9	12,099	9,297	11,059	L1-SUB-TDS-FJGS-A20-SB	6.05
31	13,838	6,651	8,413	L1-SUB-TDS-FJGS-A19-SB	1.4
73	8,818	5,126	6,888	L1-SUB-TDS-FJGS-A15-SB	< MDC
79	8,669	5,126	6,888	L1-SUB-TDS-FJGS-A17-SB	< MDC
A12 Before / After	7,604 / 7,203	3,662	5,425	Original A12 sample was remediated	N/A
A15 Before / After	5,798 / 5,958	3,662	5,425	L1-SUB-TDS-FJGS-A15-SB	< MDC
A17 Before / After	5,434 / 7,058	3,662	5,425	L1-SUB-TDS-FJGS-A17-SB	< MDC
A19 Before / After	19,934 / 15,165	6,651	8,413	L1-SUB-TDS-FJGS-A19-SB	1.4

Table 7-1 of the FSS release record for Survey Unit L1-SUB-TDS A also indicates that alarms were produced during the surface scans around sample locations A12 (original), A15, A17, and A19. Sample location A12 was part of the 200 square feet of the survey unit that was later remediated. Although scan alarms occurred around judgmental sample locations A15, A17, and A19, the maximum measured radiological concentration (Cs-137) for these samples was well below the OpDCGL. Sample location A19 was in the vicinity of scan lanes 29 through 31, and the alarms corresponded to the 1 m^2 scan area around the sample location. The scan around sample location A19 produced a reading of 19,934 cpm before the sample was collected and a reading of 15,165 cpm after sample collection. The judgmental sample collected from sample location A19 (Sample L1-SUB-TDS-FJGS-A19-SB) had a measured concentration of 1.4 pCi/g of Cs-137, which alone does not explain the high scan reading in that area. The NRC staff notes that the low measured sample concentration indicates that background radiation was contributing to the scan reading as opposed to Cs-137 in the soil being scanned.

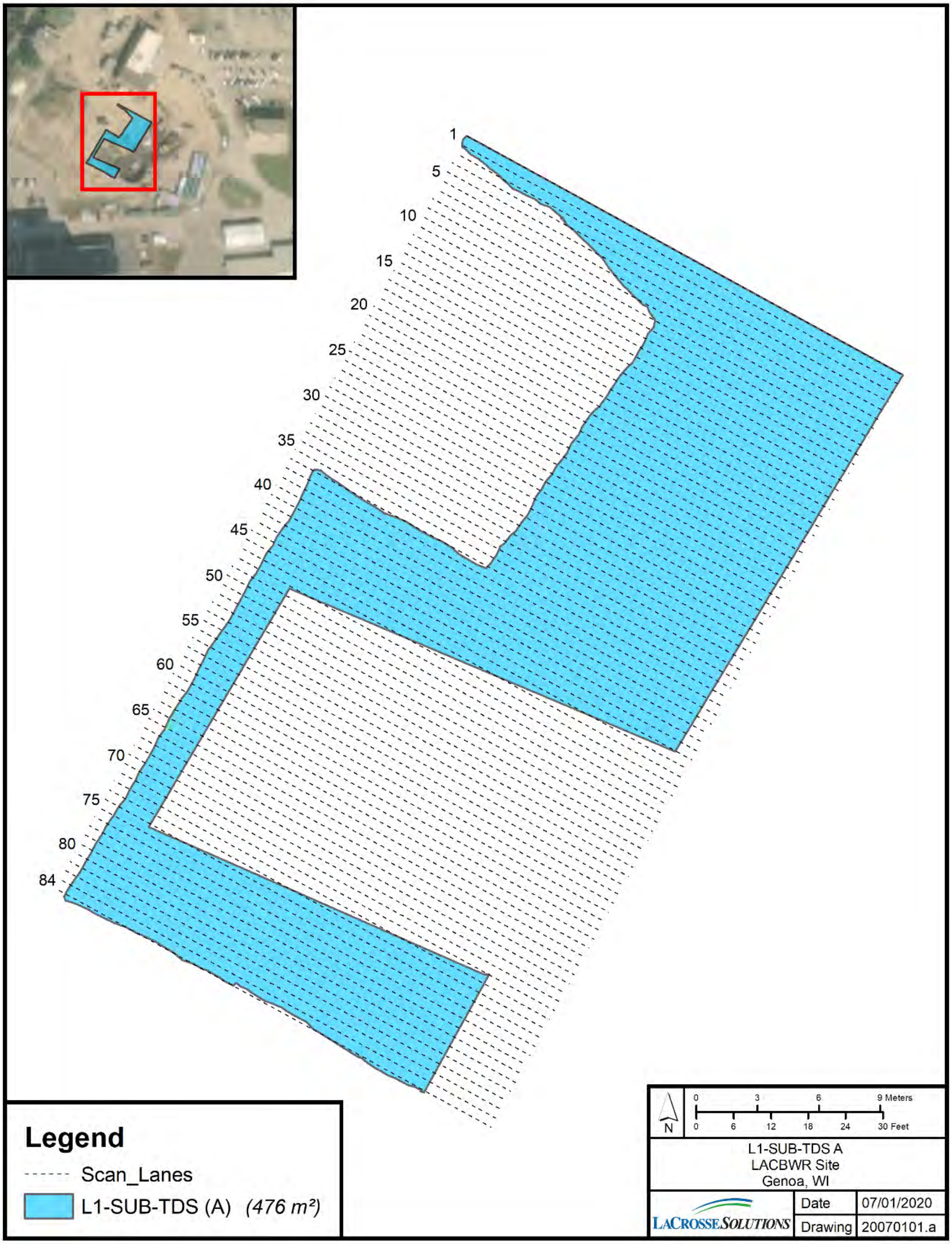


Figure 24. Survey Unit L1-SUB-TDS A Surface Scan Lanes

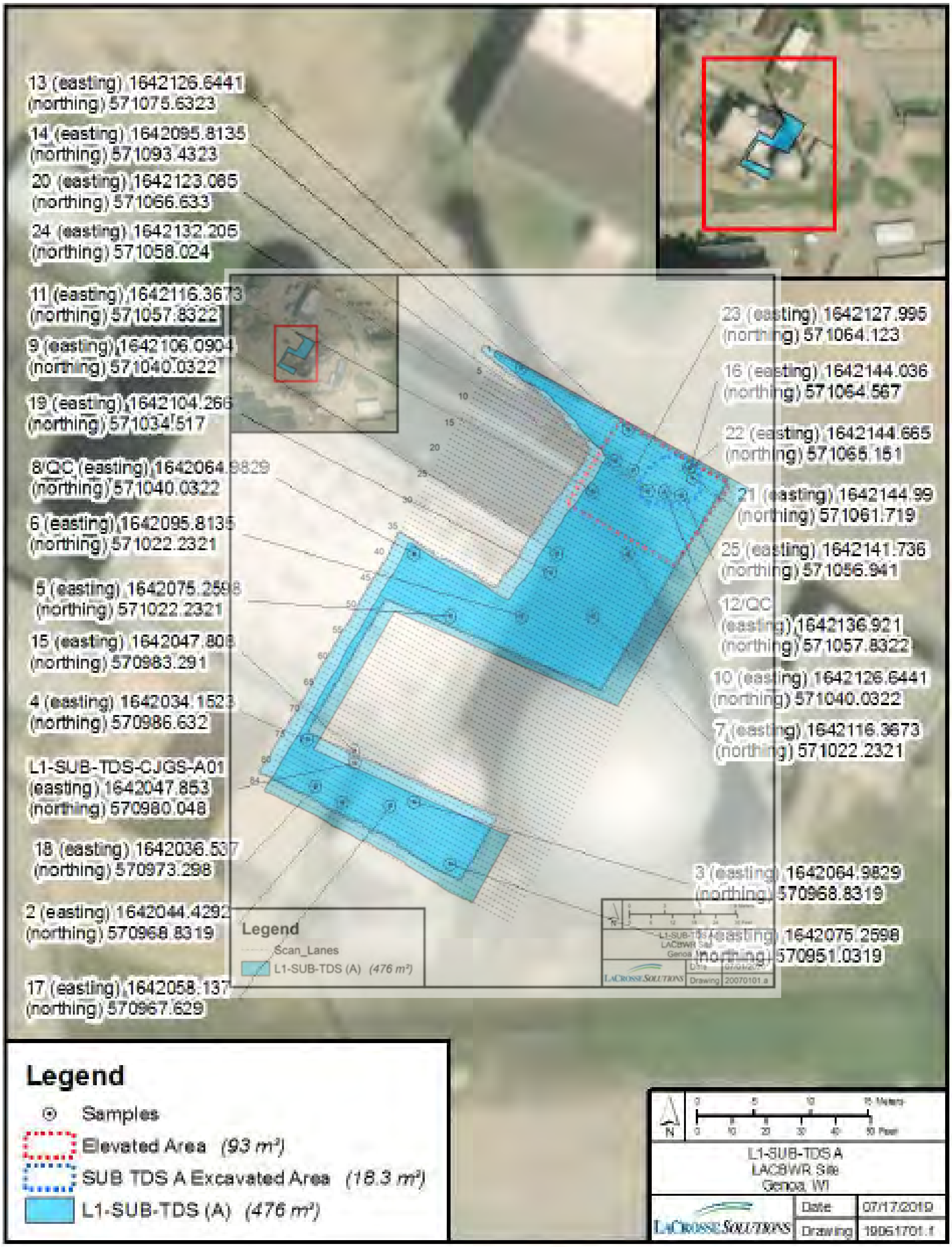


Figure 25. Survey Unit L1-SUB-TDS A Scan Lanes Overlaid on Sample Locations

During the FSS of Survey Unit L1-SUB-TDS A, the licensee remediated an area of approximately 200 square feet within the survey unit, which included several small pieces of concrete with elevated contamination from the northern section of the survey unit within scan lanes 1 through 10, as shown by the blue dotted circle area within Figure 25. Three judgmental soil samples (Sample L1-SUB-TDS-FJGS-A16-SB, Sample L1-SUB-TDS-FJGS-A21-SB, and Sample L1-SUB-TDS-FJGS-A22-SB), which were collected in the remediation area prior to remediation being conducted, were excluded from the final FSS dataset as they no longer represented the final configuration of the survey unit. Systematic soil sample location 12 was also part of the remediated area within the survey unit. Because sample location 12 was part of the original systematic survey design for the FSS, the soil sample was recollected (labeled Sample L1-SUB-TDS-FSGS-A12A-SB, and its QC duplicate labeled Sample L1-SUB-TDS-FQGS-A12A-SB). Additionally, the FSS release record indicates that the remediated area of the survey unit was completely rescanned with no significant findings.

The NRC staff notes that the process outlined in Figure 2.7, “The Characterization and Remedial Action Support Survey Portion of the Radiation Survey and Site Investigation Process,” and Figure 2.8, “The Final Status Survey Portion of the Radiation Survey and Site Investigation Process,” of MARSSIM indicates that when additional remediation is conducted during an FSS, the Data Quality Objectives should be reassessed to ensure that they are satisfied. In addition, Section 5.6.4.6.1, “Remediation, Reclassification and Resurvey,” of the LACBWR LTP states that “if an area is remediated, then a RASS will be performed to ensure that the remediation was sufficient.”

As part of the FSSR RAI response (ML20356A041) and revised FSS release record for Survey Unit L1-SUB-TDS A, the licensee clarified that all original FSS data prior to remediation of the approximately 200 square feet within the survey unit passed the Sign Test, and the mean SOF of the original survey samples was less than unity. Therefore, a new design for the survey unit or complete resurvey was not necessary. The associated FSS release record states that:

> These remediation activities were performed in accordance with Section 5.6.4.6.1 and Table 5-17 of the LTP. All original data passed the Sign Test, and the mean SOF of the original samples was less than unity. A new survey design or complete resurvey of the entire survey unit was not necessary, only rescan and re-sampling of the remediated area was required. These post-remediation scans and samples demonstrated that the remediation was successful, and the survey design and DQOs for the FSS of Survey Unit L1-SUB-TDS A are still valid given that remediation occurred.

The NRC staff notes that the area around scan lanes 29 through 31 in Survey Unit L1-SUB-TDS A, which had the highest recorded surface scan readings, does not appear to have been remediated given the information in the revised FSS release record. However, the judgmental soil sample result in this location (sample location A19 with a concentration of 1.4 pCi/g of Cs-137), was well below the OpDCGL, as was the adjacent systematic soil sample result at sample location A9, with a concentration of less than 1pCi/g of Cs-137.

Based on the above considerations, the NRC staff finds that the licensee’s approach to scanning and investigation sampling for Survey Unit L1-SUB-TDS A is adequate. Specifically, judgmental soil samples were collected in the areas of the survey unit with the highest surface scan readings, and the measured soil sample results from the survey areas with the highest scanned readings were below the OpDCGL. Therefore, the investigation sampling and scanning for the survey unit is acceptable.

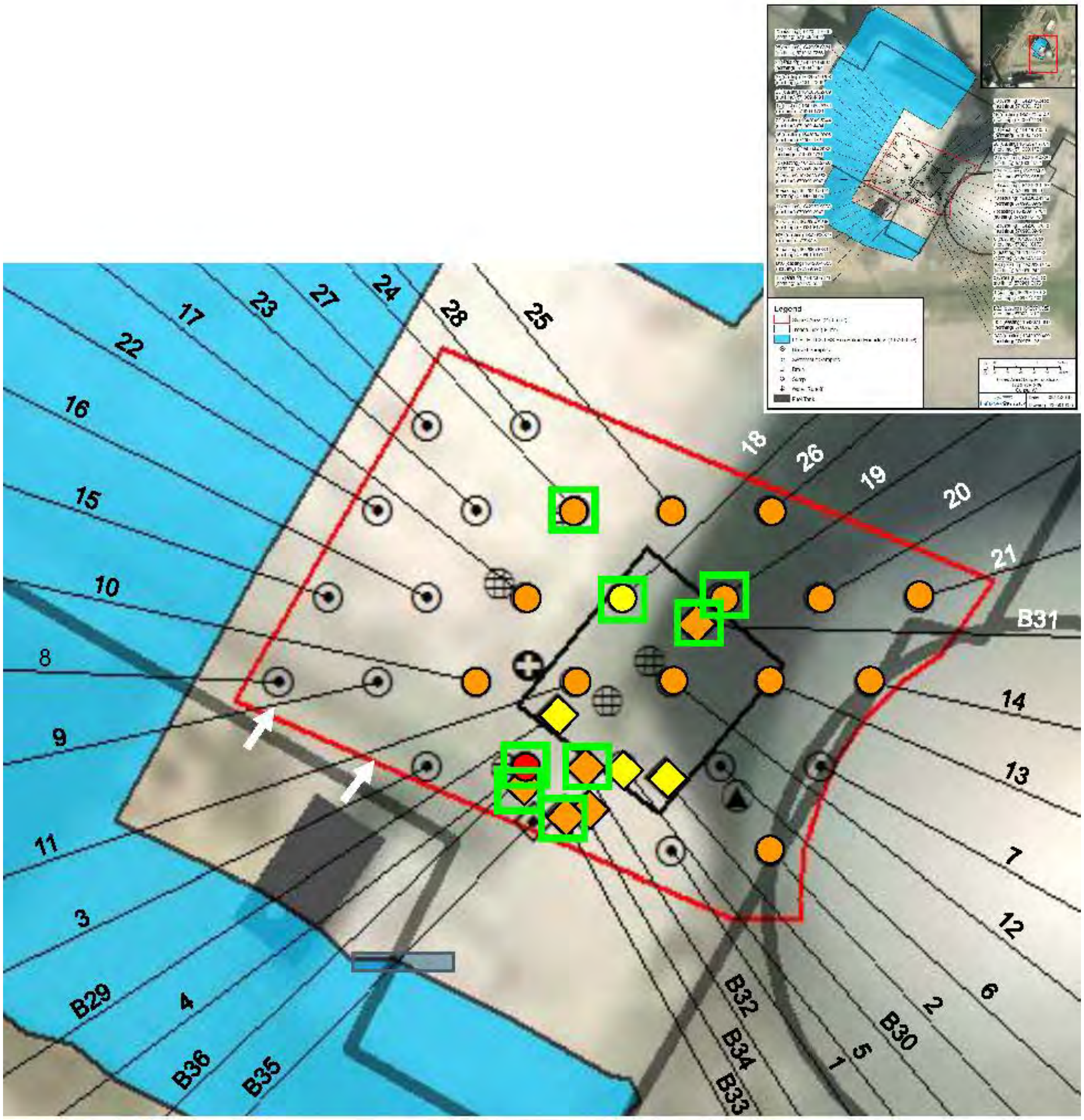
3.3.2.2.5 Survey Unit L1-SUB-TDS B, RPGPA Excavation

The RPGPA excavation area (Survey Unit L1-SUB-TDS B) is a Class 1 survey unit, which includes a historically identified leak suspected from the LACBWR turbine building drains to the groundwater system (see Section 2.3.7.3, "Previous Investigations," and Section 6.5.4, "Existing Groundwater," of the LACBWR LTP) that was not adequately characterized spatially or in duration prior to submittal of the LACBWR LTP (see Section 3.7.8.1, "1983 Leak – Turbine Building," of the NRC safety evaluation associated with approval of the LTP (ML19008A079)).

Considering the radionuclide decay rates and large sorption coefficients, significant Cs-137 from the historical leak could have been present when the LACBWR turbine building was removed, sorbed to the sediments below the building foundation. The NRC safety evaluation associated with approval of the LACBWR LTP assumed that the presence or absence of both Co-60 and Cs-137 during FSS of the RPGPA excavation would confirm the assumptions made in the LTP regarding radionuclide concentrations and groundwater contamination as a result of this event. However, a 100% surface scan of the RPGPA excavation and typical systematic sampling during FSS activities were not possible because the survey unit was backfilled prior to FSS due to groundwater intrusion from rising water levels in the adjacent Mississippi River.

As a result of the need to backfill the RPGPA excavation before FSS, the systematic soil samples necessary to satisfy the FSS survey design were collected using GeoProbe technology. Static measurements were taken of the GeoProbe sample from different stratums representing different elevations in the soil, and a scan was taken of the overall GeoProbe core material as well. The associated FSS release record indicates that "during the first few sampling attempts with the GeoProbe, it became evident that the interface could not be discerned" between the native soil of the RPGPA excavation and the backfill material. Therefore, the licensee collected GeoProbe samples from four different stratums at each systematic sample location, at three-foot intervals, and each soil sample consisted of a minimum of one liter of soil. The highest Cs-137 concentration measured in the four stratums was used in the Sign Test.

In the FSS release record for the RPGPA excavation, one of the systematic soil samples taken via GeoProbe, labeled Sample L1-SUB-TDS-FSGS-B04-SB, had an SOF of 1.4655 when compared to the OpDCGL, and a Cs-137 concentration of 24.4 pCi/g. The release record indicates that "as an investigation, additional judgmental boring locations were added, and the other three samples collected nearest the sample location were evaluated. None of the other three samples had a SOF greater than one [when compared to the OpDCGL]." The map of sample locations in the RPGPA excavation is shown in Figure 26 below, colored by the soil stratum from which the sample was collected. One judgmental GeoProbe bore sample location (B36) looks to overlap a systematic sample location (Sample L1-SUB-TDS-FSGS-B04-SB), and that judgmental sample contained a lower concentration of Cs-137 that the systematic sample (1.2 pCi/g of Cs-137 in the judgmental sample compared to 24.4 pCi/g of Cs-137 in the systematic sample). The sample location map also shows that four of the other judgmental GeoProbe bore sample locations are relatively close to Sample L1-SUB-TDS-FSGS-B04-SB (B32, B33, B34, and B35). The maximum Cs-137 concentration reported in these judgmental samples was 11 pCi/g at GeoProbe bore sample location B33.



Judgmental, Systematic

Cs-137 > 1 pCi/g

Above operational DCGL, top stratum (624 - 627 ft elevation)

Above MDC, top stratum (624 - 627 ft elevation)

Above MDC, 2nd or 3rd stratum from top (621 - 625 ft or 618-621 ft elevation)

Angled GeoProbe, 20 ft "depth" from edge of building from ~639 ft AMSL was part of initial characterization

Figure 26. RPGPA Excavation GeoProbe Sample Locations Colored by Stratum

Given that it was not clear in the FSS release record for the RPGPA excavation from which stratum (elevation) of the GeoProbe samples the maximum Cs-137 concentrations were measured, the NRC staff requested additional information related to the evaluation conducted for the three additional investigational samples near Sample L1-SUB-TDS-FSGS-B04-SB, in order to confirm that (1) the sample measurements are adequate to support the survey conclusions in the FSS release record, and (2) the investigation process for this survey unit was followed in accordance with the commitments in the approved LACBWR LTP.

For the RPGPA excavation the licensee stated that the interface between the native soil of the excavation and the backfill material could not be determined during the GeoProbe sampling activities. Therefore, the licensee collected one-meter samples to a total depth of four meters in order to ensure the horizon of the soil interface was sampled at each GeoProbe bore sample location even when considering differences in the specific depth of the excavation. The data result used to demonstrate compliance with the FSS survey design was the maximum measured activity among the four one-meter samples collected at each location, regardless of which stratum was assumed to represent the native soil to backfill soil interface. At each GeoProbe sampling location, the entire one-meter stratum of soil was mixed to comprise the sample for measurement. Additional borings were needed at several sample locations to obtain sufficient soil volume for analyses. The soil from these additional borings was mixed with the soil from the original sample prior to analyses.

The FSSR RAI response (ML20356A041) states that because the radiological dose modeling for soils at LACBWR assumed a one-meter depth for any residual contamination (see Section 6.8.2, “RESRAD Parameter Selection for Uncertainty Analysis,” of the LACBWR LTP), determination and separation of the six-inch layer of RPGPA excavation soil directly below the backfill soil for evaluation was not necessary since any residual contamination in that area falls within the one-meter-thick geometry factored into the dose model.

The NRC staff acknowledges that the LACBWR DCGLs were developed using a conceptual model with a one-meter thick contaminated zone. Although the NRC staff also notes that if the residual contamination in the RPGPA excavation only existed in a thinner layer of soil at or near the excavation surface, the mixing of the volume of soil within each one-meter stratum for the GeoProbe samples would have diluted the concentration compared to what would have been measured in the six-inch layer that would have been sampled had the systematic and judgmental soil samples been taken prior to backfill. However, this amount of dilution over approximately one liter of soil does not impact compliance because the $DCGL_{EMCs}$ for soil would have allowed smaller areas of elevated contamination, potentially greater than the DCGLs, to remain (if necessary) in the survey unit. Furthermore, the conceptual model for deriving the LACBWR DCGLs assumed the one-meter thick contaminated zone was at the surface, as opposed to the reality for the RPGPA excavation survey unit where the contaminated layer was present at a deeper level. Therefore, the DCGLs do not take credit for the clean cover layer, which would reduce the in situ dose for Cs-137 and other gamma-emitting radionuclides.

Table 7-1, “Summary of Gamma Spectroscopy Results for Samples Comprising the Statistical Sample Population,” of the FSS release record for Survey Unit L1-SUB-TDS B provides the highest activity measurement from each GeoProbe sample location. As part of its response to a request for confirmatory information (ML22297A004), the licensee clarified the nomenclature used for the GeoProbe sample labeling and how it relates to the elevation of the soil stratum from which each individual sample was collected. The location designator within the sample nomenclature is either blank, or contains an “A,” “B,” or “C” at the end to designate the depth of the sample. Specifically, samples without an end designator are from the 624 to 627-foot elevation stratum (top of the sample column nearest the surface); samples with an "A" designator are from the 621 to 624-foot elevation stratum; samples with a "B" designator are from the 618 to 621-foot elevation stratum; and samples with a "C" designator are from the 615 to 618-foot elevation stratum (bottom of the sample column at the deepest depth).

For example, Sample L1-SUB-TDS-FSGS-B01-SB is from the 624 to 627-foot elevation stratum (nearest to the surface). Sample L1-SUB-TDS-FSGS-B01**A**-SB is from the 621 to 624-foot elevation stratum. Sample L1-SUB-TDS-FSGS-B01**B**-SB is from the 618 to 621-foot elevation stratum. Sample L1-SUB-TDS-FSGS-B01**C**-SB is from the 615 to 618-foot elevation stratum (deepest sample location). The RPGPA excavation was backfilled to an elevation of 636 feet prior to conducting the GeoProbe sampling campaign. Table 14 below provides a summary of the type of GeoProbe soil samples collected within the RPGPA excavation and the number of highest Cs-137 concentration measurements found within each stratum:

Table 14. Number of Samples from Each Stratum of the GeoProbe Borings in the RPGPA Excavation with Maximum Cs-137 Concentration Readings

Sample Type	615'-618' Stratum	618'-621' Stratum	621'-624' Stratum	624'-627' Stratum
Systematic	3	6	5	14
Judgmental	0	0	2	6
Characterization	0	0	2	5

Figure 26 above shows the locations of the GeoProbe samples collected within the RPGPA excavation, and indicates which stratum contained the maximum activity reading, as well as providing some indication of radionuclide concentration in relation to MDC or the OpDCGL. The red labeled sample, which had a Cs-137 concentration of 24.4 pCi/g (B4) is adjacent to a sample with a Cs-137 concentration of 1.2 pCi/g (B36) on the same elevation. Immediately to the east of the red labeled sample is a sample with a Cs-137 concentration of 11.1 pCi/g (B33), and a sample with a Cs-137 concentration of 6.05 pCi/g (B32), which are also located within the 624 to 627-foot elevation. The RPGPA trench box was at the 618-foot elevation.

The NRC staff reviewed the gamma spectroscopy laboratory data sheets attached to the FSS release record for Survey Unit L1-SUB-TDS B to gain a better understanding of the distribution of Cs-137 residual radioactivity in the excavated surface and backfill material above the sump in the RPGPA survey area. Table 7-1 and Table 7-4, "Summary of Gamma Spectroscopy Results for Judgmental Samples," of the FSS release record identify only the maximum activity values of several radionuclides for each GeoProbe borehole with no direct discussion regarding the soil stratum elevations the sample with the maximum value was collected from, or the distribution of these maximum activity values across the various stratum depths.

In Table 15 the NRC staff provides the Cs-137 activity results from 29 of the 36 systematic and judgmental GeoProbe sample locations collected during the FSS of Survey Unit L1-TDS-SUB B. These 29 sample locations all have Cs-137 concentration values above MDC. Eight of the 29 sample locations exhibit Cs-137 activities above MDC in three or more of the soil stratums for that GeoProbe location, which is possibly indicative of residual radioactivity throughout the column of backfill material down to the natural sediments at the RPGPA excavation surface. Seventeen of the 29 GeoProbe sample locations have the maximum Cs-137 concentration value in the uppermost soil stratum, well above the RPGPA sump elevation. Twenty-four of the 29 sample locations exhibit the maximum Cs-137 activity in the upper two soil stratums, with some locations transecting through the steep sidewalls of the excavation and some entirely in the backfill directly above the RPGPA sump.

Table 15. Cs-137 Activities in Unit of pCi/g for Each Stratum from Each FSS GeoProbe Location Within the RPGPA Excavation (Survey Unit L1-SUB-TDS B).

Notes: (1) The Cs-137 concentration results above MDC are denoted in **bold**.
(2) The GeoProbe sample stratum with the maximum Cs-137 value for that GeoProbe sample location are denoted in red font.
(3) A shortened name for each GeoProbe sample location is used in the first column of the table for ease of use; an example of the full name for a GeoProbe sample location is Sample L1-SUB-TDS-FSGS-B05B-SB, which is denoted as B05-B.

Designation Elevation in feet	- 624-627 (shallowest)	A 621-624	B 618-621	C 615-618 (deepest)
B02	**4.71E-01**	**1.48E-01**	**1.37E-01**	**7.66E-02**
B04	**24.4**	**1.21**	**1.48E-01**	4.37E-02
B05-B	**8.25E-02**	**2.58E-01**	**3.35E-01**	**8.94E-02**
B07	**2.33E-01**	2.57E-02	**9.11E-02**	4.47E-02
B09-B	2.44E-02	**9.07E-02**	**9.97E-02**	4.09E-02
B10	**1.65E-01**	1.52E-02	3.36E-02	6.53E-02
B11	**3.09E-01**	**1.35E-01**	**1.15E-01**	2.65E-02
B12-A	**1.93E-01**	**7.15E-01**	**1.88E-01**	5.64E-02
B13-A	**9.10E-02**	**1.02E-01**	3.93E-02	5.12E-02
B14	**1.61E-01**	1.59E-02	3.09E-02	5.01E-02
B16-A	6.00E-02	**9.77E-02**	3.94E-02	4.57E-02
B17	**2.51E-01**	6.14E-02	7.83E-02	**9.36E-02**
B18-A	**2.23E-01**	**1.01**	**1.12E-01**	4.69E-02
B19	**4.21**	5.77E-02	5.99E-02	5.98E-02
B20	**8.45E-01**	6.45E-02	5.30E-02	5.87E-02
B21	**4.63E-01**	5.78E-02	5.60E-02	**1.01E-01**
B22-C	7.74E-02	2.65E-03	4.62E-02	**9.21E-02**
B24	**1.73**	3.74E-02	**8.47E-02**	**1.25E-01**
B25-B	4.17E-02	2.11E-02	**9.13E-02**	6.93E-02
B26	**6.47E-01**	5.64E-02	-5.90E-03	2.12E-02
B27-A	-3.19E-03	**1.18E-01**	4.79E-02	4.11E-02
B28-C	-	5.71E-02	**8.29E-02**	**1.07E-01**
B29-B	4.92E-01	**8.42E-01**	**7.36E-01**	7.84E-02
B30-A	5.13E-02	**1.42E-01**	4.36E-02	5.21E-02
B31	**1.88**	2.44E-02	4.51E-02	7.62E-02
B32	**6.05**	**4.40**	**4.07E-01**	**8.19E-01**
B33	**11.1**	7.86E-02	5.97E-02	4.22E-02
B34	**5.21E-01**	4.02E-02	9.26E-02	7.91E-02
B36	**1.20**	1.19E-02	**9.56E-02**	8.46E-02

The NRC staff notes that the summaries of Table 7-1 and Table 7-4 provided in the FSS release record for Survey Unit L1-SUB-TDS B are misleading because of two types of apparent transcription errors. Specifically:

- The licensee identified 24 GeoProbe sample locations in Table 7-1 and Table 7-4 of the FSS release record with at least one stratum containing Cs-137 concentration values above MDC. However, in reviewing the gamma spectroscopy laboratory data sheets that support the FSS release record, the NRC staff identified five additional GeoProbe sample locations with at least one stratum containing Cs-137 concentration values above MDC: these are sample locations B09, B16, B22, B27, and B28. The NRC staff notes that although the Cs-137 concentration values were above MDC at these five additional GeoProbe sample locations, none of the five sample results were above 1 pCi/g of Cs-137, which is a small fraction of the OpDCGL for Cs-137. Hence the five additional locations are not consequential, though there are 29, and not 24, of the 36 systematic and judgmental GeoProbe sample locations with results above MDC.

- The NRC staff also notes that the incorrect sample stratum was identified as containing the maximum Cs-137 concentration result in Table 7-1 of the FSS release record for the RPGPA excavation at GeoProbe sample locations B25, B28, and B29.

In addition, the NRC staff observes that the only sample with a Cs-137 concentration result above the OpDCGL was from sample location B04 in the 624 to 627-foot soil stratum. There are two gamma spectroscopy results for this sample. The second of the two gamma spectroscopy results are captured in Table 15 and yields a Cs-137 concentration of 24.4 pCi/g. The first gamma spectroscopy result for Cs-137 concentration was 26.9 pCi/g. Both of these results are significantly higher than the OpDCGL for Cs-137 of 17.31 pCi/g but are only slightly more than 50% of the Base Case DCGL for Cs-137 of 48.3 pCi/g. In summary, the staff notes that none of these transcription errors or observations related to the FSS release record for the RPGPA excavation change any of the NRC staff’s conclusions regarding the ability of the survey unit to meet the criteria for unrestricted release in accordance with 10 CFR 20.1402.

In reviewing the Cs-137 activity results for the systematic and judgmental GeoProbe sample locations with concentration values above MDC, the NRC staff noted that the maximum readings for most of the sample locations were from the elevation spanning 624 to 627 feet. This was the top (shallowest) stratum sampled, but still approximately nine feet below the top of the backfill material, which was established to an elevation of 636 feet. This created a concern that contamination might be present in the backfill material used to fill in the wider RPGPA area. However, the NRC staff also noted that the backfill of the trench box area associated with the RPGPA sump did not occur until after the trench box was removed from the RPGPA excavation.

As part of its supplemental response to a request for confirmatory information (ML22321A016), the licensee indicated that when the trench box (shown in blue in Figure 27) was removed from the RPGPA sump area, there was significant sloughing from the excavation after removal of the trench box. The licensee stated that the contamination found outside of the RPGPA sump area was a result of the excavation activities to remove – and sloughing of the excavation after removal of – the trench box, as well as soil dropping from the trench box and removal equipment (i.e., excavator bucket) while the trench box was being lifted out of the excavation and moved out of the sump area. These activities spread contamination in the immediate vicinity of the RPGPA sump, including in the area where Sample L1-SUB-TDS-FSGS-B04-SB was collected, which resulted in a Cs-137 concentration of 24.4 pCi/g as shown in Table 15.

Therefore, it is reasonable to conclude that the GeoProbe sample locations where the maximum Cs-137 concentration occurred in the 624 to 627-foot layer of the soil sample was a result of this spreading of contamination during and after removal of the trench box, as opposed to contaminated backfill material being used in the RPGPA sump area.

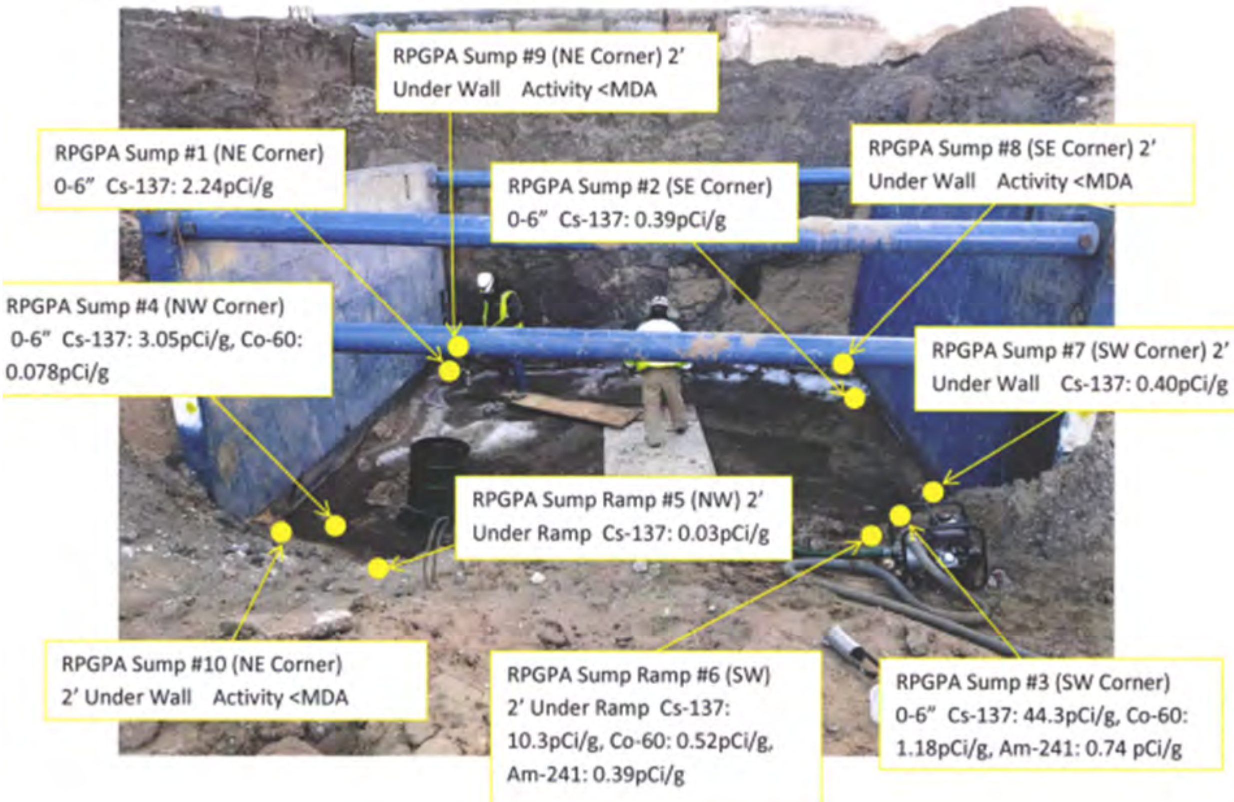


Figure 27. Survey Unit L1-SUB-TDS B RASS Sample Locations from December 9, 2017

To provide further basis that the GeoProbe sample locations where the higher radionuclide concentrations occurred in the shallower layer of the soil sample were a result of sloughing and spreading of some residual contamination that was mixed with the clean backfill material during removal of the trench box around the RPGPA sump, the licensee confirmed that isolation and control measures were maintained in accordance with the LACBWR survey procedures (ES TSD LC-FS-PR-010) until survey units L1-SUB-CDR, L1-SUB-TDS-A, and L1-SUB-TDS B were backfilled. The licensee also provided a detailed timeline of the survey and backfill activities within Survey Unit L1-SUB-CDR, Survey Unit L1-SUB-TDS A, and Survey Unit L1-SUB-TDS B, which described how isolation and control was maintained in these overlapping survey units given the timing and elevation of the various excavations. The licensee confirmed that no excavation activities affected the final surface (subject to FSS) of another excavation.

Specifically, the NRC staff notes that the final elevation of Survey Unit L1-SUB-CDR (627 feet) did not require remediation after FSS of that soil elevation. During subsequent survey activities in the deeper RPGPA excavation, which underlies a portion of Survey Unit L1-SUB-CDR, the RPGPA sample locations were designed and obtained using the entire footprint of the area for ease of FSS design. In some cases, this caused the sample locations to overlap the 627-foot elevation of Survey Unit L1-SUB-CDR surrounding the deeper trench box. However, for the GeoProbe samples that cored through the 627-foot elevation for Survey Unit L1-SUB-CDR, the measurement results for the soil in the this stratum agree with the measurement results from the FSS of Survey Unit L1-SUB-CDR (ML22321A016) and therefore support that the FSS of the CDR survey unit was not invalidated by subsequent activities in the RPGPA excavation.

In addition, as discussed previously, two samples (labeled Sump Area #1 and Sump Area #2) were taken from the RPGPA sump during the FSS activities for Survey Unit L1-SUB-CDR in September 2017, but were located in the area that was later excluded from this survey unit and became Survey Unit L1-SUB-TDS B. Therefore, the data from those two samples was not included in the FSS judgmental sample population for Survey Unit L1-SUB-CDR. Additionally, because the material originally sampled by Sump Area #1 and Sump Area #2 was removed during subsequent remediation activities, neither of the samples were utilized in the FSS sample population for Survey Unit L1-SUB-TDS B. The material associated with these two sample locations was remediated prior to backfill of the RPGPA excavation.

Given that the RPGPA excavation survey unit was backfilled prior to FSS due to groundwater intrusion, the NRC staff requested additional information regarding any surface scans of the excavation that had been performed prior to backfill. The licensee conducted a RASS in the RPGPA excavation in December 2017 using a Ludlum Model 2221 general purpose scaler-ratemeter coupled to a Ludlum Model 44-10 beta/gamma radiation detector. During the RASS, background radiation in the survey area was high (approximately 17,000 cpm) due to the proximity of the excavation to the LACBWR reactor building. The maximum scan reading in the excavation was 64,000 cpm, recorded on December 9, 2017, in the southwest corner of the trench box area. Other scan readings ranged from 15,000 cpm to 60,000 cpm. Figure 27 shows the RASS sample locations and results from the trench box. Figure 28 shows the RASS scan results from December 9, 2017. The sample with the highest Cs-137 activity from this RASS was also in the southwest corner of the survey unit with a concentration of 44.3pCi/g, which corresponded to the highest scan reading. This result is higher than the OpDCGL for Cs-137 of 17.31 pCi/g, but still lower than the Base Case DCGL for Cs-137 of 48.3 pCi/g.

Excavation activities in the RPGPA excavation continued in the sump area after this RASS was conducted until January 9, 2018. On January 9, 2018, additional survey scan measurements were collected in the trench box area after excavation of the RPGPA sump was complete. During this surface scan in January 2018, scan readings were relatively uniform, with the maximum reading of 17,300 cpm collected in the southwest corner of the trench box area, indicating that the contamination that yielded the maximum scan value during the December 2017 RASS had been remediated. Soil samples collected in the trench box in January 2018 also indicated low activity levels for Cs-137 and Co-60, with maximum concentrations of 5.32 pCi/g and 0.11 pCi/g, respectively.

In addition to the RASS in December 2017 and additional surface scans in January 2018, the licensee also performed a radiological assessment of the trench box within the RPGPA excavation in April 2019 prior to backfill of the RPGPA sump area on April 18, 2019. As part of the RA, seven soil samples were collected and analyzed by the onsite gamma spectroscopy system. The average SOF of the sample set was 0.1, with a standard deviation of 0.14. The RA data was used to design the FSS for the RPGPA excavation. The licensee also conducted surface scans during the RA. The RA scans were of accessible areas of the survey unit outside the trench box portion of the RPGPA excavation. The surface scans were performed in four general areas: north, south, east, and west portions of the survey unit due to accessibility issues and the small size of the unit. After Survey Unit L1-SUB-TDS B was backfilled to the 636-foot elevation, the 636-foot elevation of the RPGPA excavation (consisting primarily of backfill material) was not scanned. However, the survey unit remained under isolation and control until final backfill to grade occurred (from the 636-foot to the 639-foot elevation).

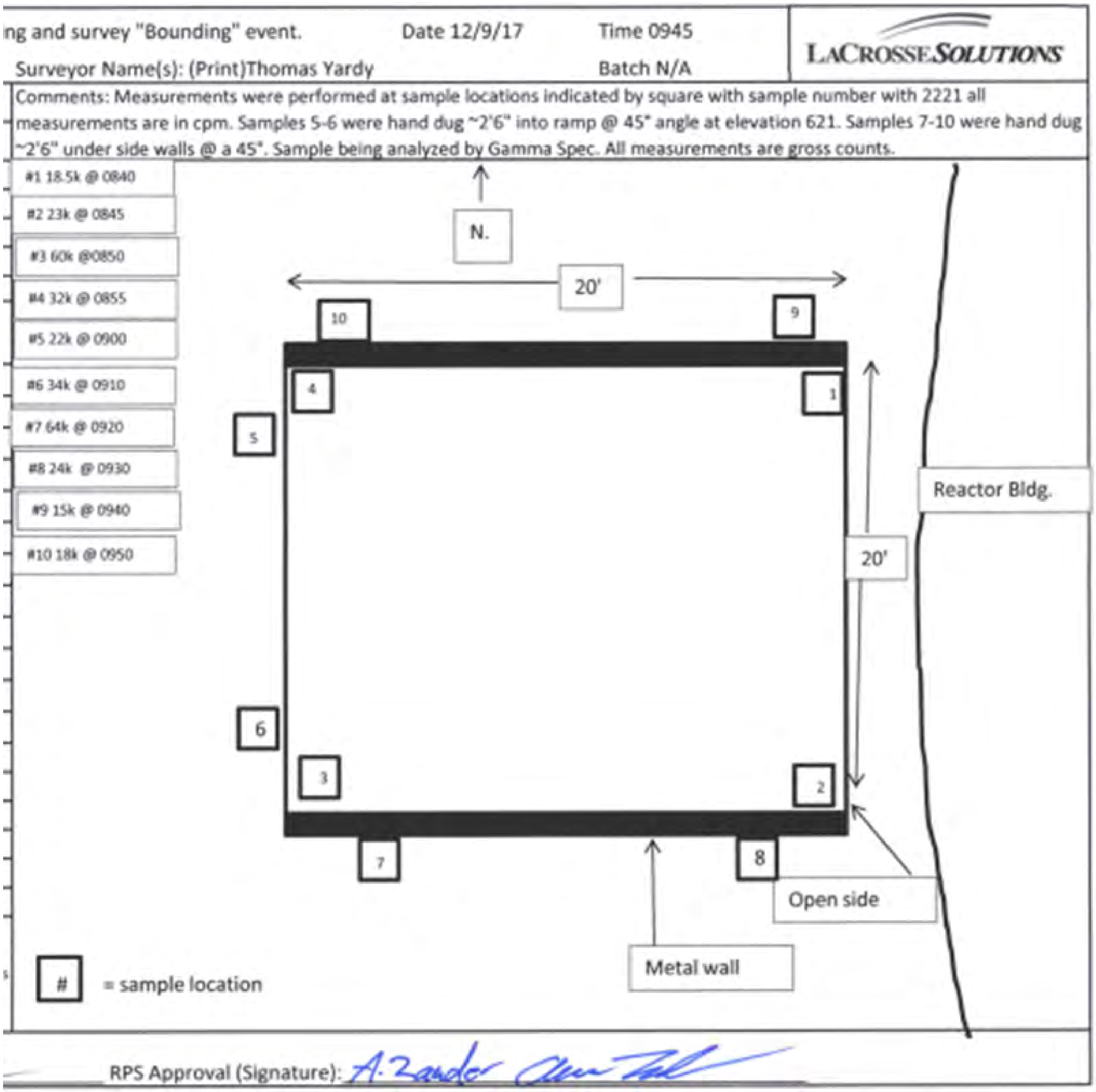


Figure 28. Survey Unit L1-SUB-TDS B RASS Scan Results from December 9, 2017

Based on the above considerations, the NRC staff finds that the licensee's approach to scanning and investigation sampling for Survey Unit L1-SUB-TDS B is adequate. Although the survey unit was backfilled prior to FSS, the static gamma measurements from surface scans and results from soil samples collected during a RASS and RA surveys prior to backfill, along with the results of the subsequent GeoProbe sampling campaign, can be relied on to provide reasonable assurance that the remaining radioactivity does not exceed the unrestricted release criteria. Given the timing, it is also reasonable that the proximity of the reactor building would have contributed to the higher surface scan readings during the RASS in December 2017. In addition, the RA surface scan results from January 2018 in the southwest corner of the trench box were close to background levels, indicating successful remediation. Therefore, the investigation sampling and scanning for the survey unit is acceptable.

3.3.2.2.6 <u>*Survey Unit L1-SUB-LES, LSA Building, Eat Shack, and Septic Excavation*</u>

In Survey Unit L1-SUB-LES, the licensee determined the scan investigation action level by taking the average of five one-minute static measurements to establish background radiation and adding the cpm equivalent to the full OpDCGL, which is 3,525 cpm. The value of 3,525 cpm equates to 100% Cs-137 having a 0.2206 µR/hr per pCi/g ERC value for a detector to end cap distance of three inches, using 17.31 pCi/g for the OpDCGL, and a assuming a detector response for Cs-137 of 940 cpm per µR/hr. Background radiation ranged from 7,874 cpm to 10,438 cpm. One scan grid location, grid E1 with a measurement of 11,850 cpm, resulted in an alarm against the scan investigation action level of 8,436 cpm, and a judgmental sample was collected. The gamma spectroscopy result for this sample for the concentration of Cs-137 was above MDC at 0.0286 pCi/g. No other ROC was identified above MDC for the sample.

A background radiation reference area or other approved method for obtaining the ambient background could have been established, rather than obtaining five one-minute measurements at various locations within the survey area at a detector height of six inches. However, given that according to MARSSIM the licensee could have potentially set the scan investigation level at a value equal to the $DCGL_W$ or the $DCGL_{EMC}$, and since the highest logged scan readings even without subtracting any ambient background radiation are in the vicinity of the cpm equivalent to the Cs-137 Base Case $DCGL_W$, the approach is reasonable.

Based on the above considerations, the NRC staff finds that the licensee's approach to scanning and investigation sampling for Survey Unit L1-SUB-TDS B is adequate. The licensee followed the scanning and investigation sampling process outlined in the approved LACBWR LTP for this survey unit. The Cs-137 concentration of the investigational sample taken was well below the OpDCGL, and no other ROCs were identified above MDC. Therefore, the investigation sampling and scanning for the survey unit is acceptable.

3.3.2.2.7 <u>*Survey Unit L1-SUB-DRS, Radiologically Controlled Area North Excavation*</u>

In Survey Unit L1-SUB-DRS, the FSS release record states that the scan investigation action level is based on the average background radiation plus 3,525 cpm (equivalent to the OpDCGL of 17.31 pCi/g for Cs-137). Background radiation ranged from 7,357 cpm to 11,975 cpm, and there were no scan alarms, so no investigational samples were collected in the survey unit. The NRC staff reviewed the licensee's scan data and notes that instead of adding 3,525 cpm to the average background radiation, the licensee added 3,697 cpm to certain scan grids (E6, F4, F5, F6, G5, and G6). This small difference in the amount added to average background does not change whether a scan alarm would have occurred or not, so is not significant to the results.

As discussed above, a background radiation reference area or other approved method for obtaining the ambient background could have been established using the provision of MARSSIM and the approved LACBWR LTP. However, since the highest logged scan readings even without subtracting any ambient background radiation are in the vicinity of the cpm equivalent to the Cs-137 Base Case $DCGL_W$, the approach is reasonable.

Based on the above considerations, the NRC staff finds that the licensee's approach to scanning and investigation sampling for Survey Unit L1-SUB-DRS is adequate. The licensee followed the scanning and investigation sampling process outlined in the LACBWR LTP for this survey unit. No scan alarms were triggered so no investigational sampling was required. Therefore, the investigation sampling and scanning for the survey unit is acceptable.

3.3.2.2.8 *<u>Conclusion for Scanning, Investigation Levels, and GeoProbe Sampling for Excavation Survey Units</u>*

The NRC staff used the information contained in Section 3.3.2.2 of this safety evaluation to evaluate the adequacy of the surface scan coverage and process for investigating areas of elevated contamination for each of the LACBWR Class 1 excavation survey units to determine whether the applicable provisions of the approved LACBWR LTP, the guidance in MARSSIM, and the unrestricted release criterion in 10 CFR 20.1402 were met.

The purpose of the 100% surface scan required during FSS of Class 1 survey units is to identify the potential for areas of elevated contamination that may exist between the systematic sample locations, and to collect judgmental samples accordingly to ensure any elevated areas are addressed and/or will not impact the ability of the survey unit to pass the FSS.

Based on the above considerations described for each survey unit, the NRC staff finds that the licensee's approach to scanning and investigation sampling for the Class 1 excavation survey units is adequate. The licensee may not have followed the approved scan investigation action level process described in the LACBWR LTP for the Class 1 excavation survey units, but in accordance with Table 5.8 of MARSSIM, the licensee could have set the scan investigation action level at the $DCGL_W$ or the $DCGL_{EMC}$ for Class 1 survey units, which would have encompassed the majority of the surface scan results in these survey areas.

3.3.2.3 *Continuing Characterization and Verification of HTD Radionuclides*

The inaccessible or not readily accessible areas discussed in Section 2.4 and Section 5.3.3.4 of the LACBWR LTP include the soil under the turbine building (especially where there was a history of a suspected broken drain line) and soil adjacent to and beneath basement structures. Therefore, the licensee performed continuing characterization of these areas when they became accessible. The purpose of the continuing characterization is to verify that the ratios assumed in the LTP for the insignificant radionuclides and the HTD ROC (Sr-90), in comparison to the gamma-emitting ROCs (Cs-137 and Co-60), remain appropriate for those areas. All continuing characterization samples were sent for analysis of the full initial suite of radionuclides in Table 5-1, "Initial Suite of Radionuclides," of the LACBWR LTP.

In addition to the continuing characterization commitments, the Section 5.1, "Radionuclides of Concern and Mixture Fractions," of the LACBWR LTP states that soil samples will be collected during FSS to confirm the HTD (Sr-90) to surrogate radionuclide ratio. Ten percent (10%) of the FSS samples collected from open land survey units (including excavations where major subgrade structures previously resided) will be analyzed for Sr-90. In addition, if any sample has a SOF of 10% of the OpDCGL or more, it was to be sent for Sr-90 analysis.

Table 16 summarizes how many systematic soil samples from the LACBWR Class 1 excavation survey areas were greater than 10% of the Operational SOF for each excavation soil survey unit, how many continuing characterization samples were collected that were sent for analysis of the full initial suite of radionuclides, and how many samples were sent for HTD ROC (Sr-90) analysis only. In some survey units, the licensee applied the continuing characterization sample results that were analyzed for the full initial suite of radionuclides to also meet the requirement for the HTD ROC (Sr-90) analysis. The NRC staff evaluated continuing characterization process and results of the samples collected during these activities for each of the LACBWR Class 1 excavation survey units to determine whether the provisions of the LACBWR LTP, the guidance in MARSSIM, and the 10 CFR 20.1402 unrestricted release criterion were met.

Table 16. Excavation Survey Unit Continuing Characterization and Sr-90 Only Samples

Survey Unit	Survey Unit Description	FSS Systematic Samples > 10% OpSOF	Continuing Characterization Samples Analyzed for Initial Suite	Samples sent for HTD ROC Analysis Only
L1-010-101C	WTB Excavation	1	2	0
L1-SUB-CDR	Stack, Pipe Tunnel, and RPGPA Excavation	4	5	0
L1-SUB-TDS	Turbine Building, Sump, and Pit Diesel Excavation	0	7	1
L1-SUB-TDS A	Eastern Portion of the Turbine Building, Sump, Pit, and Diesel Excavation	10	1	3
L1-SUB-TDS B	RPGPA Excavation	4	8	38
L1-SUB-LES	LSA Building, Eat Shack, and Septic Excavation	0	0	2
L1-SUB-DRS	Radiologically Controlled Area North Excavation	0	0	2

3.3.2.3.1 *<u>Survey Unit L1-010-101C, Waste Treatment Building Excavation</u>*

For Survey Unit L1-010-101C, two systematic samples (Sample L1-010-101-FSGS-C06-SB and Sample L1-010-101-FSGSC14-SB) collected via GeoProbe technology during FSS were selected to also serve as continuing characterization samples. Both samples were sent offsite to be analyzed for the full initial suite of radionuclides, and the results are recorded in the associated FSS release record. Only Cs-137 and Co-60 were detected in these samples. The maximum calculated insignificant contributor (IC) dose was 0.0725 mrem/yr, which is below the 2.5 mrem/yr IC dose limit assigned for DCGL adjustment in the LACBWR LTP.

Based on the above considerations, given that the maximum calculated IC dose was less than 2.5 mrem/yr and that Sr-90 was not detected in the continuing characterization samples, the characterization of the IC dose contribution and Sr-90 surrogate ratio for Survey Unit L1-010-101C is adequate.

3.3.2.3.2 *Survey Unit L1-SUB-CDR, Stack, Pipe Tunnel, and RPGPA Excavation*

For Survey Unit L1-SUB-CDR, Section 5.3.3.4 of the LACBWR LTP states that "after total removal of the Stack Slab, Piping and Ventilation Tunnels (and a small portion of the reactor / generator plant), continuing characterization samples were collected during the FSS of the resultant excavation. The sample plan specified a gamma scan over 100 percent of the survey unit including sloped walls. In addition to the systematic samples collected during FSS (minimum of 14), five additional samples were collected for continuing characterization. These five samples were sent offsite for HTD analysis of the full suite." These five continuing characterization samples are discussed in the associated FSS release record. The maximum calculated IC dose was 0.2861 mrem/yr, which is below the 2.5 mrem/yr IC dose limit assigned for DCGL adjustment in the LACBWR LTP.

Based on the above considerations, given that the maximum calculated IC dose was less than 2.5 mrem/yr and that Sr-90 was not detected in the continuing characterization samples, the characterization of the IC dose contribution and Sr-90 surrogate ratio for Survey Unit L1-SUB-CDR is adequate.

3.3.2.3.3 *Survey Unit L1-SUB-TDS, Turbine Building, Sump, and Pit Diesel Excavation*

For Survey Unit L1-SUB-TDS, Section 5.3.3.4 of the LACBWR LTP states that "after total removal of the turbine building (including the suspect broken drain lines) and the remaining portion of the reactor / generator plant, continuing characterization samples were collected during the FSS of the resultant excavation. As previously discussed, the sample plan specified that four soil samples be taken for continuing characterization; however, eight soil samples were collected and sent offsite for HTD analysis (one for Sr-90 and seven for the full suite of ROC)." These continuing characterization samples were collected from the region beneath the suspected broken drain lines, turbine sump, turbine pit, and condenser pit. As described in the associated FSS release record, these samples were considered part of the continuing characterization activities and were also used as judgmental soil samples during the FSS.

The results of the seven soil samples that were sent offsite to be analyzed for the full initial suite of radionuclides are shown in the FSS release record. Cs-137, Co-60, and Tc-99 were detected in these samples. Tc-99 was detected above MDC in two samples, but without Cs-137 or Co-60 above MDC in those samples. These two sample results indicate a yearly dose of 0.0372 and 0.0441 mrem/yr, respectively, due to Tc-99. The total IC dose for these two samples indicate 0.0457 mrem/yr and 0.0662 mrem/yr, respectively. These values are all well below the 2.5 mrem/yr assumption for IC dose contribution for the adjusted DCGLs. The maximum Tc-99 concentration of the two samples was 0.628 pCi/g. The NRC staff notes that the Tc-99 sample results were within the MDC range when accounting for the uncertainty of about +/-0.30 pCi/g.

The maximum calculated IC dose was 0.1439 mrem/yr, which is below the 2.5 mrem/yr IC dose limit assigned for DCGL adjustment in the LACBWR LTP. In addition to the seven samples sent to be analyzed for the full initial suite of radionuclides, Sample L1-SUB-TDS-FSGS-010-SB was analyzed for Sr-90. Sr-90 was not detected in any of the samples sent for offsite analysis.

Based on the above considerations, given that the maximum calculated IC dose was less than 2.5 mrem/yr and that Sr-90 was not detected in the continuing characterization or FSS samples, the characterization of the IC dose contribution and Sr-90 surrogate ratio for Survey Unit L1-SUB-TDS is adequate.

3.3.2.3.4 *Survey Unit L1-SUB-TDS A, Eastern Portion of the Turbine Building, Sump, Pit, and Diesel Excavation*

The revised FSS release record (Revision 1) for Survey Unit L1-SUB-TDS A states that only one continuing characterization sample was collected in the survey area due to the area being inaccessible at the time of characterization. The onsite gamma spectroscopy analysis for this sample revealed that Cs-137 was detected at concentrations above MDC and a maximum concentration of 0.0706 pCi/g. The continuing characterization sample was sent offsite to be analyzed for the full initial suite of radionuclides; only Cs-137 was identified above MDC.

The selection of three additional soil samples for HTD analysis met the requirement that a minimum of 10% of the samples collected for the FSS of Survey Unit L1-SUB-TDS A be analyzed for Sr-90. Sr-90 was not detected above MDC for any of the three samples. The NRC staff notes that the licensee did not analyze the 10 systematic soil samples from the survey unit with Cs-137 results that were larger than 0.1 SOF for Sr-90, as was committed to in the survey plan. Ideally, the soil samples with the highest values of Cs-137 that were also over 0.1 SOF would have been selected for HTD analysis. However, given that the continuing characterization sample, and the three additional soil samples analyzed for HTD radionuclides, did not have Sr-90 results above MDC, it is reasonable to conclude that the other soil samples in the vicinity of those four samples would not have contained Sr-90 concentrations above MDC.

Based on the above considerations, given that the maximum calculated IC dose was less than 2.5 mrem/yr and that Sr-90 was not detected in the continuing characterization or FSS samples selected for Sr-90 analysis, the characterization of the IC dose contribution and Sr-90 surrogate ratio for Survey Unit L1-SUB-TDS A is adequate.

3.3.2.3.5 *Survey Unit L1-SUB-TDS B, RPGPA Excavation*

The FSS release record for Survey Unit L1-SUB-TDS B describes eight soil samples that were collected during continuing characterization activities and sent offsite to be analyzed for the full initial suite of radionuclides. The analysis results from the eight soil samples are shown in the associated FSS release record in Table 3-2, “Continuing Characterization Off-Site Analysis Results.” A concentration above MDC of Cs-137 was present in three of the samples, and a concentration above MDC of Co-60 was present in two of the samples. The maximum calculated IC dose from these samples in the RPGPA excavation was 0.6373 mrem/yr, which is below the 2.5 mrem/yr IC dose limit assigned for DCGL adjustment in the LACBWR LTP.

In addition to the eight continuing characterization samples, three soil samples (labeled Sump Area #1, Sump Area #2, and NRC #4) from the RPGPA sump area in the survey unit were collected during the FSS activities for Survey Unit L1-SUB-CDR in 2017, in the area that later became Survey Unit L1-SUB-TDS B. These soil samples were collected prior to additional remediation in Survey Unit L1-SUB-CDR and the creation of Survey Unit L1-SUB-TDS B, which consists of the RPGPA sump area. As such, the analysis data from these samples in the RPGPA sump area is included in the FSS release record for Survey Unit L1-SUB-TDS B, although the sample area was further remediated as part of the work prior to FSS in the RPGPA excavation. The Sump Area #1 and NRC #4 soil samples were sent offsite to be analyzed for the full initial suite of radionuclides and the results are included in the FSS release record. The calculated the IC dose for the Sump Area #1 soil sample was 0.4987 mrem/yr, which is below the 2.5 mrem/yr IC dose limit assigned for DCGL adjustment in the LACBWR LTP.

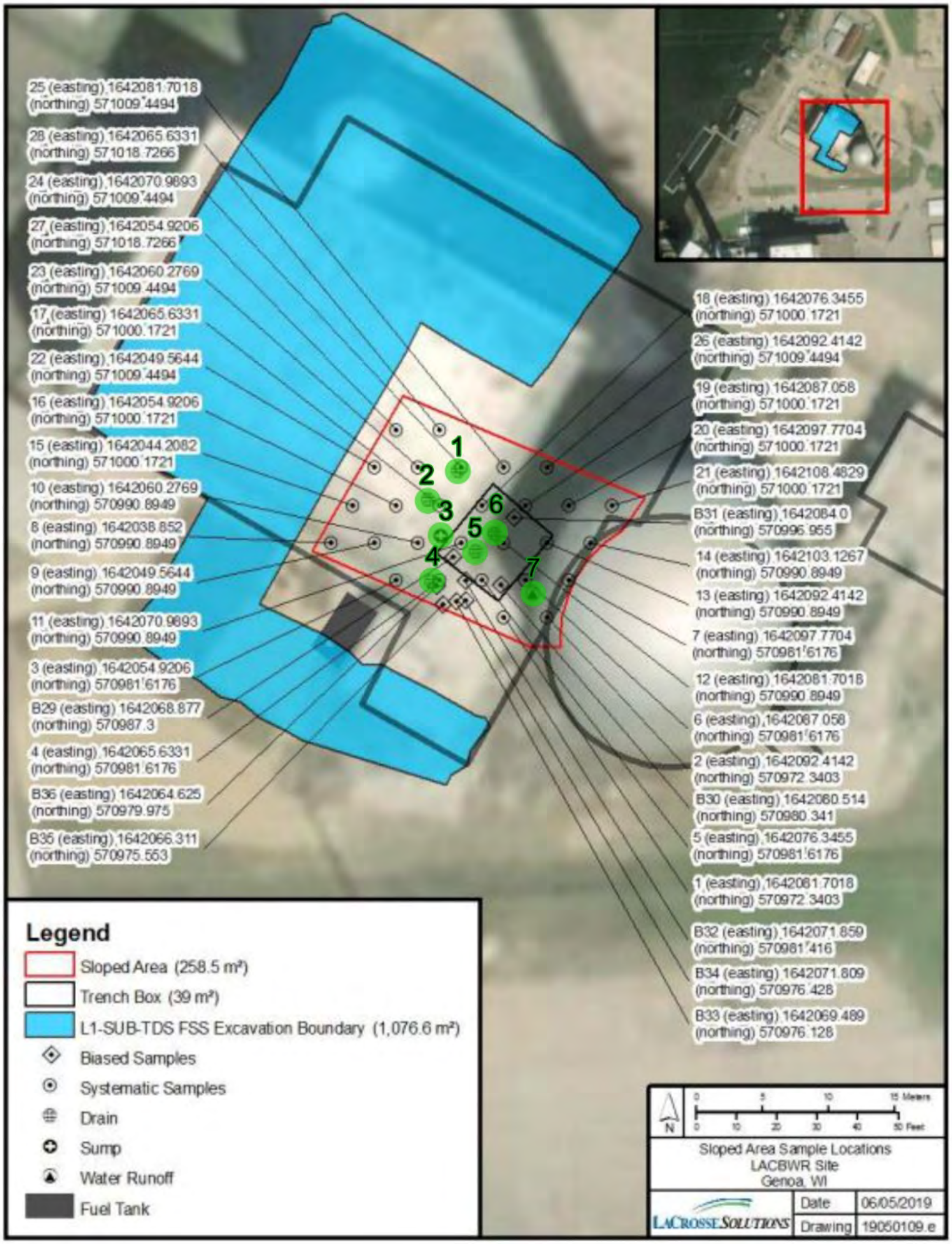


Figure 29. Survey Unit L1-SUB-TDS B Continuing Characterization Sample Locations

In addition, as part of the FSS activities for the RPGPA excavation, the offsite laboratory (GEL Laboratories) processed 38 GeoProbe stratum samples selected for HTD ROC analysis. The HTD ROCs for this survey unit were Sr-90 and H-3. Neither Sr-90 nor H-3 was detected above MDC in any of the GeoProbe samples sent for offsite analyses.

Based on the above considerations, given that the estimated IC dose contribution of the elevated RPGPA sump samples was well below 2.5 mrem/yr, and since no insignificant radionuclides or Sr-90 were detected in the continuing characterization or FSS (GeoProbe) samples selected for Sr-90 analysis, the characterization of the IC dose contribution and Sr-90 surrogate ratio for Survey Unit L1-SUB-TDS B is adequate.

3.3.2.3.6 *Survey Unit L1-SUB-LES, LSA Building, Eat Shack, and Septic Excavation*

Survey Unit L1-SUB-LES consisted of the previously inaccessible soil underlying several buildings that were used during the operation of LACBWR and in support of the nuclear steam system. A RASS performed prior to FSS activities in this survey unit revealed that further remediation was warranted. Specifically, gamma spectroscopy results revealed Cs-137 concentrations ranging between 0.053 pCi/g and 29.3 pCi/g, and Co-60 concentrations ranging between 0.123 pCi/g and 85.7 pCi/g. Areas that produced scan alarms during the RASS, and where judgmental soil samples were collected to determine the extent of elevated contamination, were bounded by the licensee and remediated to levels below the associated OpDCGLs. However, the NRC staff notes that while the licensee appropriately identified and remediated the elevated area in Survey Unit L1-SUB-LES, no continuing characterization samples were collected to be analyzed for the full initial suite of radionuclides.

As part of the supplemental information provided in support of the clarification teleconferences to discuss the LACBWR FSSR (ML22269A395), the licensee indicated that the area remediated in Survey Unit L1-SUB-LES area was not designated a continuing characterization area in accordance with Section 2.4 of the LACBWR LTP. The NRC staff notes that although this area was not specifically named as an area for continued characterization in Section 2.4 of the LTP, this area consisted of previously inaccessible soil underlying buildings, and required remediation due to the concentration of Cs-137 and Co-60 in the soil; therefore, it would have been useful to collect and analyze continuing characterization samples once it became accessible. However, given that the elevated continuing characterization samples from other excavation survey units at LACBWR did not warrant an adjustment to the IC dose contribution, it is highly unlikely that the IC dose assumptions for this survey unit would require adjustment had samples been collected and analyzed for the full initial suite of radionuclides.

In addition, as part of the FSS activities for Survey Unit L1-SUB-LES, the offsite laboratory (GEL Laboratories) processed the two samples selected for Sr-90 analysis. The laboratory results revealed that Sr-90 was not detected above MDC in either of the samples.

Based on the above considerations, given that no Sr-90 was detected in the two FSS samples selected for offsite Sr-90 analysis, the characterization of the IC dose contribution and Sr-90 surrogate ratio for Survey Unit L1-SUB-LES is adequate.

3.3.2.3.7 *Survey Unit L1-SUB-DRS, Radiologically Controlled Area North Excavation*

Survey Unit L1 SUB DRS consisted of the previously inaccessible soil underlying the railway, roadway, storm drains, service water lines and several well water lines at the LACBWR site.

While this survey unit was categorized as an excavation survey unit, continuing characterization samples beyond the samples from initial characterization of the associated above ground survey area (Survey Unit L1-010-104) were not required because Survey Unit L1 SUB DRS was not specified as requiring continuing characterization per Section 2.4 of the LACBWR LTP.

During the initial characterization activities for Survey Unit L1-010-104, which was the land area above this excavation, two subsurface soil samples and two asphalt samples were sent for offsite analysis for the full initial suite of radionuclides. No ROC was identified above the MDCs in any of these samples. However, these initial characterization samples were only taken to a depth of up to one meter beneath the original surface, and therefore may not have been representative of the excavation after removal of the railway, asphalt, and various piping.

As part of the supplemental information provided in support of the clarification teleconferences to discuss the LACBWR FSSR (ML22269A395), the licensee stated that an RA was performed in the Class 2 survey unit directly adjacent to Survey Unit L1-SUB-DRS to address the sloping of the excavation that encroached into the adjacent area. This RA was labeled L2-SUB-103, and one soil sample (Sample L2-SUB-103-AJGS-002-SB) was sent offsite to be analyzed for the full initial suite of radionuclides. No ROCs above MDC were identified in the sample.

In addition, as part of the FSS activities for Survey Unit L1-SUB-DRS, the offsite laboratory (GEL Laboratories) processed the two samples selected for Sr-90 analysis. The laboratory results revealed that Sr-90 was not detected above MDC in either of the samples.

The NRC staff notes that although this area was not specifically named as an area for continued characterization in Section 2.4 of the LTP, the soil in this excavation was originally inaccessible during initial characterization; therefore, it would have been useful to collect and analyze continuing characterization samples once it became accessible. In addition, no radionuclides above MDC were positively identified in the two subsurface soil samples collected to a depth of one meter in the survey unit immediately above the excavation, the RA sample, or the two FSS samples sent offsite to be analyzed for the full initial suite of radionuclides. Further, the service water and well water lines that were removed from this area of the LACBWR site were not contaminated, and therefore were not a source of potential contamination in this survey unit.

Based on the above considerations, given that no Sr-90 was detected in the various samples selected for offsite Sr-90 analysis, the characterization of the IC dose contribution and Sr-90 surrogate ratio for Survey Unit L1-SUB-LES is adequate.

3.3.2.3.8 *Conclusion for Continuing Characterization and Verification of HTD Radionuclides*

The NRC staff used the information contained in Section 3.3.2.3 of this safety evaluation to evaluate the adequacy of the continuing characterization process and results of the samples collected during these activities for each of the LACBWR Class 1 excavation survey units to determine whether the applicable provisions of the LACBWR LTP, the guidance in MARSSIM, and the 10 CFR 20.1402 unrestricted release criterion were met.

The purpose of continuing characterization in the parts of the site that were inaccessible during initial characterization activities is to ensure the radiological assumptions used during FSS design are adequate to capture the actual conditions of the previously unreachable areas. In addition, verification of the IC dose contribution and Sr-90 surrogate ratio ensures that the adjusted DCGLs to address HTD radionuclides are adequate for each excavation survey unit.

Based on the above considerations described for each survey unit, the NRC staff finds that the licensee included the relevant information concerning continuing characterization, insignificant radionuclides, and the HTD ROC (Sr-90) in the revised FSS release records for the LACBWR excavation survey units, which were submitted in response to the FSSR RAIs (ML20356A041). The results of the associated analyses for the full initial suite of radionuclides demonstrate that the IC dose contribution from any continuing characterization sample did not exceed what was assumed in the LACBWR LTP (i.e., 2.5 mrem/yr) and that the assumptions regarding the surrogate ratio used for Sr-90 remain valid in the excavation survey units.

3.3.2.4 Quality Control Measurements

Section 5.9, "Quality Assurance," of the LACBWR LTP states that the quality assurance (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. This section of the LTP also states that one randomly selected split sample will be chosen for QC analysis from each LACBWR survey unit. The NRC staff verified that the number of QC samples taken in each LACBWR Class 1 survey unit met or exceeded the number required for field split and duplicate analyses.

As part of the RAIs associated with the LACBWR FSSR review (ML20195A272), the NRC staff requested additional information regarding the quality control investigations associated with various FSS data to evaluate whether the licensee had followed the processes outlined in Section 5.9.3.4, "QC Investigations," of the LACBWR LTP.

Specifically, Section 5.9.3.4, "QC Investigations," of the LACBWR LTP states that:

> If QC replicate measurements or sample analyses fall outside of their acceptance criteria, a documented investigation will be performed in accordance with approved procedures; and if necessary, shall warrant a condition report in accordance with approved corrective action procedures. The investigation will include verification that the proper datasets were compared, the relevant instruments were operating properly, and the survey / sample points were properly identified and located. Relevant personnel will be interviewed, as appropriate, to determine if proper instructions and procedures were followed and proper measurement and handling techniques were used including chain of custody, where applicable. If the investigation reveals that the data is suspect and may not represent the actual conditions, additional measurements will be taken. Following the investigation, a documented determination is made regarding the usability of the survey data and if the impact of the discrepancy adversely affects the decision on the radiological status of the survey unit.

The NRC staff noted that several FSS release records for the Class 1 excavation survey units contained information in Attachment 4, "Quality Control Assessment," that indicated the LACBWR QC survey samples did not meet the acceptance criteria for compared sample results (original survey samples versus QC samples). The licensee stated that since the values were well below the OpDCGL, no further review or action was necessary, instead of investigating and, if necessary, issuing a condition report as outlined in Section 5.9.3.4 of the LACBWR LTP.

The NRC staff also noted that comparison of the QC sample results to the OpDCGL is not an adequate quality assurance criterion. As part of the RAI, the NRC staff requested that the licensee reevaluate the rationale for using the OpDCGL as a quality assurance criterion for assessing FSS data, as well as provide an alternative quality assurance criterion or discussion of the QC investigation process as described Section 5.9.3.4 of the LACBWR LTP. Using the OpDCGL as a quality acceptance criterion would imply that survey samples could be quite different from one another, yet if they are both below the OpDCGL, they would pass the quality control comparison. Therefore, the use of the OpDCGL as a criterion for quality control would not meet the intent of the quality control comparison.

As part of the associated RAI response (ML20356A041), the licensee performed a review of all the FSS data for all of the LACBWR survey units to ensure that the QA/QC protocols described in the site's Quality Assurance Program Plan and Section 5.9 of the LACBWR LTP were followed. The licensee's response also clarified the acceptance criteria for replicate static measurements. The acceptance criterion for replicate static measurements (which are the quality control measurements taken for above ground structures) is defined as the replicate measurement being within 20% of the standard measurement. The licensee's response also stated that "in addition, the Radiological Engineer would also assess the dose represented by each measurement to determine agreement." The NRC staff reviewed this information and noted that, while the level of radioactivity and the proximity to the MDC of the replicate and static measurements may be considered given the MDC's impact on uncertainty, the NRC reiterates that comparison to the OpDCGL is not an adequate quality assurance criterion.

The NRC staff independently reviewed the instances in the LACBWR excavation survey unit FSS release records where the data indicated that the QC samples did not meet the stated 20% acceptance criterion between the replicate and standard measurements for Cs-137, or where Potassium-40 (K-40) was substituted for the QC assessment comparison because Cs-137 was not identified in the standard or comparison split sample above MDC (Table 17).

In general, the NRC staff notes that K-40 should not be considered a substitute for QC assessment of Cs-137. The predominant gamma energy associated with Cs-137 is 662 kiloelectronvolt (KeV), and the gamma energy for K-40 is 1,460 KeV. These gamma energies are too far apart for K-40 to be a suitable substitute for Cs-137 during a QC assessment. However, K-40 may be acceptable for use as part of a QC assessment for Cs-137 in situations where only low, slightly above MDC Cs-137 levels are present in the standard or comparison samples. Specifically, if Cs-137 was detected in both the standard and comparison sample, but only slightly above the MDC, there would not be a high level of confidence in those QC results. In these cases, K-40 was used by the licensee for the QC assessment of Cs-137 because it is easily detectable and identifiable in most environmental media, including soil, and can be used to increase the confidence level in the QC results. Based on this limited use of the K-40 comparison in the QC sample analyses for the LACBWR excavation survey units, the NRC staff finds this QC assessment approach acceptable.

Based on the above considerations, the NRC staff finds that the licensee's methodology for assessing QC measurement samples in the LACBWR Class 1 excavation survey units, as demonstrated in the FSS release records for these survey units, is consistent with the associated discussion in the approved LACBWR LTP. Therefore, the QC approach for the LACBWR excavation survey units is acceptable.

Table 17. LACBWR Class 1 Excavation Survey Units QA/QC Results

Survey Unit	Survey Unit Description	Number of QC Samples	Notes
L1-SUB-DRS	Radiologically Controlled Area North Excavation	4	Cs-137 agreement in three samples. Cs-137 not detected in either the standard or comparison or both, so K-40 was substituted.
L1-SUB-TDS	Turbine Building, Sump, and Pit Diesel Excavation	1	Cs-137 did not agree so K-40 substituted.
L1-SUB-TDS A	Eastern Portion of the Turbine Building, Sump, Pit, and Diesel Excavation	5	Cs-137 not detected in 4 of 5 samples in either the standard or comparison or both. Cs-137 agreement in one sample. K-40 agreement in four samples.
L1-SUB-TDS B	RPGPA Excavation	2	Cs-137 agreement in both samples.
L1-SUB-LES	LSA Building, Eat Shack, and Septic Excavation	2	Cs-137 not identified in either the standard or comparison or both, so K-40 was substituted.
L1-010-101C	WTB Excavation	1	Cs-137 agreement in the sample.
L1-SUB-CDR	Stack, Pipe Tunnel, and RPGPA Excavation	1	Cs-137 did not agree in either the standard or comparison or both, so K-40 was substituted.

3.3.2.5 Confirmatory Surveys

ORISE performed a confirmatory survey of the LACBWR turbine building excavation in January 2018 (ML20296A507). The ORISE confirmatory survey report refers to the area being surveyed as Survey Unit L1-010-102, which is the label for the turbine building open land survey unit after it was backfilled. However, the confirmatory survey was conducted prior to backfill of Survey Unit L1-010-102 and is therefore a survey of Survey Unit L1-SUB-TDS. The ORISE confirmatory survey report describes the state of the excavation at the time of survey, stating that “the terrain was uneven with several flat levels descending in elevation toward a circular region northwest of the reactor building where a condensate pump had been excavated, leaving a crater approximately 10 meters across and 4 meters deep.”

The ORISE confirmatory survey noted that the physical boundary established by LACBWR for the turbine building excavation did not match the planned survey boundary established in the geographic information system (GIS) mapping files, as indicated by the difference between the ORISE and licensee survey area demarcations shown in Figure 30. As part of the supplemental information provided in support of the clarification teleconferences to discuss the LACBWR FSSR (ML22269A392), the licensee confirmed that the portion of the LACBWR turbine building excavation that was not scanned by ORISE during their confirmatory survey activities was scanned by LaCrosse*Solutions* survey technicians during FSS of Survey Unit L1-SUB-TDS.

The ORISE confirmatory survey concluded that the highest ROC concentrations measured by ORISE using the LACBWR OpDCGLs for soil revealed radionuclide concentrations that were at least an order of magnitude smaller than the OpDCGLs. Therefore, the ORISE confirmatory survey report determined that LACBWR’s FSS design and implementation were appropriate and reported results were acceptable for demonstrating compliance with the release criteria.

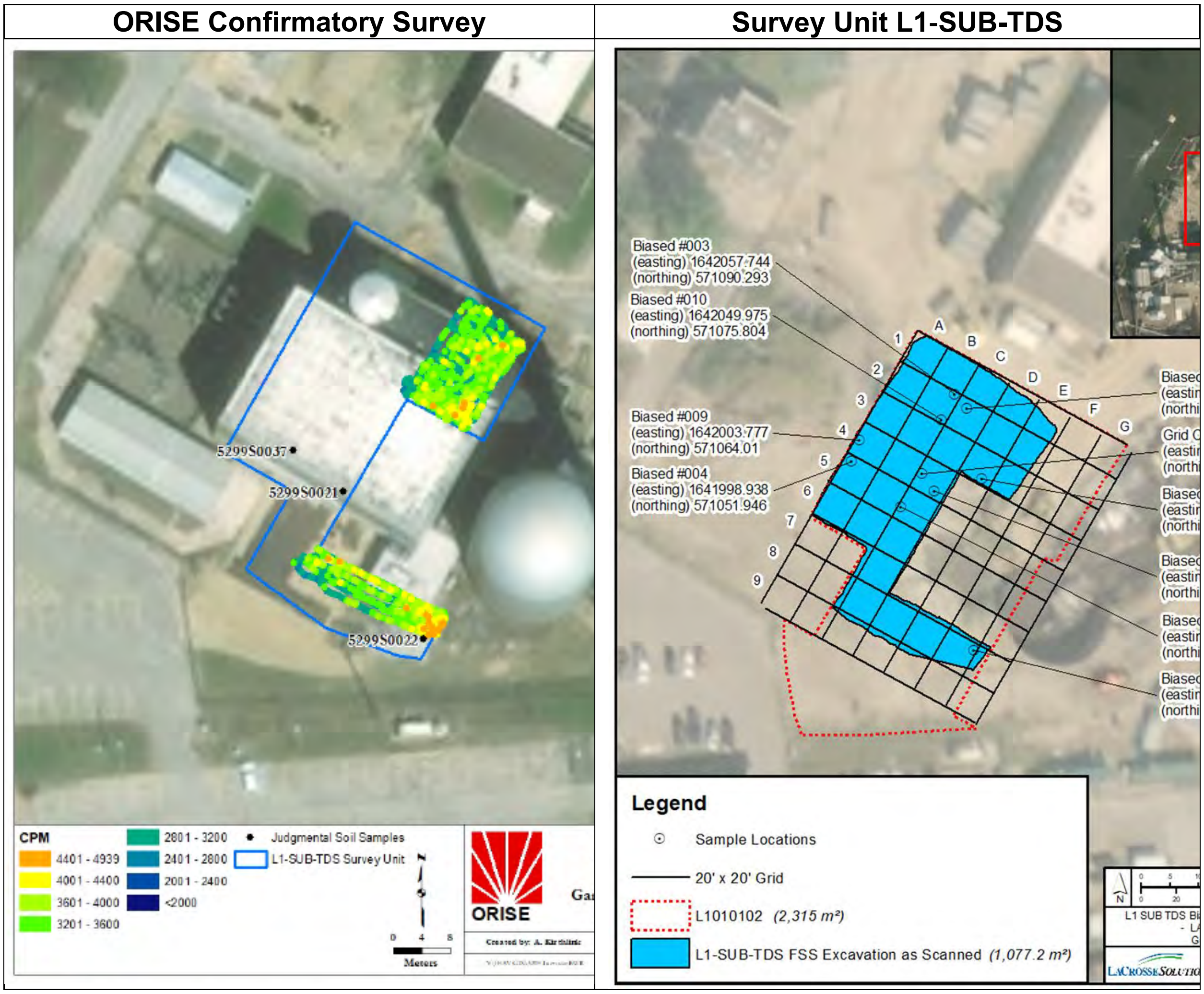


Figure 30. Turbine Building Survey Boundaries for ORISE and LaCrosse*Solutions*

3.3.2.6 Conclusion for Excavation Survey Units

The NRC's dose criteria for unrestricted site release are found in 10 CFR 20.1402, 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 mrem (0.25 millisieverts) per year, including that from groundwater sources of drinking water, and that the residual radioactivity has been reduced to levels that are 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.

For the reasons discussed in the NRC evaluation of the LACBWR Class 1 excavation survey units, the NRC staff has reasonable assurance that the FSS release records for these survey units demonstrate that the residual radioactivity in the associated survey units complies with the unrestricted release criteria. Specifically, the maximum Base Case SOF for all Class 1 excavation survey units listed in the FSS release records was from Survey Unit L1-SUB-CDR and yielded a result of 0.0408, which corresponds to a dose of 1.019 mrem/yr. Furthermore, the assumptions regarding insignificant radionuclides and HTD radionuclides in the LACBWR LTP were upheld by survey results. Given these considerations, the NRC staff concludes that the release of the LACBWR Class 1 excavation survey units will have no adverse impact on the ability of the site to meet the 10 CFR Part 20, Subpart E criteria for unrestricted release.

3.4 Class 1 Backfilled Basement Survey Units

3.4.1 Description of the Backfilled Basement Survey Units

The LACBWR site consists of two Class 1 basement survey units, as summarized below.

Table 18. Class 1 Backfilled Basement Survey Units

Survey Unit	Type	Survey Unit Description	Class
B1-010-004	Basement	Waste Gas Tank Vault (WGTV) Basement	1
B1-010-001	Basement	LACBWR Reactor Building Basement	1

The Base Case DCGLs for the LACBWR reactor building and WGTV basements are presented in Table 6-26, "Basement Fill Model (BFM) $DCGL_B$ Values for ROC Adjusted for Insignificant Contributor Dose Fraction, Mixing Sensitivity, and Alternate Scenario Dose," of the LACBWR LTP, and reproduced in Table 19 below. The OpDCGLs are presented in Table 5-4, "Operational DCGLs for Basements," of the LACBWR LTP, and reproduced in Table 20 below.

Table 19. 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

Table 20. OpDCGLs for the Reactor Building and WGTV

ROC	Reactor Building OpDCGL(pCi/m^2)	WGTV OpDCGL (pCi/m^2)
Co-60	3.61E+05	2.87E+05
Sr-90	1.02E+06	4.48E+05
Cs-137	1.52E+06	1.23E+06
Eu-152	8.33E+05	6.78E+05
Eu-154	7.71E+05	6.28E+05

3.4.1.1 Survey Unit B1-010-004, Waste Gas Tank Vault Basement

Survey Unit B1-010-004 consisted of the concrete floor of the WGTV basement, concrete walls up to three feet below grade (636-foot elevation), a concrete support column in the center of the floor that extends up to three feet below grade, and a 0.9 meter by 0.9 meter by 0.9 meter-deep sump in the northwest corner. The total surface area of the survey unit is 311 m^2 and the sump makes up approximately 5 m^2 of the total surface area.

In the structural basement survey units, the licensee used the in situ object counting system (ISOCS) technology for collecting systematic measurements to fulfill the scan coverage requirements of the FSS design, as well as the requirements for systematic, judgmental, and QC replicate measurements. In the WGTV basement, 22 systematic ISOCS measurements were collected to achieve 100% coverage. In total, 25 ISOCS measurements were collected, including the systematic, judgmental, and QC replicate measurements. The total SOF assigned to the WGTV basement survey unit is 0.0233, which equates to a dose of 0.5813 mrem/yr.

3.4.1.2 Survey Unit B1-010-001, LACBWR Reactor Building Basement

Survey Unit B1-010-001, the LACBWR reactor building basement, consisted of the reactor building floor and walls below grade (i.e., below the 636-foot elevation). The total surface area of the survey unit is 512 m^2.

In the reactor building basement, 45 systematic ISOCS measurements were collected in the survey unit to achieve 100% coverage. Six judgmental measurements were collected, and three replicate QC measurements were also acquired in reactor building basement survey locations #5, #16, and #18. The total SOF assigned to the reactor building basement, when factoring in the area-weighted SOF of the elevated judgmental ISOCS measurements, is 0.0006, which equates to a dose of 0.015 mrem/yr.

3.4.2 NRC Evaluation of the Backfilled Basement Survey Units

3.4.2.1 Number of ISOCS Measurements, Scanning, and Investigation Levels

The licensee used ISOCS technology to conduct FSS activities in the LACBWR backfilled basement survey units. The surface area covered by a single ISOCS measurement is large, and the field of view (FOV) of the measurement is substituted for the surface scanning that is typically performed using a handheld radiation detector. The majority of systematic ISOCS measurements that were taken in the LACBWR basement survey units were obtained at a standoff distance of three meters, which resulted in a FOV for each measurement of 28 m^2. Using this FOV, the license calculated the minimum number of ISOCS measurements required to fully cover the surface area of the LACBWR basement survey units and achieve 100% scan coverage for these Class 1 areas. 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 shows that 19 ISOCS measurements are required by the survey design for the reactor building basement and 11 ISOCS measurements are required for the WGTV basement.

The NRC staff notes that for Class 1 structures, MARSSIM guidance states that the maximum area of the survey unit should not exceed 100 m^2, but the size of these basement structures (roughly 300 m^2 and 500 m^2) exceeds that guidance. However, the MARSSIM guidance is related to an occupancy conceptual model for structures, which is not the same as the conceptual model for a backfilled basement. In addition, the licensee’s Class 1 backfilled basement survey unit sizes and number of systematic samples necessary when using ISOCS technology to fulfill the scan survey coverage were approved as a part of the LACBWR LTP.

The NRC safety evaluation that approved the LACBWR LTP (ML19008A079) stated the following with respect to the FSS survey unit grouping and classification for the basements:

> 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.

In addition to the systematic ISOCS measurements, the LACBWR backfilled basement surfaces underwent decommissioning support surveys as outlined in Section 5.4, "Decommissioning Support Surveys," of the LACBWR LTP; these surveys included RA surveys, RASS, and contamination verification surveys (CVS) in support of FSS development.

The NRC safety evaluation that approved the LACBWR LTP stated the following with respect to the surveys of the basements and the requirement to conduct a 100% areal scan:

> The NRC staff evaluated the use of ISOCS measurements to meet the guidance in the [NUREG-1700 standard review plan (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" (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% 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.

The NRC safety evaluation that approved the LACBWR LTP also stated the following about CVS when utilizing ISOCS technology, and how this type of survey helps to identify any area of elevated activity as a location for a judgmental ISOCS measurement during 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" (ML19007A043). A CVS will be performed within any structure that contains, or previously contained, radiological controlled areas. These surveys will be performed using handheld beta-gamma instrumentation as presented in Table 5-18, "Typical FSS Survey Instrumentation," 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% 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 OpDCGLs, and to identify any area of elevated activity that could potentially approach the OpDCGLs as a location for a judgmental ISOCS measurement during FSS.

In summary, the decommissioning support surveys, in conjunction with overlapping the ISOCS FOVs in the LACBWR backfilled basement survey units provide reasonable assurance that areas of elevated contamination are identified and remediated appropriately, which is also the purpose of the 100% areal surface scan for Class 1 survey units. A summary of the decommissioning support surveys, as well as verification of the minimum number of ISOCS measurements for each basement survey area are summarized below.

3.4.2.1.1 *Survey Unit B1-010-004, Waste Gas Tank Vault Basement*

The licensee conducted a CVS of the WGTV basement on May 19, 2017. The results of the CVS revealed dose rates of less than two millirem per hour in the survey unit. Loose surface contamination levels for alpha-emitting radionuclides were all found to be less than MDC. One elevated beta reading of 1,315 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) was discovered and secured with a paint fixative. The loose surface contamination survey conducted after the fixative was applied revealed 51 dpm/100 cm^2 for beta, which was below the 1,000 dpm/100 cm^2 limit established for the survey activities.

In addition, the associated FSS release record states that “prior to implementation of ISOCS measurements for WGTV FSS, 100% of the floor surface was scanned using a Ludlum Model 43-37 detector (a large-area gas proportional detector for alpha and beta surveys). This survey was performed to ensure that no small areas of elevated activity were present before ISOCS measurements were collected. The Alarm Set Point (ASP) for this survey was set at the Operational DCGL for basements ($OpDCGL_B$) for Co-60, converted to counts per minute, plus the average background from the survey unit. The maximum scan reading captured was 10,276 cpm. No alarms were produced during the performance of this survey.”

The FSS plan for the WGTV basement required a minimum of 22 systematic ISOCS measurements and the licensee took 22 systematic ISOCS measurements, which met the minimum requirement of the survey plan. The licensee also collected one judgmental ISOCS measurement over the sump area and two QC ISOCS measurements. Figure 31 shows the locations of the ISOCS measurements in the WGTV basement survey unit.

A rain event occurred after FSS of the WGTV basement but prior to backfill, where water and sediment were observed to enter the isolated and controlled basement of the survey area. The associated release record describes a surveillance survey that took place in order to assess the impacts of the rain event after implementation of the ISOCS measurements was concluded. The FSS release record states that “the survey was performed as a response to a change in the condition of the survey unit after a rain event caused the release of a concrete core hole plug. Water and sediment were also observed to enter the isolated and controlled basement, as it was still exposed post-FSS before being backfilled. The maximum scan reading captured during this surveillance survey was 14,383 cpm. No alarms were produced during the performance of this survey. The water and sediment intrusion from clean areas did not change the as-left radiological conditions of the survey unit and therefore, the FSS was deemed still valid."

As part of the supplemental information provided in support of the clarification teleconferences to discuss the LACBWR FSSR (ML22269A395), the licensee provided the Ludlum 2350-1 general purpose data logger download reports for the pre- and post-rain scan data from the WGTV basement. These reports show that the licensee performed scans of the survey unit after the rain event with both a Ludlum Model 44-10 beta/gamma radiation detector as well as with a Ludlum Model 43-37. The licensee also collected one sediment sample and one water sample from the sump in the WGTV survey unit as part of the surveillance after the rain event. The sediment sample contained Cs-137 at a concentration of 0.0156 pCi/g, which is significantly below the Cs-137 OpDCGL for soil of 17.31 pCi/g. The water sample contained a concentration of Cs-137 at 0.0396 pCi per millimeter, which is approximately 20% of the U.S. Environmental Protection Agency (EPA) drinking water standard for this radionuclide.

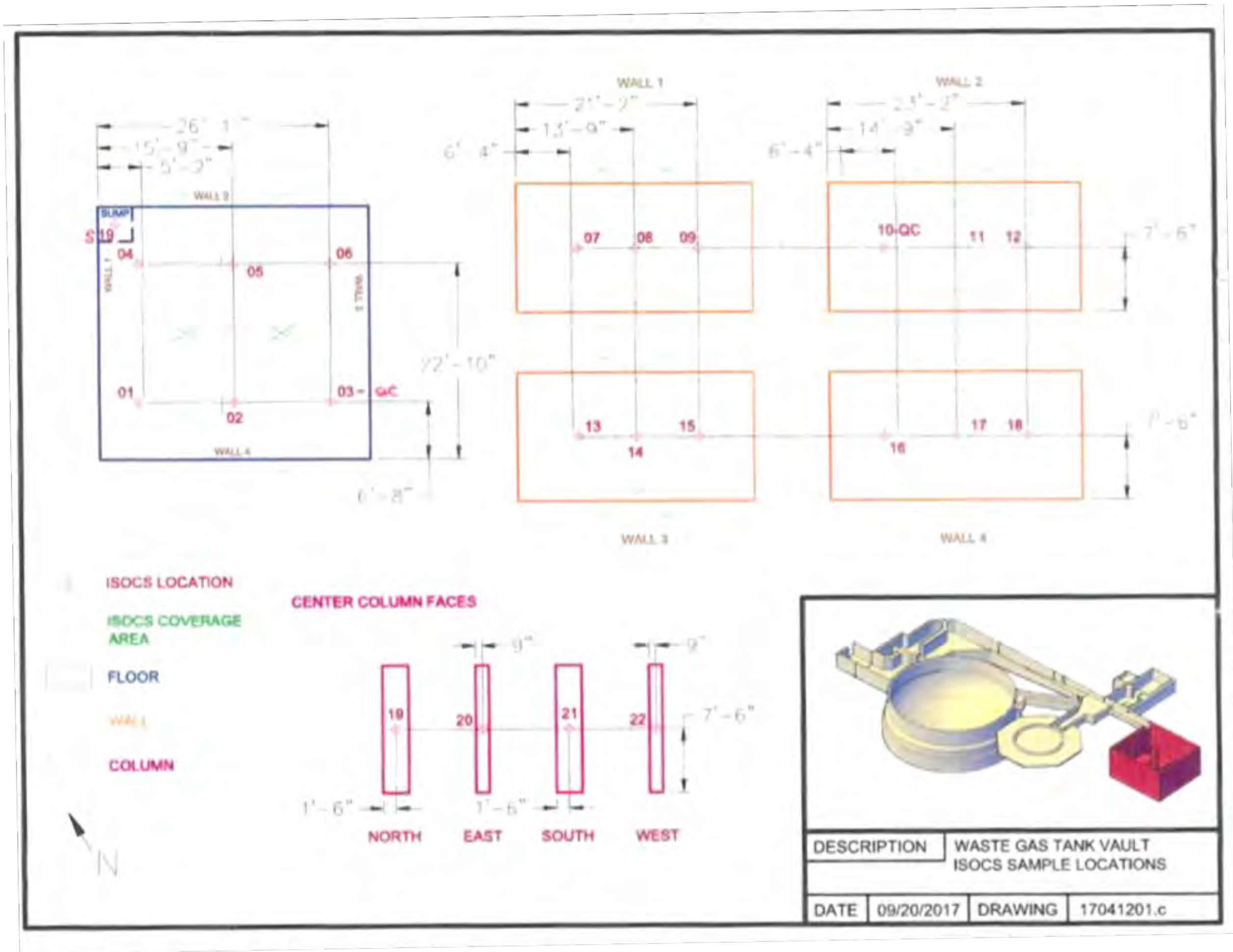


Figure 31. WGTV Basement ISOCS Systematic and Judgmental Sample Locations

Section 5.12, "Surveillance Following FSS," of the LACBWR LTP discusses surveillance following FSS and states that "in the event that isolation and control measures established for a given survey unit are compromised, evaluations will be performed and documented to confirm that no radioactive material was introduced into the area that would affect the results of the FSS." In this case, the licensee's subsequent scan and samples of the water and sediment in the WGTV sump constituted the evaluation of the survey unit after the isolation and control measures were compromised to document that no radioactive material was introduced to the area that would affect the results of the FSS. Given that the surveillance scan results were very similar to those prior to the rain event, and the low Cs-137 concentrations in the water and sediment samples, this evaluation is viewed as sufficient to indicate that radioactive material was not introduced into the WGTV basement area that would impact the FSS results.

3.4.2.1.2 *Survey Unit B1-010-001, LACBWR Reactor Building Basement*

In the LACBWR reactor building basement, an RA survey was performed to ensure that any individual ISOCS measurement would not exceed the $OpDCGL_B$ during FSS. The RA consisted of a beta-gamma and gamma-only scan over 100% of all accessible surfaces, as well as the collection of 30 loose surface contamination samples. Six concrete core samples were obtained at evenly distributed locations, and an additional five concrete core samples were obtained at areas of elevated activity identified during the scan survey. Only Cs-137 was detected at concentrations above MDC in two of the 11 concrete pucks analyzed, with a maximum of concentration of 47.7 pCi/g. The same concrete samples were sent offsite for analysis at GEL Laboratories, and yielded a maximum Cs-137 concentration result of 48.2 pCi/g. No further remediation was deemed necessary prior to FSS of the LACBWR reactor building basement survey unit based on the results of the RA survey.

The FSS plan for the LACBWR reactor building basement required a minimum of 43 systematic ISOCS measurements to achieve 100% areal coverage and the licensee took 45 systematic ISOCS measurements, which met the minimum requirement of the survey plan.

3.4.2.2 *Continuing Characterization and Verification of HTD Radionuclides*

The inaccessible or not readily accessible areas described in Section 5.3.3.4 of the LACBWR LTP include the WGTV interior structural surfaces and the underlying concrete in the LACBWR reactor building basement after liner removal. Therefore, the licensee performed continuing characterization of these areas as they became accessible.

3.4.2.2.1 *Survey Unit B1-010-004, Waste Gas Tank Vault Basement*

For continuing characterization of the WGTV soil underlying the concrete floor, four subsurface soil samples were collected from the building perimeter soil and four subsurface soil samples were collected from beneath the concrete core samples. The maximum radionuclide concentration result from the soil samples was 0.117 pCi/g of Cs-137.

For continuing characterization of the WGTV concrete, five concrete core samples were collected from the floor, two from the sump area, and one on the lower wall in the survey unit. The cores were three inches in diameter and six inches deep. The top half-inch pucks from each concrete sample were sent offsite to GEL Laboratories for gamma spectroscopy and HTD analysis. Cs-137 was positively identified in seven of the eight concrete core samples. Co-60 was positively identified in two of the eight concrete core samples. Other radionuclides identified at concentrations greater than their respective MDCs include Am-241, Pu-238, Pu-239/240, Pu-241, Tc-99, and Ni-63. The analysis results from the concrete cores taken from the WGTV basement as part of continuing characterization activities are reproduced in Table 21 below.

Table 21. WGTV Continuing Characterization Concrete Core Analysis Summary – Offsite

Radionuclide	B1-010-04 A-CJFC-009-CV (pCi/g)	B1-010-04 A-CJFC-010-CV (pCi/g)	B1-010-04 A-CJFC-011-CV (pCi/g)	B1-010-04 A-CJFC-012-CV (pCi/g)	B1-010-04 A-CJFC-013-CV (pCi/g)	B1-010-04 A-CJFC-014-CV (pCi/g)	B1-010-04 A-CJWC-015-CV (pCi/g)	B1-010-04 A-CJFC-016-CV (pCi/g)
Am-241	-1.50E-02	2.69E-02	4.40E-02	3.12E-02	**5.05E-01**	**6.83E-01**	5.13E-03	**5.20E-02**
Am-243	-4.15E-03	3.87E-03	1.57E-02	4.43E-02	-1.06E-02	1.27E-02	4.36E-03	5.06E-04
Cm-243/244	3.35E-03	7.57E-03	1.93E-03	4.92E-04	-2.57E-03	1.30E-02	5.10E-03	-3.40E-03
Np-237	1.02E-01	-1.19E-02	3.15E-02	-4.88E-02	-6.24E-02	-9.56E-03	1.83E-02	8.66E-03
Pu-238	-3.53E-03	1.64E-02	6.04E-03	-8.73E-03	**1.73E-01**	**2.33E-01**	2.16E-03	1.79E-02
Pu-239/240	-3.52E-03	-1.07E-02	3.62E-03	-1.02E-02	**8.46E-02**	**2.70E-01**	**2.07E-02**	-1.58E-03
Pu-241	-2.05E-01	9.58E-01	2.11E-01	-1.92E+00	4.40E+00	**5.59E+00**	4.22E-01	6.92E-01
Ni-59	-2.20E-01	-2.48E-01	1.01E+00	-1.35E-01	-1.81E+00	2.53E-01	-2.99E-01	5.11E-01
Cs-137	**5.32E+00**	**9.57E+00**	**6.02E+00**	**4.66E+00**	**2.54E+02**	**1.37E+02**	-7.21E-03	**6.64E+00**
Co-60	2.50E-02	6.69E-02	0.00E+00	1.13E-01	**2.66E-01**	**2.46E-01**	-4.03E-02	6.93E-02
Eu-152	8.62E-02	-3.75E-02	5.35E-02	8.38E-03	-7.97E-01	3.33E-01	1.63E-02	1.08E-01
Eu-154	-1.46E-01	-9.50E-02	-5.66E-02	-2.99E-02	-3.84E-02	-1.01E-01	-6.24E-02	1.12E-01
Eu-155	6.72E-02	1.65E-01	7.12E-02	8.03E-02	8.70E-02	7.52E-02	1.70E-01	-8.62E-02
Nb-94	-2.81E-02	3.72E-02	4.28E-02	-8.53E-04	3.00E-03	-3.79E-03	3.67E-02	1.01E-02
Sr-90	1.02E-01	2.28E-01	1.06E-01	-2.88E-02	1.28E-01	1.09E-01	-2.17E-01	-4.27E-02
H-3	3.57E+00	4.83E+00	4.29E+00	2.01E+00	1.82E+00	5.15E+00	3.73E+00	3.91E+00
C-14	-7.04E-01	-2.34E-01	-6.72E-01	9.23E-01	-1.84E+00	-1.42E-02	1.10E+00	5.25E-01
Tc-99	6.59E-02	-5.60E-01	-4.18E-01	-6.56E-01	-4.98E-01	**2.86E+00**	-5.31E-01	-5.50E-02
Fe-55	-2.95E+00	-3.71E+00	2.68E+00	-5.75E+00	-5.77E+00	-4.84E+00	1.97E+00	-4.20E+00
Ni-63	9.15E-01	**6.41E+00**	2.08E+00	2.70E+00	**1.00E+01**	**1.07E+01**	1.43E+00	1.33E+00

Note: Bold values indicate activity above MDC

The NRC staff notes that the two continuing characterization concrete cores with the highest activity (Sample B1-010-04 A-CJFC-013-CV and Sample B1-010-04 A-CJFC-014-CV) in this survey unit were collected from the WGTV sump area. The maximum calculated IC dose for the WGTV basement continuing characterization samples was 0.5042 mrem/yr for the concrete core samples, and 0.1437 mrem/yr for the soil samples, which is below the 2.5 mrem/yr IC dose limit assigned for DCGL adjustment in the LACBWR LTP.

The licensee calculated the 0.5042 mrem/yr concrete core IC dose associated with WGTV core Sample CJFC-009-CV. The licensee calculated the dose by setting negative activity results to zero and positive results, whether above the minimum detectable activity (MDA) or not, were divided by the associated Base Case DCGLs. The Base Case DCGLs for soil are provided in Table 6-6, "LACBWR Soil DCGLs for Initial Suite Radionuclides," and the Base Case DCGLs for concrete are provided in Table 6-16, "Summed Basement DCGL ($DCGL_B$) for Initial Suite Radionuclides," of Chapter 6, "Compliance with the Radiological Criteria for License Termination," of the LACBWR LTP.

The radionuclide concentration results in pCi/g for the WGTV basement concrete cores were first converted to pCi per square meter (pCi/m^2) to be able to compare to the Base Case DCGLs. The calculation for converting a pCi/g analytical value to the units of pCi/m^2 was done per Equation 12 below. This conversion assumes the depth of contamination is 0.5 inch (1.27 cm) and the density of the concrete is 2.35 grams per cubic centimeter (g/cm^3). The fractions of the DCGL for the individual radionuclides were multiplied by 25 to obtain a dose in mrem/yr for that radioisotope. The IC radionuclide dose contributions (all doses except for the ROCs: Co-60, Sr-90, Cs-137, Eu-152 and Eu-154 for LACBWR) were summed to obtain a total value in mrem/yr for the IC dose contribution from the WGTV basement.

Equation 12

$$\mathrm{x}\frac{\mathrm{pCi}}{\mathrm{g}} * 1.27\ \mathrm{cm} * 1\mathrm{m}^2 * 1\mathrm{x}10^4\frac{\mathrm{cm}^2}{\mathrm{m}^2} * 2.35\frac{\mathrm{g}}{\mathrm{cm}^3} = y\frac{\mathrm{pCi}}{\mathrm{m2}}$$

The NRC staff notes that the Sample CJFC-009-CV concrete core did not contain the maximum concentrations for the ROCs or maximum number of results above MDA for the insignificant radionuclides. However, because the licensee's method for IC dose calculation included all the positive activity values, even those positive values that were below MDA, Sample CJFC-009-CV yielded the maximum IC dose due the Neptunium-237 (Np-237) value even though the Np-237 result was less than the MDA. The NRC staff applied the same method to calculate the IC dose associated with concrete core Sample B1-010-04 A-CJFC-014-CV, which contained the most insignificant radionuclides detected above background. The resulting IC dose for concrete core Sample B1-010-04 A-CJFC-014-CV is 0.0632 mrem/yr, which is significantly less than the 0.5042 mrem/yr concrete core IC dose associated with WGTV core Sample CJFC-009-CV.

Because the concrete core containing the maximum concentration of Cs-137 was from the WGTV sump, which was a 5 m^2 surface area of the survey unit, the NRC staff independently estimated an intruder dose from this area using the same conceptual model that was applied in deriving the BFM Insitu Drilling Spoils DCGLs (Table 13 from ES TSD RS-TD-313196-004, "LACBWR Soil DCGL, Basement Concrete DCGL, and Buried Pipe DCGL," Revision 4 (ML19007A042)). In the drilling spoils scenario, an intruder is assumed to drill a well down to the concrete floor of the WGTV basement. In the LACBWR LTP, the volume of drilling spoils brought to the surface is calculated based on the borehole diameter and depth of drilling, which is conservatively assumed to be the minimum fill depth of three feet for all basements to minimize the mixing volume. The concrete and fill are uniformly mixed and spread over a circular area on the ground surface to a depth of 0.15 m, which results in an area for the drilling spoils of 0.457 m^2. The Cs-137 concentration in the concrete core with the highest value of Cs-137 (Sample CJFC-013-CV) is diluted according to the assumptions for the drilling spoils scenario (see Table 22) and compared to the approved LACBWR Soil DCGLs using the area factor for an area of 0.457 m^2. Under these assumptions, the dose to an intruder drilling directly into the WGTV sump is calculated to be 0.155 mrem/yr.

Table 22. Basement Fill Model (BFM) Insitu - Drilling Spoils Scenario

Assumptions and Unit Conversion Factors

Diameter Borehole	12.00	inch
Minimum Depth to Backfilled Concrete	91.44	cm
Depth of Contamination Within Concrete	2.54	cm
Unit Conversion	1.00E+06	cm^3/m^3
Fill Density	1.76	g/cm^3
Unit Conversion	1.00E-09	mCi/pCi
Diameter Borehole	30.48	cm
Area Borehole	729.66	cm^2
Total Borehole Depth Including Concrete	93.98	cm
Unit Concentration	1.00	pCi/g
Unit Area Factor	1.00	unitless
Unit Conversion	1.00E+04	cm^2/m^2
Unit Conversion	0.0929	m^2 per ft^2
Unit Conversion	2.54	cm per inch
Unit Conversion	30.48	cm per ft
Concrete Cs-137 Concentration	254	pCi/g
Concrete Density	2.35	g/cm^3
Cs-137 Dose to Source Ratio for an Area Factor of 0.457 m^2	1.695E-02	mrem/yr per pCi/g

Calculations

Total Spoils Volume	6.86E+04	cm^3
Total Spoils Volume	6.86E-02	m^3
Total Spread Area	4.57E-01	m^2
Total Drilling Spoils Mass	1.21E+05	g
Volume of Concrete in Borehole	1.85E+03	cm^3
Total pCi Cs-137 in Concrete	1.11E+06	pCi
Total Concrete Mass	4.36E+03	g
Concentration in Spoils	9.17E+00	pCi/g
Mass Spoils/Mass Concrete	2.77E+01	unitless
mrem/yr	1.55E-01	mrem/yr

In the LACBWR LTP, the licensee also analyzed an excavation scenario where a portion of the concrete from the remaining WGTV basement is excavated and spread on the surface at some time after license termination. After removing the concrete, it is presumed to be segregated, the rebar removed, and size reduced to be used as onsite fill. In order to independently assess and bound the potential impact of the residual radioactivity remaining in the WGTV sump in this scenario, the NRC staff performed a conservative calculation using the parameters provided by the licensee. Specifically, the concentration in the top 0.5 inch of the concrete puck from the concrete core with the maximum measured radioactivity was conservatively assumed to be the concentration of the entire volume of concrete in the sump. The WGTV sump was 3.25 feet by 3.25 feet wide by three feet deep, with one-foot-thick walls and floor. The total volume of concrete associated with the WGTV sump (74.87 cubic feet or approximately two cubic meters) is provided in Table 1, "Waste Gas Tank Vault Calculated Surface Areas, Concrete Volumes and Void Spaces," of ES TSD RS-TD-313196-002, "LACBWR End State Basement Concrete Surface Areas, Volumes, and Void Spaces" (ML23023A146). The sump is pictured in the bottom left corner of Figure 32, which shows a vertical side view of the WGTV basement.

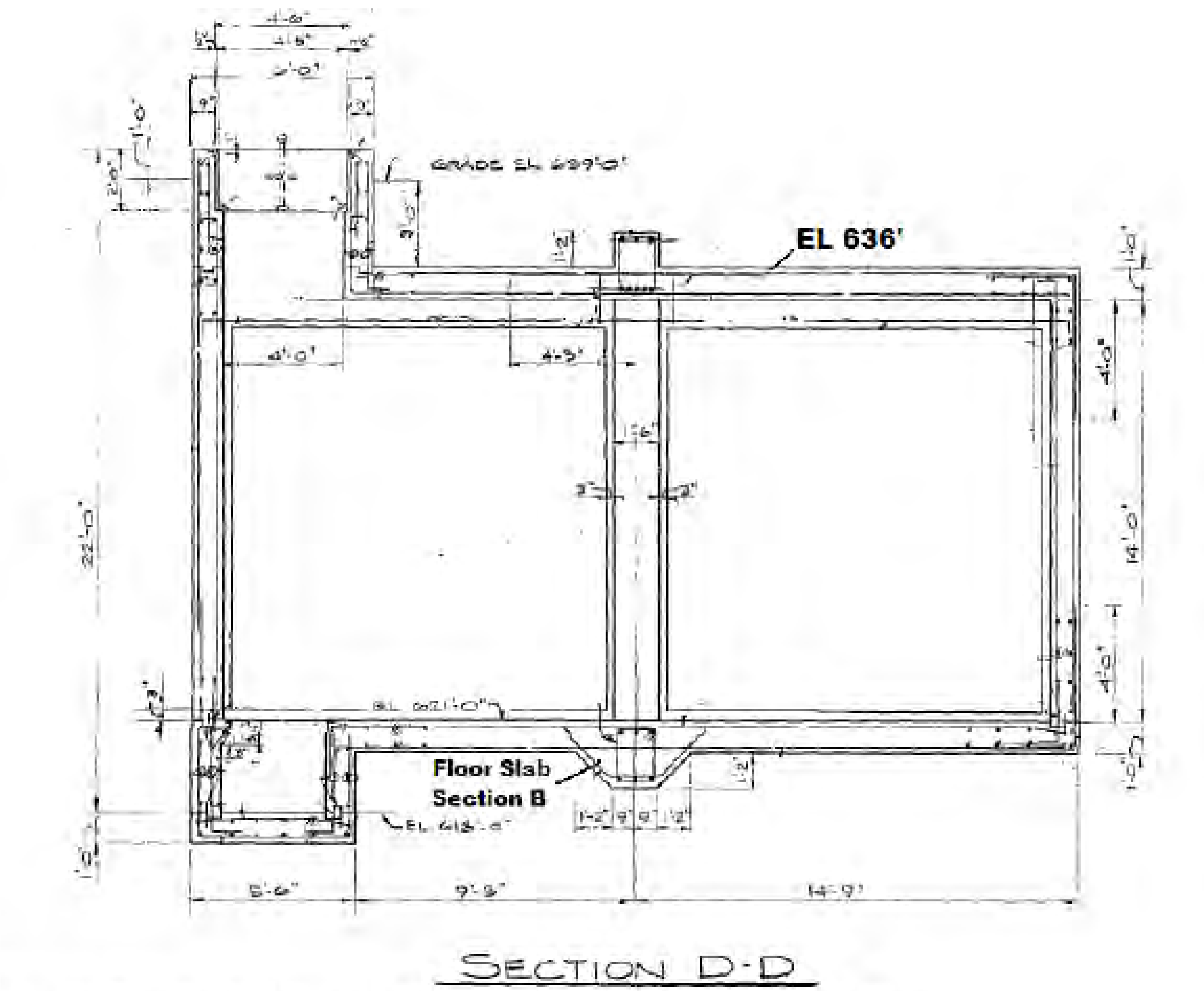


Figure 2 - Waste Gas Tank Vault Side View from 29' 6" Side from Drawing 41-503435

Figure 32. WGTV Side View (Reproduced from RS-TD-313196-002, Revision 0)

The bottom of the WGTV sump is at the 618-foot elevation and the top of the sump is at the 621-foot elevation, while the grade (surface) level for this part of the LACBWR site is at 639 feet. Realistically, if the volume of concrete from the WGTV sump was brought to the surface, it would be mixed with the fill material that is above it from the 621-foot elevation to the 639-foot elevation, which would dilute the sump material considerably. To bound this scenario using a simplified calculation, the NRC staff calculated what the dose would be without taking credit for this dilution by assuming that the entire volume of concrete from the WGTV sump, all of it contaminated with the maximum measured radioactivity from the area, is brought to the surface undiluted and spread to a thickness of one meter, which results in an area of approximately 2 m^2. The dose to source ratios (DSRs) taken from the RESRAD files used to develop the area factors (see ES TSD RS-TD-313196-004) associated with 2 m^2 are also assumed for the calculation, and the NRC staff verified that the resulting dose from the WGTV sump concrete in this bounding scenario is under 25 mrem/yr.

Specifically, the Cs-137 DSR associated with an area of 2 m^2, taken from ES TSD RS-TD-313196-004, is 0.07931 mrem/yr per pCi/g. Multiplying this DSR by 254 pCi/g, which was the maximum offsite lab result for the concentration of Cs-137 in the WGTV sump concrete, yields roughly 20 mrem/yr. The other radionuclides present in the WGTV sump contribute insignificant dose amounts. It is important to note that this simplified conservative analysis of the potential dose effects of the residual radioactivity in the WGTV sump concrete, should it be used as onsite fill, does not take credit for the additional mixing that would occur as the concrete is brought up to the surface with the fill material that exists between the ground surface (at the 639-foot elevation) and the sump (at the 621-foot to 618-foot elevation). This mixing would likely dilute the concrete by an additional factor of between ten and twenty. This simplified analysis also conservatively assumes that the entire volume of concrete in the WGTV sump is at the maximum concentration of Cs-137.

Additionally, the NRC staff evaluated the ISOCS results for the WGTV basement to determine whether they reflect the expectations in the LACBWR LTP and associated FSS release record given the radionuclide concentrations of the cores collected during continuing characterization. The highest ISOCS result, 1.32E+7 pCi/m^2, was obtained from the WGTV sump, which also contained the highest Cs-137 concentration of 148 pCi/g according to the onsite gamma spectroscopy results. When applying Equation 12 above, the value of 148 pCi/g is converted to 4.42E+6 pCi/m^2. The value of 254 pCi/g, which was the maximum offsite lab result for Cs-137, when converted to pCi/m^2 is 7.58E+6 pCi/m^2. Both of these values are smaller than the maximum ISOCS result of 1.32E+7 pCi/m^2, indicating that the contamination in the WGTV sump was adequately captured by the ISOCS result. Given that the calculated dose from the WGTV sump is less than 25 mrem/yr under these conservative assumptions, and since the sump represents a relatively very small portion of the overall LACBWR site, the NRC staff has reasonable assurance that the concentrations of residual radioactivity remaining in the sump will not exceed the compliance criteria for unrestricted use of the site.

3.4.2.2.2 *Survey Unit B1-010-001, LACBWR Reactor Building Basement*

The FSS release record for Survey Unit B1-010-001 describes the underlying concrete in the LACBWR reactor building basement after liner removal and discusses how "the top half-inch pucks from concrete core samples B1-010-001-CJFC-C04-CV, B1-010-001-CJFC-C09-CV, and B1-010-001-CJFC-C11-CV were sent offsite to GEL Laboratories for gamma spectroscopy and HTD analysis of the full suite of ROC. Cs-137 was positively identified in two of the three core samples. One core contained Cs-137 at a concentration of 48 pCi/g. No other ROC was identified in the core samples sent offsite." As a result of the FSSR RAIs (ML20195A272), the associated FSS release record was revised to include a discussion and data summary of the soil continuing characterization for the LACBWR reactor building basement, specifically the GeoProbe samples collected adjacent to and beneath the reactor building.

The revised FSS release record states:

> An additional RA was conducted to evaluate the soil adjacent to and beneath the reactor building. Vertical soil borings were performed at eight locations around the perimeter of the reactor building, and diagonal soil borings were performed at four locations. At each location, two soil samples were collected. In total, 26 soils samples were collected (two at each location plus two QC samples). Cs-137 was detected at concentrations above MDC in four of the samples, with a maximum concentration of 0.34 pCi/g. No other ROC were positively identified. Four of the soil boring samples were sent offsite to GEL Laboratories for analysis of the full suite of radionuclides. Only Cs-137 was positively identified in the analyses of the vertical borings.

The licensee assessed the results of continuing characterization in the LACBWR reactor building basement. The maximum calculated IC dose was 0.0374 mrem/yr for the concrete core samples and 0.0573 mrem/yr for the soil samples, which are below the 2.5 mrem/yr IC dose limit assigned for DCGL adjustment in the LACBWR LTP. Based on the above considerations, given that the maximum calculated IC dose was less than 2.5 mrem/yr and that Sr-90 was not detected in the continuing characterization samples, the characterization of the IC dose contribution and Sr-90 surrogate ratio for Survey Unit B1-010-001 is adequate.

3.4.2.3 Elevated Areas of Contamination

In the WGTV basement survey unit, one judgmental ISOCS measurement was collected to assess the WGTV sump, which resulted in an SOF of 14.1652 when compared to the OpDCGL, and an SOF of 0.9903 when compared to the Base Case $DCGL_B$. The licensee calculated an area-weighted SOF for the elevated measurement in the WGTV sump and added this to the average systematic measurement SOF, which was then used to calculate the overall dose assigned to the basement survey unit (see Equation 5-5 in the LACBWR LTP).

The ISOCS geometry assumed a 0.5-inch (1.27 cm) depth of contamination in the WGTV basement concrete. The NRC staff notes that the gamma spectroscopy analysis of the concrete cores from the WGTV shows higher positive Cs-137 concentrations in the top as compared to the bottom portions of the 0.5-inch-thick puck. The gamma spectroscopy reading from the bottom of the concrete puck is likely capturing the contamination that exists on the top of the puck, but the reading is attenuated through the puck itself. This indicates that the depth of contamination was less than 0.5 inches for several of the areas in the WGTV basement, and that the ISOCS geometry was conservative. In order to assess the distribution of the activity in the WGTV basement, the licensee simulated the activity using MicroShield for several geometrical representations of activity distribution. The results of this analysis were provided as part of the supplemental information from the clarification teleconferences to discuss the LACBWR FSSR (ML22269A395), and support the assumption that the contamination layer is substantially smaller than the 0.5 inches assumed in the ISOCS geometry.

Chapter 4, "Remediation Plan," of the LACBWR LTP determined that remediation beyond that required to meet the unrestricted release criteria is unnecessary, and that the remaining residual radioactivity in the WGTV basement structure was ALARA. Given that the ISOCS measurement from the WGTV sump area was very close to the Base Case SOF, the NRC staff independently analyzed the dose potential from the sump area in a bounding calculation using the radionuclide concentrations from the concrete cores collected during continuing characterization of the WGTV sump, as described in Section 3.5.2.2.1 of this safety evaluation.

In the LACBWR reactor building basement survey unit, two judgmental ISOCS measurements were collected that exceeded the OpDCGL, at a maximum SOF of 1.0737. The mean SOF of the judgmental ISOCS measurements when compared to the OpDCGL is 0.5388, and the mean SOF of the judgmental ISOCS measurements when compared to the Base Case $DCGL_B$ is 0.03779. The licensee calculated an area-weighted SOF for the two elevated measurements in the LACBWR reactor building basement and added this to the average systematic measurement SOF, which was then used to calculate the overall dose assigned to the basement survey unit (see Equation 5-5 in the LACBWR LTP).

3.4.2.4 Quality Control Measurements

For the WGTV basement survey unit, two replicate ISOCS QC measurements were taken during the FSS of this basement structure. The FSS release record describes how, since both pairs of standard and comparison QC measurements contained insignificant or no detectable radioactivity, no further action was deemed necessary by the licensee. Specifically, the release record contains information in Table 7-4, “Summary of Replicate ISOCS Measurements for QC,” Section 8, “Quality Control,” and Attachment 4, “Quality Control Assessment,” on two replicate ISOCS measurements acquired during FSS of the WGTV basement structure. According to Attachment 4 and Section 8 of the FSS release record, both pairs of measurements did not identify any radionuclides in the QC samples. Therefore, the licensee stated that the typical QA acceptance method could not be utilized for this situation, and since the detectable radioactivity levels were well below the OpDCGL for basements, no further action was deemed necessary.

Based on a review of the ISOCS survey data in Attachment 6, “Measurement Analytical Reports,” of the FSS release record for the WGTV basement, and as summarized in Table 23 below, although Cs-137 was not identified as a radionuclide in the FSS reports, the reported activity concentrations in the original and QC samples are above the reported MDAs in the associated MDA Report for the WGTV basement survey unit. This discrepancy is an artifact of the way the ISOCS survey data is presented. However, the NRC staff acknowledges that Cs-137 was not identified as a radionuclide in the FSS analytical reports, that the results were very close to the reported MDAs, and that in the case of the WGTV basement survey unit the Cs-137 replicate ISOCS measurement results were also within 20% of the systematic result.

Table 23. Cs-137 Results and MDCs for the WGTV Quality Control Measurements

Comparison Sample ID	Comparison Sample Result	Comparison Sample MDC	Systematic Sample ID	Systematic Sample Result	Systematic Sample MDC
B1-010-004-QSFC-03-GM	2.13E+05 pCi/m^2	4.81E+04 pCi/m^2	WGTV-03	1.93E+05 pCi/m^2	4.72E+04 pCi/m^2
B1-010-004-QSWC-10-GM	2.83E+04 pCi/m^2	2.20E+04 pCi/m^2	WGTV-10	2.62E+04 pCi/m^2	2.38E+04 pCi/m^2

For the LACBWR reactor building basement survey unit, three replicate ISOCS QC measurements were taken during FSS of this basement structure. The licensee evaluated these measurements against the QA acceptance method using criteria specified in a previous revision to NRC Inspection Procedure No. 84750, "Radioactive Waste Treatment, and Effluent and Environmental Monitoring" (ML19270D639). For all three pairs of standard and comparison measurements, there was acceptable QC agreement, but K-40 was substituted for Cs-137 in all three cases. For two of the comparisons K-40 was substituted because Cs-137 was not identified in either the standard or comparison QC measurement. For the other comparison location, K-40 was substituted for Cs-137 because a low Cs-137 activity was identified in the replicate measurement and no ROCs were identified in the standard measurement.

In general, and as previously discussed in Section 3.3.2.4 of this safety evaluation, the NRC staff notes that K-40 should not be considered a substitute for QC assessment of Cs-137. The predominant gamma energy associated with Cs-137 is 662 kiloelectronvolt (KeV), and the gamma energy for K-40 is 1,460 KeV. These gamma energies are too far apart for K-40 to be a suitable substitute for Cs-137 during a QC assessment. However, K-40 may be acceptable for use as part of a QC assessment for Cs-137 in situations where only low, slightly above MDC Cs-137 levels are present in the standard or comparison samples. Specifically, if Cs-137 was detected in both the standard and comparison sample, but only slightly above the MDC, there would not be a high level of confidence in those QC results. In these cases, K-40 was used by the licensee for the QC assessment of Cs-137 because it is easily detectable and identifiable in most environmental media and can be used to increase the confidence level in the QC results. Based on this limited use of the K-40 comparison in the QC sample analyses for the reactor building basement survey unit, the NRC staff finds this QC assessment approach acceptable.

In addition, the NRC staff notes that the licensee's instrument DQOs included a verification of the ability of the survey instrument to detect the radiation(s) of interest relative to the OpDCGL in the LACBWR Class 1 backfilled basement survey units. The minimum acceptable MDC for measurements obtained using field instruments was 50% of the applicable OpDCGL. Response checks were required prior to issuance and after use for the ISOCS units, and control and accountability of the ISOCS units was required to assure data quality.

Based on the above considerations, the NRC staff finds that the licensee's methodology for assessing QC measurement samples in the LACBWR Class 1 backfilled basement survey units, as demonstrated in the FSS release records for these survey units, is consistent with the associated discussion in the approved LACBWR LTP. Therefore, the QC approach for the WGTV basement and LACBWR reactor building basement survey units is acceptable.

3.4.2.5 Confirmatory Surveys

ORISE performed a confirmatory survey of the LACBWR reactor building basement bowl in April 2019 (ML20296A513). The ORISE confirmatory survey report states:

> All individual confirmatory measurements, by both in situ measurements and volumetric samples, are well below the OpDCGL and, therefore, are also below the Base Case DCGL. Based on the overlap of confidence intervals and relative mean SOF magnitudes between the confirmatory and FSS data for the in situ gamma spectrometry measurements, ORISE did not identify issues that would preclude the use of gamma-emitting ROC FSS data for demonstrating compliance with release criteria. Sr-90 was identified above its MDC in the judgmental volumetric concrete core at a depth of 0 to 1.27 cm, but the total contribution of Sr-90 to the total SOF for the survey unit is negligible. Additional analyses for

Ni-63 and H-3 were performed, at the request of NRC, on the concrete cores and only Ni-63 was detected with a max concentration of 2.40 pCi/g.

3.4.2.6 Conclusion for Backfilled Basement Survey Units

The NRC's dose criteria for unrestricted site release are stated in 10 CFR 20.1402. For the reasons discussed in the NRC evaluation of the two LACBWR Class 1 backfilled basement survey units, the NRC staff has reasonable assurance that the FSS release records for these survey units demonstrate that the residual radioactivity in the associated survey units complies with the unrestricted release criteria. Specifically, the maximum Base Case SOF for all Class 1 backfilled basement survey units in the FSS release records was from Survey Unit B1-010-004 and yielded a result of 0.0233, which corresponds to a dose of 0.5813 mrem/yr. Furthermore, the assumptions regarding insignificant radionuclides and the HTD radionuclides in the LTP were upheld by survey results. Given these considerations, the NRC staff concludes that the release of the LACBWR Class 1 backfilled basement survey units will have no adverse impact on the ability of the site to meet the 10 CFR Part 20, Subpart E criteria for unrestricted release.

3.5 Class 1 Open Land Survey Areas

3.5.1 Description of the Class 1 Open Land Survey Units

The LACBWR site consists of seven Class 1 open land survey units, as summarized below.

Table 24. Class 1 Open Land Area Survey Units

Survey Unit	Type	Survey Unit Description	Phase	Class
L1-010-101	Open Land	LACBWR Reactor Building, WTB, WGTV, and Ventilation Stack Grounds	3	1
L1-010-102	Open Land	Turbine Building, Turbine Office Building, and 1B Diesel Generator Building Grounds	3	1
L1-010-103	Open Land	LSA Building, Maintenance, and Eat Shack Grounds	3	1
L1-010-104	Open Land	North LSE Grounds	3	1
L1-010-105	Open Land	North Interim Debris Storage Area	3	1
L1-010-106	Open Land	North Loading Area	3	1
L1-010-107	Open Land	Outside East LSE Area	3	1

3.5.1.1 Survey Unit L1-010-101, LACBWR Reactor Building, WTB, WGTV, and Ventilation Stack Grounds

Survey Unit L1-010-101 is an impacted Class 1 open land survey unit, which consists of open land with a surface area of 1,992 m^2. For Survey Unit L1-010-101, 100% of the total surface area was selected for surface soil scans, which is consistent with the MARSSIM Class 1 guidance that specifies 100% coverage for surface soil scans. The survey plan specified a total of 14 systematic soil samples and one judgmental soil sample be taken in the survey unit. The NRC staff verified that 14 systematic and three judgmental soil samples were taken in the survey unit. In addition, the LACBWR LTP specified that one HTD radionuclide and one QC soil sample be taken in the survey unit. The NRC staff verified that two HTD and three QC soil samples were taken in Survey Unit L1-010-101.

The licensee stated that the maximum SOF for the applicable ROCs by direct measurement or inference when applying the respective OpDCGLs for soil is 0.0620 in Survey Unit L1-010-101. The mean SOF when applying the respective Base Case DCGLs for soil is 0.0110 in Survey Unit L1-010-101. This SOF results in a dose for this survey unit of 0.2751 mrem/yr.

3.5.1.2 Survey Unit L1-010-102, Turbine Building, Turbine Office Building, and 1B Diesel Generator Building Grounds

Survey Unit L1-010-102 is an impacted Class 1 open land survey unit, which consists of open land with a surface area of 2,315 m^2. For Survey Unit L1-010-102, 100% of the total surface area was selected for surface soil scans, which is consistent with the MARSSIM Class 1 guidance that specifies 100% coverage for surface soil scans. The survey plan specified a total of 14 systematic soil samples and one judgmental soil sample be taken in the survey unit. The NRC staff verified that 14 systematic and 10 judgmental soil samples (eight for continuing characterization) were taken in the survey unit. In addition, the LACBWR LTP specified that one HTD radionuclide and one QC soil sample be taken in the survey unit. The NRC staff verified that eight HTD (seven for continuing characterization) and two QC soil samples were taken in Survey Unit L1-010-102.

The licensee stated that the maximum SOF for the applicable ROCs by direct measurement or inference when applying the respective OpDCGLs for soil is 0.0552 for Survey Unit L1-010-102. The mean SOF when applying the respective Base Case DCGLs for soil is 0.0125 in Survey Unit L1-010-102. This SOF results in a dose for this survey unit of 0.3115 mrem/yr.

3.5.1.3 Survey Unit L1-010-103, LSA Building, Maintenance, and Eat Shack Grounds

Survey Unit L1-010-103 in an impacted Class 1 open land survey unit, which consists of open land with a surface area of 1,749 m^2. For Survey Unit L1-010-103, 100% of the total surface area was selected for surface soil scans, which is consistent with the MARSSIM Class 1 guidance that specifies 100% coverage for surface soil scans. The survey plan specified a total of 14 systematic soil samples and one judgmental soil sample be taken in the survey unit. The NRC staff verified that 14 systematic and two judgmental soil samples were taken in the survey unit. In addition, the LACBWR LTP specified that one HTD radionuclide and one QC soil sample be taken in the survey unit. The NRC staff verified that two HTD and two QC soil samples were taken in Survey Unit L1-010-103.

The licensee stated that the maximum SOF for the applicable ROCs by direct measurement or inference when applying the respective OpDCGLs for soil is 0.0679 in Survey Unit L1-010-103. The mean SOF when applying the respective Base Case DCGLs for soil is 0.014 in Survey Unit L1-010-103. This SOF results in a dose for this survey unit of 0.3393 mrem/yr.

3.5.1.4 Survey Unit L2-011-104, North LSE Grounds

Survey Unit L1-010-104 is an impacted Class 1 open land survey unit, which consists of open land with a surface area of 2,387 m^2. For Survey Unit L1-010-104, 100% of the total surface area was selected for surface soil scans, which is consistent with the MARSSIM Class 1 guidance that specifies 100% coverage for surface soil scans. The survey plan specified a total of 14 systematic soil samples and one judgmental soil sample be taken in the survey unit. The NRC staff verified that 14 systematic and four judgmental soil samples were taken in the survey unit. In addition, the LACBWR LTP specified that one HTD radionuclide and one QC soil sample be taken in the survey unit. The NRC staff verified that two HTD and two QC soil samples were taken in Survey Unit L1-010-104.

The licensee stated that the maximum SOF for the applicable ROCs by direct measurement or inference when applying the respective OpDCGLs for soil is 0.0534 in Survey Unit L1-010-104. The mean SOF when applying the respective Base Case DCGLs for soil is 0.011 in Survey Unit L1-010-104. This SOF results in a dose for this survey unit of 0.2624 mrem/yr.

3.5.1.5 Survey Unit L1-010-105, North Interim Debris Storage Area

Survey Unit L1-010-105 is an impacted Class 1 open land survey unit, which consists of open land with a surface area of 1,974 m^2. For Survey Unit L1-010-105, 100% of the total surface area was selected for surface soil scans which is consistent with the MARSSIM Class 1 guidance that specifies 100% coverage for surface soil scans. The survey plan specified a total of 14 systematic soil samples and one judgmental soil sample be taken in the survey unit. The NRC staff verified that 14 systematic and two judgmental samples were taken in the survey unit. In addition, the LACBWR LTP specified that one HTD radionuclide and one QC soil sample be taken in the survey unit. The NRC staff verified that two HTD and two QC soil samples were taken in Survey Unit L1-010-105.

The licensee stated that the maximum SOF for the applicable ROCs by direct measurement or inference when applying the respective OpDCGLs for soil is 0.051 in Survey Unit L1-010-105. The mean SOF when applying the respective Base Case DCGLs for soil is 0.0104 in Survey Unit L1-010-105. This SOF results in a dose for this survey unit of 0.2609 mrem/yr.

3.5.1.6 Survey Unit L1-010-106, North Loading Area

Survey Unit L1-010-106 is an impacted Class 1 open land survey unit, which consists of open land with a surface area of 1,936 m^2. For Survey Unit L1-010-107, 100% of the total surface area was selected for surface soil scans, which is consistent with the MARSSIM Class 1 guidance that specifies 100% coverage for surface soil scans. The survey plan specified a total of 14 systematic soil samples and one judgmental soil sample be taken in the survey unit. The NRC staff verified that 14 systematic and two judgmental samples were taken in the survey unit. In addition, the LACBWR LTP specified that one HTD radionuclide and one QC soil sample be taken in the survey unit. The NRC staff verified that three HTD and three QC soil samples were taken in Survey Unit L1-010-106.

The licensee stated that the maximum SOF for the applicable ROCs by direct measurement or inference when applying the respective OpDCGLs for soil is 0.0656 in Survey Unit L1-010-106. The mean SOF when applying the respective Base Case DCGLs for soil is 0.0104 in Survey Unit L1-010-106. This SOF results in a dose for this survey unit of 0.2603 mrem/yr.

3.5.1.7 Survey Unit L1-010-107, Outside East LSE Area

Survey Unit L1-010-107 is an impacted Class 1 open land survey unit, which consists of open land with a surface area of 1,675 m^2. For Survey Unit L1-010-107, 100% of the total surface area was selected for surface soil scans, which is consistent with the MARSSIM Class 1 guidance that specifies 100% coverage for surface soil scans. The survey plan specified a total of 14 systematic soil samples and one judgmental soil sample be taken in the survey unit. The NRC staff verified that 14 systematic and four judgmental samples were taken in the survey unit. In addition, the LACBWR LTP specified that one HTD radionuclide and one QC soil sample be taken in the survey unit. The NRC staff verified that three HTD and three QC soil samples were taken in Survey Unit L1-010-107.

The licensee stated that the maximum SOF for the applicable ROCs by direct measurement or inference when applying the respective OpDCGLs for soil is 0.0795 in Survey Unit L1-010-107. The mean SOF when applying the respective Base Case DCGLs for soil is 0.0135 in Survey Unit L1-010-107. This SOF results in a dose for this survey unit of 0.3377 mrem/yr.

3.5.2 NRC Evaluation of Class 1 Open Land Survey Areas

The NRC staff verified that the results of the LACBWR FSS demonstrate that the Class 1 open land area survey units meet the radiological criteria for license termination and may therefore be released from the LACBWR 10 CFR Part 50 license. Specifically, the NRC staff reviewed the adequacy of the survey methods and instrumentation, the sufficiency of the number of samples collected, the quality control program, the comparison of the results to the release criteria, and the results of the statistical test to demonstrate compliance. The staff also reviewed the independent confirmatory surveys that were conducted on the Class 1 open land survey areas. A discussion of the specific topics that received an in depth review is presented below.

3.5.2.1 Survey Scan Coverage

The purpose of scanning during FSS is to identify locations within the survey unit that exceed the investigation levels established in the LTP. These locations are intended to be marked and receive additional investigations to determine the concentration, area, and extent of the radiological contamination. The LACBWR LTP indicates that MARSSIM Table 5.9, “Recommended Survey Coverage for Structures and Land Areas,” was utilized to determine the recommended survey coverage for open land areas, and the amount of area to be covered by scan measurements is provided in Table 5-15, “Recommended Survey Coverage for Open Land Areas and Structures,” of the LACBWR LTP.

In accordance with the guidance contained in MARSSIM, Class 1 survey units require 100% surface soil scan coverage. Each of the seven LACBWR Class 1 open land area survey units received surface soil scans of 100% of the total surface area. For the LACBWR Class 1 open land area survey units, the associated FSS release records indicate that gridded areas were determined within each survey unit to support scanning of the surface soil, and the surveys were performed using serpentine-like scans with the detector within three inches of the surface at a speed of 0.5 m/s over the scan lanes in gridded areas.

Table 6.3, “Radiation Detectors with Applications to Gamma Surveys,” of MARSSIM Section 6.5.3, “Instrument Selection,” provides guidance on radiation detection instrumentation applicable to, and appropriate for, conducting FSS. The instrumentation selected by the licensee to perform scan surveys of the open land area survey units is the Ludlum 44-10 NaI gamma scintillation detector coupled with the Model 2350-1 rate meter/scaler/data logger. This instrumentation is consistent with the guidance contained in MARSSIM regarding appropriate radiation detection instrumentation for use during FSS.

Based on the above considerations, the NRC staff finds that the licensee’s approach to conducting scan coverage for the LACBWR Class 1 open land area survey units, as demonstrated in the FSS release records for these survey units, is consistent with the applicable MARSSIM guidance, and aligns with the associated discussion in Section 5.6.4.4, “Scan Coverage,” of the approved LACBWR LTP. Therefore, the scan coverage for the LACBWR Class 1 open land area survey units is acceptable.

3.5.2.2 Detector Efficiency and Scan Minimum Detectable Concentration

Section 6.7.2.1, “Scanning for Beta and Gamma Emitters,” of MARSSIM and Section 6.2.5, “*A Priori* Scan MDCs for Land Areas,” of NUREG-1507, Revision 1, provide guidance on scan MDCs for open land areas. The LACBWR TSD RS-TD-313196-006, “Ludlum Model 44-10 Detector Sensitivity” (ML19007A044), evaluates the sensitivity of the Ludlum 44-10 NaI radiation detector used to scan the LACBWR Class 1 open land areas. The TSD applied a conversion factor of 940 cpm per μR/hr as the detector sensitivity for Cs-137, which was derived empirically from a study described in the report. This is very similar to the sensitivity for Cs-137 of 900 cpm per μR/hr listed in Table 6.7, “NaI Scintillation Detector Scan MDCs for Common Radiological Contaminants,” of MARSSIM. The TSD also states that the NaI scan MDC uses the formulas and approach contained in the associated MARSSIM and NUREG-1507 guidance.

However, during the review of the FSS release records for the LACBWR Class 1 open land survey areas, the NRC staff noted that while the text of ES TSD RS-TD-313196-006 states that the licensee used 900 cpm per μR/hr as the detector sensitivity for Cs-137, Attachment 8.3, “Scan MDC for Various Nuclide Fractions of Co-60 and Cs-137,” of the TSD shows that the licensee applied a conversion factor of 940 cpm per μR/hr as the detector sensitivity for Cs-137. The NRC staff assessed the safety significance of this error on the calculated scan MDCs for the open land areas and determined that it is not significant and will not impact compliance with the unrestricted release criteria for these survey units. Specifically, this error would cause the licensee to use a scan investigation action level that is slightly lower than what would be used if the correct value of 900 cpm per μR/hr, instead of 940 cpm per μR/hr, was applied as the detector sensitivity for Cs-137. Therefore, this error in terms of the scan investigation action level is conservative. When assessing the associated scan MDC values, the NRC staff noted that if the correct value had been used as the detector sensitivity for Cs-137, the calculated scan MDC values would have been slightly larger. However, since the corrected scan MDC values are still below 50% of the OpDCGLs established for the LACBWR open land areas, the error does not affect compliance with the release criteria.

Based on the above considerations, as well as those discussed for open land survey areas in the “La Crosse Boiling Water Reactor - Approval to Release Class 2 and Class 3 Survey Units from the Part 50 License” (ML22122A230), the NRC staff finds that the licensee’s approach to detector efficiency and scan MDCs for the LACBWR Class 1 open land area survey units, as demonstrated in the FSS release records for these survey units, is consistent with the applicable MARSSIM and NUREG-1507 guidance and aligns with the associated discussion in the approved LACBWR LTP. Therefore, the detector efficiency and scan MDCs for the LACBWR Class 1 open land area survey units are acceptable.

3.5.2.3 Background Radiation Measurements

For the LACBWR Class 1 open land area survey units, the background radiation for the surface scan measurements was established as the average of five one-minute static measurements, while maintaining the detector 6 inches from the soil. As part of the supplemental information provided in support of the clarification teleconferences to discuss the LACBWR FSSR (ML22269A395 and ML22269A395), the licensee described that the process for acquiring background radiation measurements for the scanning of open land survey areas was not procedurally established. Rather, background radiation measurement collection requirements were denoted in the instructions of each FSS sample plan, with more detailed instruction provided through technician training and field supervisor instruction. Table 25 shows the range of average background radiation measurements that were applied for the surface scans in the Class 1 open land survey units. As shown in the table, for some survey units the range in average background radiation measurements exceeded the Count Rate Equivalent OpDCGL for Cs-137 of 3,525 cpm. The NRC staff notes that ideally, the process for measuring background radiation for scan measurements would be reviewed and approved as part of the LTP process.

As part of surface scanning activities, ideally the surveyor will pause appropriately at increases in visual or audible response of the radiation detection instrument to determine whether an area of elevated concentration is present. As detailed in Section 5.7.1.1 of the LACBWR LTP, the licensee specified that the survey technicians would reduce the scan speed or pause and attempt to isolate the elevated area during the 100% surface scans of the Class 1 open land areas. Reduction in scan speed in response to increased instrument count rates improves the quality of the scan. Finally, the NRC staff notes that the average background radiation levels identified by the licensee for the LACBWR Class 1 open land areas are comparable to the levels measured by ORISE during confirmatory survey activities. Based on the above considerations, the NRC staff finds that the licensee’s methodology for background radiation determination in the LACBWR Class 1 open land area survey units, as demonstrated in the FSS release records for these survey units, is acceptable.

Table 25. Background Ranges for Class 1 Open Land Survey Unit Scan Measurements

Survey Unit	Survey Unit Description	Background Min	Background Max
L1-010-101	LACBWR Reactor Building, WTB, WGTV, and Ventilation Stack Grounds	3,314 cpm	4,221 cpm
L1-010-102	Turbine Building, Turbine Office Building, and 1B Diesel Generator Building Grounds	3,756 cpm	4,918 cpm
L1-010-103	LSA Building, Maintenance, and Eat Shack Grounds	3,505 cpm	5,407 cpm
L1-010-104	North LSE Grounds	3,935 cpm	7,368 cpm
L1-010-105	North Interim Debris Storage Area	2,692 cpm	6,223 cpm
L1-010-106	North Loading Area	2,827 cpm	7,617 cpm
L1-010-107	Outside East LSE Area	3,314 cpm	5,078 cpm

3.5.2.4 Investigation Samples and Scan Action Levels

The purpose of the 100% surface scan required during FSS of Class 1 survey units is to identify the potential for areas of elevated contamination that may exist between the systematic sample locations, and to collect judgmental samples accordingly to ensure any elevated areas are addressed and/or will not impact the ability of the survey unit to pass the FSS. Section 5.5.2.6, “Determining Investigation Levels,” of MARSSIM provides the basis for determining FSS investigation levels to indicate when additional radiological investigations may be necessary because of survey scan outcomes. The FSS scan investigation action levels for each class of survey unit were presented previously in Table 4 of this safety evaluation.

Section 5.6.4.6 of the LACBWR LTP details how any areas of concern identified during surface scanning will be investigated by further biased surveys and sampling as necessary. While

Table 5-16 of the LACBWR LTP specifies that the scan investigation action level should be set to the OpDCGL for Class 1 survey units, the associated FSS release records show that during the scans of the LACBWR Class 1 open land area survey units, the scan investigation action level was set to be equivalent to background radiation plus the cpm equivalent to 50% of the OpDCGL (1,762 cpm) as opposed to the full OpDCGL equivalent value of 3,525 cpm. However, in accordance with Table 5.8 of MARSSIM, the licensee could have set the scan investigation level at the $DCGL_W$ or the $DCGL_{EMC}$ for Class 1 survey units. Therefore, for the LACBWR Class 1 open land survey areas the licensee was using a scan investigation action level lower (more conservative) than what was required per the approved LACBWR LTP or in accordance with the guidance contained in MARSSIM.

Table 26. Class 1 Open Land Area Scan Action Levels, Scan Alarms, and Investigations

Survey Unit	Survey Unit Description	Count Rate Added to Background to Determine Action Level (cpm)	Scan Action Level Range (cpm)	Background Range (cpm)	Number of Scan Alarms	Number of Investigation Samples
L1-010-101	LACBWR Reactor Building, WTB, WGTV, and Ventilation Stack Grounds	1,762	5,076 – 5,983	3,314 - 4,221	3	0
L1-010-102	Turbine Building, Turbine Office Building, and 1B Diesel Generator Building Grounds	1,762	5,518 – 6,680	3,756 - 4,918	3	2
L1-010-103	LSA Building, Maintenance, and Eat Shack Grounds	1,762	5,267 – 7,169	3,505 - 5,407	2	1
L1-010-104	North LSE Grounds	1,762	5697 – 9,130	3,935 - 7,368	1	1
L1-010-105	North Interim Debris Storage Area	1,762	4,454 – 7,985	2,692 - 6,223	3	2 (1 surface soil and 1 subsurface)
L1-010-106	North Loading Area	1,762	4,589 – 9,379	2,827 - 7,617	10	6 (4 surface soil and 2 subsurface)
L1-010-107	Outside East LSE Area	1,762	5,076 – 6,840	3,314 - 5,078	9	5 (3 surface soil and 2 subsurface)

In addition, for some Class 1 open land area survey units, instead of taking an investigational sample when the scan investigation action level was exceeded, the licensee took investigational samples when the equivalent of 75% of the OpDCGL above background radiation was exceeded. Therefore, although the associated FSS release records show that investigational samples were not always collected when the established scan action level (50% of the OpDCGL above background radiation) was exceeded, the licensee was still adhering to the commitment for investigation action levels in the LACBWR LTP and taking investigational samples appropriately given that the LTP called for investigational samples to be taken when the OpDCGL above background radiation was exceeded. For example, in Survey Unit L1-010-101 a total of three scan alarms were verified during surface scanning of sample locations. The associated FSS release record states that the alarms were documented, but no investigational samples were collected because the alarms were not above 75% of the OpDCGL. The maximum scan reading was 5,861 cpm, with background radiation of 3,314 cpm, so the difference of 2,502 cpm was 71% of the OpDCGL equivalent of 3,525 cpm. Table 26 above provides a summary of the scan action levels, scan alarms, and number of investigation samples that were collected in each of the LACBWR Class 1 open land area survey units. The investigational samples that were collected were all well below the OpDCGL SOF.

Based on the above considerations described for each survey unit, the NRC staff finds that the licensee's approach to scanning and investigation sampling for the Class 1 open land survey units is adequate. The licensee may not have followed the approved scan investigation action level process described in the LACBWR LTP for the Class 1 open land survey areas, but in accordance with Table 5.8 of MARSSIM, the licensee could have set the scan investigation action level at the $DCGL_W$ or the $DCGL_{EMC}$ for Class 1 survey units. Instead, the licensee added a more conservative value to background radiation (50% of the OpDCGL equivalent) to establish the scan investigation action level. While the licensee did not take an investigational sample at each scan alarm location, the overall approach is considered reasonable because the partial OpDCGL cpm equivalent value the licensee added to background radiation was conservative, and because the results of the investigational samples that were collected in the Class 1 open land survey units were all well below the OpDCGL.

3.5.2.5 Number of Samples and Sample Locations

The licensee relied on Section 5.6.4.1 of the LACBWR LTP, as well as the associated guidance documents (see Section 3.3.2.1 of this safety evaluation), to determine the number of sampling and measurement locations necessary to fulfill the statistical parameters for the Class 1 open land area survey units. In some survey units the calculated relative shift was based on data from a subsurface FSS conducted beneath the open land area (e.g., for an excavation or basement structure) prior to backfill to grade, and in other cases the calculated relative shift was based on data from the RA survey performed after backfilling the area to grade and prior to FSS of the open land survey unit. The NRC notes that it is preferrable to use the data from an RA survey for designing the FSS, as compared to using the data from surveys of a subsurface survey unit, which would most likely not represent the average and standard deviation of the land survey unit after unit has been backfilled. In all cases for the LACBWR Class 1 open land areas, the calculated relative shift was greater than 3 (see Table 27), so a value of 3 was assumed, in accordance with MARSSIM, to determine the required number of systematic samples.

Table 27. Class 1 Open Land Area Relative Shift and Systematic Sample Results

Survey Unit	Survey Unit Description	Calculated Relative Shift	Number of Systematic Samples
L1-010-101	LACBWR Reactor Building, WTB, WGTV, and Ventilation Stack Grounds	$\Delta/\sigma = (1 - 0.04) / 0.02 = 48$	14
L1-010-102	Turbine Building, Turbine Office Building, and 1B Diesel Generator Building Grounds	$\Delta/\sigma = (1 - 0.029) / 0.014 = 69$	14
L1-010-103	LSA Building, Maintenance, and Eat Shack Grounds	$\Delta/\sigma = (1 - 0.015) / 0.008 = 123$	14
L1-010-104	North LSE Grounds	$\Delta/\sigma = (1 - 0.022) / 0.0103 = 95$	14
L1-010-105	North Interim Debris Storage Area	$\Delta/\sigma = (1 - 0.03) / 0.013 = 75$	14
L1-010-106	North Loading Area	$\Delta/\sigma = (1 - 0.025) / 0.016 = 60.9$	14
L1-010-107	Outside East LSE Area	$\Delta/\sigma = (1 - 0.04) / 0.014 = 68.6$	14

The NRC staff verified that the number of sampling and measurement locations collected from the LACBWR Class 1 open land areas was determined by establishing acceptable Type I and Type II decision errors, calculating the relative shift, and using the sample size determination approach described in MARSSIM. Specifically, the LACBWR LTP committed to using a Type I and Type II decision error of 5% and applying the Sign Test. The sample size from Table 5.5 of MARSSIM that equates to a Type I and Type II decision of 5% for use with the Sign Test is an N value of 14 samples. Therefore, the NRC staff confirmed that the licensee intended to collect at least 14 static systematic measurements for the Class 1 open land areas.

The NRC staff also verified that for the LACBWR Class 1 open land areas, the number of systematic and judgmental samples actually taken in each survey unit met or exceeded the number prescribed. All the LACBWR open land area survey units required the collection of at least 14 systematic soil samples. For the Class 1 open land areas, measurement locations were based on a systematic grid with a random starting point. The Visual Sample Plan (VSP) software tool was used by the licensee to determine the systematic soil sample locations for the Class 1 open land areas, as described in ES TSD LC-FS-PR-002, "Final Status Survey Package Development" (ML23023A145). The VSP systematic measurements and sample locations are intended to be unbiased, and ensure the measurements and sample locations are independent and support the assumptions of the statistical tests.

Based on the above considerations, the NRC staff finds that the licensee's approach to determining the number of samples and sample locations for the LACBWR Class 1 open land area survey units, as demonstrated in the FSS release records for these survey units, is consistent with the applicable MARSSIM and NUREG-1757 guidance and aligns with the associated discussion in the approved LACBWR LTP. Therefore, the sampling methodology for the LACBWR Class 1 open land area survey units is acceptable.

3.5.2.6 Continuing Characterization and Verification of HTD Radionuclides (Sr-90)

The inaccessible or not readily accessible areas described in Section 5.3.3.4 of the LACBWR LTP for the Class 1 open land survey areas included soils under concrete or asphalt coverings. However, these inaccessible areas were part of Class 2 land survey areas, and were therefore assessed and approved for removal from the LACBWR 10 CFR Part 50 license as part of the "La Crosse Boiling Water Reactor - Approval to Release Class 2 and Class 3 Survey Units from the Part 50 License" (ML22122A230), and are not addressed in this safety evaluation.

Section 5.1 of the LACBWR LTP specifies the process that will be utilized to sample for HTD radionuclides during FSS and includes analyzing at least 10% of the FSS samples from open land survey units for the presence of Sr-90, as well as conducting an HTD radionuclide analysis for any sample resulting in a SOF greater than 10% of the OpDCGL. The NRC staff verified that the number of HTD radionuclide samples taken in each Class 1 open land survey unit met or exceeded the number of samples required in the LACBWR LTP.

3.5.2.7 Quality Control Measurements

Each LACBWR Class 1 open land survey unit provided at least two QC measurement samples. In total, there were 17 QC samples taken in Class 1 open land survey units. As part of the RAIs associated with the LACBWR FSSR review (ML20195A272), the NRC staff requested additional information regarding the quality control investigations associated with various FSS data to evaluate whether the licensee had followed the processes outlined in Section 5.9.3.4 of the LACBWR LTP. Specifically, certain FSS release records indicated that the QC samples did not meet the acceptance criteria for compared sample results (original samples versus QC samples). The licensee substituted K-40 as the radionuclide to measure quality control in 6 out of 7 of the Class 1 open land survey units. Given that this issue affected both the excavation and open land areas similarly, this topic is evaluated in the section of this safety evaluation that discusses QC for excavation survey units (see Section 3.4.2.4).

3.5.2.8 Confirmatory Survey Results

ORISE performed a confirmatory survey of the LACBWR surface soils associated with the remaining land areas in September 2019 (ML20296A519). The ORISE confirmatory survey report states that for all samples, the ROC concentrations were less than 50% of the respective OpDCGLs, thereby confirming the FSS survey unit classifications were appropriate. Gamma scans of the LACBWR Class 1, Class 2, and Class 3 survey units identified multiple areas of elevated radiation distinguishable from background. A total of 46 soil samples were collected across all open land area survey units: 20 random samples and 26 judgmental samples. A comparison of the confirmatory survey and FSS data indicated that, overall, the confirmatory survey SOF results are lower than the FSS SOF results for both the random and judgmental datasets. All confirmatory ROC concentrations were less than the respective OpDCGLs, and the maximum SOF for the confirmatory data was 0.107. The ROC concentrations for the two samples collected deeper than 15 cm were less than the respective MDCs.

3.5.2.9 Conclusion for Class 1 Open Land Survey Areas

For the reasons discussed in the NRC evaluation of the LACBWR Class 1 open land area survey units, the NRC staff has reasonable assurance that the FSS release records for these survey units demonstrate that the residual radioactivity in the associated open land areas complies with the unrestricted release criteria. Specifically, the ORISE confirmatory soil concentrations for ROCs in all the LACBWR Class 1 open land area survey units were less than 50% of the associated OpDCGLs. The ORISE confirmatory SOF results are also generally lower than the LACBWR FSS SOF results, providing independent verification that the survey units meet the release criteria. Given these considerations, the NRC staff concludes that the release of the LACBWR Class 1 open land area survey units will have no adverse impact on the ability of the site to meet the 10 CFR Part 20, Subpart E criteria for unrestricted release.

3.6 Final Dose for Groundwater

The NRC staff evaluated the licensee's approach for determining dose contributions from groundwater at the LACBWR site. The exposure factors for groundwater were approved as part of the LACBWR LTP and are consistent with the applicable regulatory requirements and associated guidance provided in NUREG-1700 and NUREG-1757, Volume 2. In addition, the LACBWR LTP describes two events that led to known radionuclide contamination plumes in the groundwater system that were not completely resolved prior to FSS. The first event was identification of groundwater contamination in 1983 at a temporary well-point downgradient and south of the LACBWR turbine building, which was thought to be linked to a leak from suspected broken drain lines. The second event was H-3 (tritium) released during decommissioning demolition activities in 2017 and 2018, which entered the groundwater system in the area of an excavated sump between the LACBWR turbine building and reactor building.

3.6.1 1983 Groundwater Contamination South of Turbine Building

In Section 2.3.7.3, "Previous Investigations," of the LACBWR LTP the licensee described an investigation in 1983 of groundwater contamination with concentrations of 21.7 picoCuries per liter (pCi/L) of Cs-137 and 508 pCi/L of Co-60, which was identified south of the LACBWR turbine building. The licensee stated that the investigation was associated with the recovery of a spill incident associated with potential leakage from suspected broken floor drains under the LACBWR turbine building. The investigation consisted of a single well-point established at a location downgradient from the south side of the LACBWR turbine building and below grade of the suspected drain line leak. However, the NRC staff notes that:

- The groundwater was sampled once, and the well-point was subsequently abandoned.
- The depth of the well-point was not specified; hence the elevation of the contaminated groundwater was not known.
- The source location was uncertain, hence the NRC staff considered different possible source areas upgradient of the 1983 well-point, including subsurface residual radioactivity identified from excavations during decommissioning.
- Further uncertainty involves the unlikely possibility of migration of Cs-137 and Co-60, which both strongly sorb to solids, over approximately a one-month period from a broken drain line within the building footprint to the well-point south of the building footprint.

The NRC staff assessment in this section of the safety evaluation provides context from the LACBWR LTP and the NRC's safety evaluation for the LTP regarding the 1983 groundwater contamination event, gives a description of the continuing characterization and FSS activities conducted by the licensee to assess this event, and closes the loop on the incompletely characterized subsurface contamination and other outstanding information from the LACBWR LTP. The staff assessment uses a combination of results from characterization, continuing characterization, and FSS data to provide reasonable assurance that the groundwater contamination along the transport path from the well-point to a possible source does not remain.

Because of the uncertainties in the source location for the contamination, the NRC staff considered two likely sources as part of the evaluation for this event. The first possible source location was described in the LACBWR LTP. Specifically, the licensee described the 1983 well-point investigation and occurrence of groundwater contamination in Section 2.3.7.3, "Previous Investigations," and Section 6.5.4, "Existing Groundwater," of the LACBWR LTP. However, the contamination event was not identified in the Historical Site Assessment (HSA) created for the LACBWR site, as listed in Section 2.4.1, "Radiological Spills," of the LTP.

However, the staff notes that two HSA events in Section 2.4.1 of the LACBWR LTP were listed as affecting the soils beneath the turbine building: a 1980 drain line leak was suspected of reaching the soils beneath the building, and another event later in 1980 confirmed the presence of residual radioactivity in soils beneath the turbine building. These events are mentioned here because cesium and cobalt are both strongly sorbing elements, and therefore would be expected to migrate slowly through the subsurface to the groundwater and maintain elevated concentrations in soils along the expected transport pathway.

Specifically, the NRC staff notes that cesium readily sorbs to solids unless the liquid carrying the radionuclides was of an unusual chemical composition, such as having a low pH with high ionic concentrations of competing ions such as potassium or sodium (Fuller et al., 2014). Accordingly, the staff considered the additional possibility that the well-point sample south of the LACBWR turbine building may reflect leaks that happened several to many years prior to the 1983 identification of contamination at the well-point location. The staff also notes that the sump at the eastern end of the turbine building is located at 634 feet above mean sea level (AMSL) according to Figure 42 of “La Crosse End State Basement Concrete Surface Areas, Volumes, and Void Spaces” (RS-TD-313196-002), which is slightly lower than the suspected broken drain lines along the southern side of the turbine building that lead to the sump.

For the second possible source location, the NRC staff notes that significant residual radioactivity was excavated from the area associated with the LACBWR reactor building sump. As part of the supplemental information provided in support of the clarification teleconferences to discuss the LACBWR FSSR RAI response (ML22321A014), the licensee clarified that the reactor building sump, at an elevation of 618 feet AMSL, was excavated to a depth of 615 feet AMSL in order to remove residual radioactivity that was above the OpDCGL concentration for Cs-137. The LACBWR reactor building sump is located east, but adjacent, to the east end of the LACBWR turbine building. Therefore, the projected area of excavation for Survey Unit L1-SUB-TDS B, which covered the RPGPA excavation, contains both the turbine building sump and the reactor building sump, the latter of which is the primary focus of the RPGPA.

The elevation of the water table was generally below the turbine building drain lines and sump (634 feet AMSL). Therefore, there would be a predominantly vertical pathway of any leak before reaching the water table and migrating generally horizontally westward. The elevation of the LACBWR reactor building sump (618 feet AMSL) was below all recorded water levels at the site; therefore, generally horizontal transport pathways in the saturated zone can be assumed.

Section 6.5.4 of the LACBWR LTP described five additional monitoring well pairs that were installed in late 2012 to support site characterization and license termination. Well pairs are approximately co-located monitoring wells screened at different depths. Two well pairs were located in areas downgradient from the southern portion of the turbine building. One well pair was installed in the approximate vicinity of the 1983 well-point location south of the building, though the 1983 well-point location was not precisely known. The other well pair was installed west of the building but downgradient of the drain lines in the southern portion of the building.

In a response to an RAI during the review of the LACBWR LTP (ML18169A277), the licensee clarified that one of the new well pairs was believed to be located upgradient of the likely 1983 well-point location and downgradient of possible drain leak locations in the LACBWR turbine building. Section 6.5.4 of the LACBWR LTP stated that results of groundwater sampling from this well “indicated lower groundwater contamination levels than found in 1983.” Phase 3 of the LACBWR FSSR (ML20031C839) indicated that no residual radioactivity was identified in the monitoring wells from groundwater sampling events that occurred after the LACBWR LTP submittal through the end of 2019, when the NRC approved discontinuance of groundwater monitoring at the LACBWR site (ML19268A086).

In Section 3.7.8.1, “1983 Leak – Turbine Building,” of the NRC safety evaluation that approved the LACBWR LTP on May 21, 2019 (ML19008A079), in noting the change in decommissioning plans that occurred during the review of the LTP, the NRC staff stated:

> 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% 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% 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 groundwater contamination from the leak identified in 1983 can be evaluated.

In reference to the incomplete characterization of contaminated groundwater, the NRC staff went on to state in the LACBWR LTP safety evaluation that the subsequent FSS of soils in the turbine building excavation could provide an indication of whether or not residual radioactivity from the 1983 suspected drain line leak event remained in the soils near the source and along the transport pathway. The staff noted that the single well-point measurement in 1983 likely would not represent the peak concentration of the groundwater plume, either in space or time, for a groundwater contamination event with a source of unknown location. The staff also noted that the source may have originated from the eastern half of the turbine building, which includes the drain lines of the turbine building, or from the LACBWR reactor building sump that was primary focus of Survey Unit L1-SUB-TDS B (RPGPA excavation).

In Section 3.7.8.1 of the NRC safety evaluation that approved the LACBWR LTP, the NRC staff estimated Cs-137 and Co-60 soil concentrations, projected to 2018, that exceeded the associated OpDCGLs. The estimates considered radioactive decay and assumed equilibrium sorption, but did not consider flushing in the groundwater flow system or continued source release. The staff further noted that groundwater contamination was incompletely characterized in 1983, and peak concentrations in 1983 were not bounded, the latter of which could imply a further increase in the 2018 projections for soil concentrations of Cs-137 and Co-60.

In the NRC staff evaluation below, the focus is primarily on Cs-137 rather than Co-60 because the former has significantly more results above MDC in the FSS results from the three survey units of interest to the LACBWR turbine building suspected drain line leakage event: Survey Unit L1-SUB-TDS, Survey Unit L1-SUB-TDS A, and Survey Unit L1-SUB-TDS B (Figure 33).

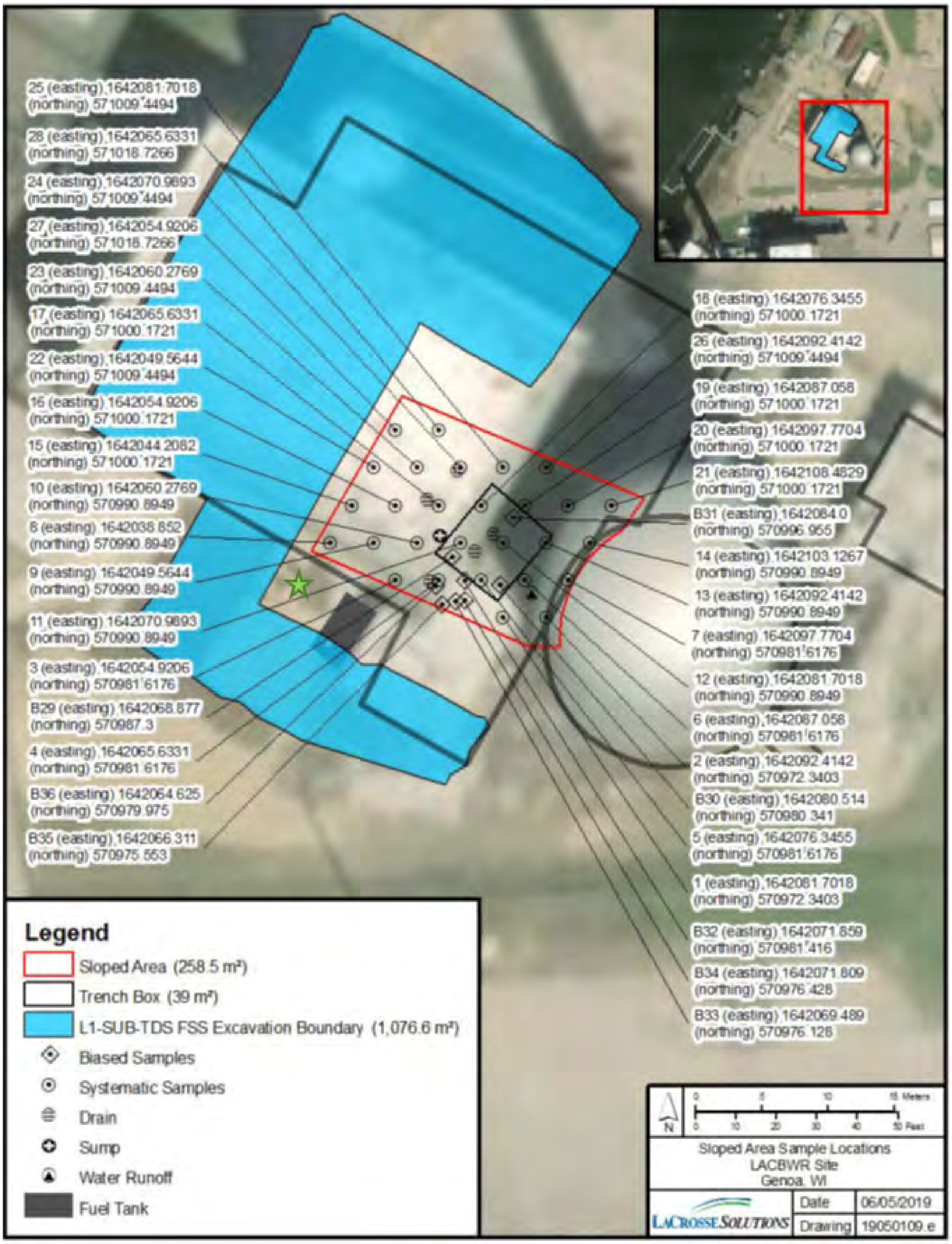


Figure 33. Survey Unit L1-SUB-TDS in Blue, Survey Unit L1-SUB-TDS B in Red Outline, and Survey Unit L1-SUB-TDS A in the Gap Between the Other Two Survey Areas; Green Star Is Approximate Location of the 1983 Well-Point (Modified from Figure 16-1 of the FSS Release Record for Survey Unit L1-SUB-TDS B, Revision 2)

In the layout for the survey units at the LACBWR site, three excavation survey units overlap the area potentially impacted by the 1983 well-point event and the possible areas beneath the drain lines that span the length of the southern side of the turbine building to the sump of the LACBWR reactor building. Specifically, Survey Unit L1-010-102, which was an open land area covering the LACBWR turbine building, turbine building office, and diesel generator grounds, was partitioned into excavation survey units L1-SUB-TDS, L1-SUB-TDS A, and L1-SUB-TDS B. The relationship between these three excavation survey units is illustrated in Figure 33. The 1983 well-point falls within the southwestern corner of Survey Unit L1-SUB-TDS A.

The LACBWR turbine building, which was primarily part of the open land area that comprised Survey Unit L1-010-102, was excavated to an elevation of 636 feet AMSL (ML22321A014), which includes excavation survey units L1-SUB-TDS (western turbine building), L1-SUB-TDS A (part of the eastern half of the turbine building), and a portion of L1-SUB-TDS B (portion of the eastern turbine building and reactor building). However, at the eastern end of the turbine building, the excavation for the reactor building sump reached an elevation of 615 feet AMSL.

Radiological characterization of Survey Unit L1-010-102 consisted of two series of GeoProbe core bores and two surface soil samples. The two 2014 vertical GeoProbe core bores and five 2015 angled GeoProbe core bores for characterization are shown in Figure 34. In the vertical core bores, samples were taken at depths of 3.3, 8.8, and 13.1 feet, the lowest of which would correspond to an elevation of 627 feet AMSL. The five 2015 angled GeoProbe locations were along the edge of, and angled underneath, the LACBWR turbine building. Three of the angled GeoProbe locations, with samples at 10, 15, and 20 feet, were located along the southern edge of the turbine building, which is the side associated with the 1983 suspected drain leak.

As part of a request for confirmatory information (ML22278A027), the NRC requested the angle of the GeoProbe core bores used during characterization activities for the LACBWR turbine building, in order to determine the depth reached by the sampling campaign. Instead of providing the angle, the licensee clarified (ML22321A014) that the reported measurements were recorded as depth from ground surface (which suggests the that the length of core composited for each sample stratum is greater than five feet) instead of 5-foot lengths along the core. With a nominal ground surface elevation of 639 feet AMSL, and a maximum GeoProbe depth of 20 feet, the lowest composited sample depth would have come within a foot of reaching the LACBWR reactor building sump at an elevation of 618 feet AMSL.

From the three FSS release records for the excavations within the footprint of Survey Unit L1-010-102, the characterization results are summarized as:

> No ROC were detected at concentrations above MDC for the surface soil samples. For subsurface soil samples, Cs-137 was detected at concentrations above MDC in four of the samples, at a maximum concentration of 0.130 pCi/g. Co-60 was not detected at concentrations above MDC for subsurface soil samples. Four subsurface soil samples, and one surface soil sample, from characterization were sent to Test America Laboratories for offsite analysis. The subsurface soil samples were analyzed for the full suite of initial ROC, while the surface soil sample was analyzed for Co-60, Nb-94, Cs-137, Eu-152, Eu-154, Eu-155, and Am-241. For subsurface samples, H-3 was identified in two samples and Ni-63 was identified in one sample at maximum concentrations of 24.7 pCi/g and 4.0 pCi/g; respectively. No ROC were identified with concentrations greater than MDC for surface soil samples.

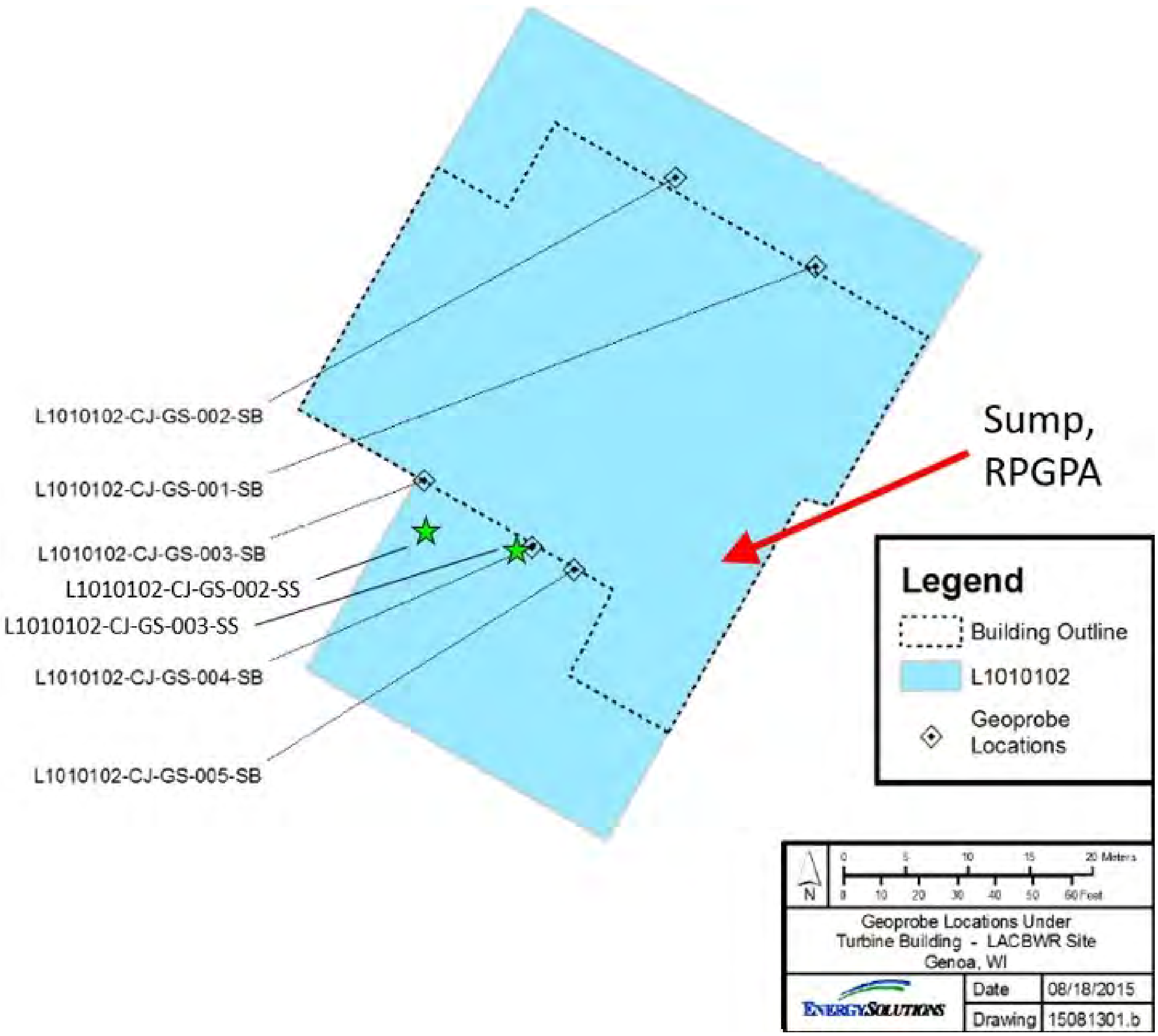


Figure 34. Approximate Locations of the Vertical and Angled GeoProbe Core Bores; Modified From Figure 9-2 and Figure 9-4 in the 2014 and 2015 Characterization Reports (GG-EO-313196-RS-RP-001 and LC-RS-PN-164017-001, Respectively)

Survey Unit L1-SUB-TDS covers the western half of the LACBWR turbine building excavation. Continuing characterization activities in September 2017, after excavation of the building slab, included soil sampling in areas previously beneath the turbine drain lines. The associated FSS release record stated that a total of eight soil samples were collected from the region beneath the broken drain lines, turbine sump, turbine pit, and condenser pit. Gamma spectroscopy results revealed that all eight soil samples contained concentrations of Cs-137 above MDC, with a maximum concentration of 0.188 pCi/g. Two samples contained concentrations of Co-60 above MDC, with a maximum concentration of 0.257 pCi/g.

During a December 2017 remedial action in Survey Unit L1-SUB-TDS, areas that alarmed in a scan survey were bounded and remediated to below the applicable OpDCGLs. As part of a subsequent RASS, five judgmental soil samples were collected in areas where survey alarms registered during the RASS surface scans; the locations of the judgmental soil samples are not known. The associated FSS release record stated that “gamma spectroscopy revealed Cs-137 concentrations ranging between 0.0394 pCi/g and 0.674 pCi/g. Co-60 concentrations ranged between 0.43 pCi/g and 0.552 pCi/g.”

For the FSS of Survey Unit L1-SUB-TDS, 14 systematic and 10 judgmental soil samples were collected, with a maximum reported concentration value for Cs-137 of 0.208 pCi/g. Seven of the systematic and four of the judgmental soil samples were located in the southern portion of Survey Unit L1-SUB-TDS, possibly associated with 1983 suspected drain leak. Seven of these soil samples were above MDC with a maximum concentration result of 0.188 pCi/g for Cs-137. No survey alarms were reported during the 100% surface scanning of the excavation survey unit. Section 3.3.2.2.3 of this safety evaluation provides a more detailed review of the FSS results for Survey Unit L1-SUB-TDS. Based on these results and the associated evaluation for the drain lines below the western end of the LACBWR turbine building, the NRC staff concludes that no remnant of the 1983 well-point groundwater contamination is reflected in the FSS scanning and sampling results reported for excavation Survey Unit L1-SUB-TDS.

Survey Unit L1-SUB-TDS A includes part of the eastern portion of the LACBWR turbine building. Prior to FSS, an area in the northeastern part of the survey unit was further excavated after a larger zone was identified with elevated contamination readings. This remediated area in the northeastern part of the survey unit is ignored in the following discussion because it is not near the suspected turbine building drain line leaks and 1983 well-point. The southern arm of the survey unit includes a small sliver that crosses the drain lines suspected in the 1983 leakage event, as well as the area south of the building where the well-point was located (Figure 33). Within this southern arm of Survey Unit L1-SUB-TDS A, one continuing characterization sample was collected after demolition of the turbine building (Sample L1-SUB-TDS-CJGS-A01). Onsite gamma spectroscopy and offsite laboratory analysis of the continuing characterization sample revealed concentration values of 0.0706 pCi/g and 0.312 pCi/g, respectively, for Cs-137.

During the FSS of Survey Unit L1-SUB-TDS A, the highest Cs-137 concentration result from six systematic and judgmental soil samples in the survey area is 0.131 pCi/g, which was recorded in Sample L1-SUB-TDS-FSGS-A02-SB. Other systematic and judgmental soil samples in the southern arm of the survey unit are: L1-SUB-TDS-FSGS-A03-SB, L1-SUB-TDS-FSGS-A04-SB, L1-SUB-TDS-FJGS-A15-SB, L1-SUB-TDS-FJGS-A17-SB, and L1-SUB-TDS-FJGS-A18-SB. One hundred percent surface scanning of the entire excavation survey unit led to 12 scan lanes with alarms, four of which led to initiation of investigations in accordance with the LACBWR LTP. Two of the alarms were along scan lanes 64 through 84 in the southern arm of the survey unit, with each one initiating an investigation. Section 3.3.2.2.4 of this safety evaluation provides a more complete discussion of FSS results for the entire area of Survey Unit L1-SUB-TDS A. Based on these results and the associated evaluation for the drain lines below a portion of the eastern end of the LACBWR turbine building within Survey Unit L1-SUB-TDS A, the NRC staff concludes that no remnant of the 1983 well-point groundwater contamination is reflected in the FSS scanning and sampling results reported for this excavation survey unit.

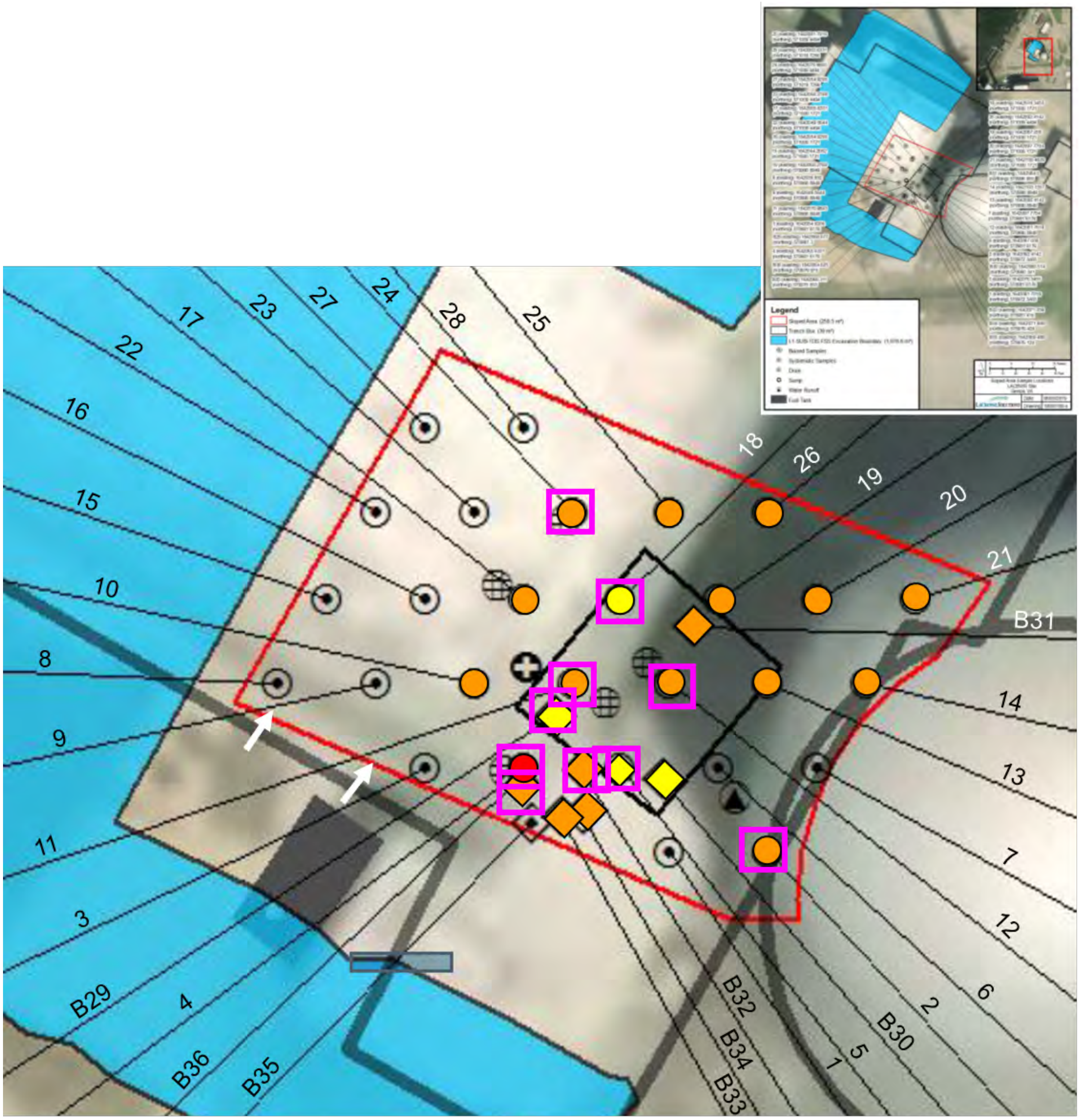
Survey Unit L1-SUB-TDS B covers a portion of the eastern part of the LACBWR turbine building excavation, including the RPGPA sump (Figure 33) to which the drain lines along the southern part of the turbine building empty. These are the drain lines suspected in the 1983 leak event to the groundwater system. According to the associated FSS release record, continuing characterization for this area included 28 samples taken from four depths at seven GeoProbe locations due to the area being inaccessible at the time of characterization. Gamma spectroscopy results showed that 12 of these samples were above MDC with a maximum concentration result of 2.70 pCi/g for Cs-137. A RASS of Survey Unit L1-SUB-TDS B was performed in December 2017 and January 2018. After excavation of the RPGPA sump area was complete, surface scan results were relatively uniform and the maximum soil sample concentration result for Cs-137 was 5.32 pCi/g.

The associated FSS release record stated that an “RA in Survey Unit L1-SUB-TDS B was performed in April 2019. Seven soil samples were collected and analyzed by the onsite gamma spectroscopy system. The average SOF of the sample set was 0.1, with a standard deviation of 0.14. The RA data was used to design the FSS.” For the FSS of Survey Unit L1-SUB-TDS B, the FSSR noted that “the maximum depth of the excavation in Survey Unit L1-SUB-TDS B is at the 618-foot elevation, which is 21 feet below grade (639-foot elevation). At the time of FSS, the excavation was backfilled and the FSS was implemented via GeoProbe technology.”

Because the RPGPA excavation was backfilled at the time of FSS, 100% surface scanning could not be conducted. Instead, FSS soil samples at four depths were obtained via GeoProbe technology at 28 systematic and eight judgmental locations. The judgmental soil sample locations were selected based on proximity to the suspected broken drain lines and the trench box location from the original excavation. Qualitative scans of the cores from all the GeoProbe sample locations produced results consistent with background radiation. The qualitative scans were unremarkable for the core lengths representing the samples with the three highest concentrations of Cs-137, including the one result that exceeded the OpDCGL. Hence, the qualitative scans of the GeoProbe core lengths do not appear useful in bounding the potential contamination from the suspected 1983 turbine building drain line leakage event.

In the FSS release record for Survey Unit L1-SUB-TDS B, the results for the systematic GeoProbe samples are summarized in Table 7-1, and those of the judgmental GeoProbe samples are summarized in Table 7-4. Seventeen of the systematic soil sample results were above MDC with a maximum concentration result of 24.4 pCi/g, a mean result of 1.32 pCi/g, and a median result of 0.163 pCi/g for Cs-137. Seven of the eight judgmental soil sample results were above MDC with a maximum concentration result of 11.1 pCi/g for Cs-137. These two tables from the FSS release record provide the maximum Cs-137 concentration result among the four samples obtained from different depths at each GeoProbe location. However, the information in the release record did not allow the NRC staff to determine which of the four depth stratums was represented by the maximum reported result. Therefore, the NRC staff requested confirmation that the maximum Cs-137 concentration from the different stratums in each GeoProbe sample location was not from the bottom elevation for any of the samples (ML22278A027). This provides reassurance that the extent of the potential contaminated soil from the broken drain lines was understood and removed from the RPGPA excavation.

As part of the supplemental information provided in support of the clarification teleconferences to discuss the LACBWR FSSR (ML22297A004), the licensee clarified the location designator nomenclature for the GeoProbe samples to denote the four different depths from which the composite cores were measured. Once the code for sample names could be tied to the stratum of each GeoProbe location, the NRC staff tabulated the Cs-137 concentration results for each GeoProbe location from the laboratory data sheets provided with the FSS release report. Table 15 in Section 3.3.2.2.5 of this safety evaluation provides the tabulated FSS results that support the conclusion that the residual radioactivity in Survey Unit L1-SUB-TDS B is bounded by the generally low activities encountered in the lowermost stratums of 36 of the GeoProbe systematic and judgmental sample locations. The horizontal and vertical distribution of Cs-137 within these GeoProbe sample locations are illustrated in Figure 35 below.



Judgmental, Systematic

Mixed vertically (3 of 4 layers are >MDC)

Above operational DCGL, top stratum (624 - 627 ft elevation)

Above MDC, top stratum (624 - 627 ft elevation)

Above MDC, 2nd or 3rd stratum from top (621 - 625 ft or 618-621 ft elevation)

Angled GeoProbe, 20 ft “depth” from edge of building from ~639 ft AMSL was part of initial characterization

Figure 35. Spatial Distribution of Cs-137 Results Delineated by MDC and Operational DCGL for Survey Unit L1-SUB-TDS B (RPGPA Excavation)

The results from Table 15 and Figure 35 suggest a mixing of sump-related residual radioactivity into the backfill above the RPGPA excavation, rather than a subsurface horizon of residual radioactivity released from the sump and extending along a downgradient transport pathway. The NRC staff notes that some of the sample locations near the edges of the excavation survey unit may reflect residual activity at the excavation surface. Downgradient GeoProbe samples collected during FSS of Survey Unit L1-SUB-TDS B, specifically those from locations on the western side of the survey unit and along the southern edge of the survey unit, yielded no samples at any horizon with Cs-137 concentration results above MDC. Therefore, the NRC staff was able to conclude that the radiological survey results within the RPGPA excavation, based on the GeoProbe sample results from FSS in combination with the characterization results from additional GeoProbe locations further downgradient (Figure 34), serve to bound the lateral extent of residual radioactivity. Section 3.3.2.2.5 of this safety evaluation provides a more complete discussion of FSS results for the entire area of Survey Unit L1-SUB-TDS B. Based on these results and the associated evaluation for the RPGPA sump, the NRC staff concludes that no remnant of the 1983 well-point groundwater contamination migration pathway beyond the immediate area of the LACBWR reactor building sump is reflected in the FSS scanning and sampling results reported for excavation Survey Unit L1-SUB-TDS B.

In summary, the LACBWR LTP indicated that 100% surface scans and MARSSIM-based systematic and judgmental soil sampling would be completed for the excavation surface of the LACBWR turbine building. The NRC safety evaluation that approved the LACBWR LTP indicated that the 100% survey scans and MARSSIM-based sampling of the excavation surface were needed to reconcile incomplete characterization of the 1983 groundwater contamination event from a source at an unknown location along the southern extent of the turbine building. However, surface scans and soil sampling over the entire area of interest in excavation survey units L1-SUB-TDS, L1-SUB-TDS A, and L1-SUB-TDS B were not possible due to water seeping into the RPGPA excavation that necessitated the area being backfilled prior to FSS. Because the excavated RPGPA sump was below the depth of all recorded water level measurements at the LACBWR site, a lesson-learned item is that consideration of both river stage levels and historical groundwater levels, together with the logistics of decommissioning adjacent structures, may have allowed the licensee to address or avoid water intrusion into these areas and permitted the MARSSIM-based survey approach to be applied to the excavations.

The 100% surface scans and MARSSIM-based soil sampling were replaced with GeoProbe sampling for the excavation areas that were backfilled prior to FSS. However, the excavation surface could not be delineated from backfill material in the composite core samples, thereby leaving open the possibility of dilution of excavation soil with clean backfill soil and an artificial decrease in measured contamination results. In addition, a contaminated area at an excavation surface could theoretically be split between two GeoProbe sample stratums, thus requiring a factor of two increase in the reported contamination result as compensation. However, the NRC staff notes that only one GeoProbe sample result was above the OpDCGL for Cs-137 (Sample L1-SUB-TDS-FSGS-B04-SB in the RPGPA sump, with a Cs-137 concentration of 24.4 pCi/g); if the factor of two was applied to this sample, the staff notes that the result would have only slightly surpassed the Base Case DCGL for Cs-137 (a concentration of 48.3 pCi/g).

Based on the above considerations, the NRC staff finds with reasonable assurance that the residual radioactivity associated with the incompletely characterized 1983 radiological release event, as well as other releases associated with suspected broken drain lines at the 634-foot elevation or the LACBWR reactor building sump at the 634-foot elevation, is not present in the subsurface because of bounding lateral and vertical supportive results from (i) groundwater sampling from onsite shallow wells (labeled MW-202 A and MW-203 A), (ii) radiological characterization at appropriate locations using GeoProbe technology, (iii) excavation of residual radioactivity around the RPGPA sump area and subsequent confirmatory measurements, and (iv) the results of GeoProbe sampling during FSS at 36 locations to appropriate depths.

3.6.2 Tritium Release During Decommissioning

Details of the groundwater contamination caused by contaminated surface water entering the subsurface at the RPGPA sump during LACBWR decommissioning activities in 2017 and 2018 were described in an RAI response dated November 15, 2018 (ML18331A023), which was provided during the review of the LACBWR LTP. The RAI response stated:

> In December 2017, elevated concentrations of tritium (13,000 pCi/L) were detected in groundwater samples from MW-203 A, as part of the semiannual groundwater monitoring program. Once detected, and as part of the investigation of the cause of the elevated tritium levels in MW-203 A, the ice/snow melt/standing water impacted by exhaust from the Reactor Building Ventilation System was sampled and found to contain tritium concentrations up to approximately 237,000 pCi/L. Upon determining the tritium levels associated with the ice/snow melt, in March 2018, the ventilation system exhaust was modified, and the condensate was treated as liquid rad waste. Thus, the bounding end time of release to the ground was in March 2018, when no additional tritium was introduced to the ground or into the RPGPA excavation.

Section 6.5.4 of the LACBWR LTP states that a maximum concentration of 24,200 pCi/L of tritium was identified in February 2018 (well location MW-203 A). Figure 36, showing the locations of impacted wells MW-202 A and MW-203 A, as well as a qualitative prediction of the tritium plume within the shallow aquifer, was submitted as part of the licensee’s RAI reponse.

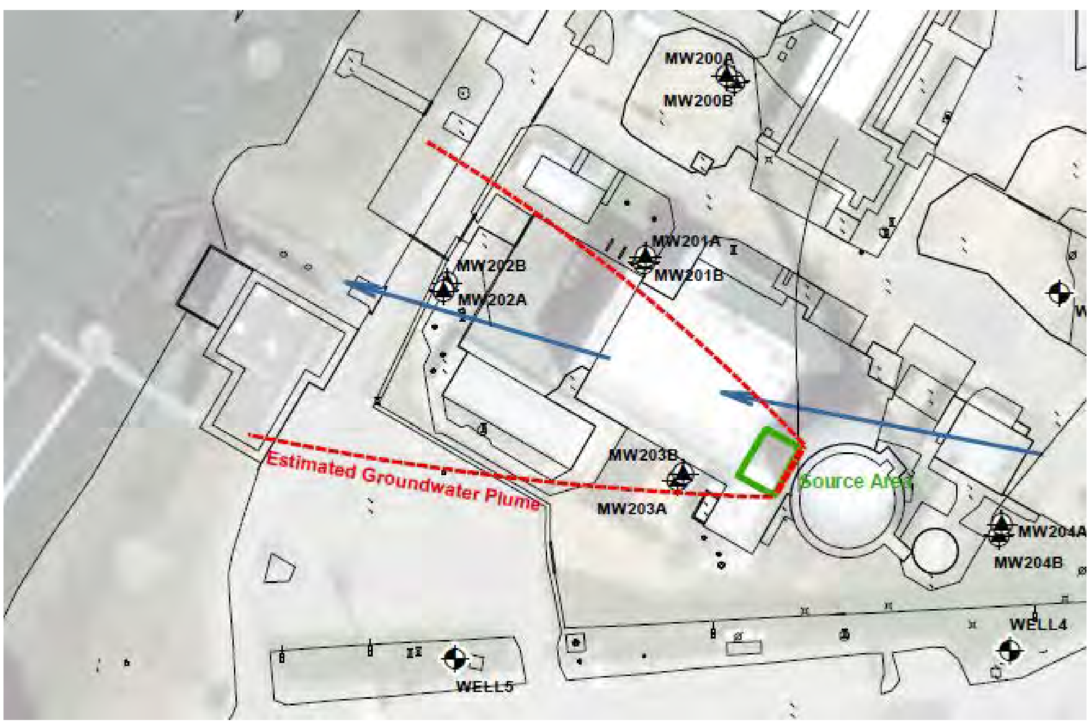


Figure 36. Predicted Path of the LACBWR Tritium Groundwater Plume in Shallow Aquifer with Well Locations

Because the measurement at well location MW-203 A did not likely reflect the maximum tritium in the plume, the licensee provided a numerical model-based estimate that utilized dye-tracer test data in the RAI response. Referencing this model-based estimate, the NRC safety evaluation that approved the LACBWR LTP (ML19008A079) stated:

> 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 safety evaluation), 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.

The November 15, 2018, RAI response also addressed the NRC staff's concern regarding bounding the maximum tritium concentration in the aquifer, rather than using maximum measured tritium concentrations from a well location that may not have been in the center of the plume. The licensee described the dose allotted to groundwater contamination as follows:

> The [radionuclide] concentrations for samples that were identified as positive in each [well] sampling event is shown in the following tables…. As shown in these tables, the maximum dose from the identified positive detections in 2014 was 0.471 mrem/yr from Pu-239 in well MW-DW7 during the June 2014 sampling event, with no identified H-3. As noted by the NRC staff, the total dose from groundwater that was assigned in ES TSD LC-FS-TSD-002, "Operational Derived Concentration Guideline Levels for Final Status Survey" (ML19007A037), Revision 1, was 3.25 mrem/yr, corresponding to a total dose fraction of 0.13 from groundwater, which was used to develop the operational DCGLs being applied for FSS activities at the site in recent months. This total dose can be reduced by 0.471 mrem/yr to obtain a remaining dose from H-3 of 2.779 mrem/yr, which corresponds to a H-3 concentration of over 110,000 pCi/L. This concentration is significantly higher than any observed H-3 concentration in groundwaters in MW-203 since January 2018. We therefore conclude that this analysis, coupled with the demonstration that we have reasonably bounded the maximum plume concentrations, confirms that the inclusion of the positive detections from the 2014 results does not change the conservative assumption in LC-FS-TSD-002, Revision 1, that the total groundwater dose from positive detections will not exceed the assigned dose of 3.25 mrem/yr.

However, while the total dose allotted for groundwater at LACBWR remained 3.25 mrem/yr, the partitioning of this dose changed between approval of the LACBWR LTP and compilation of the LACBWR FSSR. Reconciliation of the final groundwater dose allotted for incorporating the residual tritium contamination from 2017 and 2018 was discussed in Phase 3 of the LACBWR FSSR (ML20031C839), and is addressed in this safety evaluation in Section 3.6.3 below.

3.6.3 Total Assigned Groundwater Dose

Phase 3 of the LACBWR FSSR discusses the total dose assigned for existing groundwater. As described in the LACBWR LTP, the final groundwater dose could have been calculated by multiplying 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 by the groundwater exposure factors. Using this method, the licensee's assigned total dose from groundwater was 3.25 mrem/yr in accordance with ES TSD LC-FS-TSD-002.

However, Phase 3 of the LACBWR FSSR states:

> During the June 2014 sampling campaign, H-3 and Sr-90 were detected; Carbon-14, Technecium-99, Europium-152, Plutonium-239 and 240, and Americium-241 were also positively detected at low concentrations in several wells. The maximum dose rate calculated, using the [EPA's Federal Guidance Report (FGR) Number 11] FGR-11 ingestion dose conversion factors, from the identified positive detections in the June 2014 groundwater sampling event was 0.471 mrem/yr…. Although the June 2014 groundwater sampling event is outside the two-year window for inclusion in the dose summation for compliance, LaCrosse*Solutions* has conservatively reduced the 3.25 mrem/yr by 0.471 mrem/yr, thus yielding a remaining allowable dose rate for groundwater of 2.779 mrem/yr.

The NRC staff notes that the explanation for the partitioning the dose allotment for existing groundwater contamination changed, as described above, between (i) the LACBWR LTP, (ii) the November 15, 2018, RAI response and the NRC's associated safety evaluation that approved the LACBWR LTP, and (iii) Phase 3 of the LACBWR FSSR. However, the NRC staff finds that the use of a bounded maximum concentration of tritium, as discussed in the RAI response and the safety evaluation that approved the LACBWR LTP, and not the LTP itself, is maintained in Phase 3 of the LACBWR FSSR. The consequential change is that Phase 3 of the FSSR reduced the assigned dose for the existing groundwater contamination from 3.25 mrem/yr to 2.779 mrem/yr in the compliance equation (Table 28), which appears to be a nonconservative change. If the licensee's intention was to include the dose from the 2014 sampling campaign, as stated in the LACBWR LTP, the total dose of 3.25 mrem/yr allotted for existing groundwater should have been assigned to the compliance equation instead of 2.779 mrem/yr. The NRC staff, however, finds that the difference between 3.25 mrem/yr and 2.779 mrem/yr in assigned dose for the existing groundwater contamination is not consequential to compliance given that the final compliance dose from all sources for the LACBWR site was only 8.2 mrem/yr.

Table 28. Assigned Dose for Existing Groundwater from Phase 3 of the LACBWR FSSR

Sample Year	Maximum SOF	Dose (mrem/yr)
2014	0.0188	0.4710
2018/2019	0.0920	2.299
Total EGW	0.1108	2.779

3.6.4 Conclusion

For the reasons discussed above, as well as in the NRC evaluation of the LACBWR Class 1 excavation survey units and the NRC safety evaluation that approved the LACBWR LTP, the NRC staff has reasonable assurance that the approach to assessing groundwater dose, as outlined in the LACBWR FSSR and supporting documentation, is adequate to demonstrate compliance with the unrestricted release criteria specified in 10 CFR 20.1402.

3.7 Final Dose Conclusions

The NRC staff evaluated the entire LACBWR FSSR to examine the licensee's assessment of the doses resulting from exposure to residual radioactivity remaining at the LACBWR site now that the decommissioning process is complete. This review was conducted in accordance with the regulatory guidance and acceptance criteria contained in NUREG-1757, Volume 2, Revision 1, and NUREG-1700, Revision 2. Based on the discussion provided here, as well as in the associated sections of the NRC safety evaluations that approved (1) the LACBWR LTP (ML19008A079) and (2) the release of the Class 2 and Class 3 survey units from the LACBWR 10 CFR Part 50 license (ML22122A230), the NRC staff finds that the LACBWR FSSR provides reasonable assurance that the licensee performed adequate surveys to demonstrate compliance with the radiological criteria for unrestricted use, as specified in 10 CFR 20.1402.

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

- The licensee adequately characterized and applied its source term for LACBWR.
- The licensee analyzed the appropriate dose scenario(s), and the exposure group(s) adequately represent the 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 used radionuclide specific DCGLs for LACBWR and ensured that the total dose from all radionuclides and all sources (soil, backfilled basements, buried piping, remaining above ground structures, and groundwater) will meet the requirements of Subpart E of 10 CFR Part 20 using the sum of fractions approach and the compliance dose equation.

Therefore, the NRC staff concludes that the remaining portion of the LACBWR site to be released from License No. DPR-45 meets the radiological criteria for unrestricted release and may be removed from the requirements for future NRC oversight. Specifically, the total dose remaining at the LACBWR site from all of the Class 1, Class 2, and Class 3 survey areas was calculated to be 8.2 mrem/yr, which is less than the NRC unrestricted release criteria of 25 mrem/yr and is therefore acceptable (see Section 4 of this safety evaluation).

3.8 Remaining Dismantlement and Decommissioning Activities

With the exception of decommissioning activities at the LACBWR ISFSI, which will occur after all spent nuclear fuel has been permanently removed from the site, all decommissioning and dismantlement activities have been completed at LACBWR. Therefore, no dismantlement activities are required in the survey areas to be released. The LACBWR ISFSI and the immediately surrounding areas are to be retained under the 10 CFR Part 50 license.

3.9 Controls to Prevent Recontamination

The licensee stated that the requirements surrounding the LACBWR decommissioning activities, as well as the additional protections afforded by FSS isolation, control, and surveillance measures, provide strong assurance that the potential for cross-contamination of the subject survey units was minimal throughout the dismantlement process. The only remaining source of potential recontamination for the area to be released would involve the future dismantlement of the LACBWR ISFSI after the spent fuel has been permanently removed. Any contamination of the released site during ISFSI decommissioning would be considered an offsite release from the reduced (covering the LACBWR ISFSI area only) 10 CFR Part 50 licensed facility and would be addressed under the provisions of that license.

The licensee noted that the spent fuel at the LACBWR ISFSI is stored in the NAC Multipurpose Canister (MPC) system. The NAC-MPC system is a sealed and leak-tight spent fuel storage system that was subjected to in-process inspections and tests during fabrication and sealing of the canisters. The associated analyses demonstrate that there is no release of radioactive material during the normal conditions of spent fuel storage. In addition, the structural analysis of the canisters for off normal and accident conditions of storage shows that the canisters are not breached in any of the evaluated events. Consequently, there is no postulated release of radioactive material during off normal and accident conditions of storage that could impact the survey units proposed for release, thereby minimizing the potential for recontamination.

3.10 Impact of Proposed Partial Site Release on Programs and Documents

The licensing basis for LACBWR includes the maintenance of certain programs to fulfill regulatory requirements and functional responsibilities. Throughout decommissioning, the licensee has modified these programs as necessary, including terminating certain programs when the applicable concern is no longer relevant. These changes are implemented using the change processes specified for each type of program. The methodology for releasing the remaining land from the LACBWR 10 CFR Part 50 license requires a review and assessment of the impact on these programs for the lands remaining within the domain of the Part 50 license. The NRC accepted this change approach during review and approval of the LACBWR LTP.

3.10.1 Technical Specifications

The LACBWR Defueled Technical Specifications (TS) are not impacted by the release of the subject survey areas, as a size and description of the site are not included in the TS. The survey and release processes are consistent with the LACBWR LTP and associated license condition. The remaining NAC-MPC TS, addressing allowable surface contamination on the cask after loading and limiting the dose at the area boundary, among other requirements, remain in effect for the LACBWR ISFSI until that facility is decommissioned. The proposed site release will not affect the basis or applicability of any of the NAC-MPC TS.

3.10.2 Final Safety Analysis Report and PSDAR

The LACBWR Final Safety Analysis Report (FSAR) was last revised in 1986 and is considered a historical document. The document that took the place of the FSAR was the LACBWR Decommissioning Plan (D-Plan), which subsequently became the D-Plan/PSDAR and is also considered the Defueled Safety Analysis Report for the facility. The D-Plan/PSDAR does not contain a description of the site in detail; therefore, the proposed site release will not affect the overall content of the LACBWR D-Plan/PSDAR and immediate changes are not required as a result of the reduction of the 10 CFR Part 50 licensed area.

The LACBWR D-Plan/PSDAR for the reduced 10 CFR Part 50 licensed facility (i.e., covering the LACBWR ISFSI area only) will meet the 10 CFR 50.71(e) requirement for Part 50 licensed facilities to maintain an FSAR. The LACBWR 10 CFR Part 50 license, TS, and D-Plan/PSDAR, also serve as the basis for the LACBWR 10 CFR 50.59, “Changes, tests, and experiments,” program. The D-Plan/PSDAR will be maintained and updated as required by 10 CFR 50.71(e).

The LACBWR LTP is a supplement to the D-Plan/PSDAR. Upon release of the subject survey areas, the activities addressed by LACBWR LTP will be complete and there will no longer be a need for this document to be maintained or updated in accordance with either 10 CFR 50.82 or 10 CFR 50.71. A new or updated LTP will be required in the future in accordance with 10 CFR 50.82(a)(9) to support ISFSI decommissioning and final termination of the LACBWR 10 CFR Part 50 license. However, the NRC staff notes that should the licensee opt to maintain the information in the LACBWR LTP as part of the periodic updates to the D-Plan/PSDAR, efficiencies could be gained during a future review of an ISFSI LTP if similar decommissioning, radiological remediation, and/or survey methodologies are proposed. In addition, the licensee should consider what document(s) will be in effect during the movement of spent fuel offsite, and the staff notes that portions of the LACBWR LTP may be applicable to addressing the need for remediation or radiological characterization as a result of U.S. Department of Energy (DOE) transfer activities, which would potentially occur before development of the ISFSI LTP.

The LACBWR ISFSI uses the NAC-MPC dry cask storage system (DCSS) to store the LACBWR spent fuel at the onsite ISFSI under the general license provisions of 10 CFR Part 72, Subpart K, “General License for Storage of Spent Fuel at Power Reactor Sites.” The design is governed by Certificate of Compliance (CoC) 72-1025 for the NAC-MPC DCSS and its associated DCSS FSAR. The licensee for the LACBWR ISFSI, which is DPC, has fulfilled the requirements in accordance with 10 CFR 72.212, “Conditions of general license issued under § 72.210,” to conduct the required reviews for bounding the site-specific design basis and conditions of the the NAC-MPC DCSS CoC. As such, the FSAR for the reduced (covering the LACBWR ISFSI area only) 10 CFR Part 50 licensed facility will be the NAC-MPC DCSS FSAR. Maintenance of this FSAR, including additional updates to that document, will be covered by the requirements of 10 CFR Part 72 as they apply to the LACBWR ISFSI.

3.10.3 Quality Assurance Program

On November 1, 2018 (ML18277A308), the NRC approved Revision 30 to the LACBWR Quality Assurance Program Description (QAPD) to provide a consolidated overview of the quality program and controls that govern the operation and maintenance of the LACBWR ISFSI, which will remain at the site after decommissioning activities for the LACBWR reactor plant are complete. The LACBWR QAPD was updated to Revision 31 on July 12, 2022 (ML22224A137).

The changes to the QAPD reflect the organizational structure that will exist at the facility after implementation of the license transfer request (ML18184A444) from LS to DPC, which will go into effect once the LACBWR 10 CFR Part 50 license has been reduced to cover only the footprint of the ISFSI. Following approval of the proposed transfer of control of the LACBWR license (No. DPR-45), DPC will acquire full ownership of the facility, similar to what existed before the June 1, 2016 (ML16123A049), license transfer to LS. The subsequent QAPD will reflect that LS's licensed possession, maintenance, and decommissioning authorities have been transitioned back to DPC upon completion of decommissioning activities at the LACBWR site.

Thereafter, DPC will continue to maintain the onsite LACBWR ISFSI under the provisions of the QAPD and other applicable ISFSI programs, and the ultimate disposition of the spent nuclear fuel will be provided for under the terms of DPC's Standard Contract for Disposal of Spent Nuclear Fuel and/or High Level Waste with DOE. DPC will also continue to maintain its nuclear decommissioning trust, which is a grantor trust in which funds are segregated from its assets and outside its administrative control, as well as maintain the appropriate levels of insurance for the LACBWR ISFSI and the associated indemnity agreements, as appropriate.

3.10.4 Decommissioning Environmental Report

In Chapter 8, "Supplement to the Environmental Report," of the LACBWR LTP, Revision 1, the licensee evaluated the environmental impacts of decommissioning La Crosse compared to NUREG-0586, "Final Generic Environmental Impact Statement (GEIS) on Decommissioning of Nuclear Facilities," and determined that the decommissioning activities were bounded by the GEIS. The staff evaluated the environmental information contained in the LACBWR LTP as part of the review and approval of that document (ML19008A079).

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 (EA/FONSI) was published in the *Federal Register* on May 21, 2019 (84 FR 23083). Accordingly, based upon the environmental assessment, the Commission determined as part of the LTP approval that issuance of the LTP amendment did not have a significant effect on the quality of the human environment.

This NRC action, approval of the partial site release to remove the area beyond the LACBWR ISFSI footprint from the 10 CFR Part 50 license, was also considered in the EA/FONSI published in the *Federal Register* in May 2019. The decommissioning process is complete for the area to be released and was conducted under the provisions of the LACBWR LTP license amendment; therefore, the conclusions documented in the previously issued environmental reports and associated EA/FONSI are not impacted by the proposed partial site release.

3.10.5 Decommissioning Financial Assurance Reporting Requirements

The annual decommissioning financial assurance reporting requirement of 10 CFR 50.82(a)(8)(v) can be interpreted as still applying to a 10 CFR Part 50 licensee with a general licensed ISFSI, even after all decommissioning and remediation activities except those associated with the ISFSI are complete. However, 10 CFR 72.30(c) already requires the reporting (not to exceed every three years) of financial assurance for ISFSI decommissioning.

As a practical matter, the NRC staff interprets 10 CFR 50.82(a)(8)(v) as only applying to reactor decommissioning, such that when it refers to termination of the license, it is referring to the licensing of the reactor facility itself and not the licensing of the ISFSI (i.e., the 10 CFR Part 50 license could be terminated at this point in time, but the licensee would need a separate, specific license for its ISFSI in that case). Moreover, the language in 10 CFR 50.82(a)(8)(v) only mentions that residual radioactivity has been reduced to a level that "permits" termination of the license and not that the license has in fact been terminated (and the 10 CFR Part 50 license cannot be fully terminated if the licensee wants to maintain a general license for its ISFSI).

Therefore, it is considered acceptable for 10 CFR Part 50 licensees that have completed decommissioning with the exception of the general licensed ISFSI, and have terminated the 10 CFR Part 50 license outside of the boundary of the ISFSI, to provide every-three-year decommissioning financial assurance reports under 10 CFR 72.30(c) and annual spent fuel management reports under 10 CFR 50.82(a)(8)(vii), and to not provide annual decommissioning financial assurance reports under 10 CFR 50.82(a)(8)(v).

The NRC staff notes that codification of this interpretation is being proposed in an ongoing rulemaking activity related to reactor decommissioning (see: Regulatory Improvements for Production and Utilization Facilities Transitioning to Decommissioning). However, because this decommissioning rulemaking has not been finalized, the licensee should maintain awareness of the potential for additional changes in this area and plan the frequency of submittal for the LACBWR ISFSI decommissioning financial assurance reports accordingly.

3.10.6 ISFSI Emergency Plan and Security Plan

As the former nuclear plant has been dismantled and decommissioned, the Emergency Plan and Security Plan for the La Crosse site have been revised to address only the LACBWR ISFSI. The NRC approved the revised Emergency Plan in April 2022 (ML22068A210). The LACBWR ISFSI Emergency Plan describes the emergency response plan for the ISFSI, including the location of the ISFSI, the radiologically controlled and protected areas, and the Controlled Area Boundary. None of these locations or areas will be affected by the proposed partial site release, and DPC will continue to maintain control of this area in accordance with the provisions of 10 CFR 72.106, "Controlled area of an ISFSI or [Monitored Retrievable Storage] MRS," Therefore, neither the LACBWR Emergency Plan nor Security Plan will be affected by the release of the proposed areas from the LACBWR 10 CFR Part 50 license.

3.10.7 Offsite Dose Calculation Manual and Environmental Monitoring Program

Gaseous, liquid, and solid radioactive waste systems associated with the operation of LACBWR have been removed and disposed. All decommissioning activities have concluded for the site (except those required in the future for the LACBWR ISFSI), and liquid or gaseous discharges of radioactive material are no longer made. In addition, the LACBWR ISFSI casks are considered leak-tight under normal and various postulated accident conditions, and therefore are not considered a source of effluent. Accordingly, the licensee revised the Offsite Dose Calculation Manual (ODCM) and the Environmental Monitoring Program to only address the monitoring associated with the LACBWR ISFSI. The National Pollutant Discharge Elimination System (NPDES) permit for the site is solely used for coal plant discharges associated with Genoa 3. Monitoring in accordance with the LACBWR ODCM and Environmental Monitoring Program continues and will not be impacted by the proposed site release.

3.10.8 Groundwater Monitoring Program

The LACBWR groundwater monitoring program is intended to integrate all aspects of groundwater characterization, monitoring, and remediation required to support unrestricted release of the former reactor site. In a letter dated August 26, 2019 (ML19240A312), the licensee requested NRC concurrence to terminate the LACBWR groundwater monitoring program upon removal of the last shipment of radiological waste from the site prior to license termination. The NRC staff determined that termination of the LACBWR groundwater monitoring program was acceptable in a letter dated October 1, 2019 (ML19268A086), and the licensee could proceed with cancellation of the program and abandonment of the onsite and offsite monitoring wells at the end of active decommissioning activities. The Wisconsin Department of Natural Resources concurred with this decision in a letter dated January 29, 2020. Therefore, the LACBWR groundwater monitoring program is no longer required for the purposes of meeting the requirements of the 10 CFR Part 50 license.

3.10.9 Fire Protection and Training Programs

The ISFSI Fire Protection Program will not be affected by the release of the subject survey areas from the LACBWR 10 CFR Part 50 license. The training program for the ISFSI structures, systems and components that are important to safety will not be affected by the release of the subject areas from the LACBWR 10 CFR Part 50 license.

3.11 10 CFR Part 100 Siting Criteria

Part 100, “Reactor Site Criteria,” of 10 CFR addresses the design and environmental aspects to be considered during the siting of a power reactor. Decommissioning of the power reactor portion of the LACBWR site has been completed. The licensee determined that the requirements of 10 CFR Part 100 are either not impacted or not applicable to the remaining licensed portion of the site. Specifically, the LACBWR reactor vessel has been defueled and removed from the site for disposal. The spent nuclear fuel has been relocated to the south end of the site into the licensed ISFSI area. Only the LACBWR ISFSI will remain under the 10 CFR Part 50 license after the proposed site release. Therefore, the criteria of 10 CFR Part 100 no longer apply to the LACBWR reactor site and need not be further addressed.

3.12 Spent Fuel Storage and Management

In terms of spent fuel management, the NRC staff notes that DPC retains possession and ownership of, and title to, the spent nuclear fuel, keeps in effect its Standard Contract with DOE for the disposal of spent nuclear fuel, and maintains all rights and obligations under that contract, consistent with the terms of Section 302(b)(3) of the Nuclear Waste Policy Act of 1982, as amended. DPC’s continued ownership of the LACBWR spent nuclear fuel and retention of the associated title is authorized under general licenses granted for the ownership, but not possession, of spent fuel pursuant to 10 CFR 72.6(b) and the general licenses for byproduct, source, and special nuclear material granted pursuant to 10 CFR 31.9, “General license to own byproduct material,” 10 CFR 40.21, “General license to receive title to source or byproduct material,” and 10 CFR 70.20, “General license to own special nuclear material,” respectively.

Possession Only License No. DPR-45 also addresses the general licenses granted for the receipt, possession, and use of byproduct, source, and special nuclear material in accordance with the regulations in 10 CFR Part 30, “Rules of General Applicability to Domestic Licensing of Byproduct Material,” 10 CFR Part 40, “Domestic Licensing of Source Material,” and 10 CFR

Part 70, "Domestic Licensing of Special Nuclear Material." These requirements include 10 CFR 30.33, "General requirements for issuance of specific licenses," 10 CFR 40.32, "General requirements for issuance of specific licenses," 10 CFR 70.23, "Requirements for the approval of applications," and 10 CFR 70.31, "Issuance of licenses," as they apply to Possession Only License No. DPR-45. DPC's financial responsibilities related to the LACBWR ISFSI and the spent nuclear fuel will be unchanged following implementation of the transfer of control of the LACBWR license from LS to DPC at the completion of decommissioning and will not be affected by release of the subject areas from the LACBWR 10 CFR Part 50 license.

Pursuant to 10 CFR 50.54(bb), DPC submitted its original Spent Fuel Management and Funding Plan on September 26, 2003 (ML032881008), as supplemented on March 2, 2004 (ML040780310), before completion of construction of the onsite ISFSI and movement of all the LACBWR spent fuel assemblies to dry storage, which was completed in September 2012. Subsequent updates to the licensee's plan for the funding and management of the LACBWR spent fuel have been submitted in accordance with 10 CFR 72.30, "Financial assurance and recordkeeping for decommissioning," with the most recent update occurring on March 28, 2022 (ML22108A056). DPC will continue to make triennial updates to this plan as required by 10 CFR 72.30 and will include the details for decommissioning of the LACBWR ISFSI as they are established and become available in the future.

3.13 License Termination Plan

The requested site release is consistent with the information in the approved LACBWR LTP concerning FSS and partial site release criteria. A minor revision will be made to the LACBWR LTP (which is incorporated as a supplement to the D-Plan/PSDAR) to revise the area of the site still under the 10 CFR Part 50 license after the release request is approved by the NRC. The proposed release does not impact the remainder of the LACBWR LTP, which did not address the area that will remain part of the 10 CFR Part 50 license surrounding the LACBWR ISFSI.

However, because the actions described in the LACBWR LTP relative to release of the radiologically impacted portions of the site from the LACBWR 10 CFR Part 50 license, with the exception of those areas that encompass the ISFSI, are now complete, the license condition in Section 2.C.(5), "License Termination Plan," of Possession Only License No. DPR-45 is no longer required. This license condition establishes the criteria under which the licensee may make changes to the LACBWR LTP without prior NRC approval, and requires that the provisions of the LTP remain in effect while the licensee is conducting the decommissioning and license termination activities described in the approved license termination plan.

The NRC staff notes that no physical or operational changes to the facility were requested beyond those activities captured in the LACBWR PSDAR and LACBWR LTP, and removal of the LTP license condition will reflect execution of the proposed partial site release action and the results of the completion of decommissioning and license termination (outside the ISFSI footprint) activities at the site. This change to the LACBWR 10 CFR Part 50 license would involve no safety questions and is administrative in nature. Accordingly, as a matter of timing and procedure, removal of the LACBWR LTP license condition as part of a future license amendment activity is acceptable, and may be incorporated into the conforming amendment that executes the license transfer from LS to DPC once the LACBWR decommissioning activities are complete. A draft version of this amendment, which did not include the LACBWR LTP license condition, was reviewed and approved by the NRC staff as part of the evaluation of the transfer order, which was approved on September 24, 2019 (ML19008A393).

Prior to complete license termination, the licensee will be required to demonstrate to the NRC that it has reduced the residual radioactivity at the ISFSI to the levels specified in 10 CFR 20.1402 or 10 CFR 20.1403, "Criteria for license termination under restricted conditions." Such reduction in residual radioactivity will be accomplished through decontamination and other remedial activities related to removal of the LACBWR ISFSI and termination of the 10 CFR Part 50 license. As part of any future decommissioning activities, the licensee will submit, for NRC approval, a decommissioning plan (for specific licensees) or a license termination plan (for general licensees) in accordance with 10 CFR 72.54, "Expiration and termination of licenses and decommissioning of sites and separate buildings or outdoor areas," or 10 CFR 50.82, respectively. The NRC will conduct a separate environmental review in support of the licensee's ISFSI decommissioning plan or license termination plan.

As noted previously, should the licensee opt to retain the LACBWR LTP license condition and maintain the information in the LACBWR LTP as part of the periodic updates to the D-Plan/PSDAR, efficiencies could be gained during a future review of an ISFSI LTP if similar decommissioning, radiological remediation, survey methodologies, etc. are proposed. A final decision on retention and maintenance of the LACBWR LTP and its associated license condition will be documented in the conforming license amendment that will be issued after implementation of the license transfer from LS to DPC. This decision will be based on appropriate considerations from the LACBWR ISFSI licensee.

3.14 Expiration of the LACBWR Possession Only License No. DPR-45

The NRC staff notes that 10 CFR 50.51, "Continuation of license," provides for 10 CFR Part 50 operating licenses to continue in effect beyond their expiration dates for a facility that has permanently ceased operations. This continuation authorizes ownership and possession of the production or utilization facility until the Commission notifies the licensee in writing that the license is terminated. In accordance with this requirement, during the period of continued license effectiveness, the licensee shall (1) take actions necessary to decommission and decontaminate the facility and continue to maintain the facility, including, where applicable, the storage, control and maintenance of the spent fuel, in a safe condition; and (2) conduct activities in accordance with all other restrictions applicable to the facility in accordance with the NRC regulations and the provisions of the specific 10 CFR Part 50 license for the facility.

Therefore, the original LACBWR Provisional Operating License No. DPR-45, which was issued on August 28, 1973 (ML17080A423) and would have expired on August 27, 2013, remains in effect to govern the remaining portion of the 10 CFR Part 50 licensed site (approximately 39 acres surrounding the LACBWR ISFSI) after execution of the proposed site release and the general license LACBWR ISFSI, in accordance with the provisions of 10 CFR 50.51.

However, the provisions of 10 CFR 50.82(a)(3) require that:

> Decommissioning will be completed within 60 years of permanent cessation of operations. Completion of decommissioning beyond 60 years will be approved by the Commission only when necessary to protect public health and safety. Factors that will be considered by the Commission in evaluating an alternative that provides for completion of decommissioning beyond 60 years of permanent cessation of operations include unavailability of waste disposal capacity and other site-specific factors affecting the licensee's capability to carry out decommissioning, including presence of other nuclear facilities at the site.

Therefore, it may become necessary for the LACBWR licensee to address the expiration of the 60-year period for decommissioning and termination of the LACBWR 10 CFR Part 50 license specified in 10 CFR 50.82(a)(3) if the ISFSI cannot be decommissioned and the 10 CFR Part 50 license fully terminated by May 1, 2047 (60 years after the permanent shutdown date of April 30, 1987 (ML17080A422)). The NRC staff notes that that existing regulations provide for exemption requests to the decommissioning and license termination timeline under the provisions of 10 CFR 50.12, "Specific exemptions," and that specific considerations for extending the 60-year decommissioning timeframe are captured in 10 CFR 50.82(a)(3).

3.15 Additional Records Required for License Termination

The licensee stated that LACBWR will maintain the following records throughout the license termination process: (1) a map of the site identifying the reactor facility and licensed site as defined in the original license; (2) a record of the Phase 1, Phase 2, and Phase 3 survey units released under the proposed site release; and (3) documentation of the final radiological conditions of the land released under the proposed site release. In addition to the license termination requirements of 10 CFR Part 50, 10 CFR Part 30, 10 CFR Part 40, and 10 CFR Part 70 also contain requirements for the forwarding of specific records to the NRC prior to license termination. Table 29 below summarizes these requirements.

Table 29. Record Forwarding Requirements

10 CFR 30.51(d)	Prior to license termination, each licensee authorized to possess radioactive material with a half-life greater than 120 days, in an unsealed form, shall forward the following records to the appropriate NRC Regional Office: (1) Records of disposal of licensed material made under 10 CFR 20.2002 (including burials authorized before January 28, 1981), 20.2003, 20.2004, 20.2005; and (2) Records required by 10 CFR 20.2103(b)(4).
10 CFR 30.51(f)	Prior to license termination, each licensee shall forward the records required by 10 CFR 30.35(g) to the appropriate NRC Regional Office.
10 CFR 40.61(d)	Prior to license termination, each licensee authorized to possess source material, in an unsealed form, shall forward the following records to the appropriate NRC Regional Office: (1) Records of disposal of licensed material made under 10 CFR 20.2002 (including burials authorized before January 28, 1981), 20.2003, 20.2004, 20.2005; and (2) Records required by 10 CFR 20.2103(b)(4).
10 CFR 40.61(f)	Prior to license termination, each licensee shall forward the records required by 10 CFR 40.36(f) to the appropriate NRC Regional Office.
10 CFR 70.51(a)	Before license termination, licensees shall forward the following records to the appropriate NRC Regional Office: (1) Records of disposal of licensed material made under 10 CFR 20.2002 (including burials authorized before January 28, 1981), 20.2003, 20.2004, 20.2005; and (2) Records required by 10 CFR 20.2103(b)(4); and (3) Records required by 10 CFR 70.25(g).

3.16 Interaction Among the Site Release, Previous Site Releases, and Remaining Site

On April 12, 2017, the NRC staff approved the release of approximately 88 acres of the original 163-acre LACBWR site, which were classified as radiologically non-impacted, from the LACBWR license. This action was taken in response to a request dated June 27, 2016 (ML16181A068), in accordance with the provisions of 10 CFR 50.83, which requires written approval from the NRC prior to release for unrestricted use of any part of a power reactor facility or site before receiving approval of a license termination plan. These previously released areas were classified as non-impacted with release criteria of "no detectable plant-related radioactivity above background." Any migration of material from the previously released areas to the proposed release area (although unlikely) would have radionuclide concentrations well below the OpDCGLs used in the areas of the proposed release. Therefore, the previous land release will not have an adverse effect on the areas of the proposed release.

The LACBWR ISFSI is located within the boundary of the existing LACBWR site. The CAB for an ISFSI, as defined in 10 CFR 72.3, "Definitions," is the area immediately surrounding an ISFSI for which the licensee exercises authority regulating its use and within which ISFSI operations are performed. The ISFSI CAB will encompass some of the land being proposed for release from jurisdiction of the LACBWR 10 CFR Part 50 license; however, this area will continue to be under the authority and control of the licensee until the spent fuel has been transferred offsite.

As previously discussed, approximately 39 acres of land around the LACBWR ISFSI will remain under the LACBWR 10 CFR Part 50 license. The licensee performed a radiological evaluation for the LACBWR ISFSI and surrounding area in accordance with 10 CFR 72.104, "Criteria for radioactive materials in effluents and direct radiation from an ISFSI," to ensure that the associated dose requirements have been met. The proposed site release will not affect the basis for this evaluation or the NAC-MPC TS or FSAR, as the assumed residual plant area dose is on the opposite side of the site and a calculation performed by the licensee combining the dose from the LACBWR ISFSI and the residual plant area dose confirms that the NAC-MPC TS basis will continue to be maintained after the proposed site release has been implemented.

3.17 Site Release Criteria and Final Status Survey Activities

The licensee stated that the site release criteria for the LACBWR reactor site correspond to the 10 CFR 20.1402 criteria for unrestricted use. The residual radioactivity, including that from groundwater sources, which is distinguishable from background, must not cause the total effective dose equivalent (TEDE) to the average member of the critical group (AMCG) to exceed 25 mrem/yr. The residual radioactivity must also be reduced to levels that are ALARA.

The results of the licensee's final compliance dose is 8.2 mrem/yr, which meets the release criterion in 10 CFR 20.1402 for unrestricted use, including the ALARA criterion that requires an evaluation as to whether it is feasible to further reduce residual radioactivity to levels below those necessary to meet the dose criterion. The licensee's ALARA analyses for the remaining radioactivity at the LACBWR site across all types of survey units were included in the LACBWR LTP. The NRC staff confirmed that the remediation levels presented in the LACBWR FSSR support the conclusions reached during the LACBWR LTP evaluation (ML19008A079) related to acceptable methods for determining situations when the costs for additional dose reduction below the regulatory release criterion exceed the calculated benefit value. Therefore, the proposed site release complies with the ALARA criteria of 10 CFR 20.1402.

In addition, the licensee stated that the sections of the LACBWR FSSR which support this release conclusion demonstrate that the radiological surveys were conducted in a manner consistent with the LACBWR LTP, and that the survey units passed the FSS statistical test. Specifically, the LACBWR FSSR indicated that:

- each survey unit in the final reports have met the DQOs of the FSS sample plans;
- all identified ROC were used for statistical testing to determine the adequacy of the survey unit for FSS;
- the sample data in each survey unit passed the Sign Test;
- a retrospective power curve showed that adequate power was achieved in each survey unit; and
- the allowable dose for each survey unit has been met.

The licensee used the applicable guidance from MARSSIM, NUREG-1757, and the appropriate site procedures (ML23023A148) to review and assess the FSS data for the LACBWR site.

4.0 FINAL DOSE SUMMATION

In its February 14, 2020 (ML20052D015), partial site release request, the licensee stated that each radionuclide-specific Base Case DCGL for the LACBWR site is equivalent to the level of residual radioactivity (above background radiation levels) that could, when considered independently, result in a TEDE of 25 mrem/yr to the AMCG. Compliance is demonstrated through the summation of the dose from each of the ROCs in each of the five media remaining at the LACBWR site (i.e., backfilled basement concrete, soil, buried piping, above grade buildings, and existing groundwater). The compliance dose equation is reproduced below.

Equation 13

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

where:

$\text{Max BcSOF}_{\text{BASEMENT}}$ = Maximum Base Case (BcSOF) (mean of the FSS systematic results plus the dose from any identified elevated areas) for backfilled basements

$\text{Max BcSOF}_{\text{SOIL}}$ = Maximum BcSOF (mean of the FSS systematic results plus the dose from any identified elevated areas) for open land survey units

$\text{Max BcSOF}_{\text{BURIED PIPE}}$ = Maximum BcSOF (mean of the FSS systematic results plus the dose from any identified elevated areas) from buried piping survey units

$\text{Max BcSOF}_{\text{AG BUILDING}}$ = Maximum BcSOF (mean of the FSS systematic results plus the dose from any identified elevated areas) from above grade standing building survey units

$\text{GW BcSOF}_{\text{BS OB}}$ = Groundwater scenario dose from the “other

		basement" (OB), which is defined as the basement not used to generate the Max $BcSOF_{BASEMENT}$
GW $BcSOF_{BPS\ OBP}$	=	Groundwater scenario dose from the "other buried pipe" (OBP), which is defined as the buried pipe survey unit not used to generate the Max $BcSOF_{BURIED\ PIPE}$
Max SOF_{EGW}	=	Maximum sum of fraction from existing groundwater (EGW)

Dose summation for compliance was conducted as discussed in Chapter 6 of the LACBWR LTP, Revision 1, as approved in the associated NRC safety evaluation (ML19008A079), after FSS was completed in all 41 survey units. The results of the final compliance dose were calculated by the licensee using the maximum SOF dose for the five media and the two groundwater scenarios. The licensee's final dose summation is replicated in Table 30 below.

Table 30. LACBWR Final Compliance Dose Summation

Source	Survey Unit	Base Case SOF	Dose (mrem/yr)
Max $BcSOF_{BASEMENT}$	B1-010-004	0.0233	0.5813
Max $BcSOF_{SOIL}$	L1-SUB-CDR	0.0408	1.0190
Max $BcSOF_{BURIED\ PIPE}$	S3-012-109 A	0.1204	3.0112
Max $BcSOF_{AG\ BUILDING}$	B2-010-101	0.0202	0.5055
Max SOF_{EGW}	N/A	0.1108	2.770
GW $BcSOF_{BS\ OB}$	B1-010-001	0.0001	0.0025
GW $BcSOF_{BPS\ OBP}$	S2-011-101 A	0.0138	0.345
TOTAL		**0.3294**	**8.2345**

The NRC staff verified that the doses assumed for all sources represent the maximum dose for that type of survey unit and that the values are reflective of the values in the LACBWR FSSR. The NRC staff notes that the final FSS release record for Survey Unit B2-010-101, associated with the LACBWR crib house survey unit, has a dose assigned of 0.5081 mrem/yr instead of 0.5055 mrem/yr. However, this difference does not have a significant impact on the total compliance dose estimate. The licensee calculated the SOFs appropriately and summed the doses in a way that was consistent with the approved LACBWR LTP. The licensee has adequately demonstrated that the TEDE to an AMCG is less than 25 mrem/yr and ALARA.

5.0 NRC INSPECTIONS AND CONFIRMATORY SURVEYS

NRC inspectors and survey contractors from the Oak Ridge Associated Universities (ORAU) performed multiple inspection activities, as well as in-process and confirmatory surveys of the radiological conditions at LACBWR, throughout the decommissioning process, with a particular focus on the expanded decommissioning activities undertaken after the June 1, 2016, license transfer from DPC to LS. ORAU also performed confirmatory laboratory analysis of samples collected from the site. Note that the LACBWR Class 2 and Class 3 open land area survey units received confirmatory surveys as discussed in the ORAU report titled "Remaining Land Areas."

Reports associated with the ORAU confirmatory surveys and sample analyses were provided on January 23, 2017 (ML17024A021, Confirmatory Survey Results for Non-Impacted Land Areas), March 23, 2018 (ML20296A507, Confirmatory Survey of Turbine Building Survey Unit L1-010-102), June 20, 2018 (ML19007A032, Confirmatory Survey Results for Circulating Water Discharge Interior Piping), June 26, 2019 (ML20296A513, Confirmatory Survey Results for Reactor Building Basement), and January 10, 2020 (ML20296A519, Confirmatory Survey Results for Remaining Land Areas). NRC inspections of the LACBWR decommissioning and survey activities are documented in inspection reports dated July 27, 2016 (ML16210A435), March 16, 2017 (ML17080A143), February 12, 2018 (ML18043B109), February 13, 2019 (ML19045A237), October 21, 2019 (ML19294A284), October 8, 2020 (ML20282A553), January 7, 2022 (ML22005A144), and December 27, 2022 (ML22005A144).

The NRC inspectors reviewed the licensee's survey results, survey methodology, and plans for demonstrating that the survey results would confirm that the remaining structures and areas at LACBWR met the acceptable radiological levels for unrestricted release. The NRC staff also reviewed confirmatory and in-process radiation and contamination surveys conducted by ORAU. Confirmatory surveys provide confidence that the licensee's survey results are representative of the conditions for that survey unit. In-process surveys provide confidence that the licensee's survey results are accurate. Based on the data review, discussions, and ORAU and NRC staff observations, the NRC inspectors observed that the licensee had in place methods for demonstrating compliance with the unrestricted release criteria.

In summary, NRC inspections and ORAU confirmatory surveys corroborated that the radiological conditions of the LACBWR Class 1 survey units proposed to be released from the 10 CFR Part 50 license met the approved site-specific DCGLs, and that LACBWR's radiological laboratory data were consistent and in agreement with the ORAU analytical results.

6.0 EVALUATION OF THE NEED FOR NRC/EPA LEVEL 2 CONSULTATION

The NRC and the EPA entered into a Memorandum of Understanding (MOU) for "Consultation and Finality on Decommissioning and Decontamination of Contaminated Sites" on October 9, 2002 (ML022830208). The MOU provides that, unless an NRC-licensed site exceeds any of three trigger criteria contained in the MOU, the EPA agrees to a policy of deferral to the NRC for decisions on decommissioning, without the need for consultation. For sites that trigger the criteria in the MOU, the NRC will consult with the EPA at two points in the decommissioning process: (1) prior to NRC approval of the licensee's LTP or Decommissioning Plan, which the NRC terms Level 1 consultation; and (2) following completion of the FSS, which the NRC terms Level 2 consultation.

On December 17, 2017 (ML17047A604), the NRC sent a Level 1 consultation letter to the EPA titled "Consultation on the Decommissioning of the La Crosse Boiling Water Reactor in Genoa, Wisconsin." This letter was sent because the licensee's proposed DCGLs for certain radionuclides at LACBWR exceeded the soil concentration values in Table 1 of the MOU related to the industrial use scenario. The EPA responded to the Level 1 consultation by letter dated March 13, 2018 (ML18303A311).

As noted in the Level 1 consultation letter to the EPA (ML17047A604), the DCGLs for all of the proposed ROCs at LACBWR (Co-60, Cs-137, and Sr-90) exceed the MOU soil concentration levels for the industrial use scenario. However, the residual radioactivity at the site was lower than the proposed DCGL values because meeting the "not to exceed 25 mrem/yr" criteria must be demonstrated using an all pathways, SOF approach. Each individual DCGL represents a concentration level corresponding to 25 mrem/yr. Thus, in applying the SOF requirement, the actual cleanup values were reduced to ensure that the potential dose from all residual radioactivity at the site from all media is less than 25 mrem/yr.

In a letter dated September 3, 2021 (ML21235A121), the NRC informed the EPA that a Level 2 consultation is not required based on the measured residual radioactivity remaining at the LACBWR site at this time. Specifically, the NRC staff determined that none of the LACBWR survey unit average concentrations exceeded the SOF trigger value of 1.0 when compared to the Table 1 values of the EPA MOU.

7.0 CONCLUSION

The requirements in 10 CFR 50.82(a)(11) establish the criteria to be used by the NRC for terminating all or portions of the license of a power reactor facility that has an approved LTP. These criteria include: (1) dismantlement has been performed in accordance with the approved LTP, and (2) the final radiation survey and associated documentation demonstrate that the facility and site have met the criteria for decommissioning in 10 CFR Part 20, Subpart E.

The NRC staff has concluded that all decommissioning and dismantlement activities have been completed in the sixteen survey units to be released from the LACBWR license as part of this action, and the release of the subject survey units supports the process of license termination by demonstrating that this portion of the site can be released from the 10 CFR Part 50 license. The FSS activities have confirmed that the residual radioactivity in each of the survey units meets the criteria established in the LACBWR LTP.

The NRC staff's review of the LACBWR LTP determined that the proposed DCGLs would ensure that the 10 CFR Part 20, Subpart E, release criteria would be met. The NRC staff's subsequent review of the LACBWR FSSR determined that the FSS reports demonstrated compliance with the derived concentration guideline levels in the LACBWR LTP. Therefore, the FSS results demonstrate that the survey areas to be released as part of this action meet the radiological criteria for unrestricted release. The total dose for the site was 8.2 mrem/yr, which is less than the NRC unrestricted release criteria of 25 mrem/yr, and in compliance with the ALARA criteria established in the LACBWR LTP, and is therefore acceptable.

Based on these considerations, the NRC staff finds that the data in the licensee's LACBWR FSS reports dated September 17, 2019, December 16, 2019, and January 28, 2020 (ML19261A344, ML20006D756, and ML20031C839, respectively), as supplemented by information provided on November 2, 2020, July 28, September 7, October 20, and November 11, 2022 (ML20356A041, ML22223A088, ML22269A395, ML22297A004, and ML22321A014 respectively), is adequate to provide reasonable assurance that the remaining LACBWR Class 1 survey units meet the unrestricted use criteria of 10 CFR 20.1402. The NRC staff's findings are supported by multiple NRC inspections and ORAU/ORISE confirmatory measurements that substantiated that the licensee's decommissioning and FSS programs adequately assessed radiological conditions at the site.

In addition, the NRC staff concluded that (1) the FSS activities were effectively conducted in accordance with the underlying assumptions of the LACBWR LTP; (2) the applicable portions of the LACBWR FSSR contain the necessary information identified in NUREG-1757, "Consolidated NMSS Decommissioning Guidance;" and (3) the FSS results demonstrate that the residual radioactivity assessed meets the radiological criteria for unrestricted release identified in the NRC-approved LACBWR LTP (ML19008A079). Therefore, the NRC determined that the subject sixteen survey areas from the LACBWR Possession Only License, No. DPR-45, as specified in the LaCrosse*Solutions*, LLC, February 14, 2020 (ML20052D015), partial site release request, meet the criteria for release from the license and that these survey units shall, therefore, be released from the license. Accordingly, the NRC now considers Possession Only License No. DPR-45 to be terminated outside the boundary of the LACBWR ISFSI.

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