2.4S.13 Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters

The following site-specific supplement addresses COL License Information Item 2.21.

The information presented in this subsection describes the ability of groundwater and surface water systems to delay, disperse, dilute, or concentrate liquid effluent released from the STP site. The source of the liquid effluent would be a postulated tank rupture in the liquid radwaste system. The likelihood of an environmental release of liquid radwaste is remote due to multiple levels of protection in the liquid radwaste system. Subsection 15.7.3.3 describing the design basis accident indicates that “the liquid pathway is not considered due to the mitigative capabilities of the Radwaste Building.” Subsection 15.7.3.1 indicates “the probability of a complete tank release is considered low enough to warrant this event as a limiting fault.” In addition, Subsection 12.2.1.2.10 states that in the event of an accident involving radioactive sources in the Primary Containment or Reactor Building, such sources would be contained and isolated for further treatment and decontamination.

2.4S.13.1 Direct Release to Groundwater

Although not considered to be a credible event, this section provides a prudently conservative analysis of a postulated, accidental liquid release of effluents to the groundwater at the STP site. The groundwater pathway includes the components of advection, dispersion, retardation, and decay. The advective component is discussed in Subsection 2.4S.12.3. In one dimension, dispersion is the spreading of a contaminant beyond the advective front (longitudinal) due to the concentration gradient within and ahead of the front. In two and three dimensions, dispersion also includes transverse components (e.g., laterally in all directions). Chemicals that react with the aquifer matrix can reduce in concentration along the flow, relative to their initial groundwater concentration. Reactions with the aquifer matrix include cation/anion exchange, complexation, oxidation-reduction reactions, and surface sorption. Radionuclide concentrations in the groundwater pathway can be significantly influenced by radioactive decay, depending on the half-life of the radionuclide.

2.4S.13.1.1 Accident Scenario

It is postulated that a liquid radwaste tank ruptures and its contents are released to groundwater. The volume of the liquid to be released and the associated radionuclide concentrations were selected to produce an accident scenario that could lead to contamination of groundwater or surface water via the groundwater pathway. Release points are discussed in Subsection 11.2.3.

An inventory of radioactive sources in the liquid radwaste system tanks is discussed in Section 12.2. A review of the radioactive sources suggests that the Low Conductivity Waste (LCW) collector tank has the greatest concentrations of radioisotopes. Each LCW collector tank has a volume of 140 m^3 (36,984 gallons) (Section 11.2, Table 11.2.4), and its radionuclide concentrations are shown on Table 2.4S.13-1. These radionuclide concentration values were compared with the reactor coolant radionuclide concentrations from Section 11.1, as shown on Table 2.4S.13-1. For conservatism, the highest concentration from either the LCW collector tank or the reactor coolant was used as a source term concentration for each radionuclide.

Several of the radionuclides are part of a decay chain sequence. Figure 2.4S.13-1 presents the decay chain sequences for chains important for dosimetric purposes. Table 2.4S.13-1 includes the half-lives of the radionuclides of concern based on information from References 2.4S.13-1 and 2.4S.13-2. The accident scenario assumes that the LCW collector tank ruptures and that its contents are released to the groundwater.

2.4S.13.1.2 Conceptual Model

This subsection describes the conceptual model used to evaluate an accidental release of liquid effluent to groundwater or surface water via the groundwater pathway. The key elements and assumptions embodied in the conceptual model are provided below.

The conceptual model of the site groundwater system is based on the hydrogeological information presented in Subsection 2.4S.12. The site groundwater system consists of two aquifers; the Shallow Aquifer and the Deep Aquifer. The Shallow Aquifer extends from near ground surface and is approximately 100 ft to 150 ft thick. The Shallow Aquifer is separated from the Deep Aquifer by a 100 ft to 150 ft thick sequence of clay and silt. Potentiometric surface maps created from onsite groundwater level measurements indicate that flow in the Deep Aquifer is towards the onsite groundwater production wells located on the east and west sides of the STP site. The Deep Aquifer is greater than 500 ft thick and is the principal groundwater production interval in the site area.

The Shallow Aquifer is divided into the Upper Shallow Aquifer and Lower Shallow Aquifer that are separated by a clay and silt layer. Both zones are considered to be semi-confined to confined with a downward hydraulic gradient between the zones. The Upper Shallow aquifer is comprised of interbedded sand layers to depths of approximately 50 ft below ground surface. The Lower Shallow Aquifer consists of interbedded sand layers approximately 50 ft to 150 ft below ground surface. Site investigations indicate that this separation is not continuous and leakage between the two units is occurring. The groundwater flow direction in both the Upper and Lower zones of the Shallow Aquifer is to the east-southeast, toward the Colorado River, with a minor flow component toward the southwest in the western portion of the site. The Shallow Aquifer has limited production capability and is used for livestock watering and occasional domestic supply within Matagorda County.

As discussed in the previous subsection, the LCW collector tank inside the Radwaste Building is assumed to be the source of the release. The Radwaste Building basement floor is at a depth of approximately 45 ft below nominal post-construction plant grade and the Radwaste Building foundation is at a depth of approximately 53 ft below nominal post-construction plant grade (Section 3.8). The excavation for the adjacent Reactor Building extends to a depth of approximately 94 ft below nominal post-construction plant grade, which would involve placement of structural fill beneath the Radwaste Building as part of backfilling around the Reactor Building. The Radwaste

Building includes several levels of protection such as an alarmed tank level monitoring system and steel-lined compartments surrounding the radwaste tanks. Furthermore, all radwaste tanks are located inside the Radwaste Building, which has a basemat and walls to a height necessary to retain spilled liquids (Section 11.2) and is equipped with a sump collection system designed to collect any leakage from the steel compartments around the tanks.

The LCW collector tank is postulated to rupture, and 80% of the liquid volume (29,587 gallons) is assumed to be released in accordance with Branch Technical Position 11-6 in NUREG-0800 (Reference 2.4S.13-3). Flow from the tank rupture is postulated to flood the Radwaste Building. Fluids are theorized to migrate past the tank's steel lined compartment and sump collection system, and that a pathway is created that would allow the entire 29,587 gallons to enter the groundwater system. This assumption is very conservative because it requires failure of the steel lined compartment and the sump collection system. The LCW collector tank rupture is postulated to occur in either the STP 3 or 4 Radwaste Building, which would represent the shortest pathway to off site receptors based on the current understanding of groundwater flow conditions.

With the postulated release of the contents of the LCW collector tank to groundwater, radionuclides would enter the Shallow Aquifer. Potential offsite effluent release pathways resulting from a theoretical accidental release of liquid effluent to groundwater were described in Subsection 2.4S.12.3. Conceptually, four release pathways were selected as the most likely complete exposure pathways:

- Pathway 1: Upper and Lower Shallow Aquifer – Flow from the STP 3 area discharges to the unnamed tributary and a hypothetical off-site Shallow Aquifer water supply well at the east site boundary.
- Pathway 2: Upper and Lower Shallow Aquifer – Flow from the STP 3 area that discharges to a Shallow aquifer livestock watering well (well number 2004120846) located offsite, to the southeast of STP 1 & 2. This pathway assumes that the well captures the effluent release and the well discharges to livestock watering troughs or the well water could be used for domestic or other human consumption.
- Pathway 3: Lower Shallow Aquifer – Flow from the STP 3 area discharges to the Colorado River.
- Pathway 4: Upper Shallow Aquifer – Flow from the STP 4 area discharges to Little Robbins Slough or a hypothetical off-site Shallow Aquifer water supply well at the western site boundary.

Figure 2.4S.13-2 shows these pathways in relation to the STP site. The excavation required for the construction of STP 3 & 4 penetrates into both the Upper and Lower Shallow Aquifer zones, but is above the thick sequence of clay and silt that separates the Shallow Aquifer from the more productive Deep Aquifer. The Upper Shallow Aquifer would be impacted by the postulated LCW release as it occurs at the base of the Upper Shallow Aquifer. In addition, considering there is a downward vertical hydraulic gradient between the Upper and Lower Shallow Aquifer zones and the backfilled excavation, which may hydraulically connect both aquifer zones, a likely groundwater pathway for an accidental release would also be in the Lower Shallow Aquifer.

- Pathway 1 includes two scenarios: a) discharge to the unnamed tributary at the east site boundary from the Upper Shallow Aquifer; and b) discharge to a hypothetical off-site water well installed within both the Upper and Lower Shallow Aquifers at the east site boundary. The well, which could serve as a domestic drinking water well, would represent a direct human exposure.
- Pathway 2 terminates at an existing 80-foot deep, off-site Shallow Aquifer livestock watering well. This well is assumed to penetrate both the Upper and Lower Shallow Aquifer and to possibly also be used for domestic water supply. The well is reported to pump 200,000 gallons per year (Reference 2.4S.13-4). This well could be a direct exposure pathway if used for human consumption.
- Pathway 3 terminates at the Colorado River. The Colorado River is believed to flow within a channel incised into both the Upper and the Lower Shallow Aquifers. This would also be an indirect exposure pathway through animals (livestock watering) and crops (irrigation). Note that the Colorado River is not used as a source of potable water downstream of the site area (Subsection 2.4S.1).
- Pathway 4 terminates at Little Robbins Slough or a hypothetical supply well along the western site boundary.

Pathway 3 represents a combined groundwater/surface water pathway, and the influent groundwater concentrations would be reduced by dilution from unimpacted surface water mixing in the Colorado River. The most conservative case would be a release during low flow conditions. The minimum 7-day low flow rate over the period from 1948 and 2006 is approximately 0.5 cfs (Subsection 2.4S.11.1).

Other pathways that were considered and then rejected include (1) flow to the relief wells surrounding the MCR dike, (2) flow in the Deep Aquifer, (3) flow to the southwest in the Lower Shallow Aquifer from the Unit 4 Radwaste Building, (4) flow due to thermal buoyancy effects at the release, and (5) enhanced transport due to chelating agents. The rationale for rejecting these pathways is provided below.

(1) Groundwater potentiometric surface maps (Figures 2.4S.12-17 and 2.4S.12-19) and a hydrogeologic cross section (Figure 2.4S.12-21) indicate that Shallow Aquifer groundwater flow is from, rather than toward, the MCR, thus precluding a transport pathway to the MCR.

(2) As discussed above, the Deep Aquifer is separated from the Shallow Aquifer by greater than 100 ft of low hydraulic conductivity silt and clay, and groundwater flow in the Deep aquifer within the site boundary appears to be controlled by pumping from onsite groundwater production wells. These factors suggest that it is unlikely that the Deep Aquifer would be a pathway for offsite release.

(3) The westward flow component in the Shallow Aquifer may represent a pathway from the Unit 4 Radwaste Building in the Upper Zone. However, in the Lower zone, a sedimentary facies change is present between Unit 4 and the west site boundary. This material is predominantly silt and clay instead of sand as indicated by soil boring logs B-420, B-932L, and B-951L (Subsection 2.5S.4). Corroborating the observed facies change are slug test results from observation wells OW-910L, OW-951L, and OW-950L, which indicate the hydraulic conductivity of the Lower Shallow Aquifer decreases by an order of magnitude from Unit 4 to the west and southwest site boundary (Figure 2.4S.12-26). In addition, potentiometric maps (Figure 2.4S.12-19) indicate the hydraulic gradient in this area is very small compared with the predominant southeast flowpaths and that substantial seasonal and perhaps climatic variability has occurred at the proposed Unit 4 area. These hydrogeologic findings do not support a southwestward preferential pathway from Unit 4 in the Lower Shallow Aquifer. The findings also indicate that potential southwestward travel times would likely be great enough for concentrations of radionuclides to decrease to the point of compliance prior to reaching the exposure point at the west site boundary as in the case of the analysis for Pathway 4 in the Upper Shallow Aquifer. Consequently, no analysis of Transport Pathway 4 in the Lower Shallow Aquifer is necessary.

(4) To evaluate potential buoyancy effects due to a release of heated radwaste water from the Radwaste Building, the plan view dimensions (214 feet by 124 feet) and the depth of this building below the water table (35 feet assuming a depth to water table of 10 feet) are considered. The estimated total volume of the Radwaste Building below the water table is:

(214 ft)(124 ft)(35 ft) = 928,760 ft^3 or roughly 6,950,000 gallons.

Assuming about half of this volume is void space (i.e., unoccupied by building and/or equipment infrastructure), the volume of void space in the Radwaste Building below the water table, where mixing of groundwater with radwaste could occur, is estimated to be about:

$Volume_{mix}$ = (0.5) (6,950,000 gal) = 3,475,000 gallons.

The estimated volume of liquid radwaste ($Volume_{rw}$) is assumed to be the total volume of four radwaste tanks, or about 150,000 gallons, and the volume of ambient groundwater ($Volume_{gw}$) that can mix with the heated liquid radwaste is simply the difference between $Volume_{mix}$ and $Volume_{rw}$, or 3,325,000 gallons.

To estimate the resulting temperature of the mixing waters, a weighted average based on the equation for heat transfer ($Q = mc\Delta T$) and the First Law of Thermodynamics, is calculated using estimated quantities and temperatures of these waters:

$(Temp_{mix}) = [(Temp_{rw})(Volume_{rw}) + (Temp_{gw})(Volume_{gw})]/(Volume_{mix})$
$(Temp_{mix}) = (80^o\ C)(150{,}000\ gal) + (23.2^o\ C)(3{,}325{,}000\ gal)/3{,}475{,}000\ gal = 25.7^o\ C$

The difference in temperature between the mixture of spilled radwaste and groundwater in the Radwaste Building and ambient groundwater is estimated at about: 25.7º C – 23.2º C = 2.5º C, and would not likely cause buoyancy.

(5) The effect that chelating agents might have on the transport of radionuclides released during the postulated accident has also been considered and is concluded not to be significant. Conditions that promote enhanced migration over long distances in an aquifer include (a) high concentrations of organic chelating agents, (b) low concentrations of competing cations, (c) alkaline pH values, (d) chelating agents with slow biodegradation rates, and (e) kinetically inert complexes (Reference 2.4S.13-11).

In condition (a), a rupture of the spent resin storage tank or a high integrity container (HIC) filled with spent resin in the Unit 3 Radwaste Building would have to also occur during the postulated accident involving a spill of LCW water. The chelating agents would be substantially diluted by flooding of the building that would occur if a pathway to the adjacent aquifer were completed.

In condition (b), the clays and silts of the Shallow Aquifer can be expected to provide an abundant source of competing cation exchange minerals.

In condition (c), the water quality tests conducted on the Shallow Aquifer do not indicate that alkaline pH conditions are present. The existence of the remaining two listed conditions is undetermined, but their effect likely would not outweigh the lack of high concentrations of chelating agents, abundance of cation exchange minerals and neutral pH in the Shallow Aquifer. For these reasons, it appears unlikely that the process of complexation of radionuclides with organic chelating agents would significantly affect the long-distance transport of radionuclides in the STP groundwater system.

2.4S.13.1.3 Analysis of Accidental Releases to Groundwater

A radionuclide transport analysis has been conducted to estimate the radionuclide concentrations that might expose existing and future water users based on a release of the radioactive liquid of a LCW collector tank. The locations and users of surface water are discussed in Subsection 2.4S.1.2.

Analysis of liquid effluent release commences with the simplest of screening models, using demonstratively conservative assumptions and coefficients. Radionuclide concentrations resulting from the preliminary analysis are then compared against the maximum permissible concentrations, stated as the effluent concentration limits (ECLs) identified in 10 CFR 20, Appendix B, Table 2, Column 2, to determine acceptability. Further analysis, using progressively more realistic and less conservative assumptions and modeling techniques, is conducted when preliminary results using conservative assumptions and coefficients exceed 1 percent of an ECL.

This analysis accounts for the parent radionuclides expected to be present in the radwaste tank plus progeny radionuclides that would be generated subsequently during transport. The analysis considered all progeny radionuclides in the decay chain sequences that are important for dosimetric purposes. International Commission on Radiation Protection (ICRP) Publication 38 (Reference 2.4S.13-1) was used to identify the member for which the decay chain sequence can be truncated. For some of the radionuclides expected to be present in the tanks, consideration of up to three members of the decay chain sequence was required. The derivation of the equations governing the transport of the parent and progeny radionuclides follows.

Transport of the parent radionuclide along a groundwater pathline is governed by the advection-dispersion-reaction equation (Reference 2.4S.13-5), which is given as

$$R\frac{\partial C}{\partial t} = D\frac{\partial^2 C}{\partial x^2} - v\frac{\partial C}{\partial x} - \lambda RC$$ Equation 2.4S.13-1

where: C = radionuclide concentration; R = retardation factor; D = coefficient of longitudinal hydrodynamic dispersion; v = average linear velocity; t = groundwater travel time, x = travel distance, and λ = radioactive decay constant. The retardation factor is defined from the relationship

$$R = 1 + \frac{\rho_b K_d}{n_e}$$ Equation 2.4S.13-2

where: ρ_b = bulk density; K_d = distribution coefficient; and n_e = effective porosity. The average linear velocity is determined using Darcy's law, which is

$$v = -\frac{K}{n_e}\frac{dh}{dx}$$ Equation 2.4S.13-3

where: K = hydraulic conductivity; and dh/dx = hydraulic gradient. The radioactive decay constant can be written as

$$\lambda = \frac{\ln 2}{t_{1/2}}$$ Equation 2.4S.13-4

where $t_{1/2}$ = radionuclide half-life.

Using the method of characteristics approach described in Reference 2.4S.13-6, the material derivative of concentration can be written as

$$\frac{dC}{dt} = \frac{\partial C}{\partial t} + \frac{dx}{dt}\frac{\partial C}{\partial x}$$ Equation 2.4S.13-5

According to Reference 2.4S.13-5, the coefficient of longitudinal hydrodynamic dispersion (D) is determined from the relationship:

$$D = \alpha_L v \qquad \text{Equation 2.4S.13-6}$$

The longitudinal dispersivity (α_L) is estimated by Reference 2.4S.13-7 by:

$$\alpha_L = 0.83(\log L)^{2.414} \qquad \text{Equation 2.4S.13-7}$$

where L = the length of the transport flowpath. Equation 2.4S.13-7 assumes α_L and L are in units of meters. Using site-specific values for L and v, the longitudinal dispersivity and the longitudinal coefficient of hydrodynamic dispersion are obtained.

To estimate the radionuclide concentrations in groundwater, the following equations are applied as appropriate along the three groundwater transport pathways originating at the Radwaste Building at Unit 3 and the pathway originating at the Unit 4 Radwaste Building. The analysis was performed as described in 2.4S.13.1.3.1.

2.4S.13.1.3.1 Transport Considering Radioactive Decay

The initial conservative screening analysis was performed considering radioactive decay only. Transport Pathways 1 and 4 are the shortest pathways, thus having the least radioactive decay, and represent opposing flow directions that originate one from each of the proposed Radwaste Buildings. Transport Pathway 2 and 3 are longer, allowing more decay time than Pathways 1 or 4. Concentrations would be greater at the point of compliance for Transport Pathways 1 and 4 than that for Transport Pathway 2 or 3. As a result, the results for Pathways 1 and 4 are considered to be prudently conservative compared to Pathways 2 and 3. Although the screening results are presented in Table 2.4S.13-2A and -2B, only the results from the Pathways 1 and 4 analyses are discussed below.

This analysis assumed that all radionuclides migrate at the same rate as groundwater and considered no adsorption or dispersion, which could otherwise result in changes in plume concentrations over distance. Under these assumptions, the radionuclide concentration along a groundwater pathline can be expressed as a function of the groundwater travel time using the Bateman equations as given in Appendix B of NUREG/CR-5512, Vol. 1 (Reference 2.4S.13-2). The expressions for the parent, first progeny, and second progeny are as follows:

$$C_1(t) = C_{10}\exp(-\lambda_1 t)$$

Equation 2.4S.13-8

$$C_2(t) = \left(\frac{d_{12}\lambda_2 C_{10}}{\lambda_2 - \lambda_1}\right)\exp(-\lambda_1 t) + \left(C_{20} - \frac{d_{12}\lambda_2 C_{10}}{\lambda_2 - \lambda_1}\right)\exp(-\lambda_2 t)$$

Equation 2.4S.13-9

$$\begin{aligned} C_3(t) = &\left[\frac{d_{13}\lambda_3 C_{10}}{\lambda_3 - \lambda_1} + \frac{d_{23}\lambda_2 d_{12}\lambda_3 C_{10}}{(\lambda_3 - \lambda_1)(\lambda_2 - \lambda_1)}\right]\exp(-\lambda_1 t) \\ &+ \left[\frac{d_{23}\lambda_3 C_{20}}{\lambda_3 - \lambda_2} - \frac{d_{23}\lambda_2 d_{12}\lambda_3 C_{10}}{(\lambda_3 - \lambda_2)(\lambda_2 - \lambda_1)}\right]\exp(-\lambda_2 t) \\ &+ \left[C_{30} - \frac{d_{13}\lambda_3 C_{10}}{\lambda_3 - \lambda_1} - \frac{d_{23}\lambda_3 C_{20}}{\lambda_3 - \lambda_2} + \frac{d_{23}\lambda_2 d_{12}\lambda_3 C_{10}}{(\lambda_3 - \lambda_1)(\lambda_3 - \lambda_2)}\right]\exp(-\lambda_3 t) \end{aligned}$$

Equation 2.4S.13-10

where:

C_1 = concentration of the parent radionuclide (µCi/cm^3)
C_2 = concentration of the first progeny radionuclide (µCi/cm^3)
C_3 = concentration of the second progeny radionuclide (µCi/cm^3)
C_{10} = initial concentration of the parent radionuclide (µCi/cm^3)
C_{20} = initial concentration of the first progeny radionuclide (µCi/cm^3)
C_{30} = initial concentration of the second progeny radionuclide (µCi/cm^3)
λ_1 = radioactive decay constant for the parent radionuclide (day^{-1})
λ_2 = radioactive decay constant for the first progeny radionuclide (day^{-1})
λ_3 = radioactive decay constant for the second progeny radionuclide (day^{-1})
d_{12} = fraction of parent radionuclide transitions resulting in first progeny production
d_{13} = fraction of parent radionuclide transitions resulting in second progeny
d_{23} = fraction of first progeny transitions that result in production of second progeny
t = groundwater travel time (day)

The radioactive decay constant expressed in Equation 2.4S.13-4 is related to the radionuclide half-life.

Pathway 1 was screened using the representative linear groundwater velocities and the maximum linear groundwater velocities for the Upper Shallow Aquifer (56,154 days and 20,857 days, respectively) and for the Lower Shallow Aquifer (45,625 days and 28,077 days, respectively) as summarized by Table 2.4S.12-17. Similarly, Pathway 4 was screened for the Upper Shallow Aquifer using representative and maximum linear groundwater velocities (120,000 days and 42,857 days, respectively). The results of the screening analysis using the representative linear groundwater velocities are summarized in Table 2.4S.13-2A, and the results using the maximum linear groundwater velocities are summarized in Table 2.4S.13-2B.

The results for Pathway 1a and 1b using representative (average) travel times indicate that the radionuclides Ni-63, Sr-90, Y-90, Cs-137, and Pu-239 may be of concern. Using maximum travel times for Pathway 1a and 1b indicate the five aforementioned radionuclides plus H-3 and Co-60 may be of concern. The results for Pathway 4 using representative (average) travel times indicate that the radionuclides Ni-63, Sr-90, Cs-137, and Pu-239 may be of concern, and using maximum travel times for this pathway, the four aforementioned radionuclides plus H-3 and Y-90 may be of concern.

The computed concentrations were compared with the 10 CFR 20, Appendix B, Table 2, ECLs. The ratio of the groundwater concentration to the ECL was used as the screening indicator. Ratios that were greater than or equal to 0.01, which means that the groundwater concentration is predicted to be greater than or equal to one percent of the ECL, were selected for further evaluation using retardation, advection, and dispersion.

2.4S.13.1.3.2 Transport Considering Retardation, Advection, and Dispersion

The representative average linear velocity is considered to best represent subsurface site conditions based on the observed decay in the one-dimensional sense along a groundwater pathline for each aquifer. The radionuclides of concern identified by the screening analysis of Transport Pathways 1a and 1b (Ni-63, Sr-90, Y-90, Cs-137, and Pu-239) and Transport Pathway 4 (Ni-63, Sr-90, Cs-137, and Pu-239) were further evaluated in the next step, considering advection, dispersion, and retardation using the representative travel times from Table 2.4S.12-17 and the bulk densities presented in Table 2.4S.12-14. Distribution coefficients for these radionuclides were assigned using either literature based or site-specific laboratory measured values. Yttrium (Y-90) was not evaluated further due to the relatively insignificant short half-life (about 64 hours) as compared to the relatively long representative travel times estimated for each analyzed transport pathway (154 to 330 years).

Assuming a constant input concentration for a period of time t_0, the concentration along a groundwater pathline may be given by (Reference 2.4S.13-5):

$$\frac{C(x,t)}{C_0} = A(x,t) \quad 0 < t \le t_0$$
$$\frac{C(x,t)}{C_0} = A(x,t) - A(x,t-t_0) \quad t > t_0$$

Equation 2.4S.13-11

where:

$$A(x,t) = \frac{v}{v+U}\exp\left[\frac{x(v-U)}{2D}\right]\mathrm{erfc}\left[\frac{Rx-Ut}{2(DRt)^{1/2}}\right] + \frac{v}{v-U}\exp\left[\frac{x(v+U)}{2D}\right]\mathrm{erfc}\left[\frac{Rx+Ut}{2(DRt)^{1/2}}\right] + \frac{v^2}{2DR\lambda}\exp\left[\frac{vx}{D}-\lambda t\right]\mathrm{erfc}\left[\frac{Rx+vt}{2(DRt)^{1/2}}\right]$$

Equation 2.4S.13-12

with

$$U = (v^2 + 4DR\lambda)^{1/2}$$

Equation 2.4S.13-13

Definitions for the parameters in the above equations are as follows:

C = radionuclide concentration (μCi/cm^3)
C_0 = radionuclide input concentration (μCi/cm^3)
t_0 = period of time a radionuclide is input at C_0 (y)
v = average pore water velocity (ft/y)
D = longitudinal coefficient of hydrodynamic dispersion (ft^2/y)
R = retardation factor
λ = radioactive decay constant (y^{-1})

The parameters to be specified in Equations 2.4S.13-11 and 2.4S.13-12 include C_0, t_0, v, D, R, and λ. The basis for assigning these parameters is described below.

The radionuclide input concentration C_0 is assumed to be the concentration in either the LCW tank or the reactor coolant, whichever is greater. The values for H-3, Co-60, Ni-63, Sr-90, and Cs-137 are tabulated in Appendix 1. However, the input concentration of Pu-239 – a daughter product of Np-239 – is estimated by assuming all source Np-239 decays instantaneously to Pu-239. This is a reasonable assumption considering the half-life of Np-239 is small (2.36 days) relative to the transport time scales of interest. The input concentration for Pu-239 was calculated using the relationship between the activity concentration and atom density, i.e.

$$C = \lambda N$$ Equation 2.4S.13-14

where N is the atom density (atoms/cm^3). Assuming all Np-239 decays to Pu-239, the atom density is a constant and C_0 for Pu-239 can be determined as:

$$^{Pu-239}C_0 = {}^{Np-239}C_0 \frac{\lambda_{Pu-239}}{\lambda_{Np-239}} = (2.7\text{E}-02\ \mu\text{Ci/cm}^3)\left(\frac{7.89\text{E}-08\ \text{day}^{-1}}{2.94\ \text{E}-01\ \text{day}^{-1}}\right) = 7.25\ \text{E}-09\ \mu\text{Ci/cm}^3$$

Equation 2.4S.13-15

The input time period t_0 is taken to be the operating life of the plant or 60 years (40 years initial operating license plus 20 years license renewal). This assumption is conservative in that the equipment drain collection tank is taken to leak continuously undetected for the entire plant operating life. At the end of plant operation, it is assumed that all radwaste tanks are drained and that any leakage ceases at that point in time.

Site-specific distribution coefficients were used for Ni-63, Sr-90, Cs-137, and Pu-239. These values were based on the laboratory K_d analysis of 10 soil samples obtained from the Lower Shallow Aquifer at the STP 3 & 4 site (Reference 2.4S.13-8) as shown on Table 2.4S.13-3. ASTM method 4646-03 (Reference 2.4S.13-9) was used to determine laboratory K_d values using site groundwater. For individual K_d test results reported as greater than the given value, the given value is used for the K_d . For each of these radionuclides, the geometric mean of the reported values was used in the transport analysis to best represent the subsurface material in the Lower Shallow Aquifer zone beneath the site (Table 2.4S.13-4).

The predicted concentrations of the radionuclides from the analysis using representative conditions are summarized on Table 2.4S.13-4 for Pathways 1a, 1b, and 4 (east and west site boundaries, respectively).

- Pathway 1a (Upper Shallow Aquifer): No radionuclides are predicted to exceed the ECL at the east site boundary.
- Pathway 1b (Lower Shallow Aquifer): No radionuclides are predicted to exceed the ECL at the east site boundary.
- Pathway 4 (Upper Shallow Aquifer): No radionuclides are predicted to exceed the ECL at the west site boundary.

2.4S.13.1.4 Compliance with 10 CFR 20

As previously stated, the Shallow Aquifer is considered the most likely groundwater pathway to be impacted by an accidental release (LCW collector tank rupture). The radionuclide transport analysis presented for the Shallow Aquifer indicates that the accidental release of radionuclides to groundwater is individually below each of their ECLs at the exposure points using representative conditions (Pathways 1a and 1b - hypothetical well at eastern site boundary, Pathway 2 - existing off-site well, Pathway 3 - surface water in the Colorado River, or Pathway 4 – west site boundary). 10 CFR 20, Appendix B, Table 2 imposes additional requirements when the identity and concentration of each radionuclide in a mixture are known. In this case, the ratio of the concentration present in the mixture and the concentration otherwise established in 10 CFR 20 for the specified radionuclides not in a mixture may not exceed "1" (i.e., "unity"). The sum of fractions approach has been applied to the radionuclide concentrations estimated above. Results are summarized in Table 2.4S.13-4. The sum of fractions for the mixtures is below 1 for each pathway. The longer travel times for Pathways 2 and 3 would allow additional radioactive decay and would result in lower predicted concentrations than those at the terminus of Pathways 1 and 4. The analysis results indicate that an accidental liquid release of effluents in groundwater would not exceed 10 CFR 20 limits at any of the four postulated Shallow Aquifer exposure points.

A sensitivity analysis was performed using the range of average linear velocities/travel times from Table 2.4S.12-17 and the range of distribution coefficients (K_d) from Table 2.4S.13-3. For example, the maximum average linear velocity (shortest travel time) incorporated the minimum laboratory K_d values.

The result of the sensitivity analysis indicates that no exceedence of ECLs occur when using the maximum average linear velocity (minimum travel time) and minimum K_d laboratory values for any of the Transport Pathways. The geologic depositional environment at the STP site suggests that the use of the maximum average linear velocity would be extreme and that the representative average linear velocities used in the analyses best represents the hydrogeologic conditions beneath the STP site. The representative average linear velocities utilizing averages and geometric means of the material properties would best represent the discontinuous, fine-grained mixtures of the sand, silt, and clay subsurface materials described in Subsection 2.4S.12. Using the representative average linear velocities, no radionuclides are predicted to exceed the ECL.

The analysis presented in this section is considered to be conservative because:

- The analysis does not consider diffusion or dilution; both of these mechanisms would act to reduce the concentrations of the radionuclides.
- The analysis assumes that no mitigative measures are implemented to reduce offsite exposure. Because the travel times to the receptors are on the order of hundreds of years, it would be possible to implement measures to further reduce off site exposure.
- No credit is taken for the radwaste system components designed to prevent environmental releases, such as a stainless steel lined compartment to contain tank spillage and specially constructed building components surrounding the tanks to capture and prevent releases from the Radwaste Building. In accordance with

Branch Technical Position 11-6 in NUREG-0800 (Reference 2.4S.13-3), these design components would mitigate potential release from the building tanks to the subsurface environment.

- The radwaste building foundation level is below the groundwater potentiometric surface of both the Upper and Lower Shallow Aquifer zones. In the unlikely event the basement exterior walls leaked and associated steel liners and sump pumps were to fail simultaneously, groundwater would flow into the Radwaste Building, precluding the release of liquid effluents out of the building unless the water level in the building is higher in elevation than that of the surrounding groundwater potentiometric head.

2.4S.13.2 Direct Releases to Surface Waters

The design of the Liquid Radioactive Waste System (LWMS) for STP 3 & 4 as described in Section 11.2 specifies that all liquid radwaste tanks are to be contained inside of the Radwaste Building. The Radwaste Building, which is designed in accordance with Regulatory Guide 1.143, will have walls and basemat of sufficient dimensions to contain all liquid radwaste. There are no outdoor tanks in the LWMS that could release radioactive effluent. Therefore, a postulated accident scenario involving the release of effluent directly to surface water is a rapid and catastrophic flood, such as that caused by a breach of the MCR embankment, inundating the Radwaste Building coinciding with leakage from the indoor tanks on the basement level of the Radwaste Building.

The Radwaste Building is a reinforced concrete structure. As described in Section 3.4, the building does not contain safety-related equipment and is not contiguous with other plant structures except through the radwaste piping and tunnel. In case of flooding, the building structure serves as a large sump which can collect and hold leakage within the building. The medium and large radwaste tanks are housed in sealed compartments which are designed to contain any spillage or leakage from tanks that may rupture.

Subsection 2.4S.1, Figure 2.4S.1-9 shows the flood inundated areas delineated by the Federal Emergency Management Agency in the vicinity of the STP site. STP 3 & 4 is located in Zone C, identified as areas of minimal flooding. The figure suggests STP 3 & 4 is beyond the areas moderately impacted by 100-year and 500-year flood event.

The design basis flooding (DBF) elevation for the STP 3 & 4 site is determined by considering a number of different flooding scenarios. The potential flooding scenarios applicable and investigated for the site include the following: local probable maximum precipitation (PMP) at the site, potential dam failures, probable maximum flood (PMF) on streams and rivers, probable maximum surge and seiche (PMSS), probable maximum tsunami (PMT), flooding due to ice effects, and flooding caused by channel diversions. In applicable cases the flooding scenarios were investigated in conjunction with other flooding and meteorological events, such as wind-generated waves and tidal levels, as recommended in the guidelines presented in ANSI/ANS 2.8-1992 (Reference 2.4S.2-9). Detailed discussions on each of these flooding events and how they were estimated are found in Subsections 2.4S.2 through 2.4S.7, and Subsection

2.4S.9. The estimated flood elevations are based on the site plan provided in the COLA Subsection 2.4S.4.

The maximum water level due to a local PMP storm event is estimated and discussed in Subsection 2.4S.2. The maximum water level in the power block area due to a local PMP storm event is estimated to be at elevation 36.6 ft MSL. This level is higher than the ground floor elevation of approximately 35 ft MSL at the Radwaste Buildings for Units 3 and 4, where the postulated accident described in Section 2.4S.13.1.1 occurs. Therefore, a local PMP storm event could potentially pose a flooding risk to a Radwaste Building.

The impacts of postulated dam failures on the STP 3 & 4 safety-related SSCs are discussed in Subsection 2.4S.4. Two aspects of flooding are considered. First, flood elevation at the site is investigated as a result of cascading failure of dams in the Colorado River basin and its tributaries upstream of the site. The resulting water level at the site is 28.6 ft MSL without wind effects, 32.5 ft MSL including coincidental wind set-up, and 34.4 ft including coincidental wind set-up and wave run-up. Second, the flood elevation at the site is investigated due to the failure of the Main Cooling Reservoir (MCR) embankment. A maximum flood elevation of 38.8 ft MSL was determined at the STP 3 & 4 site as a result of the MCR embankment breach. Conservatively, the design basis flood elevation was established at 40.0 ft MSL.

Estimation of the PMF water level on the Colorado River is discussed in Subsection 2.4S.3. The maximum PMF water level for the Colorado River at the STP 3 & 4 site has been determined to be at elevation 26.3 ft MSL. However, including coincidental wind set-up and wave run-up, the water level at the site from the PMF would be slightly lower than the flood elevation due to cascading failure of dams in the upstream Colorado River basin (34.4 ft MSL). Both flooding scenarios would not pose a flooding risk to the Radwaste Building.

Flooding from probable maximum surge and seiche as a result of the probable maximum hurricane (PMH) in the Gulf of Mexico is discussed in Subsection 2.4S.5. The maximum water level at the site due to the PMH is estimated to be elevation 31.1 ft MSL. Since this water level is lower than the water level of 32.5 ft for upstream dam failure (with coincidental wind set-up), the resulting maximum water level at the site after factoring in the wave run-up would be lower than 34.4 ft that was predicted for the upstream cascading dam failure event. The water level at the site due to the PMH, including coincidental wind set-up and wave run-up, is not higher than the entrance elevation to the Radwaste Buildings at STP 3 and STP 4. Therefore, maximum surge and seiche due to the PMH would not pose a risk of flooding the Radwaste Buildings.

Subsection 2.4S.6 describes estimation of the probable maximum tsunami water level. The maximum water level associated with a PMT at the STP 3 & 4 site is 11.5 ft MSL. Therefore, the PMT would not be a flood risk to the STP 3 & 4 site. As discussed in Subsections 2.4S.7 and 2.4S.9, ice effects and channel diversions, respectively, would not pose a flooding risk to the STP 3 & 4 site.

Of the several flooding mechanisms considered, other than a breach of the MCR embankment, the local PMP storm is the only mechanism having the potential to flood the Unit 3 and Unit 4 Radwaste Buildings.

The local PMP storm event can be considered a slow-moving event for which advance notice would be available. For this reason, there would be opportunity to initiate operator action to mitigate potential flooding effects. Except during shipment of waste, doors to the Radwaste Building are normally closed to optimize performance of the HVAC system. Upon receiving a flood warning, plant procedures would require securing the doors and implementing other mitigating action such as sandbagging [COM 19.9-3]. Therefore, none of the flooding mechanisms considered presents a credible risk of environmental contamination.

A flood, such as that caused by an MCR dike breach, could flood the Radwaste Building and potentially release radioactive materials into the environment. A flood of this magnitude would disperse and dilute the radionuclide concentration of a surface water spill. As stated in Subsection 2.4S.1, there are no known Colorado River or Little Robbins Slough water users downstream of the STP site and therefore, no surface water user would be affected by a diluted surface water release due to an unlikely event of a flood of this magnitude.

2.4S.13.3 References

2.4S.13-1 “Radionuclide Transformations – Energy and Intensity Emissions, International Commission on Radiation Protection, ICRP Publication 38, 11-13,” ICRP 1983, 1983.

2.4S.13-2 “Residual Radioactive Contamination from Decommissioning,” NUREG/CR-5512, Volume 1, Kennedy, W.E and Strenge, D.L., Pacific Northwest Laboratory, October, 1992.

2.4S.13-3 “Postulated Radioactive Releases Due to Liquid-Containing Tank Failures,” Branch Technical Position 11-6, NUREG-0800, U.S. Nuclear Regulatory Commission, March 2007.

2.4S.13-4 Coastal Plain/Coastal Bend Groundwater Conservation Districts Database. available at http://www.gis.aecom/cbcpgcd, accessed 3/20/07.

2.4S.13-5 “Groundwater Transport: Handbook of Mathematical Models, Water Resources Monograph 10,” Javandel, I., Doughty, C. and Tsang, C-F, American Geophysical Union, 1984.

2.4S.13-6 “Computer Model of Two-Dimensional Solute Transport and Dispersion in Ground Water,” Chapter C2, Book 7, Techniques of Water-Resources Investigations of the United States Geological Survey, Konikow, L. F., and Bredehoeft, J. D., 1978.

2.4S.13-7 "Use of Weighted Least-Squares Method in Evaluation of the Relationship Between Dispersivity and Field-scale", *Ground Water*, v. 33, No. 6, Xu, M., and Eckstein, Y., 1995.

2.4S.13-8 "STP COL Geotechnical Data Report", Attachment H, K_d Testing Data, Volume 1 of 1, MACTEC Engineering and Consulting, Inc., April 30, 2008.

2.4S.13-9 "Standard Test Method for 24-h Batch-Type Measurements of Contaminant Sorption by Soils and Sediments," ASTM (American Society for Testing and Materials), 2003.

2.4S.13-10 "Development of Probabilistic RESRAD 6.0 and RESRAD-BUILD 3.0 Computer Codes," NUREG/CR-6697, Yu, C., LePoire, D., Gnanapragasam, E., Arnish, J., Kamboj, S., Biwer, B.M., Cheng, J-J, Zilen, A., and Chen, S.Y., Argonne National Laboratory, 2000.

2.4S.13-11 "Radionuclide-Chelating Agent Complexes in Low-Level Radioactive Decontamination Waste; Stability, Adsorbtion and Transport Potential," NUREG/CR-6758, February 2002.

Table 2.4S.13-1 Low Conductivity Waste Collection Tank and Reactor Coolant Radionuclide Inventory

Radioisotope	Half-life [1] $t^{1/2}$ (days)	Low Conductivity Waste Tank [2] Activity (MBq)	Low Conductivity Waste Tank [2] Concentration (µCi/mL)	Reactor Coolant [3] Concentration (MBq/g)	Reactor Coolant [3] Concentration (µCi/mL)
H-3	4,510	NA	NA	3.7E-04	1.0E-02
Na-24	0.625	1.3E+04	2.5E-03	1.3E-03	3.5E-02
P-32	14.3	2.7E+03	5.1E-04	2.4E-05	6.5E-04
Cr-51	27.7	1.0E+05	2.0E-02	7.4E-04	2.0E-02
Mn-54	313	2.2E+03	4.3E-04	8.5E-06	2.3E-04
Mn-56	0.107	1.2E+04	2.3E-03	6.7E-03	1.8E-01
Fe-55	986	1.1E+04	2.1E-03	1.2E-04	3.2E-03
Fe-59	44.5	6.0E+02	1.2E-04	3.7E-06	1.0E-04
Co-58	70.8	4.4E+03	8.6E-04	2.4E-05	6.5E-04
Co-60	1,930	1.5E+04	2.8E-03	4.8E-05	1.3E-03
Ni-63	35,100	3.8E+04	7.3E-03	1.2E-04	3.2E-03
Cu-64	0.529	3.2E+04	6.1E-03	3.7E-03	1.0E-01
Zn-65	244	6.0E+03	1.2E-03	2.4E-05	6.5E-04
Rb-89	0.0106	9.4E+01	1.8E-05	7.8E-04	2.1E-02
Sr-89 [4]	50.5	2.1E+03	4.1E-04	1.2E-05	3.2E-04
Sr-90	10,600	2.7E+02	5.2E-05	8.5E-07	2.3E-05
Sr-91	0.396	3.3E+03	6.4E-04	5.2E-04	1.4E-02
Sr-92	0.113	2.6E+03	5.0E-04	1.4E-03	3.8E-02
Y-90 [4]	2.67	2.7E+02	5.2E-05	8.5E-07	2.3E-05
Y-91 [4]	58.5	3.0E+04	5.7E-03	4.8E-06	1.3E-04
Y-92 [4]	0.148	2.3E+03	4.5E-04	8.1E-04	2.2E-02
Y-93	0.421	2.7E+04	5.3E-03	5.2E-04	1.4E-02
Zr-95	64	6.0E+03	1.2E-03	9.6E-07	2.6E-05
Nb-95 [4]	35.2	6.0E+03	1.2E-03	9.6E-07	2.6E-05
Mo-99	2.75	8.9E+03	1.7E-03	2.4E-04	6.5E-03
Tc-99m [4]	0.251	8.9E+03	1.7E-03	2.4E-04	6.5E-03
Ru-103	39.3	1.4E+04	2.7E-03	2.4E-06	6.5E-05
Ru-106	368	2.7E+03	5.2E-04	3.7E-07	1.0E-05
Rh-103m [4]	0.0392	1.4E+04	2.7E-03	2.4E-06	6.5E-05
Rh-106 [4]	0.000345	2.7E+03	5.2E-04	3.7E-07	1.0E-05
Ag-110m	250	3.0E+01	5.8E-06	1.2E-07	3.2E-06
Te-129m	33.6	7.1E+02	1.4E-04	4.8E-06	1.3E-04

Table 2.4S.13-1 Low Conductivity Waste Collection Tank and Reactor Coolant Radionuclide Inventory (Continued)

Radioisotope	Half-life [1] $t^{1/2}$ (days)	Low Conductivity Waste Tank [2]		Reactor Coolant [3]	
		Activity (MBq)	Concentration (μCi/mL)	Concentration (MBq/g)	Concentration (μCi/mL)
Te-131m	1.25	2.3E+02	4.3E-05	1.2E-05	3.2E-04
Te-132	3.26	5.1E+02	9.8E-05	1.2E-06	3.2E-05
I-131 [4]	8.04	2.0E+04	3.9E-03	5.9E-04	1.6E-02
I-132 [4]	0.0958	8.1E+03	1.6E-03	5.2E-03	1.4E-01
I-133	0.867	5.5E+04	1.1E-02	4.1E-03	1.1E-01
I-134	0.0365	5.3E+03	1.0E-03	8.9E-03	2.4E-01
I-135	0.275	2.5E+04	4.8E-03	5.6E-03	1.5E-01
Cs-134	753	4.0E+02	7.7E-05	3.3E-06	8.9E-05
Cs-136	13.1	1.4E+02	2.6E-05	2.2E-06	5.9E-05
Cs-137	11,000	1.2E+03	2.4E-04	8.9E-06	2.4E-04
Cs-138	0.0224	5.5E+02	1.1E-04	1.5E-03	4.1E-02
Ba-140	12.7	5.0E+03	9.7E-04	4.8E-05	1.3E-03
La-140 [4]	1.68	1.9E+05	3.6E-02	4.8E-05	1.3E-03
Ce-141	32.5	2.0E+04	3.9E-03	3.7E-06	1.0E-04
Ce-144	284	2.7E+03	5.1E-04	3.7E-06	1.0E-04
Pr-143	13.6	2.7E+03	5.1E-04	NA	NA
Pr-144 [4]	0.012	NA	NA	3.7E-07	1.0E-05
W-187	0.996	5.7E+02	1.1E-04	3.7E-05	1.0E-03
Np-239 [4]	2.36	3.2E+04	6.2E-03	1.0E-03	2.7E-02
Total		7.4E+05	1.4E-01	4.5E-02	1.2E+00

Bounding concentration used for source term

[1] Values from references 2.4S.13-1 and 2.4S.13-2

[2] Concentrations obtained by dividing the activities by the tank volume of 140,000,000 mL. Activity concentrations from Section 12.2 (Low Conductivity Waste Tank)

[3] Concentrations obtained from Section 11.1 (Reactor Coolant Water)

[4] Decay chain progeny

Table 2.4S.13-2A Screening Analysis Considering Radioactive Decay and Representative Conditions

											Pathway 1a Upper Shallow Aquifer				Pathway 1b Lower Shallow Aquifer				Pathway 4 Upper Shallow Aquifer			
Parent	Progeny	Half-life (days)	d12	d13	d23	Decay Rate (days-1)(a)	Bounding Concentration (µCi/cm3)(b)	K1(c)	K2(d)	K3(e)	Travel Time (days)(f)	Groundwater (µCi/cm3)(g)	ECL (µCi/cm3)(h)	Groundwater/ ECL Ratio	Travel Time (days)(f)	Groundwater (µCi/cm3)(g)	ECL (µCi/cm3)(h)	Groundwater/ ECL Ratio	Travel Time (days)(f)	ter (µCi/cm3)(g)	ECL (µCi/cm3)(h)	Groundwa ter/ECL Ratio
H-3		4.51E+03				1.54E-04	1.00E-02				5.62E+04	1.8E-06	1.00E-03	1.79E-03	4.56E+04	9.0E-06	1.00E-03	9.01E-03	1.20E+05	9.8E-11	1.00E-03	9.78E-08
Na-24		6.25E-01				1.11E+00	3.50E-02				5.62E+04	0.0E+00	5.00E-05	0.00E+00	4.56E+04	0.0E+00	5.00E-05	0.00E+00	1.20E+05	0.0E+00	5.00E-05	0.00E+00
P-32		1.43E+01				4.85E-02	6.50E-04				5.62E+04	0.0E+00	9.00E-06	0.00E+00	4.56E+04	0.0E+00	9.00E-06	0.00E+00	1.20E+05	0.0E+00	9.00E-06	0.00E+00
Cr-51		2.77E+01				2.50E-02	2.00E-02				5.62E+04	0.0E+00	5.00E-04	0.00E+00	4.56E+04	0.0E+00	5.00E-04	0.00E+00	1.20E+05	0.0E+00	5.00E-04	0.00E+00
Mn-54		3.13E+02				2.21E-03	4.30E-04				5.62E+04	4.2E-58	3.00E-05	1.41E-53	4.56E+04	5.7E-48	3.00E-05	1.89E-43	1.20E+05	1.7E-119	3.00E-05	5.57E-115
Mn-56		1.07E-01				6.48E+00	1.80E-01				5.62E+04	0.0E+00	7.00E-05	0.00E+00	4.56E+04	0.0E+00	7.00E-05	0.00E+00	1.20E+05	0.0E+00	7.00E-05	0.00E+00
Fe-55		9.86E+02				7.03E-04	3.20E-03				5.62E+04	2.3E-20	1.00E-04	2.30E-16	4.56E+04	3.8E-17	1.00E-04	3.76E-13	1.20E+05	7.4E-40	1.00E-04	7.39E-36
Fe-59		4.45E+01				1.56E-02	1.20E-04				5.62E+04	0.0E+00	1.00E-05	0.00E+00	4.56E+04	0.0E+00	1.00E-05	0.00E+00	1.20E+05	0.0E+00	1.00E-05	0.00E+00
Co-58		7.08E+01				9.79E-03	8.60E-04				5.62E+04	1.5E-242	2.00E-05	7.51E-238	4.56E+04	8.8E-198	2.00E-05	4.40E-193	1.20E+05	0.0E+00	2.00E-05	0.00E+00
Co-60		1.93E+03				3.59E-04	2.80E-03				5.62E+04	4.9E-12	3.00E-06	1.63E-06	4.56E+04	2.1E-10	3.00E-06	7.14E-05	1.20E+05	5.4E-22	3.00E-06	1.79E-16
Ni-63		3.51E+04				1.97E-05	7.30E-03				5.62E+04	2.4E-03	1.00E-04	2.41E+01	4.56E+04	3.0E-03	1.00E-04	2.97E+01	1.20E+05	6.8E-04	1.00E-04	6.83E+00
Cu-64		5.29E-01				1.31E+00	1.00E-01				5.62E+04	0.0E+00	2.00E-04	0.00E+00	4.56E+04	0.0E+00	2.00E-04	0.00E+00	1.20E+05	0.0E+00	2.00E-04	0.00E+00
Zn-65		2.44E+02				2.84E-03	1.20E-03				5.62E+04	6.3E-73	5.00E-06	1.26E-67	4.56E+04	6.2E-60	5.00E-06	1.23E-54	1.20E+05	1.1E-151	5.00E-06	2.15E-146
Rb-89		1.06E-02				6.54E+01	2.10E-02				5.62E+04	0.0E+00	9.00E-04	0.00E+00	4.56E+04	0.0E+00	9.00E-04	0.00E+00	1.20E+05	0.0E+00	9.00E-04	0.00E+00
	Sr-89	5.05E+01	1			1.37E-02	4.10E-04	-8.61E-08	4.14E-04		5.62E+04	0.0E+00	8.00E-06	0.00E+00	4.56E+04	4.4E-276	8.00E-06	5.55E-271	1.20E+05	0.0E+00	8.00E-06	0.00E+00
Sr-90		1.06E+04				6.54E-05	5.20E-05				5.62E+04	1.3E-06	5.00E-07	2.64E+00	4.56E+04	2.6E-06	5.00E-07	5.26E+00	1.20E+05	2.0E-08	5.00E-07	4.07E-02
	Y-90	2.67E+00	1			2.60E-01	5.20E-05	5.20E-05	-1.31E-08		5.62E+04	1.3E-06	7.00E-06	1.89E-01	4.56E+04	2.6E-06	7.00E-06	3.76E-01	1.20E+05	2.0E-08	7.00E-06	2.90E-03
Sr-91		3.96E-01				1.75E+00	1.40E-02				5.62E+04	0.0E+00	2.00E-05	0.00E+00	4.56E+04	0.0E+00	2.00E-05	0.00E+00	1.20E+05	0.0E+00	2.00E-05	0.00E+00
	Y-91m	3.45E-02	0.578			2.01E+01	0.00E+00	8.86E-03	-8.86E-03		5.62E+04	0.0E+00	2.00E-03	0.00E+00	4.56E+04	0.0E+00	2.00E-03	0.00E+00	1.20E+05	0.0E+00	2.00E-03	0.00E+00
	Y-91	5.58E+01		0.422	1	1.24E-02	5.70E-03	-4.45E-05	5.48E-06	5.76E-03	5.62E+04	6.6E-306	8.00E-06	8.27E-301	4.56E+04	4.2E-249	8.00E-06	5.24E-244	1.20E+05	0.0E+00	8.00E-06	0.00E+00
Sr-92		1.13E-01				6.13E+00	3.80E-02				5.62E+04	0.0E+00	4.00E-05	0.00E+00	4.56E+04	0.0E+00	4.00E-05	0.00E+00	1.20E+05	0.0E+00	4.00E-05	0.00E+00
	Y-92	1.48E-01	1			4.68E+00	2.20E-02	-7.10E-02	1.45E-01		5.62E+04	0.0E+00	4.00E-05	0.00E+00	4.56E+04	0.0E+00	4.00E-05	0.00E+00	1.20E+05	0.0E+00	4.00E-05	0.00E+00
Y-93		4.21E-01				1.65E+00	1.40E-02				5.62E+04	0.0E+00	2.00E-05	0.00E+00	4.56E+04	0.0E+00	2.00E-05	0.00E+00	1.20E+05	0.0E+00	2.00E-05	0.00E+00
Zr-95		6.40E+01				1.08E-02	1.20E-03				5.62E+04	9.0E-268	2.00E-05	4.49E-263	4.56E+04	3.0E-218	2.00E-05	1.50E-213	1.20E+05	0.0E+00	2.00E-05	0.00E+00
	Nb-95m	3.61E+00	0.007			1.92E-01	0.00E+00	8.90E-06	-8.90E-06		5.62E+04	6.7E-270	3.00E-05	2.22E-265	4.56E+04	2.2E-220	3.00E-05	7.43E-216	1.20E+05	0.0E+00	3.00E-05	0.00E+00
	Nb-95	3.52E+01		0.993	1	1.97E-02	1.20E-03	2.65E-03	1.02E-06	1.32E-03	5.62E+04	2.0E-267	3.00E-05	6.61E-263	4.56E+04	6.6E-218	3.00E-05	2.21E-213	1.20E+05	0.0E+00	3.00E-05	0.00E+00
Mo-99		2.75E+00				2.52E-01	6.50E-03				5.62E+04	0.0E+00	2.00E-05	0.00E+00	4.56E+04	0.0E+00	2.00E-05	0.00E+00	1.20E+05	0.0E+00	2.00E-05	0.00E+00
	Tc-99m	2.51E-01	0.876			2.76E+00	6.50E-03	6.27E-03	2.34E-04		5.62E+04	0.0E+00	1.00E+03	0.00E+00	4.56E+04	0.0E+00	1.00E+03	0.00E+00	1.20E+05	0.0E+00	1.00E+03	0.00E+00
Ru-103		3.93E+01				1.76E-02	2.70E-03				5.62E+04	0.0E+00	3.00E-05	0.00E+00	4.56E+04	0.0E+00	3.00E-05	0.00E+00	1.20E+05	0.0E+00	3.00E-05	0.00E+00
	Rh-103m	3.90E-02	0.997			1.78E+01	2.70E-03	2.69E-03	5.43E-06		5.62E+04	0.0E+00	6.00E-03	0.00E+00	4.56E+04	0.0E+00	6.00E-03	0.00E+00	1.20E+05	0.0E+00	6.00E-03	0.00E+00
Ru-106		3.68E+02				1.88E-03	5.20E-04				5.62E+04	6.0E-50	3.00E-06	2.01E-44	4.56E+04	2.5E-41	3.00E-06	8.26E-36	1.20E+05	3.6E-102	3.00E-06	1.19E-96
	Rh-106	3.45E-04	1			2.01E+03	5.20E-04	5.20E-04	-4.88E-10		5.62E+04	6.0E-50	NA	NA	4.56E+04	2.5E-41	NA	NA	1.20E+05	3.6E-102	NA	NA
Ag-110m		2.50E+02				2.77E-03	5.80E-06				5.62E+04	1.4E-73	6.00E-06	2.34E-68	4.56E+04	6.7E-61	6.00E-06	1.12E-55	1.20E+05	1.9E-150	6.00E-06	3.10E-145
	Ag-110	2.85E-04	0.0133			2.43E+03	0.00E+00	7.71E-08	-7.71E-08		5.62E+04	1.9E-75	NA	NA	4.56E+04	8.9E-63	NA	NA	1.20E+05	2.5E-152	NA	NA
Te-129m		3.36E+01				2.06E-02	1.40E-04				5.62E+04	0.0E+00	7.00E-06	0.00E+00	4.56E+04	0.0E+00	7.00E-06	0.00E+00	1.20E+05	0.0E+00	7.00E-06	0.00E+00
	Te-129	4.83E-02	0.65			1.44E+01	0.00E+00	9.11E-05	-9.11E-05		5.62E+04	0.0E+00	4.00E-04	0.00E+00	4.56E+04	0.0E+00	4.00E-04	0.00E+00	1.20E+05	0.0E+00	4.00E-04	0.00E+00
Te-131m		1.25E+00				5.55E-01	3.20E-04				5.62E+04	0.0E+00	8.00E-06	0.00E+00	4.56E+04	0.0E+00	8.00E-06	0.00E+00	1.20E+05	0.0E+00	8.00E-06	0.00E+00
	Te-131	1.74E-02	0.222			3.98E+01	0.00E+00	7.20E-05	-7.20E-05		5.62E+04	0.0E+00	8.00E-05	0.00E+00	4.56E+04	0.0E+00	8.00E-05	0.00E+00	1.20E+05	0.0E+00	8.00E-05	0.00E+00
	I-131	8.04E+00		0.778	1	8.62E-02	1.60E-02	-5.36E-05	1.56E-07	1.60E-02	5.62E+04	0.0E+00	1.00E-06	0.00E+00	4.56E+04	0.0E+00	1.00E-06	0.00E+00	1.20E+05	0.0E+00	1.00E-06	0.00E+00
Te-132		3.26E+00				2.13E-01	9.80E-05				5.62E+04	0.0E+00	9.00E-06	0.00E+00	4.56E+04	0.0E+00	9.00E-06	0.00E+00	1.20E+05	0.0E+00	9.00E-06	0.00E+00
	I-132	9.58E-02	1			7.24E+00	1.40E-01	1.01E-04	1.40E-01		5.62E+04	0.0E+00	1.00E-04	0.00E+00	4.56E+04	0.0E+00	1.00E-04	0.00E+00	1.20E+05	0.0E+00	1.00E-04	0.00E+00
I-133		8.67E-01				7.99E-01	1.10E-01				5.62E+04	0.0E+00	7.00E-06	0.00E+00	4.56E+04	0.0E+00	7.00E-06	0.00E+00	1.20E+05	0.0E+00	7.00E-06	0.00E+00
	Xe-133m	2.19E+00	0.029			3.17E-01	0.00E+00	-2.09E-03	2.09E-03		5.62E+04	0.0E+00	NA	NA	4.56E+04	0.0E+00	NA	NA	1.20E+05	0.0E+00	NA	NA
	Xe-133	5.25E+00		0.971	1	1.32E-01	0.00E+00	-2.11E-02	-1.50E-03	7.75E-02	5.62E+04	0.0E+00	NA	NA	4.56E+04	0.0E+00	NA	NA	1.20E+05	0.0E+00	NA	NA
I-134		3.65E-02				1.90E+01	2.40E-01				5.62E+04	0.0E+00	4.00E-04	0.00E+00	4.56E+04	0.0E+00	4.00E-04	0.00E+00	1.20E+05	0.0E+00	4.00E-04	0.00E+00
I-135		2.75E-01				2.52E+00	1.50E-01				5.62E+04	0.0E+00	3.00E-05	0.00E+00	4.56E+04	0.0E+00	3.00E-05	0.00E+00	1.20E+05	0.0E+00	3.00E-05	0.00E+00
	Xe-135m	1.06E-02	0.154			6.54E+01	0.00E+00	2.40E-02	-2.40E-02		5.62E+04	0.0E+00	NA	NA	4.56E+04	0.0E+00	NA	NA	1.20E+05	0.0E+00	NA	NA

Table 2.4S.13-2A Screening Analysis Considering Radioactive Decay and Representative Conditions (continued)

Parent	Progeny	Half-life (days)	d12	d13	d23	Decay Rate (days-1)(a)	Bounding Concentration (µCi/cm3)(b)	K1(c)	K2(d)	K3(e)	Travel Time (days)(f)	Groundwater (µCi/cm3)(g)	ECL (µCi/cm3)(h)	Groundwater/ ECL Ratio	Travel Time (days)(f)	Groundwater (µCi/cm3)(g)	ECL (µCi/cm3)(h)	Groundwater/ ECL Ratio	Travel Time (days)(f)	ter (µCi/cm3)(g)	ECL (µCi/cm3)(h)	Groundwa ter/ECL Ratio
Cs-136		1.31E+01				5.29E-02	5.90E-05				5.62E+04	0.0E+00	6.00E-06	0.00E+00	4.56E+04	0.0E+00	6.00E-06	0.00E+00	1.20E+05	0.0E+00	6.00E-06	0.00E+00
Cs-137		1.10E+04				6.30E-05	2.40E-04				5.62E+04	7.0E-06	1.00E-06	6.97E+00	4.56E+04	1.4E-05	1.00E-06	1.35E+01	1.20E+05	1.2E-07	1.00E-06	1.25E-01
	Ba-137m	1.77E-03	0.946			3.92E+02	0.00E+00	2.27E-04	-2.27E-04		5.62E+04	6.6E-06	NA	NA	4.56E+04	1.3E-05	NA	NA	1.20E+05	1.2E-07	NA	NA
Cs-138		2.24E-02				3.09E+01	4.10E-02				5.62E+04	0.0E+00	4.00E-04	0.00E+00	4.56E+04	0.0E+00	4.00E-04	0.00E+00	1.20E+05	0.0E+00	4.00E-04	0.00E+00
Ba-140		1.27E+01				5.46E-02	1.30E-03				5.62E+04	0.0E+00	8.00E-06	0.00E+00	4.56E+04	0.0E+00	8.00E-06	0.00E+00	1.20E+05	0.0E+00	8.00E-06	0.00E+00
	La-140	1.68E+00	1			4.13E-01	3.60E-02	1.50E-03	3.45E-02		5.62E+04	0.0E+00	9.00E-06	0.00E+00	4.56E+04	0.0E+00	9.00E-06	0.00E+00	1.20E+05	0.0E+00	9.00E-06	0.00E+00
Ce-141		3.25E+01				2.13E-02	3.90E-03				5.62E+04	0.0E+00	3.00E-05	0.00E+00	4.56E+04	0.0E+00	3.00E-05	0.00E+00	1.20E+05	0.0E+00	3.00E-05	0.00E+00
Ce-144		2.84E+02				2.44E-03	5.10E-04				5.62E+04	1.5E-63	3.00E-06	5.12E-58	4.56E+04	2.2E-52	3.00E-06	7.41E-47	1.20E+05	3.2E-131	3.00E-06	1.08E-125
	Pr-144m	5.07E-03	0.0178			1.37E+02	0.00E+00	9.08E-06	-9.08E-06		5.62E+04	2.7E-65	NA	NA	4.56E+04	4.0E-54	NA	NA	1.20E+05	5.8E-133	NA	NA
	Pr-144	1.20E-02		0.9822	0.999	5.78E+01	1.00E-05	5.01E-04	6.63E-06	3.61E-04	5.62E+04	1.51E-63	6.00E-04	2.51E-60	4.56E+04	2.2E-52	6.00E-04	3.64E-49	1.20E+05	3.2E-131	6.00E-04	5.32E-128
Pr-143		1.36E+01				5.10E-02	5.10E-04				5.62E+04	0.0E+00	2.00E-05	0.00E+00	4.56E+04	0.0E+00	2.00E-05	0.00E+00	1.20E+05	0.0E+00	2.00E-05	0.00E+00
W-187		9.96E-01				6.96E-01	1.00E-03				5.62E+04	0.0E+00	3.00E-05	0.00E+00	4.56E+04	0.0E+00	3.00E-05	0.00E+00	1.20E+05	0.0E+00	3.00E-05	0.00E+00
Np-239		2.36E+00				2.94E-01	2.70E-02				5.62E+04	0.0E+00	2.00E-05	0.00E+00	4.56E+04	0.0E+00	2.00E-05	0.00E+00	1.20E+05	0.0E+00	2.00E-05	0.00E+00
	Pu-239	8.79E+06	1			7.89E-08	0.00E+00	-7.25E-09	7.25E-09		5.62E+04	7.2E-09	2.00E-08	3.61E-01	4.56E+04	7.2E-09	2.00E-08	3.61E-01	1.20E+05	7.2E-09	2.00E-08	3.59E-01

Notes:
Radionuclides in highlight exceed 1% of the ECL for that parameter. ECLs in highlight are exceeded by predicted concentration in previous column.
NA - Not Available
0.00E+00 - Radionuclide decayed to zero concentration at Point of Compliance (POC)
Notes:
(a) Equation 2.4S.13-4
(b) Table 2.4S.13-1
(c) and (d) For the first progeny, K1 and K2 are substitutions for terms in Equation 2.4S.13-9; $K_1 = \frac{d_{12}\lambda_2 C_{10}}{\lambda_2 - \lambda_1}$ and $K_2 = C_{20} - \frac{d_{12}\lambda_2 C_{10}}{\lambda_2 - \lambda_1}$
(e) For the second progeny, K1, K2 and K3 are substitutions for the terms in Equation 2.4S.13-10; $K_1 = \frac{d_{13}\lambda_3 C_{10}}{\lambda_3 - \lambda_1} + \frac{d_{23}\lambda_2 d_{12}\lambda_3 C_{10}}{(\lambda_3 - \lambda_1)(\lambda_2 - \lambda_1)}$, $K_2 = \frac{d_{23}\lambda_3 C_{20}}{\lambda_3 - \lambda_2} - \frac{d_{23}\lambda_2 d_{12}\lambda_3 C_{10}}{(\lambda_3 - \lambda_2)(\lambda_2 - \lambda_1)}$, and $K_3 = C_{30} - \frac{d_{13}\lambda_3 C_{10}}{\lambda_3 - \lambda_1} - \frac{d_{23}\lambda_3 C_{20}}{\lambda_3 - \lambda_2} + \frac{d_{23}\lambda_3 d_{12}\lambda_2 C_{10}}{(\lambda_3 - \lambda_1)(\lambda_3 - \lambda_2)}$
(f) Table 2.4S.12-17
(g) Equation 2.4S.13-8, 2.4S.13-9, or 2.4S.13-10 depending on position in decay chain.
(h) 10CFR20 Appendix B Table 2 Column 2

Table 2.4S.13-2B Screening Analysis Considering Radioactive Decay and Fastest Flow Conditions

											Pathway 1a Upper Shallow Aquifer				Pathway 1b Lower Shallow Aquifer				Pathway 4 Upper Shallow Aquifer			
Parent	Progeny	Half-life (days)	d12	d13	d23	Decay Rate (days-1)(a)	Bounding Concentration (µCi/cm3)(b)	K1(c)	K2(d)	K3(e)	Travel Time (days)(f)	Groundwater (µCi/cm3)(g)	ECL (µCi/cm3)(h)	Groundwater/ ECL Ratio	Travel Time (days)(f)	Groundwater (µCi/cm3)(g)	ECL (µCi/cm3)(h)	Groundwater/ ECL Ratio	Travel Time (days)(f)	ter (µCi/cm3)(g)	ECL (µCi/cm3)(h)	Groundwater/ECL Ratio
H-3		4.51E+03				1.54E-04	1.00E-02				2.09E+04	4.1E-04	1.00E-03	4.05E-01	2.81E+04	1.3E-04	1.00E-03	1.34E-01	4.29E+04	1.4E-05	1.00E-03	1.38E-02
Na-24		6.25E-01				1.11E+00	3.50E-02				2.09E+04	0.0E+00	5.00E-05	0.00E+00	2.81E+04	0.0E+00	5.00E-05	0.00E+00	4.29E+04	0.0E+00	5.00E-05	0.00E+00
P-32		1.43E+01				4.85E-02	6.50E-04				2.09E+04	0.0E+00	9.00E-06	0.00E+00	2.81E+04	0.0E+00	9.00E-06	0.00E+00	4.29E+04	0.0E+00	9.00E-06	0.00E+00
Cr-51		2.77E+01				2.50E-02	2.00E-02				2.09E+04	4.3E-229	5.00E-04	8.68E-226	2.81E+04	1.5E-307	5.00E-04	2.99E-304	4.29E+04	0.0E+00	5.00E-04	0.00E+00
Mn-54		3.13E+02				2.21E-03	4.30E-04				2.09E+04	3.8E-24	3.00E-05	1.25E-19	2.81E+04	4.3E-31	3.00E-05	1.42E-26	4.29E+04	2.6E-45	3.00E-05	8.68E-41
Mn-56		1.07E-01				6.48E+00	1.80E-01				2.09E+04	0.0E+00	7.00E-05	0.00E+00	2.81E+04	0.0E+00	7.00E-05	0.00E+00	4.29E+04	0.0E+00	7.00E-05	0.00E+00
Fe-55		9.86E+02				7.03E-04	3.20E-03				2.09E+04	1.4E-09	1.00E-04	1.37E-05	2.81E+04	8.6E-12	1.00E-04	8.57E-08	4.29E+04	2.6E-16	1.00E-04	2.63E-12
Fe-59		4.45E+01				1.56E-02	1.20E-04				2.09E+04	9.7E-146	1.00E-05	9.71E-141	2.81E+04	1.4E-194	1.00E-05	1.40E-189	4.29E+04	1.5E-294	1.00E-05	1.46E-289
Co-58		7.08E+01				9.79E-03	8.60E-04				2.09E+04	1.8E-92	2.00E-05	8.97E-88	2.81E+04	3.6E-123	2.00E-05	1.80E-118	4.29E+04	5.2E-186	2.00E-05	2.59E-181
Co-60		1.93E+03				3.59E-04	2.80E-03				2.09E+04	1.6E-06	3.00E-06	5.21E-01	2.81E+04	1.2E-07	3.00E-06	3.90E-02	4.29E+04	5.8E-10	3.00E-06	1.93E-04
Ni-63		3.51E+04				1.97E-05	7.30E-03				2.09E+04	4.8E-03	1.00E-04	4.84E+01	2.81E+04	4.2E-03	1.00E-04	4.19E+01	4.29E+04	3.1E-03	1.00E-04	3.13E+01
Cu-64		5.29E-01				1.31E+00	1.00E-01				2.09E+04	0.0E+00	2.00E-04	0.00E+00	2.81E+04	0.0E+00	2.00E-04	0.00E+00	4.29E+04	0.0E+00	2.00E-04	0.00E+00
Zn-65		2.44E+02				2.84E-03	1.20E-03				2.09E+04	2.2E-29	5.00E-06	4.45E-24	2.81E+04	2.8E-38	5.00E-06	5.51E-33	4.29E+04	1.6E-56	5.00E-06	3.21E-51
Rb-89		1.06E-02				6.54E+01	2.10E-02				2.09E+04	0.0E+00	9.00E-04	0.00E+00	2.81E+04	0.0E+00	9.00E-04	0.00E+00	4.29E+04	0.0E+00	9.00E-04	0.00E+00
	Sr-89	5.05E+01	1			1.37E-02	4.10E-04	-8.61E-08	4.14E-04		2.09E+04	1.9E-128	8.00E-06	2.43E-123	2.81E+04	1.8E-171	8.00E-06	2.23E-166	4.29E+04	1.4E-259	8.00E-06	1.75E-254
Sr-90		1.06E+04				6.54E-05	5.20E-05				2.09E+04	1.3E-05	5.00E-07	2.66E+01	2.81E+04	8.3E-06	5.00E-07	1.66E+01	4.29E+04	3.2E-06	5.00E-07	6.31E+00
	Y-90	2.67E+00	1			2.60E-01	5.20E-05	5.20E-05	-1.31E-08		2.09E+04	1.3E-05	7.00E-06	1.90E+00	2.81E+04	8.3E-06	7.00E-06	1.18E+00	4.29E+04	3.2E-06	7.00E-06	4.51E-01
Sr-91		3.96E-01				1.75E+00	1.40E-02				2.09E+04	0.0E+00	2.00E-05	0.00E+00	2.81E+04	0.0E+00	2.00E-05	0.00E+00	4.29E+04	0.0E+00	2.00E-05	0.00E+00
	Y-91m	3.45E-02	0.578			2.01E+01	0.00E+00	8.86E-03	-8.86E-03		2.09E+04	0.0E+00	2.00E-03	0.00E+00	2.81E+04	0.0E+00	2.00E-03	0.00E+00	4.29E+04	0.0E+00	2.00E-03	0.00E+00
	Y-91	5.58E+01		0.422	1	1.24E-02	5.70E-03	-4.45E-05	5.48E-06	5.76E-03	2.09E+04	1.7E-115	8.00E-06	2.18E-110	2.81E+04	2.0E-154	8.00E-06	2.44E-149	4.29E+04	3.6E-234	8.00E-06	4.49E-229
Sr-92		1.13E-01				6.13E+00	3.80E-02				2.09E+04	0.0E+00	4.00E-05	0.00E+00	2.81E+04	0.0E+00	4.00E-05	0.00E+00	4.29E+04	0.0E+00	4.00E-05	0.00E+00
	Y-92	1.48E-01	1			4.68E+00	2.20E-02	-7.10E-02	1.45E-01		2.09E+04	0.0E+00	4.00E-05	0.00E+00	2.81E+04	0.0E+00	4.00E-05	0.00E+00	4.29E+04	0.0E+00	4.00E-05	0.00E+00
Y-93		4.21E-01				1.65E+00	1.40E-02				2.09E+04	0.0E+00	2.00E-05	0.00E+00	2.81E+04	0.0E+00	2.00E-05	0.00E+00	4.29E+04	0.0E+00	2.00E-05	0.00E+00
Zr-95		6.40E+01				1.08E-02	1.20E-03				2.09E+04	9.5E-102	2.00E-05	4.73E-97	2.81E+04	1.0E-135	2.00E-05	5.19E-131	4.29E+04	3.1E-205	2.00E-05	1.57E-200
	Nb-95m	3.61E+00	0.007			1.92E-01	0.00E+00	8.90E-06	-8.90E-06		2.09E+04	7.0E-104	3.00E-05	2.34E-99	2.81E+04	7.7E-138	3.00E-05	2.57E-133	4.29E+04	2.3E-207	3.00E-05	7.77E-203
	Nb-95	3.52E+01		0.993	1	1.97E-02	1.20E-03	2.65E-03	1.02E-06	1.32E-03	2.09E+04	2.1E-101	3.00E-05	6.96E-97	2.81E+04	2.3E-135	3.00E-05	7.64E-131	4.29E+04	6.9E-205	3.00E-05	2.31E-200
Mo-99		2.75E+00				2.52E-01	6.50E-03				2.09E+04	0.0E+00	2.00E-05	0.00E+00	2.81E+04	0.0E+00	2.00E-05	0.00E+00	4.29E+04	0.0E+00	2.00E-05	0.00E+00
	Tc-99m	2.51E-01	0.876			2.76E+00	6.50E-03	6.27E-03	2.34E-04		2.09E+04	0.0E+00	1.00E+03	0.00E+00	2.81E+04	0.0E+00	1.00E+03	0.00E+00	4.29E+04	0.0E+00	1.00E+03	0.00E+00
Ru-103		3.93E+01				1.76E-02	2.70E-03				2.09E+04	4.7E-163	3.00E-05	1.56E-158	2.81E+04	2.3E-218	3.00E-05	7.76E-214	4.29E+04	0.0E+00	3.00E-05	0.00E+00
	Rh-103m	3.90E-02	0.997			1.78E+01	2.70E-03	2.69E-03	5.43E-06		2.09E+04	4.7E-163	6.00E-03	7.80E-161	2.81E+04	2.3E-218	6.00E-03	3.87E-216	4.29E+04	0.0E+00	6.00E-03	0.00E+00
Ru-106		3.68E+02				1.88E-03	5.20E-04				2.09E+04	4.5E-21	3.00E-06	1.50E-15	2.81E+04	5.6E-27	3.00E-06	1.87E-21	4.29E+04	4.6E-39	3.00E-06	1.52E-33
	Rh-106	3.45E-04	1			2.01E+03	5.20E-04	5.20E-04	-4.88E-10		2.09E+04	4.5E-21	NA	NA	2.81E+04	5.6E-27	NA	NA	4.29E+04	4.6E-39	NA	NA
Ag-110m		2.50E+02				2.77E-03	5.80E-06				2.09E+04	4.5E-31	6.00E-06	7.43E-26	2.81E+04	9.0E-40	6.00E-06	1.50E-34	4.29E+04	1.4E-57	6.00E-06	2.40E-52
	Ag-110	2.85E-04	0.0133			2.43E+03	0.00E+00	7.71E-08	-7.71E-08		2.09E+04	5.9E-33	NA	NA	2.81E+04	1.2E-41	NA	NA	4.29E+04	1.9E-59	NA	NA
Te-129m		3.36E+01				2.06E-02	1.40E-04				2.09E+04	1.9E-191	7.00E-06	2.74E-186	2.81E+04	4.0E-256	7.00E-06	5.66E-251	4.29E+04	0.0E+00	7.00E-06	0.00E+00
	Te-129	4.83E-02	0.65			1.44E+01	0.00E+00	9.11E-05	-9.11E-05		2.09E+04	1.3E-191	4.00E-04	3.13E-188	2.81E+04	2.6E-256	4.00E-04	6.45E-253	4.29E+04	0.0E+00	4.00E-04	0.00E+00
Te-131m		1.25E+00				5.55E-01	3.20E-04				2.09E+04	0.0E+00	8.00E-06	0.00E+00	2.81E+04	0.0E+00	8.00E-06	0.00E+00	4.29E+04	0.0E+00	8.00E-06	0.00E+00
	Te-131	1.74E-02	0.222			3.98E+01	0.00E+00	7.20E-05	-7.20E-05		2.09E+04	0.0E+00	8.00E-05	0.00E+00	2.81E+04	0.0E+00	8.00E-05	0.00E+00	4.29E+04	0.0E+00	8.00E-05	0.00E+00
	I-131	8.04E+00		0.778	1	8.62E-02	1.60E-02	-5.36E-05	1.56E-07	1.60E-02	2.09E+04	0.0E+00	1.00E-06	0.00E+00	2.81E+04	0.0E+00	1.00E-06	0.00E+00	4.29E+04	0.0E+00	1.00E-06	0.00E+00
Te-132		3.26E+00				2.13E-01	9.80E-05				2.09E+04	0.0E+00	9.00E-06	0.00E+00	2.81E+04	0.0E+00	9.00E-06	0.00E+00	4.29E+04	0.0E+00	9.00E-06	0.00E+00
	I-132	9.58E-02	1			7.24E+00	1.40E-01	1.01E-04	1.40E-01		2.09E+04	0.0E+00	1.00E-04	0.00E+00	2.81E+04	0.0E+00	1.00E-04	0.00E+00	4.29E+04	0.0E+00	1.00E-04	0.00E+00
I-133		8.67E-01				7.99E-01	1.10E-01				2.09E+04	0.0E+00	7.00E-06	0.00E+00	2.81E+04	0.0E+00	7.00E-06	0.00E+00	4.29E+04	0.0E+00	7.00E-06	0.00E+00
	Xe-133m	2.19E+00	0.029			3.17E-01	0.00E+00	-2.09E-03	2.09E-03		2.09E+04	0.0E+00	NA	NA	2.81E+04	0.0E+00	NA	NA	4.29E+04	0.0E+00	NA	NA
	Xe-133	5.25E+00		0.971	1	1.32E-01	0.00E+00	-2.11E-02	-1.50E-03	7.75E-02	2.09E+04	0.0E+00	NA	NA	2.81E+04	0.0E+00	NA	NA	4.29E+04	0.0E+00	NA	NA
I-134		3.65E-02				1.90E+01	2.40E-01				2.09E+04	0.0E+00	4.00E-04	0.00E+00	2.81E+04	0.0E+00	4.00E-04	0.00E+00	4.29E+04	0.0E+00	4.00E-04	0.00E+00
I-135		2.75E-01				2.52E+00	1.50E-01				2.09E+04	0.0E+00	3.00E-05	0.00E+00	2.81E+04	0.0E+00	3.00E-05	0.00E+00	4.29E+04	0.0E+00	3.00E-05	0.00E+00
	Xe-135m	1.06E-02	0.154			6.54E+01	0.00E+00	2.40E-02	-2.40E-02		2.09E+04	0.0E+00	NA	NA	2.81E+04	0.0E+00	NA	NA	4.29E+04	0.0E+00	NA	NA
	Xe-135	3.79E-01		0.846	1	1.83E+00	0.00E+00	-3.36E-01	6.91E-04	6.65E-02	2.09E+04	0.0E+00	NA	NA	2.81E+04	0.0E+00	NA	NA	4.29E+04	0.0E+00	NA	NA
Cs-134		7.53E+02				9.21E-04	8.90E-05				2.09E+04	4.1E-13	9.00E-07	4.54E-07	2.81E+04	5.3E-16	9.00E-07	5.90E-10	4.29E+04	6.6E-22	9.00E-07	7.28E-16

Table 2.4S.13-2B Screening Analysis Considering Radioactive Decay and Fastest Flow Conditions (Continued)

Parent	Progeny	Half-life (days)	d12	d13	d23	Decay Rate (days-1)(a)	Bounding Concentration (µCi/cm3)(b)	K1(c)	K2(d)	K3(e)	Travel Time (days)(f)	Groundwater (µCi/cm3)(g)	ECL (µCi/cm3)(h)	Groundwater/ ECL Ratio	Travel Time (days)(f)	Groundwater (µCi/cm3)(g)	ECL (µCi/cm3)(h)	Groundwater/ ECL Ratio	Travel Time (days)(f)	ter (µCi/cm3)(g)	ECL (µCi/cm3)(h)	Groundwa ter/ECL Ratio
	Xe-135	3.79E-01		0.846	1	1.83E+00	0.00E+00	-3.36E-01	6.91E-04	6.65E-02	2.09E+04	0.0E+00	NA	NA	2.81E+04	0.0E+00	NA	NA	4.29E+04	0.0E+00	NA	NA
Cs-134		7.53E+02				9.21E-04	8.90E-05				2.09E+04	4.1E-13	9.00E-07	4.54E-07	2.81E+04	5.3E-16	9.00E-07	5.90E-10	4.29E+04	6.6E-22	9.00E-07	7.28E-16
Cs-136		1.31E+01				5.29E-02	5.90E-05				2.09E+04	0.0E+00	6.00E-06	0.00E+00	2.81E+04	0.0E+00	6.00E-06	0.00E+00	4.29E+04	0.0E+00	6.00E-06	0.00E+00
Cs-137		1.10E+04				6.30E-05	2.40E-04				2.09E+04	6.4E-05	1.00E-06	6.45E+01	2.81E+04	4.1E-05	1.00E-06	4.09E+01	4.29E+04	1.6E-05	1.00E-06	1.61E+01
	Ba-137m	1.77E-03	0.946			3.92E+02	0.00E+00	2.27E-04	-2.27E-04		2.09E+04	6.1E-05	NA	NA	2.81E+04	3.9E-05	NA	NA	4.29E+04	1.5E-05	NA	NA
Cs-138		2.24E-02				3.09E+01	4.10E-02				2.09E+04	0.0E+00	4.00E-04	0.00E+00	2.81E+04	0.0E+00	4.00E-04	0.00E+00	4.29E+04	0.0E+00	4.00E-04	0.00E+00
Ba-140		1.27E+01				5.46E-02	1.30E-03				2.09E+04	0.0E+00	8.00E-06	0.00E+00	2.81E+04	0.0E+00	8.00E-06	0.00E+00	4.29E+04	0.0E+00	8.00E-06	0.00E+00
	La-140	1.68E+00	1			4.13E-01	3.60E-02	1.50E-03	3.45E-02		2.09E+04	0.0E+00	9.00E-06	0.00E+00	2.81E+04	0.0E+00	9.00E-06	0.00E+00	4.29E+04	0.0E+00	9.00E-06	0.00E+00
Ce-141		3.25E+01				2.13E-02	3.90E-03				2.09E+04	2.5E-196	3.00E-05	8.45E-192	2.81E+04	3.4E-263	3.00E-05	1.13E-258	4.29E+04	0.0E+00	3.00E-05	0.00E+00
Ce-144		2.84E+02				2.44E-03	5.10E-04				2.09E+04	4.0E-26	3.00E-06	1.33E-20	2.81E+04	8.8E-34	3.00E-06	2.95E-28	4.29E+04	1.9E-49	3.00E-06	6.36E-44
	Pr-144m	5.07E-03	0.0178			1.37E+02	0.00E+00	9.08E-06	-9.08E-06		2.09E+04	7.1E-28	NA	NA	2.81E+04	1.6E-35	NA	NA	4.29E+04	3.4E-51	NA	NA
	Pr-144	1.20E-02		0.9822	0.999	5.78E+01	1.00E-05	5.01E-04	6.63E-06	3.61E-04	2.09E+04	3.91E-26	6.00E-04	6.51E-23	2.81E+04	8.7E-34	6.00E-04	1.45E-30	4.29E+04	1.9E-49	6.00E-04	3.12E-46
Pr-143		1.36E+01				5.10E-02	5.10E-04				2.09E+04	0.0E+00	2.00E-05	0.00E+00	2.81E+04	0.0E+00	2.00E-05	0.00E+00	4.29E+04	0.0E+00	2.00E-05	0.00E+00
W-187		9.96E-01				6.96E-01	1.00E-03				2.09E+04	0.0E+00	3.00E-05	0.00E+00	2.81E+04	0.0E+00	3.00E-05	0.00E+00	4.29E+04	0.0E+00	3.00E-05	0.00E+00
Np-239		2.36E+00				2.94E-01	2.70E-02				2.09E+04	0.0E+00	2.00E-05	0.00E+00	2.81E+04	0.0E+00	2.00E-05	0.00E+00	4.29E+04	0.0E+00	2.00E-05	0.00E+00
	Pu-239	8.79E+06	1			7.89E-08	0.00E+00	-7.25E-09	7.25E-09		2.09E+04	7.2E-09	2.00E-08	3.62E-01	2.81E+04	7.2E-09	2.00E-08	3.62E-01	4.29E+04	7.2E-09	2.00E-08	3.61E-01

Notes:

Radionuclides in highlight exceed 1% of the ECL for that parameter. ECLs in highlight are exceeded by predicted concentration in previous column.

NA - Not Available

0.00E+00 - Radionuclide decayed to zero concentration at Point of Compliance (POC)

Notes:

(a) Equation 2.4S.13-4

(b) Table 2.4S.13-1

(c) and (d) For the first progeny, K1 and K2 are substitutions for terms in Equation 2.4S.13-9; $K_1 = \frac{d_{12}\lambda_2 C_{10}}{\lambda_2 - \lambda_1}$ and $K_2 = C_{20} - \frac{d_{12}\lambda_2 C_{10}}{\lambda_2 - \lambda_1}$

(e) For the second progeny, K1, K2 and K3 are substitutions for the terms in Equation 2.4S.13-10; $K_1 = \frac{d_{13}\lambda_3 C_{10}}{\lambda_3 - \lambda_1} + \frac{d_{23}\lambda_2 d_{12}\lambda_3 C_{10}}{(\lambda_3 - \lambda_1)(\lambda_2 - \lambda_1)}$, $K_2 = \frac{d_{23}\lambda_3 C_{20}}{\lambda_3 - \lambda_2} - \frac{d_{23}\lambda_2 d_{12}\lambda_3 C_{10}}{(\lambda_3 - \lambda_2)(\lambda_2 - \lambda_1)}$, and $K_3 = C_{30} - \frac{d_{13}\lambda_3 C_{10}}{\lambda_3 - \lambda_1} - \frac{d_{23}\lambda_3 C_{20}}{\lambda_3 - \lambda_2} + \frac{d_{23}\lambda_2 d_{12}\lambda_3 C_{10}}{(\lambda_3 - \lambda_1)(\lambda_3 - \lambda_2)}$

(f) Table 2.4S.12-17

(g) Equation 2.4S.13-8, 2.4S.13-9, or 2.4S.13-10 depending on position in decay chain.

(h) 10CFR20 Appendix B Table 2 Column 2

Table 2.4S.13-3 Laboratory Distribution Coefficient Measurements in mL/g for the Lower Shallow Aquifer

Boring ID	Sample ID	Corresponding Well	Replicate Analysis	Fe K_d Value	Fe K_d Ave.	Fe K_d St Dev	Ni K_d Value	Ni K_d Ave.	Ni K_d St Dev	Pu K_d Value	Pu K_d Ave.	Pu K_d St. Dev.	Co K_d Value	Co K_d Ave.	Co K_d St. Dev.	Sr K_d Value	Sr K_d Ave.	Sr K_d St. Dev.	Cs K_d Value	Cs K_d Ave.	Cs K_d St. Dev.
B-308	SS25	OW-308 L	-	-	>1820.0	1971.0	-	35.1	7.3	-	>1037.7	510.0	-	17.1	5.3	-	2.3	0.7	-	531.7	287.9
			1	>426.3	-	-	40.3	-	-	1398.3	-	-	13.4	-	-	1.8	-	-	328.2	-	-
			2	>3213.7	-	-	29.9	-	-	>677.1	-	-	20.8	-	-	2.8	-	-	735.3	-	-
B-332	SS23	OW-332 L [R]	-	-	847.5	896.2	-	50.2	2.1	-	>1577.2	399.4	-	8.3	0.1	-	1.6	0.1		160.1	0.1
			1	1481.2	-	-	48.7	-	-	>1294.7	-	-	8.2	-	-	1.6	-	-	160.2	-	-
			2	213.8	-	-	51.7	-	-	1859.6	-	-	8.4	-	-	1.5	-	-	160.1	-	-
B-348	SS17	OW-348 L	-	-	164.0	195.7	-	113.3	97.6	-	>962.2	284.6	-	9.6	0.8	-	2.0	1.0	-	242.6	65.4
			1	302.4	-	-	44.3	-	-	>1163.4	-	-	9.0	-	-	1.3	-	-	288.9	-	-
			2	25.6	-	-	182.3	-	-	761.0	-	-	10.2	-	-	2.6	-	-	196.4	-	-
B-349	SS23	OW-349 L	-	-	>1513.5	570.3	-	39.2	8.2	-	>2434.2	3.9	-	13.1	2.7	-	2.9	0.3	-	409.5	203.5
			1	>1916.8	-	-	44.9	-	-	2437.0	-	-	15.0	-	-	3.1	-	-	553.5	-	-
			2	>1110.2	-	-	33.4	-	-	>2431.4	-	-	11.2	-	-	2.7	-	-	265.6	-	-
B-408	SS22	OW-408 L	-	-	>1880.5	1856.2	-	31.6	10.7	-	>979.9	417.8	-	11.2	2.6	-	2.2	0.5	-	520.0	124.0
			1	>3193.0	-	-	39.1	-	-	>684.4	-	-	13.1	-	-	2.6	-	-	607.7	-	-
			2	>567.9	-	-	24.0	-	-	>1275.3	-	-	9.4	-	-	1.8	-	-	432.3	-	-
B-438	SS24	OW-438 L	-	-	>2447.5	920.2	-	30.3	5.1	-	877.6	353.8	-	5.5	1.2	-	1.0	0.9	-	104.0	27.3
			1	>3098.2	-	-	33.9	-	-	627.4	-	-	6.3	-	-	1.6	-	-	123.3	-	-
			2	>1796.8	-	-	26.7	-	-	1127.8	-	-	4.7	-	-	0.3	-	-	84.7	-	-
B-910	SS24	OW-910 L	-	-	>2032.5	1332.7	-	>567.9	744.6	-	>1063.4	550.2	-	24.1	1.2	-	6.5	0.8	-	2994.3	32.6
			1	>1090.2	-	-	>1094.4	-	-	>1452.4	-	-	24.9	-	-	7.1	-	-	3017.4	-	-
			2	>2974.9	-	-	41.3	-	-	>674.4	-	-	23.2	-	-	5.9	-	-	2971.3	-	-
B-930	SS27	OW-930 L	-	-	21.7	16.0	-	177.6	106.2	-	>627.3	822.4	-	5.9	0.6	-	1.3	0.4	-	83.3	9.3
			1	33.0	-	-	102.4	-	-	>1208.8	-	-	6.3	-	-	1.6	-	-	89.9	-	-
			2	10.4	-	-	252.7	-	-	45.8	-	-	5.4	-	-	1.1	-	-	76.8	-	-
B-933	SS24	OW-933 L	-		40.9	0.7	-	74.3	25.4	-	311.7	260.3	-	5.8	0.1	-	1.2	0.1	-	78.5	0.1
			1	41.3	-	-	56.3	-	-	495.7	-	-	5.9	-	-	1.3	-	-	78.6	-	-
			2	40.4	-	-	92.3	-	-	127.6	-	-	5.8	-	-	1.1	-	-	78.5	-	-
B-934	SS26	OW-934 L	-		15.5	8.1	-	237.5	46.3	-	141.8	134.9	-	6.6	0.9	-	1.9	0.8	-	56.5	4.1
			1	9.8	-	-	270.2	-	-	237.2	-	-	6.0	-	-	1.3	-	-	53.6	-	-
			2	21.2	-	-	204.7	-	-	46.4	-	-	7.3	-	-	2.4	-	-	59.4	-	-

Summary Statistics	Fe K_d	Ni K_d	Pu K_d	Co K_d	Sr K_d	Cs K_d
Number of samples	10.0	10.0	10.0	10.0	10.0	10.0
Minimum	15.5	30.3	141.8	5.5	1.0	56.5
Maximum	>2447.5	>567.9	>2434.2	24.1	6.5	2994.3
Arithmetic Mean	>1078.4	>135.7	>1001.3	10.7	2.3	518.1
Geometric Mean	>370.9	>81.8	>792.1	9.5	2.0	234.6
Standard Deviation	964.9	167.3	646.5	6.0	1.6	889.1
Skewness	0.0	2.3	1.1	1.4	2.4	2.9

Table 2.4S.13-3 Laboratory Distribution Coefficient Measurements in mL/g for the Upper Shallow Aquifer (Continued)

				Fe K_d			Ni K_d			Pu K_d			Co K_d			Sr K_d			Cs K_d		
Boring Id	Sample Id	Corresponding Well	Replicate Analysis	Value	Ave.	St Dev	Value	Ave.	St Dev	Value	Ave.	St Dev	Value	Ave.	St Dev	Value	Ave.	St Dev	Value	Ave.	St Dev
B-308	SS15(1)	OW-308 U	-	-	>2079.1	1675.9	-	29.8	4.7	-	242.8	34.3	-	13.5	1.0	-	2.1	0.4	-	359.9	12.7
			1	>3264.1	-	-	33.1	-	-	218.5	-	-	14.2	-	-	2.3	-	-	368.9	-	-
			2	>394.1	-	-	26.5	-	-	267.0	-	-	12.8	-	-	1.8	-	-	351.0	-	-
B-332	SS12	OW-332 U	-	-	45.4	22.7	-	224.4	192.4	-	65.3	17.8	-	6.4	0.3	-	1.5	0.1	-	61.0	2.2
			1	29.3	-	-	88.3	-	-	52.7	-	-	6.7	-	-	1.4	-	-	59.5	-	-
			2	61.4	-	-	360.4	-	-	77.9	-	-	6.2	-	-	1.6	-	-	62.6	-	-
B-348	SS8	OW-348U	-	-	>2021.8	1517.9	-	23.0	0.5	-	102.3	12.0	-	10.9	0.1	-	2.0	0.4	-	348.1	120.1
			1	>948.5	-	-	23.4	-	-	110.8	-	-	11.0	-	-	1.7	-	-	433.1	-	-
			2	>3095.1	-	-	22.7	-	-	93.8	-	-	10.9	-	-	2.4	-	-	263.2	-	-
B-349	SS14	OW-349 U	-	-	99.8	48.6	-	233.9	43.2	-	109.2	12.9	-	7.7	2.5	-	1.0	0.7	-	147.4	50.1
			1	65.4	-	-	264.4	-	-	118.3	-	-	9.5	-	-	1.5	-	-	182.8	-	-
			2	134.2	-	-	203.4	-	-	100.1	-	-	6.0	-	-	0.6	-	-	112.0	-	-
B-408	SS14	OW-408 U	-	-	>3308.4	3471.7	-	26.8	0.6	-	55.4	5.6	-	15.2	2.0	-	3.1	1.6	-	189.1	12.2
			1	>5763.3	-	-	27.2	-	-	59.3	-	-	16.7	-	-	4.3	-	-	197.7	-	-
			2	>853.6	-	-	26.4	-	-	51.4	-	-	13.8	-	-	2.0	-	-	180.5	-	-
B-438	SS12	OW-438 U	-	-	>751.9	219.1	-	20.0	1.7	-	180.2	3.2	-	12.8	1.8	-	1.7	0.5	-	321.0	19.3
			1	>906.8	-	-	18.8	-	-	177.9	-	-	14.1	-	-	2.1	-	-	334.6	-	-
			2	>597.0	-	-	21.2	-	-	182.5	-	-	11.5	-	-	1.4	-	-	307.4	-	-
B-910	SS14	OW-910 U	-	-	289.7	304.7	-	110.7	85.7	-	364.5	316.4	-	10.3	0.5	-	1.7	0.4	-	212.1	8.7
			1	74.3	-	-	171.3	-	-	140.7	-	-	9.9	-	-	1.3	-	-	206.0	-	-
			2	505.2	-	-	50.1	-	-	588.2	-	-	10.6	-	-	2.0	-	-	218.3	-	-
B-930	SS14	OW-930 U	-	-	>952.0	697.4	-	31.0	7.1	-	1060.8	357.4	-	11.2	1.3	-	3.1	0.7	-	554.5	10.3
			1	>458.9	-	-	26.1	-	-	808.1	-	-	12.1	-	-	3.5	-	-	561.8	-	-
			2	>1445.2	-	-	36.0	-	-	1313.5	-	-	10.3	-	-	2.6	-	-	547.2	-	-
B-933	SS14	OW-933 U	-	-	>1780.5	1266.0	-	25.2	1.7	-	53.6	10.5	-	14.9	0.8	-	3.0	0.2	-	486.2	38.4
			1	>885.3	-	-	24.0	-	-	61.1	-	-	14.3	-	-	2.9	-	-	513.3	-	-
			2	>2675.7	-	-	26.4	-	-	46.2	-	-	15.5	-	-	3.1	-	-	459.0	-	-

Table 2.4S.13-3 Laboratory Distribution Coefficient Measurements in mL/g for the Upper Shallow Aquifer (Continued)

				Fe K_d			Ni K_d			Pu K_d			Co K_d			Sr K_d			Cs K_d		
Boring Id	Sample Id	Corresponding Well	Replicate Analysis	Value	Ave.	St Dev	Value	Ave.	St Dev	Value	Ave.	St Dev	Value	Ave.	St Dev	Value	Ave.	St Dev	Value	Ave.	St Dev
B-934	SS15	OW-934 U	-	-	>3361.0	3275.5	-	27.9	0.5	-	447.5	247.8	-	6.3	0.1	-	1.6	0.3	-	113.1	8.2
			1	>5677.1	-	-	27.5	-	-	302.3	-	-	6.3	-	-	1.3	-	-	119.0	-	-
			2	1044.9	-	-	28.2	-	-	652.8	-	-	6.4	-	-	1.8	-	-	107.3	-	-

Summary Statistics	Fe K_d	Ni K_d	Pu K_d	Co K_d	Sr K_d	Cs K_d
Number of samples	10.0	10.0	10.0	10.0	10.0	10.0
Minimum	45.4	20.0	53.6	6.3	1.0	61.0
Maximum	>3361.0	233.9	1060.8	15.2	3.1	554.5
Arithmetic Mean	>1469.0	75.3	268.2	10.9	2.1	279.2
Geometric Mean	>775.0	46.4	166.5	10.4	2.0	231.5
Standard Deviation	>1238.8	85.4	309.7	3.3	0.7	162.2
Skewness	>0.4	1.5	2.2	-0.2	0.4	0.4

Note:
(1) Broken jar sample. Contents transferred to secondary jar prior to shipment to laboratory.

Table 2.4S.13-4 Transport Analysis Considering Dispersion, Advection, Radioactive Decay, and Retardation

Pathway 1a) Upper Shallow Aquifer at Site Boundary - Representative Conditions

Pathway length =	7,300	ft		
Travel time =	154	yr (ave.)		
Pore water velocity =	47	ft/yr		
Dispersivity =	50.3	ft		
Coeff dispersion =	2389	ft^2/yr		
Total porosity =	0.41	from Table 2.4S.12-12		
Effective porosity =	0.33	from Table 2.4S.12-13		
Bulk density =	1.58	from Table 2.4S.12-14		
Input period =	60	yr (estimated life of plant)		
Radionuclide	Ni-63	Sr-90	Cs-137	Pu-239
ECL	1.00E-04	5.00E-07	1.00E-06	2.00E-08
C(0,t)	7.32E-03	5.15E-05	2.36E-04	7.25E-09
K_d (cm^3/g) (Lab ave.)	46.4	2	231.5	166.5
R	223.2	10.6	1109.4	798.2
I (yr-1)	7.21E-03	2.39E-02	2.30E-02	2.88E-05
U	133	68	496	50

RESULT: Using "representative" (average) travel time, K_d and porosity values, the 1-D advection+decay+redardation+dispersion model indicates that at 7,300 ft:

►No ECL violations

►No sum of fraction violations.

►C(x,t)/ECL ratios below 1%

Table 2.4S.13-4 Transport Analysis Considering Dispersion, Advection, Radioactive Decay, and Retardation (continued)

Pathway 1a) Upper Shallow Aquifer at East Site Boundary - Representative Conditions

x (ft)	t (yr)	C(x,t)/ECL				Sum
		Ni-63	Sr-90	Cs-137	Pu-239	
7300	50	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	500	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	600	0.00E+00	3.03E-23	0.00E+00	0.00E+00	3.03E-23
7300	700	0.00E+00	4.88E-19	0.00E+00	0.00E+00	4.88E-19
7300	800	0.00E+00	2.37E-16	0.00E+00	0.00E+00	2.37E-16
7300	900	0.00E+00	1.09E-14	0.00E+00	0.00E+00	1.09E-14
7300	1,000	0.00E+00	9.50E-14	0.00E+00	0.00E+00	9.50E-14
7300	1,100	0.00E+00	2.42E-13	0.00E+00	0.00E+00	2.42E-13
7300	1,200	0.00E+00	2.43E-13	0.00E+00	0.00E+00	2.43E-13
7300	1,300	0.00E+00	1.19E-13	0.00E+00	0.00E+00	1.19E-13
7300	1,400	0.00E+00	3.31E-14	0.00E+00	0.00E+00	3.31E-14
7300	1,500	0.00E+00	5.83E-15	0.00E+00	0.00E+00	5.83E-15
7300	1,600	0.00E+00	7.12E-16	0.00E+00	0.00E+00	7.12E-16
7300	1,700	0.00E+00	6.42E-17	0.00E+00	0.00E+00	6.42E-17
7300	1,800	0.00E+00	4.50E-18	0.00E+00	0.00E+00	4.50E-18
7300	1,900	0.00E+00	2.55E-19	0.00E+00	0.00E+00	2.55E-19
7300	2,000	0.00E+00	1.21E-20	0.00E+00	0.00E+00	1.21E-20
7300	2,100	0.00E+00	4.92E-22	0.00E+00	0.00E+00	4.92E-22
7300	2,200	0.00E+00	1.75E-23	0.00E+00	0.00E+00	1.75E-23
7300	2,300	0.00E+00	5.57E-25	0.00E+00	0.00E+00	5.57E-25
7300	2,400	0.00E+00	1.61E-26	0.00E+00	0.00E+00	1.61E-26
7300	2,500	0.00E+00	4.88E-28	0.00E+00	0.00E+00	4.88E-28
7300	2,600	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	2,700	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	2,800	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	2,900	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	3,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	4,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	5,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	6,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 2.4S.13-4 Transport Analysis Considering Dispersion, Advection, Radioactive Decay, and Retardation (continued)

Pathway 1a) Upper Shallow Aquifer at East Site Boundary - Representative Conditions

x (ft)	t (yr)	C(x,t)/ECL				Sum
		Ni-63	Sr-90	Cs-137	Pu-239	
7300	7,000	1.57E-71	0.00E+00	0.00E+00	0.00E+00	1.57E-71
7300	7,500	3.95E-68	0.00E+00	0.00E+00	0.00E+00	3.95E-68
7300	8,000	2.01E-65	0.00E+00	0.00E+00	0.00E+00	2.01E-65
7300	9,000	1.63E-61	0.00E+00	0.00E+00	0.00E+00	1.63E-61
7300	10,000	4.09E-59	0.00E+00	0.00E+00	0.00E+00	4.09E-59
7300	11,000	8.27E-58	0.00E+00	0.00E+00	0.00E+00	8.27E-58
7300	12,000	2.53E-57	0.00E+00	0.00E+00	0.00E+00	2.53E-57
7300	13,000	1.81E-57	0.00E+00	0.00E+00	0.00E+00	1.81E-57
7300	14,000	4.15E-58	0.00E+00	3.50E-302	0.00E+00	4.15E-58
7300	14,500	1.39E-58	0.00E+00	1.34E-300	0.00E+00	1.39E-58
7300	15,000	3.82E-59	0.00E+00	1.86E-299	0.00E+00	3.82E-59
7300	15,500	8.70E-60	0.00E+00	1.03E-298	0.00E+00	8.70E-60
7300	16,000	1.68E-60	0.00E+00	2.46E-298	0.00E+00	1.68E-60
7300	16,500	2.78E-61	0.00E+00	2.76E-298	0.00E+00	2.78E-61
7300	17,000	4.01E-62	0.00E+00	1.55E-298	0.00E+00	4.01E-62
7300	18,000	5.77E-64	0.00E+00	7.76E-300	0.00E+00	5.77E-64
7300	19,000	5.42E-66	0.00E+00	4.59E-302	0.00E+00	5.42E-66
7300	20,000	3.54E-68	0.00E+00	0.00E+00	0.00E+00	3.54E-68
7300	25,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	50,000	0.00E+00	0.00E+00	0.00E+00	9.96E-18	9.96E-18
7300	55,000	0.00E+00	0.00E+00	0.00E+00	5.68E-15	5.68E-15
7300	60,000	0.00E+00	0.00E+00	0.00E+00	8.66E-13	8.66E-13
7300	65,000	0.00E+00	0.00E+00	0.00E+00	4.72E-11	4.72E-11
7300	70,000	0.00E+00	0.00E+00	0.00E+00	1.15E-09	1.15E-09
7300	75,000	0.00E+00	0.00E+00	0.00E+00	1.46E-08	1.46E-08
7300	80,000	0.00E+00	0.00E+00	0.00E+00	1.10E-07	1.10E-07
7300	85,000	0.00E+00	0.00E+00	0.00E+00	5.37E-07	5.37E-07
7300	90,000	0.00E+00	0.00E+00	0.00E+00	1.83E-06	1.83E-06
7300	95,000	0.00E+00	0.00E+00	0.00E+00	4.62E-06	4.62E-06
7300	100,000	0.00E+00	0.00E+00	0.00E+00	9.02E-06	9.02E-06

Table 2.4S.13-4 Transport Analysis Considering Dispersion, Advection, Radioactive Decay, and Retardation (continued)

Pathway 1a) Upper Shallow Aquifer at East Site Boundary - Representative Conditions

x (ft)	t (yr)	C(x,t)/ECL				Sum
		Ni-63	Sr-90	Cs-137	Pu-239	
7300	105,000	0.00E+00	0.00E+00	0.00E+00	1.41E-05	1.41E-05
7300	110,000	0.00E+00	0.00E+00	0.00E+00	1.83E-05	1.83E-05
7300	115,000	0.00E+00	0.00E+00	0.00E+00	2.01E-05	2.01E-05
7300	116,000	0.00E+00	0.00E+00	0.00E+00	2.01E-05	2.01E-05
7300	117,000	0.00E+00	0.00E+00	0.00E+00	2.00E-05	2.00E-05
7300	118,000	0.00E+00	0.00E+00	0.00E+00	1.98E-05	1.98E-05
7300	119,000	0.00E+00	0.00E+00	0.00E+00	1.95E-05	1.95E-05
7300	120,000	0.00E+00	0.00E+00	0.00E+00	1.91E-05	1.91E-05
7300	125,000	0.00E+00	0.00E+00	0.00E+00	1.60E-05	1.60E-05
7300	130,000	0.00E+00	0.00E+00	0.00E+00	1.20E-05	1.20E-05
7300	135,000	0.00E+00	0.00E+00	0.00E+00	8.09E-06	8.09E-06
7300	140,000	0.00E+00	0.00E+00	0.00E+00	5.01E-06	5.01E-06
7300	145,000	0.00E+00	0.00E+00	0.00E+00	2.87E-06	2.87E-06
7300	150,000	0.00E+00	0.00E+00	0.00E+00	1.53E-06	1.53E-06
7300	200,000	0.00E+00	0.00E+00	0.00E+00	1.78E-10	1.78E-10
7300	250,000	0.00E+00	0.00E+00	0.00E+00	1.14E-15	1.14E-15
7300	300,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

	Max =	2.53E-57	2.43E-13	2.76E-298	2.01E-05	2.01E-05

Table 2.4S.13-4 Transport Analysis Considering Dispersion, Advection, Radioactive Decay, and Retardation (Continued)

Pathway 1b) Lower Shallow Aquifer at East Site Boundary - Representative Scenario

Pathway length =	7,300	ft		
Travel time =	125	yr (ave)		
Pore water velocity =	58	ft/yr		
Dispersivity =	50.3	ft		
Coeff dispersion =	2940	ft^2/yr		
Total porosity =	0.39	from Table 2.4S.12-12		
Effective porosity =	0.31	from Table 2.4S.12-13		
Bulk density =	1.63	from Table 2.4S.12-14		
Input period =	60	yr (estimated life of plant)		
Radionuclide	Ni-63	Sr-90	Cs-137	Pu-239
ECL	1.00E-04	5.00E-07	1.00E-06	2.00E-08
C(0,t)	7.32E-03	5.15E-05	2.36E-04	7.25E-09
K_d (cm^3/g) (Lab ave.)	81.8	2	234.6	792.1
R	431	12	1235	4166
I (yr-1)	7.21E-03	2.39E-02	2.30E-02	2.88E-05
U	200	82	581	69

RESULT: Using representative (average) travel time, K_d and porosity values, the 1-D advection+decay+redardation+dispersion model indicates at 7,300 ft:

►No ECL violations

►No sum of fraction violations.

►H-3 C(x,t)/ECL ratio exceeds 1% from 130 to 160 yrs.

Table 2.4S.13-4 Transport Analysis Considering Dispersion, Advection, Radioactive Decay, and Retardation (Continued)

Pathway 1b) Lower Shallow Aquifer at East Site Boundary - Representative Scenario

x (ft)	t (yr)	C(x,t)/ECL				Sum
		Ni-63	Sr-90	Cs-137	Pu-239	
7300	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	50	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	500	0.00E+00	1.51E-24	0.00E+00	0.00E+00	1.51E-24
7300	600	0.00E+00	5.30E-19	0.00E+00	0.00E+00	5.30E-19
7300	700	0.00E+00	1.31E-15	0.00E+00	0.00E+00	1.31E-15
7300	800	0.00E+00	1.46E-13	0.00E+00	0.00E+00	1.46E-13
7300	900	0.00E+00	1.99E-12	0.00E+00	0.00E+00	1.99E-12
7300	1,000	0.00E+00	6.09E-12	0.00E+00	0.00E+00	6.09E-12
7300	1,100	0.00E+00	6.23E-12	0.00E+00	0.00E+00	6.23E-12
7300	1,200	0.00E+00	2.77E-12	0.00E+00	0.00E+00	2.77E-12
7300	1,300	0.00E+00	6.50E-13	0.00E+00	0.00E+00	6.50E-13
7300	1,400	0.00E+00	9.21E-14	0.00E+00	0.00E+00	9.21E-14
7300	1,500	0.00E+00	8.71E-15	0.00E+00	0.00E+00	8.71E-15
7300	2,000	0.00E+00	1.32E-21	0.00E+00	0.00E+00	1.32E-21
7300	2,500	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	5,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	7,500	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	10,000	2.44E-88	0.00E+00	0.00E+00	0.00E+00	2.44E-88
7300	15,000	3.06E-77	0.00E+00	2.15E-282	0.00E+00	3.06E-77
7300	16,000	3.81E-77	0.00E+00	2.34E-282	0.00E+00	3.81E-77
7300	17,000	1.82E-77	0.00E+00	1.62E-283	0.00E+00	1.82E-77
7300	18,000	3.92E-78	0.00E+00	1.14E-285	0.00E+00	3.92E-78
7300	19,000	4.31E-79	0.00E+00	1.16E-288	0.00E+00	4.31E-79
7300	20,000	2.68E-80	0.00E+00	2.28E-292	0.00E+00	2.68E-80
7300	25,000	5.28E-89	0.00E+00	0.00E+00	0.00E+00	5.28E-89
7300	50,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	100,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	150,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	175,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
7300	200,000	0.00E+00	0.00E+00	0.00E+00	3.52E-22	3.52E-22

Table 2.4S.13-4 Transport Analysis Considering Dispersion, Advection, Radioactive Decay, and Retardation (Continued)

Pathway 1b) Lower Shallow Aquifer at East Site Boundary - Representative Scenario

x (ft)	t (yr)	C(x,t)/ECL				Sum
		Ni-63	Sr-90	Cs-137	Pu-239	
7300	250,000	0.00E+00	0.00E+00	0.00E+00	3.19E-16	3.19E-16
7300	300,000	0.00E+00	0.00E+00	0.00E+00	5.53E-13	5.53E-13
7300	350,000	0.00E+00	0.00E+00	0.00E+00	2.73E-11	2.73E-11
7300	400,000	0.00E+00	0.00E+00	0.00E+00	1.46E-10	1.46E-10
7300	410,000	0.00E+00	0.00E+00	0.00E+00	1.68E-10	1.68E-10
7300	415,000	0.00E+00	0.00E+00	0.00E+00	1.77E-10	1.77E-10
7300	420,000	0.00E+00	0.00E+00	0.00E+00	1.84E-10	1.84E-10
7300	425,000	0.00E+00	0.00E+00	0.00E+00	1.88E-10	1.88E-10
7300	430,000	0.00E+00	0.00E+00	0.00E+00	1.90E-10	1.90E-10
7300	435,000	0.00E+00	0.00E+00	0.00E+00	1.91E-10	1.91E-10
7300	440,000	0.00E+00	0.00E+00	0.00E+00	1.88E-10	1.88E-10
7300	445,000	0.00E+00	0.00E+00	0.00E+00	1.84E-10	1.84E-10
7300	450,000	0.00E+00	0.00E+00	0.00E+00	1.79E-10	1.79E-10
7300	455,000	0.00E+00	0.00E+00	0.00E+00	1.71E-10	1.71E-10
7300	460,000	0.00E+00	0.00E+00	0.00E+00	1.62E-10	1.62E-10
7300	465,000	0.00E+00	0.00E+00	0.00E+00	1.53E-10	1.53E-10
7300	470,000	0.00E+00	0.00E+00	0.00E+00	1.42E-10	1.42E-10
7300	475,000	0.00E+00	0.00E+00	0.00E+00	1.31E-10	1.31E-10
7300	480,000	0.00E+00	0.00E+00	0.00E+00	1.20E-10	1.20E-10
7300	485,000	0.00E+00	0.00E+00	0.00E+00	1.09E-10	1.09E-10
7300	490,000	0.00E+00	0.00E+00	0.00E+00	9.81E-11	9.81E-11
7300	495,000	0.00E+00	0.00E+00	0.00E+00	8.76E-11	8.76E-11
7300	500,000	0.00E+00	0.00E+00	0.00E+00	7.76E-11	7.76E-11
7300	600,000	0.00E+00	0.00E+00	0.00E+00	1.86E-12	1.86E-12
7300	700,000	0.00E+00	0.00E+00	0.00E+00	7.64E-15	7.64E-15
7300	800,000	0.00E+00	0.00E+00	0.00E+00	1.04E-17	1.04E-17
7300	900,000	0.00E+00	0.00E+00	0.00E+00	6.83E-21	6.83E-21
7300	1,000,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

	Max =	3.81E-77	6.23E-12	2.34E-282	1.91E-10	1.91E-10

Table 2.4S.13-4 Transport Analysis Considering Dispersion, Advection, Radioactive Decay, and Retardation (Continued)

Pathway 4) Upper Shallow Aquifer at West Site Boundary - Representative Conditions

Pathway length =	6,000	ft		
Travel time =	329	yr (ave)		
Pore water velocity =	18	ft/yr		
Dispersivity =	47.3	ft		
Coeff dispersion =	863	ft^2/yr		
Total porosity =	0.41	from Table 2.4S.12-12		
Effective porosity =	0.33	from Table 2.4S.12-13		
Bulk density =	1.58	from Table 2.4S.12-14		
Input period =	60	yr (estimated life of plant)		
Radionuclide	Ni-63	Sr-90	Cs-137	Pu-239
ECL	1.00E-04	5.00E-07	1.00E-06	2.00E-08
C(0,t)	7.32E-03	5.15E-05	2.36E-04	7.25E-09
K_d (cm^3/g) (Lab ave.)				
R				
I (yr-1)	7.21E-03	2.39E-02	2.30E-02	2.88E-05
U				

RESULT: Using "representative" (average) travel time, K_d and porosity values, the 1-D advection+decay+redardation+dispersion model indicates that at 6,000 ft:

- ►No ECL violations
- ►No sum of fraction violations.
- ►C(x,t)/ECL ratio below 1%

Table 2.4S.13-4 Transport Analysis Considering Dispersion, Advection, Radioactive Decay, and Retardation (Continued)

Pathway 4) Upper Shallow Aquifer at West Site Boundary - Representative Conditions

x (ft)	t (yr)	C(x,t)/ECL				Sum
		Ni-63	Sr-90	Cs-137	Pu-239	
6000	5	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
6000	50	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
6000	500	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
6000	1,000	0.00E+00	9.06E-35	0.00E+00	0.00E+00	9.06E-35
6000	1,500	0.00E+00	1.08E-25	0.00E+00	0.00E+00	1.08E-25
6000	1,600	0.00E+00	4.30E-25	0.00E+00	0.00E+00	4.30E-25
6000	1,700	0.00E+00	9.84E-25	0.00E+00	0.00E+00	9.84E-25
6000	1,800	0.00E+00	1.42E-24	0.00E+00	0.00E+00	1.42E-24
6000	1,850	0.00E+00	1.46E-24	0.00E+00	0.00E+00	1.46E-24
6000	1,900	0.00E+00	1.38E-24	0.00E+00	0.00E+00	1.38E-24
6000	2,000	0.00E+00	9.68E-25	0.00E+00	0.00E+00	9.68E-25
6000	2,500	0.00E+00	4.54E-27	0.00E+00	0.00E+00	4.54E-27
6000	3,000	0.00E+00	4.92E-31	0.00E+00	0.00E+00	4.92E-31
6000	3,500	0.00E+00	6.26E-36	0.00E+00	0.00E+00	6.26E-36
6000	4,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
6000	5,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
6000	10,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
6000	11,000	1.16E-101	0.00E+00	0.00E+00	0.00E+00	1.16E-101
6000	12,000	2.46E-97	0.00E+00	0.00E+00	0.00E+00	2.46E-97
6000	13,000	3.45E-94	0.00E+00	0.00E+00	0.00E+00	3.45E-94
6000	14,000	5.72E-92	0.00E+00	0.00E+00	0.00E+00	5.72E-92
6000	15,000	1.72E-90	0.00E+00	0.00E+00	0.00E+00	1.72E-90
6000	16,000	1.29E-89	0.00E+00	0.00E+00	0.00E+00	1.29E-89
6000	16,500	2.28E-89	0.00E+00	0.00E+00	0.00E+00	2.28E-89
6000	17,000	3.10E-89	0.00E+00	0.00E+00	0.00E+00	3.10E-89
6000	17,500	3.33E-89	0.00E+00	0.00E+00	0.00E+00	3.33E-89
6000	18,000	2.88E-89	0.00E+00	0.00E+00	0.00E+00	2.88E-89
6000	19,000	1.20E-89	0.00E+00	0.00E+00	0.00E+00	1.20E-89
6000	20,000	2.53E-90	0.00E+00	0.00E+00	0.00E+00	2.53E-90
6000	22,000	2.13E-92	0.00E+00	0.00E+00	0.00E+00	2.13E-92

Table 2.4S.13-4 Transport Analysis Considering Dispersion, Advection, Radioactive Decay, and Retardation (Continued)

Pathway 4) Upper Shallow Aquifer at West Site Boundary - Representative Conditions

x (ft)	t (yr)	C(x,t)/ECL				Sum
		Ni-63	Sr-90	Cs-137	Pu-239	
6000	23,000	9.82E-94	0.00E+00	0.00E+00	0.00E+00	9.82E-94
6000	24,000	3.09E-95	0.00E+00	0.00E+00	0.00E+00	3.09E-95
6000	25,000	6.93E-97	0.00E+00	0.00E+00	0.00E+00	6.93E-97
6000	50,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
6000	100,000	0.00E+00	0.00E+00	0.00E+00	6.13E-19	6.13E-19
6000	125,000	0.00E+00	0.00E+00	0.00E+00	1.90E-13	1.90E-13
6000	150,000	0.00E+00	0.00E+00	0.00E+00	2.41E-10	2.41E-10
6000	175,000	0.00E+00	0.00E+00	0.00E+00	1.33E-08	1.33E-08
6000	200,000	0.00E+00	0.00E+00	0.00E+00	1.05E-07	1.05E-07
6000	210,000	0.00E+00	0.00E+00	0.00E+00	1.61E-07	1.61E-07
6000	220,000	0.00E+00	0.00E+00	0.00E+00	2.08E-07	2.08E-07
6000	230,000	0.00E+00	0.00E+00	0.00E+00	2.31E-07	2.31E-07
6000	240,000	0.00E+00	0.00E+00	0.00E+00	2.23E-07	2.23E-07
6000	250,000	0.00E+00	0.00E+00	0.00E+00	1.92E-07	1.92E-07
6000	275,000	0.00E+00	0.00E+00	0.00E+00	8.52E-08	8.52E-08
6000	300,000	0.00E+00	0.00E+00	0.00E+00	2.31E-08	2.31E-08
6000	325,000	0.00E+00	0.00E+00	0.00E+00	4.28E-09	4.28E-09
6000	350,000	0.00E+00	0.00E+00	0.00E+00	5.89E-10	5.89E-10
6000	375,000	0.00E+00	0.00E+00	0.00E+00	6.39E-11	6.39E-11
6000	400,000	0.00E+00	0.00E+00	0.00E+00	5.71E-12	5.71E-12
6000	425,000	0.00E+00	0.00E+00	0.00E+00	4.36E-13	4.36E-13
6000	450,000	0.00E+00	0.00E+00	0.00E+00	2.91E-14	2.91E-14
6000	475,000	0.00E+00	0.00E+00	0.00E+00	1.74E-15	1.74E-15
6000	500,000	0.00E+00	0.00E+00	0.00E+00	9.47E-17	9.47E-17
6000	525,000	0.00E+00	0.00E+00	0.00E+00	4.76E-18	4.76E-18
6000	550,000	0.00E+00	0.00E+00	0.00E+00	2.36E-19	2.36E-19
6000	575,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
6000	600,000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Max =	3.33E-89	1.46E-24	0.00E+00	2.31E-07	2.31E-07

Figure 2.4S.13-1 Decay Chains Considered in Accidental Effluent Release

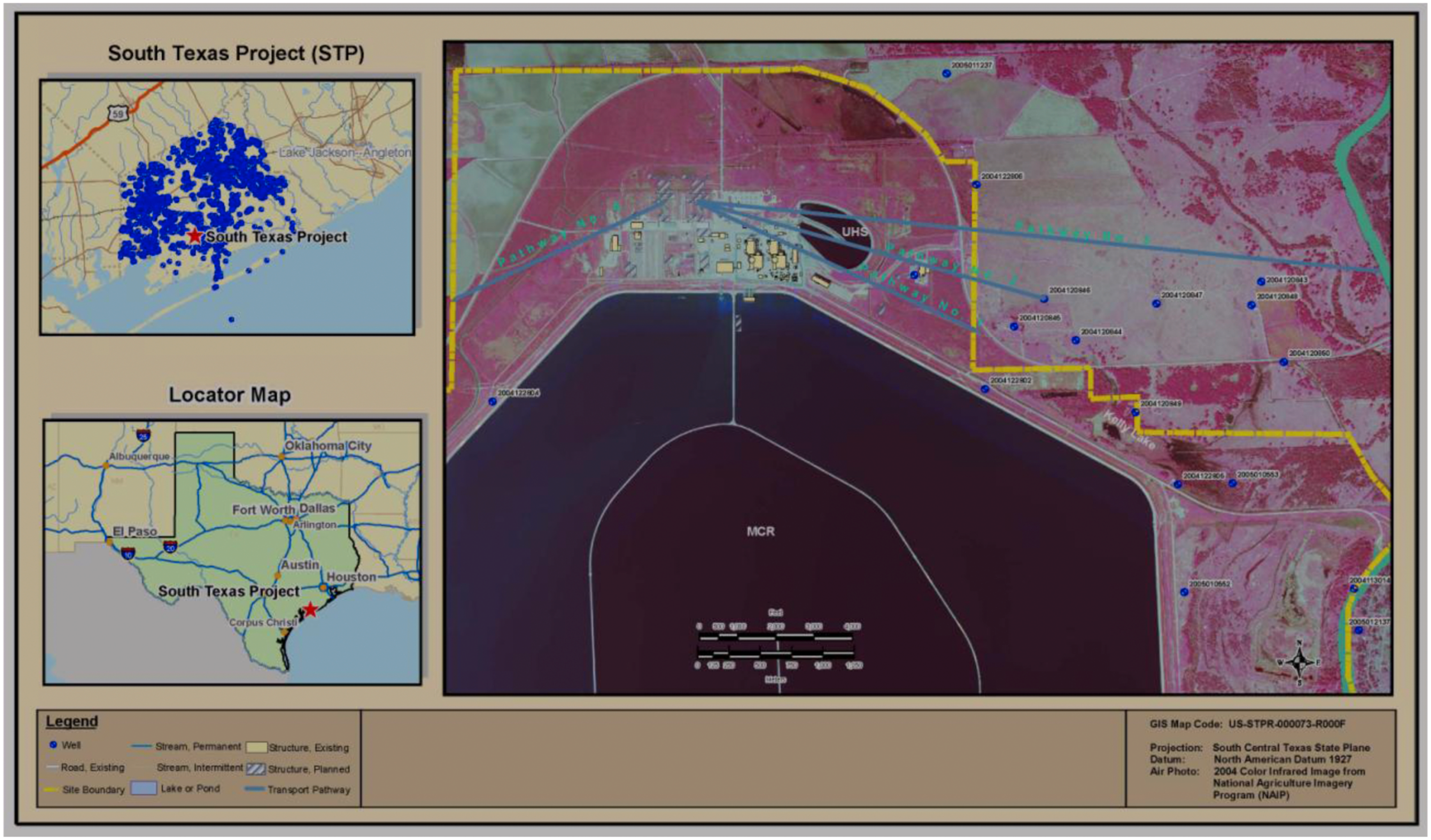

Figure 2.4S.13-2 Groundwater Transport Pathways