

BOE- P-03-Draft Natural Resource Damage Assessment for Groundwater-XXXXXX

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EFFECTIVE DATE: Date, 202X

SIGNATURES:

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PURPOSE:

Natural Resource Damage Assessment (NRDA) is applied in the context of formal enforcement to compensate for injury to Tennessee's natural resources. These funds are then applied to restoration projects to offset natural resource damages. NRDA calculations are intended to assist the department in determining a monetary value for these damages. This calculation is focused on injury caused by illicit activities affecting groundwater of the State.

The following Natural Resource Damage Assessment (NRDA) calculation is used to derive a dollar value (i.e., damages) for injuries to groundwater resources of the State. The resulting dollar value will be used to determine the scope of a restoration project. The restoration project will either be implemented by the State after the Respondent pays the full dollar amount, or the parties will negotiate a project to be implemented by either the Respondent or a third party, including land protection or green infrastructure that provides an equivalent volume of groundwater resources.

PROCEDURE:

After groundwater is contaminated by a release, a decision will be made by department staff in consultation with the Natural Resource Trustee (NRT) Program manager and the Office of the General Counsel (OGC) on whether to pursue Natural Resource Damages (NRD).

If NRD is to be pursued, department staff will determine the input values needed to calculate damage amounts. Past damages will be determined by calculating a stock volume. Future damages will be determined by calculating a flux volume over time. The overall NRD for a site with multiple

BOE- P-03-Draft Natural Resource Damage Assessment for Groundwater-XXXXXX

contaminated groundwater plumes is the total of summing the NRD for each plume. See Additional Considerations section for more information on calculating damage amounts for each contaminated groundwater plume.

NRD is in addition to any required cleanup and does not replace groundwater cleanup or offset groundwater cleanup costs. Proactive groundwater cleanup performed in cooperation with the department that will decrease the areal extent or duration of the injury may be a factor in determining the final NRDA.

CALCULATION INPUTS

INPUT	INPUT DESCRIPTION AND VALUES
Planning Area	The <u>Planning Area</u> is the county and grand division of the state (West, Middle or East) in which the contaminant plume is located.
Annual Groundwater Recharge	<u>Annual Groundwater Recharge</u> is the value in feet per year (ft/yr) for the Planning Area <u>West Tennessee</u> 1 ft/yr.¹ <u>Highland Rim, Central Basin or Valley and Ridge (Karst)</u> Highland Rim: 0.62 ft/yr.² Central Basin: 0.47 ft/yr.² Valley and Ridge: 0.55 ft/yr.² <u>Blue Ridge</u> 0.98 ft/yr.² <u>Cumberland Plateau</u> 0.54 ft/yr.²

¹ A Pilot Study for Delineation of Areas Contributing Water to Wellfields at Jackson, Tennessee, R.E. Broshears, J.F. Connell, and N.C. Short, 1991; U. S. Geological Survey; Water Resources Investigations Report 89-4201.

² Hoos, Anne B., 1990, Recharge rates and aquifer hydraulic characteristics for selected drainage basins in Middle and East Tennessee: : U.S. Geological Survey Water-Resources Investigations Report, 90-4015, 34 p.
<https://pubs.er.usgs.gov/publication/wri904015>

BOE- P-03-Draft Natural Resource Damage Assessment for Groundwater-XXXXXX

INPUT	INPUT DESCRIPTION AND VALUES
Average Unit Restoration Cost	<u>Average Unit Restoration Cost</u> is the current value for the Planning Area and is the current average cost for groundwater protection through land purchase found in the State of Tennessee Comptroller of the Treasury records by dividing the land market value by the total acreage of the property(ies). This is the cost to protect the volume of water produced on a yearly basis per acre.
Areal Extent of Groundwater Injury	The <u>Areal Extent of Groundwater Injury</u> is case-specific and includes the areal extent in square feet (ft ²) of the contaminated groundwater determined in the groundwater investigation. This is the entire area of impact regardless of being onsite or offsite.
Plume Thickness (only applicable if Stock Volume Calculation)	The <u>Plume Thickness</u> is case-specific and is the thickness in feet (ft) of the contaminant plume or saturated contaminated area. The department will determine plume thickness and document methodologies, formulas, assumptions, and any other rationale necessary to establish this variable.
Duration	<u>Duration</u> , in years, is the time period from the date of areal extent determination until <i>baseline</i> conditions would be met. If duration is more than 100 years, 100 years may be used for the calculation. <u>Baseline</u> is the pre-release event condition of the groundwater. The department will make the determination of pre-release event condition based on available information. Some sites may have groundwater that was degraded prior to the release event. Degraded conditions will require additional evaluation with the NRT Program manager.
Porosity (only applicable if Stock Volume Calculation)	<u>Porosity</u> is the ratio or percent volume of void spaces in a rock or sediment to the total volume of the rock or sediment. ³ Porosity value(s) may be derived from actual laboratory analyses or from scientifically acceptable reference tables for appropriate lithology as determined by department staff.

³ Applied Hydrogeology; CW Fetter, et. al. 3rd Edition.

ADDITIONAL CONSIDERATIONS

- If multiple plumes overlap, the overlap area is only counted once for the contaminant with the longest expected duration (defined below). For example, if two plumes overlap, NRD will be calculated for the areal extent of plume A that does not overlap, the areal extent of plume B that does not overlap, and the areal extent of the overlapping plumes.
- The department may segregate a plume where contaminant mobility and persistence, aquifer properties, or other considerations may significantly alter the NRDA, calculate NRD for the areas separately, and sum the parts to develop an overall NRD total.
- If a plume is expanding, then modeling or other techniques may be incorporated in the NRDA to estimate the areal extent of injury.
- If contaminants are co-located in an area of impact, the contaminant with the longer duration controls the duration value.

FLUX VOLUME CALCULATION

Step 1: Calculate the Injured Flux Volume (gal/yr) =
 $\text{Areal Extent (ft}^2\text{)} \times \text{Annual Recharge (ft/yr)} \times 7.48 \text{ (gal/ft}^3\text{) conversion factor}$

Step 2: Select the applicable average unit restoration cost (\$/acre) by dividing the parcel(s) land market value by the total acreage. (If the information is not available from the Comptroller of the Treasurer records, use a calculated average from a comparable, nearby property with similar zoning/land use characteristics).

Step 3: Convert the applicable unit average restoration cost per acre to an average restoration cost per gallon.

- a) Calculate the number of gallons 1 acre recharges in a year.

Gallons Recharged (gal/acre) =
 $1 \text{ year (yr)} \times \text{Annual Recharge (ft/yr)} \times 43,560 \text{ (ft}^2\text{/acre) conversion factor} \times 7.48 \text{ (gal/ft}^3\text{) conversion factor}$

- b) Calculate the average unit restoration cost (\$/gal).

Average Restoration Cost (\$/gal) =
 $\text{Average Restoration Cost (\$/acre) from Step 2} / \text{Gallons Produced (gal/acre) from Step 3a}$

BOE- P-03-Draft Natural Resource Damage Assessment for Groundwater-XXXXXX

Step 4: Calculate the damages (\$) for the total injured flux volume for the duration of groundwater injury.

$$\text{Damages (\$)} = \text{Injured Flux Volume (gal/yr) from Step 1} \times \text{Duration (yrs)} \times \text{Average Restoration Cost (\$/gal) from Step 3b}$$

STOCK VOLUME CALCULATION

Step 1: Calculate the Injured Stock Volume (ft³) =
Areal Extent (ft²) x Plume Thickness (ft) x Porosity (unitless)

Step 2: Calculate the damages (\$) for the stock volume of injured groundwater.

$$\text{Damages (\$)} = \text{Injured Stock Volume (ft}^3\text{) from Step 1} \times \text{Average Restoration Cost (\$/gal) from Flux Step 3b} \times 7.48 \text{ (gal/ft}^3\text{) conversion factor}$$

EXAMPLE CALCULATIONS

INPUT	SITE-SPECIFIC DESCRIPTION/VALUES
Planning Area	County – Hardeman Grand Division – West Tennessee
Annual Groundwater Recharge	1 ft/yr
Average Unit Restoration Cost	\$2,491
Areal Extent of Groundwater Injury	32,700 ft ²
Plume Thickness	10 ft
Duration	30 years

BOE- P-03-Draft Natural Resource Damage Assessment for Groundwater-XXXXXX**FLUX VOLUME CALCULATION**

Step 1: Calculate the Injured Flux Volume (gal/yr) =

$$32,700 \text{ (ft}^2\text{)} \times 1 \text{ (ft/yr)} \times 7.48 \text{ (gal/ft}^3\text{)} = \underline{244,596 \text{ gal/yr}}$$

Step 2: Select the applicable average unit restoration cost (\$/acre) by dividing the parcel(s) land market value by the total acreage. (If the information is not available from the Comptroller of the Treasurer records, use a calculated average from a comparable, nearby property with similar zoning/land use characteristics). \$2,491/acre

Step 3: Convert the applicable unit average restoration cost per acre to an average restoration cost per gallon.

a) Calculate the number of gallons that 1 acre recharges in a year.

Gallons Recharged (gal/acre) =

$$1 \text{ year} \times 1 \text{ (ft/yr)} \times 43,560 \text{ (ft}^2\text{/acre)} \times 7.48 \text{ (gal/ft}^3\text{)} = \underline{325,828.8 \text{ gal/acre}}$$

b) Calculate the average unit restoration cost (\$/gal).

Average Restoration Cost (\$/gal) =

$$2,491 \text{ ($/acre) from Step 2} / 325,828.8 \text{ (gal/acre) from Step 3a} = \underline{0.008 \text{ $/gal}}$$

Step 4: Calculate the damages (\$) for the total injured flux volume for the duration of groundwater injury.

Damages (\$) =

$$244,596 \text{ (gal/yr) from Step 1} \times 30 \text{ (yrs)} \times 0.008 \text{ ($/gal) from Step 3b} = \underline{\$58,703.04}$$

STOCK VOLUME CALCULATION

Step 1: Calculate the Injured Stock Volume (ft³) =

$$32,700 \text{ (ft}^2\text{)} \times 10 \text{ (ft)} \times 0.25 \text{ (porosity-unitless)} = 327,000 \text{ ft}^3 \times .25 = 81,750 \text{ ft}^3$$

Step 2: Calculate the damages (\$) for the stock volume of injured groundwater.

Damages (\$) =

$$81,750 \text{ (ft}^3\text{) from Step 1} \times 0.008 \text{ ($/gal) from Flux Step 3b} \times 7.48 \text{ (gal/ft}^3\text{)} = \underline{\$4,891.92}$$

BOE- P-03-Draft Natural Resource Damage Assessment for Groundwater-XXXXXX

Total Damages = Flux Volume Damages + Stock Volume Damages

$$\$58,703.04 + \$4,891.92 = \underline{\$63,594.96}$$

REVISION HISTORY:

Revision Number	Date	Brief Summary of Change
1	xx.xx.xxxx	Updated the method for determining the applicable average unit restoration cost to use real-time data. Clarified determination of past and future damages calculation.
0	01.14.2020	Developed