



**HITACHI**

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Environmental Review Branch  
Division of Waste Management and Environmental Protection  
Office of Federal and State Materials and Environmental Management Programs  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

Subject: **SUBMITTAL OF CORRECTED RESPONSE TO RAI 4-1-A**

Dear Ms. Davis:

Per our phone conversation on November 19, 2009, GE-Hitachi Global Laser Enrichment LLC (GLE) hereby corrected response to RAI 4-1-A. The reason for the correction is that the population values allocated to river locations and associated with the various recreation activities in the original calculation sheet were incorrect. The corrected collective dose estimate presented in the table and in one sentence are the only changes in the RAI 4.1-A response. The methodology and all the other calculations remain unchanged as does all other text of the RAI response and its conclusions.

If there are any questions regarding this letter and its contents, please do not hesitate to contact me at 910-819-4799 or at Julie.Olivier@ge.com.

Sincerely,

Julie Olivier  
GLE Senior Licensing Professional

Docket No. 70-7016

Enclosures:

1. Corrected response to RAI 4-1-A

**Enclosure 1**  
**Corrected RAI Response to Question 4-1-A**

**4-1 Public Health Impacts from Liquid Effluent Releases:**

- A. Provide the information specified below to support an analysis the dose contributions of liquid effluents from the proposed Global Laser Enrichment (GLE) facility.
1. Provide estimated doses to the maximally exposed member of the public and the collective dose to the population in the region of influence from liquid effluent releases attributable to the proposed GLE facility.
  2. Provide the estimated radionuclide concentration in the liquid effluent releases from the proposed GLE facility, dilution factors at the receiving water bodies where humans may be exposed, and applicable exposure pathways.

Basis: The ER does not include public impacts from liquid effluent releases. Section 4.12.2.2.2 indicates that “any impacts on human health to nearby resident or on-site workers from these effluents or from receiving waters are anticipated to be SMALL” without providing supporting information. The total annual dose to the public from all exposure pathways will be compared to the dose limits in 10 CFR 20.1301 and 40 CFR 190.

**Response 1:**

In order to assess potential public health impacts from liquid effluents that would be discharged from the Proposed GLE Facility, dose estimates associated with these discharges were calculated using GENII (version 2.06). GENII input and output files are provided as part of this RAI response. GENII was developed for EPA to provide a set of programs for calculating radiation dose and risk from radionuclides released to the environment. It implements dosimetry models recommended by the International Commission on Radiological Protection (ICRP) in Publications 26, 30, 48, and 56 through 72, and the related risk factors published in Federal Guidance Report 13. For this analysis, the option to calculate doses and/or risks using ICRP-30 and -48 factors (Federal Guidance Reports 11 and 12) was selected because these methods have been approved by the DOE. The ICRP dosimetry and risk models are considered to be state-of-the-art by the international radiation protection community and have been adopted by most national and international organizations as their standard dosimetry methodology (Napier, 2007).

There are two potential water-based recreationally related exposure pathways to the general public associated with the Northeast Cape Fear River, which would receive the liquid effluent discharging from the Proposed GLE Facility: fish ingestion and recreational surface water use (i.e., swimming, boating, and shoreline activity). Details about these exposure pathways are discussed under Response 2 (see exposure factor discussion below).

The potential radiological impacts to an adult were assessed through calculations estimating the annual effective dose equivalent. The term “dose equivalent” refers to a 50-year committed dose equivalent. The sum of the ingestion-related doses (i.e., eating fish and drinking water) and direct dose equivalents provides an estimate of the total effective dose equivalent (TEDE).

**Maximally Exposed Member of the Public**

Generally, dose equivalents for adults engaging in recreational activities along the Northeast Cape Fear River were calculated by potential exposure pathway for the total body.

Concentration inputs to GENII were taken from the uranium concentrations attributable to liquid effluent that would be discharged from the Proposed GLE Facility calculated for the portion of the Northeast Cape Fear River between the confluence of Unnamed Tributary #1 with Northeast Cape Fear River (i.e., adjacent to the GE Wilmington Site) to the confluence with a branch of the Cape Fear River (see GLE ER Figure 3.4-19)<sup>1</sup>. This 6.3-mile long segment of the Northeast Cape Fear River is hereafter referred to as the “reach-of-interest”.

Maximum in-stream concentrations would occur in the reach-of-interest at the confluence with Unnamed Tributary #1 to Northeast Cape Fear River, and these concentrations are used for the maximally exposed member of the general public. Moreover, the maximally exposed member of the public is assumed to be engaged in all of the recreational activities shown in Table 4.1(A-1). Details about in-river dilution of the effluent discharge are discussed under Response 2 (see dilution factor discussion below) as are details about the exposure pathways (see applicable exposure pathways discussion below).

The adult TEDE for the maximally exposed member of the public, based on the assumptions mentioned above, was calculated to be 5.09E-05 mrem per year. These doses are well below the EPA 25 mrem per year standard (40 CFR 190) and the NRC TEDE 100 mrem per year limit (10 CFR 20). Therefore, radiological impacts to off-site receptors attributable to liquid effluent that would be discharged from the Proposed GLE Facility are anticipated to be SMALL.

Table 4.1(A-1). Calculated Effective Dose Equivalent for the Maximally Exposed Member of the Public.

Exposure Pathway	Effective Dose Equivalent for GLE* (mrem/year)
Boating	2.00E-12
Shoreline activities	2.00E-06
Swimming (immersion and incidental water ingestion)	6.30E-07
Fish ingestion	4.82E-05
<b>Sum Total (TEDE)</b>	<b>5.09E-05</b>

\* Effective Dose Equivalent estimates are the dose attributable to liquid effluent that would be discharged from the Proposed GLE Facility.

### Collective Dose to the Population in the Region of Influence

Collective dose is calculated by multiplying the average individual dose by the number of people exposed to the individual dose. As shown in Table 4.1(A-2), the collective does is estimated to be 0.21 persons-mrem/year (0.0002 persons-rem/year).

In this analysis, collective dose was estimated as follows:

1. Downstream concentrations were estimated for locations where the general public could potentially come in contact with waters of the reach-of-interest (i.e., the portion of the

<sup>1</sup> As discussed in ER Section 3.12.2, effluents from the Wilmington Site final process lagoon facility (which would receive the liquid effluents from the Proposed GLE Facility) drain to the effluent channel (Discharge Location 001 on GLE ER Figure 3.12-1), which also receives stormwater and groundwater discharge. The Site dam, shown on GLE ER Figure 3.4-19, marks the approximate boundary between the industrial effluent channel and a natural stream channel, referred to as “Unnamed Tributary #1 to Northeast Cape Fear River”. This stream may be locally known as Brickyard Creek; however, the name is not officially recognized by any federal or State regulatory agency.

Northeast Cape Fear River potentially impacted by liquid effluents from the Proposed GLE Facility). These locations and concentrations are listed in Table 4.1(A-2) and discussed in Response 2 (see dilution factor discussion below).

2. Individual dose was estimated for each of the three potential exposure locations using the same calculation method and scenario as used for the maximally exposed member of the public. That is, the exposure scenario shown in Table 4.1(A-1) is assumed to be the same at each location but the concentrations vary due to downstream dilution. These concentrations are shown in Table 4.1(A-2).
3. The number of people engaged in water-based recreation (e.g., boating, swimming, fishing, and shoreline activity) associated with each potential exposure location shown in Table 4.1(A-2) was estimated. The calculation method for estimating the number of people engaged in water-based recreation on the Northeast Cape Fear River is discussed separately below.
4. For each location shown in Table 4.1(A-2), the number of people was multiplied by the dose to estimate the collective dose.
5. Finally, the collective dose at each location was summed to estimate the collective dose in the region of interest.

Table 4.1(A-2). Calculated Collective Dose to the Population in the Region of Influence.

Potential Exposure Location	Modeled Total Uranium Concentration* (pCi/mL)	Dilution Factor**	Recreational Activity	Dose (mrem/yr)	Potentially Exposed Population	Collective Dose (person-mrem/yr)
Confluence with Unnamed Tributary #1 to Northeast Cape Fear River	1.17E-06	4.9E-6	Fish Ingestion	4.82E-05	1414	6.82E-02
			Swimming	6.30E-07	1906	1.20E-03
			Boating	2.0E-12	1244	2.49E-09
			Shoreline	2.0E-06	1231	2.46E-03
			Subtotal			7.18E-02
Just South of GE Wilmington Site Boundary	1.17E-06	4.9E-6	Fish Ingestion	4.82E-05	1414	6.82E-02
			Swimming	6.30E-07	1906	1.20E-03
			Boating	2.0E-12	1244	2.49E-09
			Shoreline	2.0E-06	1231	2.46E-03
			Subtotal			7.18E-02
Highway 133 Bridge	1.13E-06	4.7E-6	Fish Ingestion	4.64E-05	1414	6.56E-02
			Swimming	6.07E-07	1906	1.16E-03
			Boating	1.93E-12	1244	2.40E-09
			Shoreline	1.92E-06	1231	2.36E-03
			Subtotal			6.91E-02
All Locations				Total:		2.13E-01

\* The GENII model input requires isotopic concentrations, which were calculated from total uranium concentrations using the following isotopic weight fractions for enriched uranium that would be produced by the Proposed GLE Facility:  $^{234}\text{U}$ :  $8.64 \times 10^{-4}$ ;  $^{235}\text{U}$ :  $8.02 \times 10^{-2}$ ; and  $^{238}\text{U}$ :  $9.19 \times 10^{-1}$ .

\*\* Dilution factor is the modeled in-stream uranium concentration divided by the concentration in the liquid effluent that would be discharged from the GLE Radioactive Liquid Effluent System.

To estimate the number of people using the Northeast Cape Fear River for recreational purposes, we examined the land use adjacent to the River along the reach-of-interest, with particular attention to recreation access points. The reach-of-interest is where potential public

exposure might occur, and extends from the confluence with Unnamed Tributary #1 to Northeast Cape Fear River (i.e., adjacent to the GE Wilmington Site) to the confluence with a branch of the Cape Fear River. There are no general public access points (e.g., parks, boat ramps) along the reach-of-interest. Much of the river along this reach is bordered by undeveloped land or industrial sites. There are few private docks associated with private residences. A boat yard and marina are located at the Highway 133 bridge, approximately 5.6 miles (9 km) downstream of the confluence with Unnamed Tributary #1 to Northeast Cape Fear River; no general public access is provided via the marina. The general public would most likely access the reach-of-interest via boating from an upstream or downstream location or via overland across undeveloped land.

To estimate the number of people who potentially may be exposed as shown in Table 4.1(A-2), the numbers of people engaged in fishing, swimming, boating, and shoreline activity on or along the Northeast Cape Fear River were estimated. These population estimates were calculated as follows:

1. The number of people in the region of interest was determined. It was assumed that people within 15 miles are close enough to possibly use the Northeast Cape Fear River for recreational purposes on a regular basis. This distance is equivalent to an approximate 20 minute travel time, and is the median travel distance for boaters. As noted above, boating is likely to be the main means of access to the Northeast Cape Fear River reach-of-interest.
2. Water bodies in the region where water-based recreation takes place were identified, and the populations estimated in Step 1 were allocated to the Northeast Cape Fear River versus the other water bodies that they may use based on the water body surface areas.
3. Given that access to the Northeast Cape Fear River reach-of-interest likely will be via boat or direct access from private or undeveloped (e.g., nonindustrial) land, the populations estimated in Step 2 were equally allocated to three locations along the reach-of-interest: 1) at the confluence of Unnamed Tributary #1 to Northeast Cape Fear River (i.e., where maximum in-stream concentrations would occur); 2) just south of the GE Wilmington Site boundary; and 3) at the Highway 133 bridge.
4. The population estimated in Step 3 (i.e., people who might use the Northeast Cape Fear River for recreational purposes at specific locations) were allocated to specific activities (i.e., fishing, boating, swimming, and other shoreline activity) using recreational survey data.

It should be noted that there are substantial uncertainties related to this collective dose estimate. To address these uncertainties, conservative assumptions were made, that tend to over predict the estimated collective dose.

As explained above, collective dose is calculated from the estimate of the number of people from the general population who potentially would be exposed and the estimated average exposure dose. Therefore, the meaningfulness of the calculated collective dose is limited by the degree of uncertainty in both these estimates.

Regarding average dose, the same recreational user exposure scenario was used for the entire population as was used for the maximally exposed member of the population, as described in Table 4.1(A-1). The number of people potentially exposed is based, in part, on regional (southeast United States) surveys of recreational behavior. These surveys provide estimates, for example, of the number of people engaged in boating, but do not provide information on the

frequency of boating activity. So, people reported to engage in boating activity may do so once a year or much more frequently. The exposure scenario used for this collective dose assessment assumes boating takes place 50 days per year. While such an assumption may be appropriate for the maximally exposed recreational boater, it is unlikely that the average boater engages in boating activity 50 days per year.

Regarding the number of people engaged in water-based recreation on the Northeast Cape Fear River reach-of-interest, there is a large degree of uncertainty in the estimate. As noted above, the number of people potentially exposed is based, in part, on regional surveys of recreational behavior that are representative of the southeast United States. Surveys of recreational behavior specific to New Hanover County have not been identified, let alone for the reach-of-interest of the Northeast Cape Fear River. In this analysis, the numbers of people estimated to engage in specific recreational activities were allocated to the Northeast Cape Fear River based on the surface area ratio of the reach-of-interest to that of competing water bodies where similar recreational activities occur. However, the Northeast Cape Fear River reach-of-interest has no public boat ramps or parks, and is bordered mostly by industrial and swamp land and little residentially developed land. Therefore, there is very little in the way of adjacent development that would draw recreational users to the reach-of-interest. For these reasons, the estimate of the number of people recreationally using the reach-of-interest is uncertain and very likely has been overestimated.

## **Response 2:**

Provided below are the estimated radionuclide concentration in the liquid effluent that would be released from the Proposed GLE Facility, an explanation of how dilution factors were calculated for the potential locations of exposure along the Northeast Cape Fear River reach-of-interest, and descriptions of applicable exposure pathways.

### **Estimated Radionuclide Concentration in the Liquid Effluent Releases from the Proposed GLE Facility**

The calculated doses presented above in Response 1 are those attributable to the liquid effluent that would be discharged from the Proposed GLE Facility. The GLE Radioactive Liquid Effluent System (RLETS) is designed and will be operated to treat effluent to lower levels than required by the 10 CFR 20 standard for uranium of  $3 \times 10^{-7}$   $\mu\text{Ci}/\text{mL}$ . GLE has established an Administrative Limit for operation of the RLETS at 80% of the 10 CF 20 standard, or  $2.4 \times 10^{-7}$   $\mu\text{Ci}/\text{mL}$ . The GENII model input requires isotopic concentrations, and these concentrations were calculated from the Administrative Limit total uranium concentration of  $2.4 \times 10^{-7}$   $\mu\text{Ci}/\text{mL}$  using the following isotopic weight fractions for enriched uranium that would be produced by the Proposed GLE Facility:  $^{234}\text{U}$ :  $8.64 \times 10^{-4}$ ;  $^{235}\text{U}$ :  $8.02 \times 10^{-2}$ ; and  $^{238}\text{U}$ :  $9.19 \times 10^{-1}$ . The isotopic concentrations calculate to:  $^{234}\text{U}$ :  $2.07 \times 10^{-10}$ ;  $^{235}\text{U}$   $1.92 \times 10^{-8}$ ; and  $^{238}\text{U}$   $2.21 \times 10^{-7}$   $\mu\text{Ci}/\text{mL}$ . As presented in Section 4.13.2.2.1.1 of the GLE ER, total average daily liquid effluent volume to be discharged from the GLE RLETS would be 5,000 gallons per day.

### **Dilution Factors at the Receiving Water Bodies Where Humans May Be Exposed**

The dilution factor for the GLE RLETS effluent discharge into the Northeast Cape Fear River was calculated using the QUAL2K stream model, developed by EPA. In-stream concentrations and dilution factors are shown in Table 4-1(A-2). QUAL2K is a recent update to the QUAL2E in-stream model that has been in used since the 1980s. QUAL2K (as well as QUAL2E) simulates

one-dimensional water quality within a stream (meaning the stream channel is well-mixed vertically and laterally). The stream channel is represented through segments of varying lengths and includes the opportunity to allow for tributary flow and point and diffuse sources. This model calculates in-stream concentrations at various points downstream from the effluent discharge point (i.e., the confluence of the Northeast Cape Fear River and Unnamed Tributary #1 to Northeast Cape Fear River). The model estimates water concentrations for conservative constituents such as uranium (ignoring decay). A summer average for the water flow rate in the river was used, as these rates tend to be lower than annual average flow rates, and recreational activities are most likely to occur during warmer months. This flow rate and other model settings are conservative in that they result in higher estimated water uranium concentrations.

Concentrations were calculated at various points along the Northeast Cape Fear River reach-of-interest. These locations are identified below along with the rationale for their selection:

- **Confluence with Unnamed Tributary #1 to Northeast Cape Fear River.** This is the location where a member of the general public potentially could be exposed to maximum concentrations in the Northeast Cape Fear River. The model assumes uniform mixing at this location. While it is true that uniform mixing will not likely occur until further downstream, this assumption is reasonable considering the nature of the exposure pathways and scenario considered (see discussion of exposure pathways below).
- **Just south of the GE Wilmington Site boundary.** This location is adjacent to where the planned River Bluffs subdivision is proposed. While this subdivision is not planned as a water-based recreational development and will not likely provide general public access to the river, the location is nevertheless included to provide a conservative dose assessment considering its proximal downstream position to the confluence with Unnamed Tributary #1 to Northeast Cape Fear River.
- **Highway 133 crossing the Northeast Cape Fear River.** This location is approximately 5.6 miles (9 km) downstream of the confluence with Unnamed Tributary #1 to Northeast Cape Fear River. A marina and a boat yard are located at this point in the river. Although the marina supports recreational activities, it does not provide access for the general public. Aside from this marina, no other river access locations were identified other than a sole private dock and several industrial docks associated with adjacent industrial and barge operations. (Note: another boat dock that could provide recreational access was identified approximately 15 miles upstream of the reach-of-interest.)
- **Confluence of the Northeast Cape Fear River and a branch of the Cape Fear River.** This location is approximately 6.3 miles (10.2 km) downstream of the confluence with Unnamed Tributary #1 to Northeast Cape Fear River. This location was included to demonstrate where a significant drop in uranium concentrations occurs due to distance downstream of the discharge point and the additional flow from a branch of the Cape Fear River.

### Applicable Exposure Pathways

There are two potential exposure pathways to the general public associated with Site liquid effluent discharges to the Northeast Cape Fear River: fish ingestion and recreational surface water use (i.e., swimming, boating, and shoreline activity). There are no public water intakes on the Northeast Cape Fear River downstream of the confluence with Unnamed Tributary #1 to Northeast Cape Fear River. For this exposure analysis, we assume a recreational fisher and

recreational user of the Northeast Cape Fear River with an exposure scenario as shown in Table 4.1(A-3).

Table 4.1(A-3). Exposure Pathways

<b>Activity</b>	<b>Scenario Description</b>
Boating	Adult travels by boat for 2 hours per day, 50 days per year (independent of other activity).
Shoreline Activity	Shoreline activity occurs 2 hours per day, 50 days per year (independent of other activity).
Swimming	2 hours per day, 50 days per year (independent of other activity).
	Ingestion of 0.042 liters per day of water during swimming for each of the 50 days, based on EPA Exposure Factor Handbook.
Fish Consumption	44 grams for 365 days per year (approximately 3/4 pounds per week) consumed from fish caught on the Northeast Cape Fear River, based on EPA Exposure Factor Handbook.

The exposure assumptions shown in Table 4.1(A-3) were made at each of the three assumed exposure locations along the reach-of-interest. Maximum exposures potentially occur because the maximally exposed member of the public is assumed to engage in all these activities and because these activities are assumed to take place at a point in the river where maximum water uranium concentration is modeled; that is, at the river segment containing the confluence with Unnamed Tributary #1 to Northeast Cape Fear River. The assumed location of maximum exposure is not readily accessible to the public, and public exposure to liquid effluents that would be discharged from the Proposed GLE Facility would more likely take place downstream after the effluent is further diluted by the Northeast Cape Fear River.

As indicated in Table 4.1(A-3), the exposure scenario assumptions are consistent with and further support the uniform mixing assumption made for the river segment that was assumed to be the location of maximum potential exposure scenario (see dilution factor discussion above); that is, 1) boating activity would likely to take place over the entire surface of the river and therefore would provide an integration or averaging of exposure across all points in this river segment; 2) fish would be traversing and integrating or averaging exposure across this river segment; 3) swimming could occur from either shoreline and may be associated with boating activity; and 4) shoreline activity could involve movement along either shoreline. As a result, while uniform mixing may not physically occur instantaneously at the confluence, the mechanisms that would result in exposure for these activities integrate the range of uranium concentrations that would exist across the entire river segment containing the confluence with Unnamed Tributary #1 to Northeast Cape Fear River, thus reasonably representing maximum potential exposures of a member of the general public.