Audit Questions & Clarifications

Health Physics

1) **Data Reporting:** Clarify how HDI reports results from site characterization/final status surveys.

   HDI's characterization summary data tables in the proposed LTP report minimal detectable concentration (MDC) as the analytical result if the actual result was less than the MDC. *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) guidance (NUREG-1575, Revision 2) states that the actual sample results should be reported even if less than "0." In the proposed LTP, HDI states it was developed following MARSSIM guidance. MARSSIM states results should be directly reported even if less than the MDC which is inconsistent with the data being presented in the characterization summary. If the results are not provided in future reports, the NRC staff anticipates additional data requests to obtain the analytical results for statistical tests so that staff can verify the licensee's statistical results.

   NRC Comment: However, it would be beneficial to the NRC staff if HDI continued its practice of "bolding" those results that are greater than the MDC. A summary statistic table of the MDC data could be added to address the topic of achieved MDCs for the survey. This practice could further streamline the NRC staff's review as it would demonstrate that measurements had sufficient sensitivity to see residual radioactivity at the derived concentration guideline levels (DCGL) level. The only time the results less than "0" should be rounded up to "0" is when demonstrating a compliance dose (if the average concentrations of a radionuclide of concern (ROC) in a survey unit is less than "0", it should be rounded to "0" to determine a sum-of-fractions (SOF) value and associated dose for a survey unit) as there is no such thing as a negative dose. This usually means that the average concentrations for a survey unit are derived for each radionuclide and those averages that are less than "0" are then rounded to "0" before establishing the survey unit's SOF value. The licensee should make note of this for future data reports being submitted.

   HDI Response: For Final Status Survey (FSS) data reporting, HDI will add a new LTP Subsection 5.9.8.2 to describe a practice that aligns with MARSSIM, as follows:

   - All measured values will be reported, including negative values and values below MDC.
   - Results greater than the critical level (Lc) will be bolded to identify statistically significant detections.
   - Statistical evaluations (e.g., mean, standard deviation, hypothesis testing) will include both positive and negative values.
   - For dose assessments (e.g., sum-of-fractions, DCGL comparisons):
     - Negative values will be rounded to zero, consistent with MARSSIM and NEI guidance.
     - Values between Lc and MDC will not be zeroed out unless justified as non-detects based on confidence level.
     - MDC values may be used only when actual analytical results are not available.

   HDI will include a summary MDC statistics table in FSS reports to demonstrate that our survey methods are capable of achieving the required DCGL sensitivity based on the survey unit classification.

   This approach will be documented in HDI procedures to ensure consistent implementation

throughout the FSS campaign.

2) **Determination of 75th Percentile:** Clarify how HDI determines a 75th percentile**.** An HDI walk through of their methods will assist in an efficient review of TSD 025-032, Rev. 0 "Radionuclides of Concern in Support of the Oyster Creek Station License Termination Plan."

   NRC Question: In TSD 025-032, Rev 0, it appears that HDI uses all data to derive a 75th percentile ratio to Cs-137 or mixture ratio. The NRC staff has found it acceptable for licensees to use data which was detected above the MDC to make these types of determinations. Rather than using 75th percentiles of primarily low certainty data (less than the MDC) that could give misleading results. The NRC staff anticipates evaluating only data greater than the MDC to verify that the licensee's method provides reasonable results. Please clarify whether there is a safety-related reason why HDI is using all data to derive a 75th percentile ratio?

   Also, staff mentioned several times that there is concern that the data originated from a relatively small portion of the site and may not be true for all portions. As denoted on pages 5-18/19/20 of the LTP, HDI indicated it would be verifying the ROCs and Insignificant contributors during continuing characterization and in most survey units (soil and concrete) by analyzing a survey unit sample for the full suite of radionuclides and verifying the insignificant radionuclide were appropriate or of little significance difference. Clarification is needed on what actions will be taken if the full suite analyzed sample during FSS does not conform with the assumptions (e.g., will an investigation be conducted as suggested elsewhere in this section?). It probably is worthwhile to clarify survey units/areas where investigations may occur vs whether the full suite analysis samples may be combined across survey units to determine what insignificant contributors may be present (e.g., outlying survey "areas" not encompassing processing buildings). Also, if using the data for surrogates, a correlation between the inferred and surrogate should be established consistent with MARSSIM. HDI should justify use of data indicating a weak correlation.

   HDI Response: A walk-through/presentation was given on the July 28, 2025 audit call. An overview of the processes used in TSD 25-032 was provided along with examples of the percentile determinations and relative dose fraction calculations (to determine ROCs/ICs).

   HDI will perform the following evaluation:

   - Identify which radionuclides in the 21-member suite had a sufficient number of results greater than the MDC.
   - For those radionuclides, calculate the 75th percentile mixture fraction based only on >MDC data.
   - Compare these values to the previously derived 75th percentile fractions from the full data set (including <MDC values) and the determination of ROCs/ICs using a relative dose fraction calculation as described in TSD 25-032.
   - Assess whether the originally applied values were appropriately conservative or require adjustment.

   The evaluation will be summarized and submitted in a revision to TSD 025-032 to demonstrate that either the original approach is conservative or bounded by the >MDC-based analysis or revised ratios will be adopted

3) **LTP Section 4.8, ALARA Evaluation:** Confirm the method that HDI will use to perform as-low-as-reasonably achievable (ALARA) evaluations.

   It appears that the HDI is pursuing a pre-determined compliance measure method for demonstrating compliance with the ALARA requirements. Per Section 6.3.6 of NUREG-1757, Vol 2, Rev. 1, "Characterization, Survey, and Determination of Radiological Criteria", there are two acceptable options for demonstrating compliance with the ALARA requirement currently in the guidance: a performance-based compliance method as well as the pre-determined compliance measure. Please verify HDI intends to pursue the pre-determined compliance measure method currently described in the proposed LTP as opposed to the performance-based compliance method.

   NRC question: Further, in the HDI ALARA compliance demonstration in the proposed LTP, the costs for remediation detailed in the analysis appear relatively high on a per unit basis. For example, the cost of planning and engineering have a total time commitment of 10 hours per m^3 of soil remediation. This seems unreasonable as there is seldom just a single m^3 of soil remediation necessary. It implies that remediation of 100 m^3 of soil as a project would require 1,000 hours for the planning and engineering when, instead, the originally estimated 10 hours is more likely to be defrayed over the entire project so that any 1 m^3 of soil remediation would be charged 0.1 hour for planning and engineering. This type of overhead costs should be reduced to a reasonable time frame for a reasonably sized project.

   NRC Question: Clarification also is needed of why one analysis uses a discount rate of "0.07" while the other uses "0"?

   NRC Question: Please clarify the basis for HDI's costs for the time commitment to remediation and the discount rates used to allow the staff to determine compliance with 10 CFR 20.1402.

   HDI Response: HDI is pursuing a pre-determined compliance measure method for demonstrating compliance with ALARA requirements.

   LTP Section 4.8 will be updated to apply a planning and engineering time of 0.1 hours per cubic meter of soil, consistent with NRC expectations and industry norms for batch remediation activities. In addition, HDI will revise the building structure ALARA evaluation to apply a 0% discount rate in place of the previously assumed 7%, consistent with the soil ALARA evaluation. Additionally, modifications were made to $cost_{ACC}$, $cost_{wdose}$, and $cost_t$ to reflect the value of statistical life. Furthermore, all ROCs were included in the Action Level analysis.

4) **LTP Section 5.2.6.4, Surrogate Ratio DCGLs, and 5.2.6.5, Gross Activity DCGLs**: Explain how HDI determined the ratios and fractional activity associated with these derivations and whether HDI determined that the results are reasonably conservative.

   Walking the NRC staff through some of its technical papers on this subject (TSD 24-01-12-2888, "Dose Contribution from Insignificant Radionuclides in the Oyster Creek Site-Specific Suite of Radiological Nuclides," and TSD 24-062, "*OCNGS Structure Nuclide Fractions and Gross Activity DCGLs (DCGLGA)"* will save NRC staff review time before reading in-depth and verifying some of the details.

NRC Question: For example, using the average/median ratio for surrogates would likely underestimate at least half of the represented concentrations in samples which could be problematic if a sample concentration approaches the DCGL. In the past, the NRC staff reviewed and approved use of a conservative ratio or fractions for these types of derivations. For acceptability, the NRC staff must determine in their safety evaluation, among other things, that the dose methodology does not lead to underestimation of dose.

HDI Response: TSD 24-01-12-2888 has been withdrawn and replaced by TSD 25-032; reference to TSD 24-01-12-2888 will be removed from LTP. HDI walked the NRC staff through this technical paper in question 2 above. Activity fractions were established in TSD 25-032, and FSS ROC mixture fractions were provided in Section 2.4.4 of the TSD.

5) **Section 5.2.3.9, Measurement Locations**: Explain the rationale for allowing the final status survey (FSS) supervisor to adjust the FSS plan during a FSS (e.g., within 10-foot radius of the initially identified inaccessible location if practical, else a random location within the survey unit will be chosen to replace the location that is inaccessible). The NRC staff must understand HDI's FSS strategy and for acceptability, among other things, must determine that the FSS strategy meets the data quality objective process if HDI commits to following MARSSIM or is using some other approach. The NRC reviews the FSS plan to ensure all necessary information is collected for decision-making. This process involves defining the problem, identifying decisions, specifying inputs, setting study boundaries, developing decision rules, and specifying acceptable limits for potential decision errors.

   HDI Response: HDI confirms that the Final Status Survey (FSS) process is conducted in accordance with the seven-step Data Quality Objectives (DQO) process outlined in MARSSIM, ensuring that all survey decisions are technically defensible and aligned with the project's decision-making framework.

   In field conditions, some survey locations may become inaccessible due to physical obstructions, safety concerns, or logistical constraints. To maintain survey efficiency and data integrity, HDI has established a structured protocol for managing such occurrences:

   - If a designated systematic survey location is inaccessible, the FSS Supervisor is authorized to adjust the measurement location by relocating it within a 10-foot radius of the original point, provided that the alternative location remains within the same survey unit and exhibits similar physical and radiological characteristics.

   - If no accessible location exists within a 10-foot radius, a new random location will be generated within the survey unit to replace the original point, maintaining the statistical design of the survey.

   - All substitutions will be clearly documented in the survey package and referenced in the FSS survey unit report, including the reason for the change, the new coordinates, and a justification that the adjustment did not compromise the representativeness of the data.

   HDI will clarify this approach in an update to Chapter 5 of the LTP.

6) **Section 5.2.6.7, Elevated Measurement Comparison Evaluations**: Define/clarify what is meant as "areas of elevated activity." The NRC staff believe clarifying this term for the site would streamline staff FSS report reviews.

HDI Response: LTP Chapter 5 will be updated to clarify that an area of elevated activity is the smallest contiguous area over which the residual contamination exceeds the $DCGL_w$.

7) **Section 5.3.1, Scan Surveys and Section 5.3.2, Direct Measurements for Surfaces**:

Please describe how/if ambient background will be subtracted from measurements. Understanding how HDI will address the ambient background will streamline the NRC staff's FSS report reviews.

HDI Response: Technicians will respond to visual and audible indications above the background. For direct measurements, paired observations are used when the ambient background impairs the collection of surface measurements. Protocols for collecting ambient background measurements are established during FSS planning (beta shield may be necessary). HDI intends to ignore background if it does not represent a significant fraction of the DCGL or the release criteria.

HDI will update LTP Subsection 5.3.1 to describe the above approach for scans and measurements.

8) **Section 5.4.2, Bulk Materials**: Clarify how reused site bulk materials (especially those that may be used for backfilling) will be characterized.

In the past, the NRC staff expected materials that may be used as backfill to be characterized to the rigors of the LTP commitments of an FSS. The NRC staff understands that special considerations may be appropriate if a licensee is planning to reuse building materials for backfill (e.g., the licensee would perform volumetric instead of structural surveys). Therefore, HDI should explain if it anticipates any special considerations to avoid future challenges in their decommissioning strategy.

HDI Response: Holtec confirms that any site-derived bulk materials proposed for reuse, such as on-site soils or rubblized structural debris, will be characterized in accordance with Final Status Survey (FSS) protocols prior to reuse, consistent with the survey design and quality objectives outlined in LTP Sections 5.3.1.1 (Scan Surveys) and 5.3.3.2 (Volumetric Sampling).

HDI will update LTP Subsections 5.4.2 to describe the following approach for scans and surveys of bulk materials used for backfill.

- Soil or other bulk materials proposed for backfilling will undergo FSS-level radiological surveys to ensure compliance with the applicable Derived Concentration Guideline Levels (DCGLs) prior to reuse.
- The survey process will be implemented in 6-inch lifts, with each lift subject to a walk-over gamma scan using a NaI(Tl) detector or an ISOCS fixed-point scan, depending on material geometry and accessibility.
- Scan surveys will be conducted at a scan rate and detector height to ensure adequate sensitivity to surface or near-surface activity. For ISOCS use, geometry files will be developed to provide adequate coverage and conservative detection efficiency.
- Volumetric sampling will be conducted on representative aliquots of the material to assess compliance with applicable soil DCGLs. These sample results will form the basis of the dose assessment, using the same methods and dose modeling applied

to other Class 1 and Class 2 survey units.
- The decision to reuse any material will be conditioned on full compliance with the FSS release criteria, and all survey results will be documented in accordance with DQOs.

Potential dose from backfill material that contains licensed materials that are distinguishable from background will be evaluated in accordance with LTP Section 6.11, Determination of Dose from Backfill Soil.

9) **Section 5.7.4, Advanced Technologies**: The NRC staff would like to discuss to understand whether HDI will tie operator training and qualifications to data quality objectives. The NRC staff will need this information when determining whether use of advanced technologies will provide reasonable assurance in the results of such measurements.

HDI Response: As described in LTP Subsection 5.10, the objective of the FSS Quality Assurance Project Plan (QAPP) is to ensure that the survey data collected are of the type and quality needed to demonstrate with sufficient confidence that the site is suitable for unrestricted release. The objective is met through the use of the DQO process for FSS design, analysis, and evaluation. The plan surveys are conducted by trained personnel using calibrated instrumentation as described in LTP Subsection 5.10.3.

10) **Section 5.9.2.1, Posting Plots**: Clarify whether scanning will be posted on a map (preferred) or be documented in some other way. Review of scanning data is part of the NRC staff's review of the FSS reports and knowing how this data will be presented will streamline the staff's review.

HDI Response: HDI confirms that scan surveys will be graphically documented on maps included in the Survey Unit Release Records (SURRs) and Final Status Survey (FSS) reports. Walk-over gamma scans performed using portable NaI(Tl) detectors will be linked to GPS coordinates, allowing real-time recording of the scan path and location-specific gross count data. The following practices will be implemented:

- Scan coverage maps will display the actual scan path, area coverage, key features, and survey boundaries.
- These maps will also include post-processed visualizations of scan results (e.g., graduated color maps) to clearly illustrate any elevated count areas relative to background or investigation levels.
- The GPS-integrated scan logs and visual outputs will be archived in the survey package and included in the associated SURR for NRC review.

This approach ensures that scanning is fully traceable, transparent, and technically defensible, and it streamlines NRC review of the FSS data by providing a clear visual record of both scan coverage and results.

This approach and methodology will be described in an update to LTP Subsection 5.9.2.1

11) **Section 5.9.6, Record Keeping and Section 5.9.8, Final Status Survey Reporting**: Clarify how HDI will document the FSSs and what HDI will submit to the NRC for review of

the FSS Report. This information will assist the NRC staff in planning its FSS reviews to be more efficient.

NRC Question: For example, will HDI submit "release records" for each survey unit and make the "final status survey report" a stand-alone summary document submitted after all FSSs have been completed.

HDI Response: HDI will submit the Survey Unit Release Record (SURR) and FSS Reports. FSS Reports are a compilation of all the SURRs for the Survey Area. The minimum report content is outlined in LTP Subsection 5.9.8.1

SEE RESPONSE TO ADDITIONAL QUESTION 7

12) **Radionuclides of Concern (ROCs):** Explain why HDI believes it is appropriate to determine ROCs for most of the site areas, including outdoor areas, based on concrete building sampling only. Based on NRC staff's review experience it is uncommon that one area stands to represent all survey units. Further, if HDI plans to use new data in the future, HDI should explain its method for updating its ROC determination methodology.

HDI Response: The proposed actions associated with Health Physics Question #2 above address this question.

13) **Insignificant Contributors:** Clarify the basis for the insignificant contributor's (IC) dose and the listing of ICs. Page 6-4 of the proposed LTP appears to state that the dose from insignificant radionuclides is based on concrete measurements. Based on NRC staff's experience concrete measurements are not expected to be representative of activity fractions in subsurface soils or above ground buildings planned for reuse.

NRC Question: Also, Technical Support Document No. 25-032, Rev. 0, indicates that concrete samples were used to determine ICs. Please provide more details regarding the current basis for ICs and whether HDI has plans to validate the significant or ICs list consistent with MARSSIM guidance.

HDI Response: HDI plans continuing characterization to evaluate ROCs/ICs using a relative dose fraction similar to that used in TSD 25-032. These results will be compared to the initial ROCs developed using concrete results and additional risk significant ICs will be included if they are observed.

14) **Validation of Significant Contributors**: The text at the end of Section 5.2.6.3, Page 5-20 states that 5 percent of the samples will be analyzed for hard-to-detects (HTDs) to verify the ICs. Typically, 10 percent of samples are used to validate assumed surrogate ratios and by extension the lack of need to analyze for HTDs. Clarify the basis for using 5 percent. The staff needs this information to determine whether HDI HTD verification practices are acceptable.

HDI Response: HDI will revise the FSS methodology described in LTP Subsection 5.2.6.3 and 5.10.1 to ensure that a minimum of 10% of the collected soil, concrete, and groundwater media samples are analyzed for the full suite of ROCs.

15) **Dose Contributions from Insignificant Contributors**: The text on page 5-21 states that 0.075 mrem/yr will be added to the dose to account for the dose from ICs in soil. Section 3.3

of NUREG-1757, Volume 2, Rev. 2, “Insignificant Radionuclides and Exposure Pathways” states that the uncertainty should be accounted for in the evaluation of ICs, including dose from less likely but plausible (LLBP) exposure scenarios. Clarify how this information is used to determine that HTD radionuclides are insignificant to LLBP residential scenarios. The NRC staff notes that the methodology used to calculate the dose contributions for HTDs does not appear to be complete as it (i) does not account for varying mobility of easy to detect radionuclides (ETD) versus HTD radionuclides (e.g., assumes HTDs will be co-located with ETDs), and (ii) assumes that five samples will be sufficient to determine representative concentrations for use in dose calculations. Page 2-104 of the proposed LTP states that Sr-90 was only found in subsurface samples. The number of subsurface samples are limited, and the concentrations of Sr-90 do not appear to be correlated to less mobile Cs-137 or Co-60 concentrations. Therefore, the use of a maximum concentration of 0.07 pCi/g (see Table 3-1, page 7 of OCNGS Technical Basis Document No. 24-01-12-2888, Revision 011 “Dose Contribution from Insignificant Radionuclides,” based on 5 samples where Cs-137 and Co-60 concentrations are highest) to calculate the dose from Sr-90, when higher Sr-90 concentrations closer to 5 pCi/g are measured in limited subsurface samples (e.g., see page 2-124 of RCA-DEP6-043-B in the proposed LTP). The NRC staff seeks to understand HDI’s approach and why additional subsurface soil samples would not be needed to better understand the contributions of Sr-90 to dose. This comment may apply to other HTDs in addition to Sr-90.

HDI Response: Technical Basis Document 24-01-12-2888 has been withdrawn and will be replaced by reference to TBD 25-032, “Radionuclides of Concern in Support of the Oyster Creek Station License Termination Plan” in LTP Subsection 5.2.6.4

An Insignificant Contributor dose contribution of 1.25 mrem/y from the soil will be added to the FSS survey unit total dose, as provided in OCNGS TSD 25-032. As continuing characterization progresses, the insignificant contributors will be updated to account for new data (e.g., concrete measurements may not reflect the key risk drivers for above-ground buildings, and subsurface soils and buried piping). New data will be reviewed to establish correlations and evaluate the need for multiple sets of ratios to account for variability within media and for different media.

Consistent with NUREG-1757, Volume 2, Rev. 2, Section 3.3, uncertainty in the insignificant contributors will be considered by evaluating less likely but plausible exposure scenarios, including consideration of the groundwater pathway. HDI will update TSD 25-032 to include analysis of ICs using LLBP scenarios (i.e., Industrial Use and the Residential use with the groundwater drinking pathway open) and will update LTP Table 6-4 to include LLBP ICs.

Prior to obtaining complete groundwater data, a conservative *a priori* value of 1 mrem/yr (0.04 dose fraction) will be assumed (see LTP Chapter 6 Section 6.13 for details). The final groundwater contribution to the compliance dose will be assessed based on actual sample data. However, it is emphasized that the assumed *a priori* dose fractions are likely to change as ongoing decommissioning activities proceed and as final status surveys are completed.

Technical Support Document No. 24-111, “Surface/Sub Surface Characterization Survey Plan for Oyster Creek Nuclear Generating Station” documents the plan for a characterization campaign to determine the contamination from known spills or contamination identified in the Historical Site Assessment (HSA) and initial characterization surveys. As described in LTP Section 2.3, subsurface soil samples were collected in

selected areas to evaluate potential radiological contamination in areas with historical spills. Two hundred seventy-nine samples were collected from sixty-one locations in the RCA area: 4 sediment samples, 15 asphalt samples, 58 surface soil samples, and 202 samples at depths up to 20 feet were obtained based on indications in the HSA where plant-related radioactivity had been introduced from spills and plant operations.

Groundwater

1) **FSS Plan for Groundwater:** Clarify HDI's FSS plan or strategy for estimating residual radioactivity in groundwater for use as input calculating dose due to existing groundwater contamination. Section 5.6 of the proposed LTP mentions that the measurements from wells will be used as input to Equation 5-9. Clarify (i) the period over which measurements will be collected (duration over which trends can be verified), (ii) when the measurements will be collected (e.g., after last soil disturbing activity), and (iii) why measurements at wells reflect maximum concentration across the site. This information is needed for the staff to make a determination regarding the adequacy of the groundwater survey method.

   HDI Response: HDI will update sections 5.6 and 6.12 of the LTP to include the FSS plan for groundwater inputs utilizing the following approach.

   HDI will describe a strategy for evaluating residual radioactivity in the subsurface that has the potential to contribute to the groundwater pathway. This strategy will integrate groundwater monitoring data with evaluations of residual radioactivity in soil with assessment of potential dose contributions using site-specific hydrogeologic information. Where necessary, HDI will supplement the existing monitoring well network to confirm spatial representativeness or evaluate potential localized contributions to groundwater contamination.

   To verify that monitoring results represent decreasing or stable equilibrium conditions, data from multiple semi-annual sampling rounds will be assessed to confirm that no significant statistical upward trends in concentrations are present. Monitoring will be performed for a minimum of two semi-annual cycles following completion of soil disturbing activities to encompass seasonal variations in the site groundwater potentiometric subsurface conditions and ensure that monitoring results reflect final site conditions.

   Where HDI assumes that a well or set of wells represents the maximum concentration, a supporting basis will be provided. As new information (e.g., release events or identification of subsurface contamination) becomes available during decommissioning, the capability of the monitoring network to identify the possible maximum and spatial extent of contamination will be reassessed. HDI will modify section 5.6 of the LTP to be consistent with Chapter 6.

   Input for existing groundwater contamination will come from the well monitoring network described in LTP Section 2.4 that provides coverage for the present contamination and any potential future contamination associated with decontamination and demolition activities. As a conservative approach, the maximum positively detected groundwater concentration for each ROC will be used consistent with MARLAP guidance described in the response to Question 2 below. If there are no positive results for a given ROC, the dose assigned to the ROC will be zero.

2) **Detection Decision for Groundwater:** Section 5.6 of the proposed LTP indicated that a dose of zero for existing groundwater contamination will be assigned for ROCs when laboratory analyses show no positive results. Clarify what is meant by "positive result" in section 5.6 of the proposed LTP Revision 1 and definition of the term "detection limit" as used in section 2.4 of the proposed LTP Revision 1 so that staff can compare the information to the terminology in Chapter 20 of Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP, NUREG-1576) guidance (i.e., decision level and critical level measurements after the last soil disturbing activity). If HDI does not intend to use MARLAP guidance, then identify if it is using other guidance or explain the basis for its groundwater detection decision strategy. Providing the requested information should assist the NRC to efficiently review the proposed LTP.

   HDI Response: HDI will ensure that the interpretation and reporting of laboratory analyses of groundwater will be consistent with guidance in MARLAP. The "detection limit" is the Minimum Detectable Concentration (MDC), below which the laboratory result may indicate the statistical detection of radionuclides, but the reported value is unreliable, and further assessment may be needed for confirmation. MDC is a statistical metric that defines the sensitivity of a measurement result in terms of a hypothetical distribution of results at a particular concentration above a blank or background. The critical level, Lc, is a value below the MDC where a small fraction (e.g., 5 percent) of the population of results would be expected to exceed that of the truly blank sample. Laboratory results between Lc and MDC indicate that there is a higher probability that radionuclides were detected than the probability of a false positive. Typically, users apply a fraction equivalent to 5% for the probability of a false detection in a sample containing no radionuclides, but other values can be used consistent with the derivation and definition of the Lc. The Lc is used as a criterion for determining "positive results." Approximately 5% of the results should exceed Lc. This type of testing will be used to determine if the population of analytical data represents positive detections. If a population of data is between the Lc and MDC, then an investigation may be performed to evaluate the possibility of false detections, including re-analysis and /or resampling for the applicable ROC.

   Any reduction in the suite of radionuclides in the groundwater laboratory analyses based on historical releases, identified subsurface contamination, and mobility will be supported by a basis and plan for periodic verification checks.

   HDI will revise Section 6.12 of the LTP to be consistent with the description above and ensure the wording in Section 5.6 is consistent with the revised Section 6.12.

3) **Groundwater Flow and Transport Pathways:** Clarify or provide information that supports the simplification of the conceptual site model (CSM) considering the two uses of the CSM (i) abstraction for RESRAD inputs for flow and transport, and (ii) linking potential Historical Site Assessment (HSA) events and possible transport directions. This information is needed so that the staff can determine whether the CSM presented by HDI adequately represents the Oyster Creek site.

   The simplifications for each usage may vary but should consider the three-dimensional flow field that evolved from 2006 to 2024 due to annual recharge variations, influence of construction fill and breaching of aquitard between Cape May and Cohansey aquifers, pump-and-treat remediation, and reduction in number and areal extent of wells used for groundwater contouring. Also, what is the long-term nature of the flow field, i.e., has the

effect of the pump-and-treat remediation on the flow field dissipated?

NRC Question:

- For part (i) for RESidual RADioactivity (model) (RESRAD) abstraction, clarify support for hydrologic inputs (e.g., unsaturated zone (UZ) thickness, gradient) for the one-dimensional RESRAD flow abstraction considering the three-dimensional characteristics of the flow field. The discussion should involve abstractions that do not lead to underestimation of dose. The NRC staff notes that the proposed LTP and supporting documents did not include the parameter inputs for the LLBP resident farmer scenario (see request of RESRAD files in Dose Assessment section of questions). This information is necessary for the staff to review the dose assessment to determine whether it is acceptable and does not underestimate the dose.
- For part (ii) on linking potential transport pathways with the HSA, clarify any supporting information that possible releases from locations west of the Reactor Building (e.g., the Old Radwaste Building and the New Radwaste Building) migrate only to the west; i.e., that contamination does not migrate vertically in the construction fill to the Cohansey aquifer and then eastward as possibly implied (though uncertain) by the mounding of represented by the potentiometric contouring of the Cohansey

HDI Response: Based on a review of historical groundwater elevations within the Cohansey Formation, groundwater flow patterns have remained stable over time. The expected radial flow away from the mound toward the canal is evident, with only a minor eastward component observed in the power block area of the site. To evaluate whether historical groundwater elevations could reliably predict current flow conditions, HDI reviewed trends in wells W-10, W-66I, W-68I, and W-14. Results show variability without a consistent trend, indicating stability in flow direction and gradients. Accordingly, historical groundwater data remain representative and can be used to predict current groundwater flow. Under this assumption, east-northeast flow within the Cohansey Formation as depicted on the July 2016 groundwater contour map (see Figure 5.3 of the 2022 HIR) is limited to the power block area and ultimately flows to the canal.

Potential eastward migration of the tritium plume was also assessed. Historical tritium results from Cohansey wells (Appendix F, 2022 HIR) show that nearly all locations remain non-detect, with detections limited to areas near the Turbine and Reactor Buildings. Easternmost locations LW-4 and W-3A have consistently returned non-detect results. These findings indicate that tritium migration eastward with groundwater flow is not occurring; instead, the plume remains confined to the western portion of the site near the Turbine and Reactor Buildings. Figure 3.3 of the 2022 HIR illustrates this western confinement. Therefore, the current Cohansey monitoring well network provides adequate coverage of site groundwater flow, direction, and gradient.

As a conservative measure, when decommissioning activities present the potential to mobilize residual ROCs toward the eastern portion of the site, a subset of eastern site wells will continue to be monitored to assess impacts. In addition, a new monitoring well will be installed northeast of the Augmented Off-Gas (AOG) building prior to slab removal, ensuring earlier detection of potential releases than the existing well network might allow.

RESRAD-Onsite models the site along the downgradient flow path from the source to the well located at the downstream edge of the contaminated zone, and we do not take credit for lateral dispersion that would dilute concentrations at that well (conservative). Using RESRAD-ONSITE's non-dispersion model is recommended for contaminant areas >1,000 m^2, which avoids lateral dispersion credit that could otherwise dilute concentrations at the POC well.

Hydrologic inputs used for RESRAD flow abstractions are:

- Saturated-zone effective porosity (n_e): 0.25 (site-specific deterministic); basis: OCNGS 2017 HIR.
- Hydraulic conductivity (K): 2,741 m/yr (deterministic); basis: OCNGS HIR. High K shortens travel time (conservative).
- Hydraulic gradient (i): Uniform 0.01–0.04, basis: HIR §5.1.4
- Unsaturated-zone (UZ) thickness: Uniform 1.37–5.94 m; basis: OCNGS HIR site groundwater depth range + minimum contaminated-zone thickness (2017 HIR).
- Lateral mixing: The non-dispersion model in RESRAD was selected, which does not account for lateral dispersion.
- Downgradient well/drinking water note (scenario-specific): The Chapter 6 tables note that the drinking water pathway input is not required/inactive for certain scenarios (e.g., Industrial Use), preventing non-conservative dilution credits; when evaluating the LLBP scenarios, we retain conservative mixing at the downgradient well.

In summary, RESRAD's 1-D model does not underestimate dose because the abstraction shortens travel times and reduces attenuation relative to plausible 3-D realizations.

The 2017 HIR documents horizontal and vertical groundwater migration beneath site structures and supports the conservative 1-D abstraction. Specifically, it shows:

- Breaches of the confining unit beneath major structures,
- Potentiometric surfaces indicating flow toward the Intake/Discharge Canals,
- Measured vertical hydraulic gradients between the Cape May and Cohansey formations.

The LLBP evaluations comprise: (i) Industrial Use with the drinking-water pathway enabled; (ii) Residential with drinking-water enabled; and (iii) Residential with drinking-water disabled. The corresponding RESRAD-Onsite input/output files for all LLBP cases have been provided to the NRC. Hydrologic inputs in those files (UZ thickness, K, n_e, hydraulic gradient, recharge/ET/runoff, ND/no-dispersion setting, and receptor-well parameters) match the values and bases listed in Chapter 6 tables.

4) **Unsaturated Zone Thickness:** Clarify how the contaminated zone thickness and UZ thickness are implemented in the Industrial Use (IU) scenario (Table 6-15) for RESRAD simulations. Based on site information, the UZ thickness appears to vary between 5 and 20 ft across the site (excluding immediately adjacent to the canals), which is consistent with the input listed in Table 6-15. However, it is not clear if the UZ thickness includes the contaminated zone thickness, or if the thickness reflects the uncontaminated zone that lies below the contaminated zone as defined in RESRAD. The NRC staff needs this information

to understand the groundwater modeling for the IU scenario.

HDI Response: The variable thickness of the CZ is based on historical radiological data from soil samples collected inside the protected area (PA), and the thickness of the UZ is based on information from the OC 2017 HIR. Sensitivity analysis identified the CZ thickness as a risk-sensitive parameter for only C-14 and H-3. The UZ thickness was not identified as a risk-sensitive parameter for any OC ROCs. Given that a change in input value for a risk-sensitive parameter significantly impacts dose, the 75th percentile value (3m) was used as input for CZ thickness for C-14 and H-3 to account for uncertainty associated with input for that parameter. For the other ROCs, the variable thickness was retained as input because changes in the input value for non-risk-sensitive parameters do not significantly impact dose. The effects of including "non-real" combinations of CZ and UZ thickness (i.e., combinations that do not exist at the Oyster Creek site) are not expected to have a significant impact on dose because the CZ and UZ thicknesses are not risk-sensitive parameters for all ROCs except C-14 and H-3. The insignificant impact of a non-real combination of the CZ and UZ thicknesses also applies to LLBP scenarios because the site modeling does not change.

The DCGL values were developed from the "peak of the mean" doses resulting from the probabilistic analysis using "deterministic" input (i.e., site-specific information and the 25th or 75th percentile values) and stochastic input (i.e., parameter distributions).

5) **Uncaptured Dose Calculation for Groundwater Pathway:** Clarify the approach of subtracting RESRAD groundwater concentration from existing groundwater contamination in Equation 6-17 for the dose contribution of future groundwater contamination presented in section 6.12 of the proposed LTP and in Enclosure 26 "TSD 24-081, Oyster Creek Groundwater Dose Calculation Methodology to Support License Termination Plan." Describe the assumed connection between existing groundwater contamination measurements and every solid media source term in the RESRAD-ONSITE calculations (RESRAD water concentrations in Table 6-38). Clarification may include a description of the input for the source term used to estimate the RESRAD water concentrations. This information is needed for the NRC staff to understand HDI's groundwater dose assessment strategy.

   HDI Response: HDI will modify Section 6.12 and Equation 6-17 to remove the subtraction of the Ci, RESRAD gw term. Dose from existing groundwater will be determined from sampling and analysis of site monitoring wells to determine concentrations of each radionuclide, i, and multiplying by the nuclide's dose conversion factor, DCF_i. The dose from existing groundwater will be added to the compliance dose summation described in LTP Subsection 6-13. In addition, HDI will confirm that Section 5.6 and Equation 5-9 are consistent with the revision to Section 6.12 of the LTP.

6) **Hydrology Reference:** Clarify why the 2017 Hydrogeologic Investigation Report (HIR) is not included in the submittal or provide it on the docket. If the 2017 HIR data is used in the proposed LTP, then the staff will ask that it be submitted on the docket. The 2017 HIR, 2022 HIR, and generic OCNGS HIR are all mentioned in the proposed LTP text and tables. But only the 2022 HIR is included in the reference lists of the proposed LTP Chapters 2, 6, and 8 and only the 2022 HIR is included as an enclosure to the submittal. The 2022 HIR does not appear to contain the same information on parameter support that was in the 2017 HIR for at least one parameter. For the UZ thickness as an example, Table 6-15 of

the proposed LTP stated that the basis of the range of UZ thicknesses of 1.37 to 5.94 m is the 2017 HIR where the water table was stated to 5 to 20 feet below ground surface. The 2022 HIR does not include information on the UZ thickness. The NRC staff must use the information that is docketed if it is using it in their safety evaluation report.

HDI Response: The 2017 Oyster Creek Hydrogeologic Investigation Report will be submitted to the NRC for review.

Dose Assessment

1) **Residential Scenario Exposure Pathways:** Clarify whether the drinking water pathway was considered for the residential exposure scenario (LTP Section 6.3.2). HDI evaluated the dose from Cs-137, Co-60, and C-14 according to Table 6-4 in the proposed LTP. Key assumptions of the analysis could not be identified (e.g., plant and drinking water ingestion rates) and should be provided with the RESRAD files to allow NRC to review the technical basis for the analysis. The requested modeling assumptions are risk-significant for this review because the NRC staff has not yet determined whether the residential scenario is reasonably foreseeable and eliminating exposure pathways in the IU scenario leads to higher DCGLs.

   HDI Response: The drinking water pathway was not considered for the Residential LLBP scenario in LTP Subsection 6.3.2.

   A deferred Industrial Use LLBP scenario with drinking water is presented in LTP Subsection 6.3.2.4. HDI provided the NRC Staff the RESRAD input and output files for the industrial scenarios with drinking water for a single radionuclide.

   HDI will add a Residential LLBP scenario with drinking water to Section 6.3 of the LTP.

   HDI will formalize the Industrial Use with groundwater LLBP scenario with a TSD.

2) **Surface and Subsurface DCGLs for Soils:** Surface and subsurface soil DCGLs appear to be combined. While use of a single DCGL for soil may be acceptable, staff seeks to understands HDI's plans to document and implement its methods that will be used in the FSS to ensure that dose is not underestimated due to the potential compositing of relatively clean soils with higher concentration soils (e.g., scanning of soil cores to identify any elevated areas and depth discrete sampling). A good understanding of the sensitivity of dose to the depth and thickness of residual radioactivity should be reflected in survey procedures to ensure comparison of radiological survey data results to DCGLs does not underestimate dose.

   HDI Response: If compositing is required for subsurface samples, the DQO process will determine the depth and intervals at which composite samples will be taken and specify them in the Survey Unit survey plan. A description of general sampling and compositing strategies will be added to LTP Subsection 5.3.3.2.

3) **Groundwater Usage Surrounding the Site:** The proposed LTP provides information on domestic potable and non-potable wells within a 1-mile radius of the site (Table 1-1, proposed LTP page 1-5); however, it is unclear what these wells are used for (e.g., drinking water, irrigation, IU) and the applicability of the Lacey Township ordinance on municipal

water supply in the surrounding area. Please clarify (i) domestic groundwater well uses in the area surrounding the site, (ii) the applicability of Lacey Township ordinance requirements related to use of municipal water supply for properties surrounding the site; (iii) any exceptions to the ordinance; and (iv) any available information on the enforceability of the requirements. The DCGLs are significantly higher, particularly for buried sources (e.g., orders of magnitude), when the groundwater pathway is not considered. Because the unrestricted release of the site is being pursued, the basis for exclusion of the groundwater/drinking water pathway must be well understood. Clarification regarding groundwater usage in the area is needed to provide support for not including the groundwater pathway in deriving DCGLs.

HDI Response: LTP Table 1-1 and Table 1-2 associated text will be updated in the LTP to clarify the domestic water uses in nearby locations and the applicability of the local ordinance to properties in the surrounding area.

4) **Municipal Water Supply Requirements:** Clarify the requirements of the municipal ordinance with respect to connecting to municipal water supply and disconnecting and sealing wells, which seem to apply to certain areas in Lacey Township. Does the ordinance require OCNGS to connect to the municipal water supply and does the ordinance requiring sealing of wells apply to the OCNGS based on its location (i.e., its block and lot number)? Finally, please clarify if any potential ongoing use of groundwater wells onsite is intended for other than drinking water purposes. Licensees are to follow applicable requirements from state and local governments which may be used to provide support for elimination of the groundwater pathway; however, it is unclear what requirements apply to the OCNGS.

   HDI Response: HDI provided information regarding state and local regulations that prohibit construction of domestic drinking water wells on the OCNGS site and the sealing of existing domestic drinking water wells in the future to provide support for the elimination of the groundwater pathway based on reasonably foreseeable future land use.

   The LTP will be updated to clarify local ordinance requirements regarding well sealing, prohibitions on future well construction, and any wells remaining onsite (e.g., industrial use well). As described in the response to Question #1 above, RESRAD input and output files for each scenario will be provided, including the industrial use scenario with the groundwater pathway “turned on.”

   The former private water supply system at the Oyster Creek Nuclear Generating Site has been replaced with a connection to the municipal public water system (Lacey), and an NJ-licensed well driller has sealed the existing on-site well to prevent future use.

5) **Groundwater Exclusion Zone:** Clarify the extent of the groundwater exclusion zone. The groundwater exclusion zone appears to apply to a portion of the site based on the map presented below. If portions of the site are not under groundwater exclusion zone restrictions, then there may be a higher likelihood of groundwater use than currently assumed.

   The groundwater classification exception area (CEA) is applicable to a portion of the site and does not preclude well installation outside of the CEA.

   HDI will provide additional information in the LTP about the horizontal and vertical extent of

the CEA and information about monitoring and potential longevity of the restrictions.

6) **Risk Associated with the Excavation Scenario:** The excavation scenario assumes that excavation only occurs above the water table resulting in only 800 m^3 of drilling spoils brought to the surface, thereby limiting the dose from human intrusion into the subsurface/substructures. Bases should be presented to support the limited depth of excavation, or a more robust analysis should be performed to derive DCGLs for subsurface materials (e.g., deeper depth of excavation). Rationale for assumptions must be provided by licensees for the NRC staff to determine whether the assumptions are reasonable. Reasonable assumptions are needed to ensure appropriate exposure scenarios and potential risk are assessed, thus providing reasonable assurance that the 10 CFR 20.1402 criteria are met.

   The licensee thinks it is reasonable to assume that the unlikely excavation of a portion of subgrade structure reinforced concrete would not proceed below the water table due to cost, safety, dewatering, and permitting challenges. Because NRC does not agree that it is reasonable to assume an excavation would be limited to above the water table, However, HDI will evaluate the excavation of a single reinforced concrete wall in the Reactor Building subgrade structure down to and including the foundation mat in order to confirm that the existing scenario is bounding relative to volume of potentially contaminated excavated concrete. Alternatively, the licensee can show that the volume of material brought to the surface approximates an infinite source (i.e., that additional material brought to the surface would not lead to a lower DCGL). Or the licensee can provide additional information to show that it is not reasonable for a future owner of the site to excavate below the water table (however, NRC staff do not think that this latter alternative would be compelling).

   HDI Response: HDI evaluated an excavation of a single reinforced concrete wall of the Reactor Building subgrade structure, including that portion of the base mat under the wall (756 m^3), and determined that the volume was 14% less than the assumed volume in our scenario (872 m^3). HDI does not believe that it is reasonable to assume that the unlikely excavation of a portion of a subgrade reinforced concrete structure would proceed below the water table due to cost, safety, dewatering, permitting, and logistical challenges. There is adequate space on the OCNGS site to install deeply embedded structures with access to existing cooling water, transmission, and transportation infrastructure without the challenges associated with removing heavily reinforced concrete below the water table.

7) **Building Occupancy vs. Renovation Scenario Dose:** TSD 24-085, Rev. 0, “Probabilistic Dose Comparisons: Building Occupancy Scenario Vs. Room Renovation Scenario” is the technical basis document supporting the conclusion that the building occupancy dose is larger for above ground buildings compared to the renovation scenario. It appears that energetic activities associated with the renovation scenario may not be reflected in the model (e.g., higher resuspension rates and removable fractions may be associated with the renovation scenario). A more thorough review and analysis will be performed by NRC staff to assess the risk-significance of the renovation scenarios. Staff seeks to further understand HDI’s approach for this scenario to ensure it doesn’t underestimate dose. HDI could also provide additional information on why they think the renovation scenario is not reasonably foreseeable.

NRC was particularly interested in sumps and trenches in the Class 1 low-level radioactive waste storage facility and presence of alpha emitters that could be suspended due to energetic activities that could create airborne radioactivity.

HDI Response: The comparison between the building occupancy scenario versus the room renovation scenario presented in TSD 24-085 is reasonable because the renovation is assumed to be performed in the same room as the building occupant location for logical dose comparison purposes.

Behavioral and physical parameters were selected in accordance with the guidance in NUREG 5512 and NUREG-6755. The renovation scenario assumed a higher breathing rate than the occupancy scenario. Both scenarios assumed a distribution for the resuspension rates, and the removable fraction was kept the same. The duration under the occupancy scenario was one year, and the assumed renovation occupancy was 13 weeks.

Buildings that will remain onsite have not been subject to exposure to significant radiological impacts from plant operation. As described in the HSA, most of the equipment and waste stored in the Low Level Radwaste Storage Facility is containerized and in shippable form. All radioactive contaminated materials stored without containers have fixed contamination with no smearable contamination being allowed.

Characterization data of the surfaces of buildings that will remain onsite following completion of decommissioning activities will be performed to support assumptions regarding risk-significance of potential radionuclide removal and resuspension.

8) **Limitations of the RESRAD-ONSITE Computer Code in Simulating Flow Through Reactor Basement Substructures.** Explain how the use of RESRAD-ONSITE to support development of DCGLs for reactor basement substructures does not underestimate dose. RESRAD-ONSITE's conceptual model does not support flow through relatively impermeable substructures, while basement substructures that remain at the time of license termination may act as resistive flow barriers. Additionally, the RESRAD-ONSITE computer code does not support evaluation of various source-to-well geometries that may be more appropriate considering the final configuration of site structures at the time of license termination. Limitations of the RESRAD-ONSITE computer code with respect to simulating hydraulic barriers and complex geometry assumptions should be evaluated to ensure that dose is not underestimated. For example, HDI could use a more sophisticated model capable of modeling the expected conditions at license termination to develop DCGLs or show that the RESRAD-ONSITE modeling is conservative (i.e., leads to higher doses). Alternatively, the NRC staff could review the modeling in more detail to ensure that dilution is not overestimated in the analysis. HDI should provide their RESRAD input and output files for review along with additional justification for the approach taken.

While NRC staff agree that is likely unnecessary to use a more sophisticated model to simulate groundwater flow and transport to a well in the scenarios that consider drinking water, NRC staff were concerned with the implementation of the industrial use sensitivity case where the drinking water pathway was considered. NRC staff requested the RESRAD input and output files for this scenario. A dilution factor close to 1 could be simulated to ensure the concentrations and dose are not underestimated, or a more sophisticated model could be run to simulate more realistic conditions.

HDI Response: The RESRAD model assumes one-dimensional, non-dispersive

groundwater flow with the theoretical well located at the down-gradient edge of the contaminated zone with no opportunity for dilution in the transport path prior to intersection with the well. The building foundation is conservatively assumed not to impede the transport of radionuclides from building foundations, embedded pipe, and fill. RESRAD assumes direct transport through the vadose zone to the water table and conservatively overstates radionuclide mobility. Therefore, it is unnecessary to model radionuclide transport using more sophisticated models or techniques. Refer to Groundwater Question 3 for additional information.

HDI has provided the RESRAD input, output, and library files for the LLBP scenarios evaluated.