



MEMORANDUM

TO: Steam Electric Rulemaking Record - EPA-HQ-OW-2009-0819

FROM: U.S. EPA

DATE: May 1, 2026

SUBJECT: Technical Support Memorandum for the Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category - Unmanaged Combustion Residual Leachate – DCN SE12105

1. Introduction

This memorandum presents the engineering analyses supporting the proposed 2026 Steam Electric Rulemaking for Unmanaged Combustion Residual Leachate (CRL). The EPA defines unmanaged CRL in this rule to mean the following: (1) discharges of CRL that the permitting authority determines are the functional equivalent of a direct discharge to waters of the United States (WOTUS) through groundwater or (2) discharges of CRL that has leached from a waste management unit into the subsurface and mixed with groundwater prior to being captured and pumped to the surface for discharge directly to a WOTUS.

The EPA evaluated the population of coal combustion residual (CCR) waste management units at steam electric power plants to calculate the potential volume of unmanaged CRL from these waste management units and the rate at which unmanaged CRL could be pumped to a groundwater recovery system for management and treatment. The EPA used these estimated pumping rates and volumes to calculate bounded estimates of compliance costs, pollutant loadings, and non-water quality environmental impacts (NWQEI) associated with the proposed regulatory options outlined in the preamble (Section VI). This analysis builds on the methodology developed for the Final 2024 Steam Electric Rulemaking and presented in *Evaluation of Unmanaged CRL - DCN SE11501* (U.S. EPA, 2024a).

Section 2 presents the data collection activities supporting the proposed ELGs. Section 3 presents the methodology for estimating the population of waste management units that may discharge unmanaged CRL. Section 4 presents the EPA's approach to estimating the volume and pumping rate of unmanaged CRL at the waste management units. Sections 5 through 8 present the EPA's methodology and results for calculating bounded estimates of compliance costs, pollutant loadings, and NWQEIs associated with the regulatory options.

2. Data Collection

This section presents the data collection activities the EPA conducted for the 2026 proposed ELG.

2.1 Data requests

In December 2021, the EPA invited eight steam electric power companies to participate in a voluntary program designed to obtain data to supplement the wastewater characterization data set for CRL. The EPA requested these data from facilities believed to have constructed new landfills pursuant to the 2015 CCR rule. Six power companies chose to participate in this program. The EPA incorporated these data into the CRL analytical dataset used in the 2024 ELG and in today's proposed action to estimate pollutant loadings.

As part of the 2025 Deadline Extensions Rule (90 FR 47693), the EPA solicited comment on any pilot or full-scale treatment data for unmanaged CRL. The EPA also solicited comment on any engineering cost estimates, bids, vendor quotes, or other cost information regarding treatment of unmanaged CRL.

Ten of the comment letters received as part of the proposed 2025 Deadline Extensions Rule addressed aspects of the unmanaged CRL requirements in the 2024 ELG (U.S. EPA, 2024b). Commenters primarily raised concerns regarding the legal basis, technical feasibility, and economic reasonableness of nationally applicable effluent limitations, particularly for functionally equivalent direct discharges through groundwater to a WOTUS. Many asserted that applying uniform technology-based limits to groundwater-mediated releases may be inconsistent with statutory authority and could overlap with existing groundwater regulatory frameworks. Commenters also questioned the adequacy of the technical record supporting numeric limits, citing uncertainty in hydrogeologic conditions, variability in leachate characteristics, and limited demonstrated effectiveness of available treatment technologies for dissolved constituents such as arsenic and mercury. Several commenters further stated that zero-liquid-discharge requirements could be infeasible or excessively costly in certain circumstances, including facilities with small leachate volumes, commingled wastewater streams, or units undergoing closure.

Commenters broadly supported greater reliance on site-specific, permit-level determinations rather than uniform national limits. Many supported eliminating or narrowing requirements associated with groundwater-related discharges while retaining flexibility for captured and treated leachate mixtures, including BPJ based permitting for site-specific factors. Some commenters also identified the potential for emerging or in situ treatment approaches and requested additional data development or extended compliance timeframes during reconsideration.

2.2 Meetings with Individual Utilities

To gather information to support the 2026 proposed ELG, the EPA met with representatives from four utilities. Two of these utilities reached out to the EPA after the 2025 press release. The EPA contacted four other utilities due to their known experience or potential consideration of the EPA's BAT technologies. At these meetings, the EPA discussed the operation of the utility's coal-fired generating units and the treatment and management of CRL, particularly unmanaged CRL, since the 2020 and 2024 ELGs. The specific objectives of these meetings were to gather general information about coal-fired power plant operations, pollution prevention and wastewater treatment system operations, and ongoing pilot or laboratory scale study information for CRL (U.S. EPA, 2025a, 2025b, 2025c, 2025d).

2.3 Site Visits

The EPA conducted two site visits during the development of this proposed ELG to the Colstrip Steam Electric Station in Colstrip, MT and the Monroe Power Plant / Sibley Quarry Landfill in Monroe, MI. The purpose of these site visits was to understand each plant's practical experiences implementing the Steam Electric ELGs, understand how each electric generating unit's wastewaters are managed overall, and understand the range of management and treatment options for unmanaged CRL at both impoundments and landfills. See the site visit notes for more information (U.S. EPA, 2026a, 2026b).

2.4 Meetings With Trade Associations

From 2024 to 2026, EPA met with the Edison Electric Institute and the American Public Power Association. These trade associations represent investor-owned utilities and community-owned utilities, respectively. They provided information and perspectives on the current status of many utilities transitioning away from coal.

2.5 Coal Combustion Residuals Rule

The EPA reviewed industry data for landfills and impoundments and groundwater from the CCR rules. This included the CCR Comprehensive Compliance Report (CCR database) (U.S. EPA, 2025e), which is compiled and maintained by the Office of Land and Emergency Management (OLEM). This database contains a list of waste management units at U.S. coal-fired power plants and data for each unit related to groundwater monitoring, the closure status of the waste management units, links to pertinent CCR reports and data at each plant's website, and other information.

2.6 Other Data Sources

The EPA gathered information on steam electric generating plants from the Department of Energy's (DOE's) Energy Information Administration (EIA) Forms EIA-860 (Annual Electric Generator Report) and EIA-923 (Power Plant Operations Report) (U.S. EIA, 2025, 2026). The EPA used the 2024 Form EIA-860 data and the 2025 Form EIA-960 data to update the industry profile, including operating statuses and planned retirement dates.

3. Identification of Waste Management Units

To estimate the waste management unit population for the 2026 proposed ELG analyses, the EPA used the June 11, 2025 version of the CCR Comprehensive Compliance Report (CCR database) (U.S. EPA, 2025e). The EPA used the same methodology to identify waste management units with unmanaged CRL as it did in the 2024 ELG analyses, only making updates for new information presented in the 2025 CCR database.

3.1 Methodology to Identify Waste Management Units Potentially Discharging Unmanaged CRL

The CCR database contains information for 783 waste management units, which are designated as landfills (249 units) or surface impoundments (534 units). The EPA evaluated liner information included in the CCR database to determine the subset of landfills and surface impoundments that may discharge unmanaged CRL to groundwater and be subject to the proposed ELG. The EPA identified landfills that were categorized as **not composite lined** and the surface impoundments categorized as **not clean closed or composite lined** as the population of waste management units which could potentially be discharging unmanaged CRL.

The installation of a composite liner¹ below CCR material stored in a landfill or surface impoundment is intended to minimize the potential for leachate to seep into the groundwater. In landfills or surface impoundments with a composite liner, leachate from the CCR material can be collected and is often stored in a leachate collection system (*e.g.*, a pond). For the purpose of identifying waste management units that are discharging unmanaged CRL, the EPA assumed that leachate discharged to groundwater from composite-lined landfills and surface impoundments, while still possible, is likely negligible. Additionally, the EPA assumed that leachate from surface impoundments that are clean closed (*i.e.*, without CCR material in place) is negligible, even if the surface impoundments are unlined. Therefore, the EPA excluded landfills and surface impoundments that have a composite liner or were clean closed by 2025 according to information in the CCR database.

For the remaining waste management units, the EPA evaluated the following unit-specific documents to determine if each waste management unit should be considered in the rulemaking analyses:

- Closure reports
- Liner certifications
- Run-on/run-off control plans
- Annual inspection reports
- Annual groundwater monitoring and corrective action reports
- Groundwater monitoring system design reports

During the 2024 ELG analyses, the EPA identified units as composite lined if the reviewed documents contained an explicit statement that the waste management unit has a composite liner or a description of a liner system that is consistent with the design criteria outlined in 40 CFR § 257.70. The EPA identified waste management units as clean closed if the reviewed documents described “removal” of all CCR material or used the term “clean closed.” The EPA did not review new unit-specific documents as part of this proposed rulemaking.

The EPA included the following landfills and surface impoundments in its proposed population of waste management units that may discharge unmanaged CRL:

¹ A composite liner design must meet the criteria established in 40 CFR § 257.70.

- Waste management units at plants that submitted CCR Part B regulation applications for alternate liners and plan to demonstrate that there is no reasonable probability that the plant's waste management unit(s) will have adverse effects to human health and the environment.
- Waste management units where the documentation indicated both lined and unlined areas.
- Waste management units characterized as being closed or in the process of closing with waste in place. The EPA only included the waste management unit in the unmanaged CRL analysis if there was an explicit statement that CCR material was being left "in place."

3.2 Waste Management Units Identified as Potentially Discharging Unmanaged CRL

The EPA used the criteria outlined in Section 3.1 to characterize whether each landfill does or does not have a composite liner. Of the 249 landfills that the EPA evaluated, 105 landfills were categorized as **not composite-lined** based on the CCR database and compliance documents stating that the landfill either was not lined, the liner did not meet the composite liner requirements, or information on the presence and design of the liner was not found in the documentation. Because of these criteria, these 105 landfills were identified as potentially discharging unmanaged CRL and were included in the analysis. Other landfills that were composite lined were assumed not to be discharging unmanaged CRL and were excluded from the analysis.

The EPA used the criteria outlined in Section 3.1 to characterize whether each surface impoundment has a composite liner or not, and whether the surface impoundment will be clean closed or closed with CCR waste in place. Surface impoundments that have composite liners or are clean closed as of 2024 were excluded from the unmanaged CRL analyses,² because they were assumed to not be discharging unmanaged CRL. The EPA assumed that only surface impoundments that were not composite lined or clean closed could be discharging unmanaged CRL. Of the 534 total surface impoundments that the EPA evaluated, 302 surface impoundments were identified as clean closed or composite lined (and therefore, not discharging unmanaged CRL and excluded from the analysis). For the remaining 232 surface impoundments:

- 7 surface impoundments were identified as clean closed or composite lined in the CCR database but were categorized as **not clean closed or composite lined** for the unmanaged CRL analysis because CCR compliance documents on the power company's website stated that the surface impoundment was closed with CCR material in place and either was not lined, the liner did not meet the composite liner requirements, or information on the presence and design of the liner was not found. These 7 surface impoundments were identified as potentially discharging unmanaged CRL and included in the analysis.
- 212 surface impoundments were categorized as **not clean closed or composite lined** because both the CCR database and the CCR compliance documents made available online stated that the surface impoundment was closed with CCR material in place and either was not lined, the liner did not meet

² One additional surface impoundment in the CCR database was excluded from population as it was replaced by another listed in the CCR database (The Bottom Ash Pond at Cardinal Plant was replaced by the Retrofitted Bottom Ash Pond).

the composite liner requirements, or information on the presence and design of the liner was not found. These 212 surface impoundments were identified as potentially discharging unmanaged CRL and included in the analysis.

- 13 surface impoundments were identified as **not clean closed or composite lined** in the CCR database and did not have publicly accessible CCR compliance documents to otherwise characterize the surface impoundments. These units were excluded from subsequent analyses.

In total, the EPA identified 105 landfills that were categorized as **not composite lined** and the 219³ surface impoundments categorized as **not clean closed or composite lined** as the population of waste management units which could potentially be discharging unmanaged CRL.

4. Groundwater Pumping Rates

For leachate determined to meet the definition of unmanaged CRL, the leachate-laden groundwater will likely be pumped from the ground prior to treatment. For purposes of estimating compliance costs, pollutant loadings, and NWQEI, the EPA assumed that the flows receiving treatment would be equal to the flows of pumped groundwater.

As part of the 2024 ELG, the EPA estimated groundwater pumping rates and volumes associated with unmanaged CRL for 65 landfill groundwater pumping systems and 110 surface impoundment pumping systems (U.S. EPA, 2024a). Due to the limited changes between the CCR database used for the 2024 ELG and the 2025 CCR database, the EPA did not update groundwater pumping rates or estimate new groundwater pumping rates for the 2026 proposed ELG. This section presents the EPA's methodology for estimating groundwater pumping rates and flow volumes to wastewater treatment. In brief, the EPA used available information in the CCR database and public CCR compliance documents to determine the aquifer characteristics specific to the unit and calculations consistent with hydrology references and government guidance documents to estimate groundwater pumping rates (Kruseman et al., 1990; Lohman, 1972; U.S. EPA, 1996).

4.1 Methodology for Estimating Groundwater Pumping Rates

The EPA assumed that groundwater pumping systems are each comprised of a series of wells designed to capture groundwater by drawing down the groundwater elevation along the hydraulically downgradient cross-sectional width of the waste management unit. This configuration would generate a hydraulic gradient that causes leachate-laden groundwater to flow toward the wells where it would be pumped out

³ The EPA considers 534 surface impoundments to be the total universe of surface impoundments across all plants. The EPA focused its analysis on surface impoundments and landfills that could potentially be discharging unmanaged CRL. The analysis reflects only those surface impoundments that are not composite lined or not clean closed and are capable of discharging unmanaged CRL. Surface impoundments that are composite lined or clean closed are accordingly not expected to discharge unmanaged CRL and were therefore excluded from the analysis. The count of 219 surface impoundments is a subset of the 534 surface impoundments that the EPA identified as not composite lined and not clean closed (and thus, potentially discharging unmanaged CRL). The number of unlined / not clean closed surface impoundments comes from the CCR rule compliance database, which was last updated in June 2025. The analysis captures plants that have more than one impoundment by costing the total flows of all affected impoundments.

and conveyed to a treatment facility. Figure 1 is a conceptual illustration of a groundwater pumping system designed to capture leachate from an unlined waste management unit.

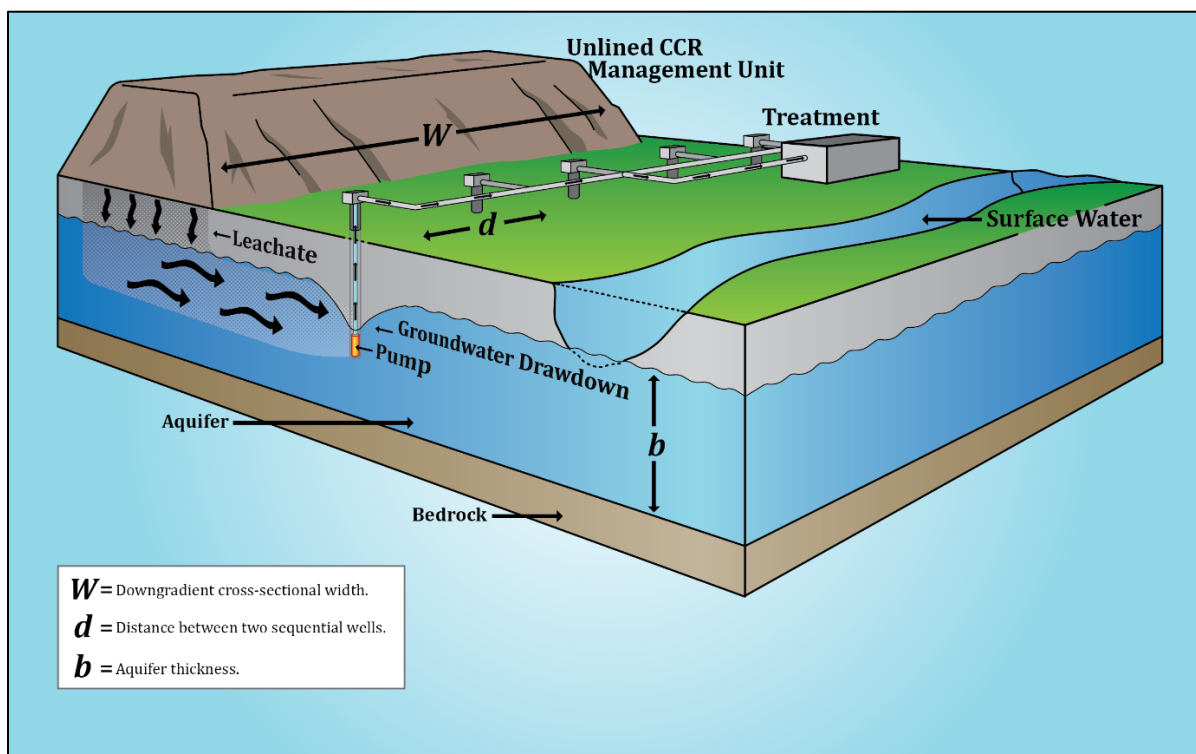


Figure 1. Groundwater Pumping System to Capture Unmanaged CRL

At plants with multiple surface impoundments in close proximity to each other, the EPA assumed that the impoundments would share a common groundwater pumping system. Due to the assumptions of a shared system collecting unmanaged CRL commingled from various waste management units, the EPA also retained closed surface impoundments units so that treatment costs would not be underestimated. See the *Unmanaged CCR Flow - Impoundment* file for the pumping rate estimates for each groundwater pumping system and identification of surface impoundments at plants where the EPA assumed a common groundwater pumping system (ERG, 2024a, 2024b). If the EPA did not have sufficient data from the plant and CCR documentation to determine the proximity of surface impoundments at a plant, the EPA developed costs for individual ground water pumping systems for each surface impoundment.

The EPA developed the pumping rate calculation methodology outlined in Section 4.1.2 to estimate the rate at which groundwater could be pumped and treated to manage leachate from landfills and surface impoundments included in this analysis. See Attachment 1 of *Evaluation of Unmanaged CRL - DCN SE11501* for a step-by-step example of the pumping rate calculation for a CCR landfill (U.S. EPA, 2024a).

4.1.1 Pumping Rate Data Collection

The rate at which groundwater could be pumped is specific to each waste management unit and is dependent on the unit's geometry and local hydrogeologic characteristics. Sufficient information on these

characteristics was available for only some waste management units. Therefore, the EPA developed unit-specific groundwater pumping rate estimates for those landfills and surface impoundments for which information on the hydraulic conductivity and aquifer characteristics were available.

The EPA gathered data during the 2024 ELG for the following parameters from the CCR compliance documents posted on each power company's website:

- Average hydraulic conductivity of the aquifer.
- Average thickness of the aquifer.
- Width of the landfill cross-section perpendicular to the groundwater flow gradient (i.e., the hydraulically downgradient cross-sectional width).⁴

4.1.2 Pumping Rate Calculations

The design of a groundwater recovery system is dependent upon the conditions at that site with multiple possible designs for each location. The design used in this analysis is one that could be applied to any unit and is based on the waste management unit data that are available, supplemented by assumptions presented within this document and consistent with accepted guidance documents. The process outlined here is consistent with hydrology textbooks and government guidance documents (Kruseman et al., 1990; Lohman, 1972; U.S. EPA, 1996). The EPA developed a Python Script to compute the estimated pumping rates of groundwater that would need to be pumped from each waste management unit for which data were available (ERG, 2024a, 2024b).

The rate at which groundwater could be pumped at a given waste management unit is equal to the product of an average pumping rate from each well multiplied by the total number of wells, shown in Equation [1]:

$$\dot{Q}_{Total} = n_{well} \times \dot{Q}_{well} \quad [1]$$

Where:

\dot{Q}_{Total}	=	Total pumping rate of groundwater (gallons per minute; gpm).
n_{well}	=	Total number of wells (dimensionless).
\dot{Q}_{well}	=	Average pumping rate per well (gpm).

An ideal unit-specific groundwater pumping system design would optimize the number of wells to minimize costs while achieving the necessary drawdown.⁵ A greater number of wells would increase the upfront capital cost of the pumping system but could decrease the total volume of water that would require pumping (and subsequent treatment) due to less spatial variation in the groundwater elevation profile. Rather than conducting a unit-specific economic analysis to determine an optimum number and configuration of wells for each groundwater pumping system for more than 330 waste management units

⁴ In addition to publicly available information on the power companies' CCR compliance websites, satellite imagery from Google Earth was used to estimate downgradient cross-sectional width.

⁵ Drawdown is the local depression in groundwater elevation created by pumping groundwater. See Equation [3].

across the U.S., the EPA assumed that the wells would be located equidistant from one another along the downgradient cross-sectional width of the landfill or surface impoundment. The EPA recognizes that a large waste management unit likely would not install pumping wells at the same spacing as a small waste management unit. Accordingly, the EPA determined the number of wells for each groundwater pumping system based on the magnitude of the waste management unit’s downgradient cross-sectional width, as shown in Table 4-1⁶. These estimates were developed using best professional judgment to balance the economic and technical factors that would be considered in designing a groundwater pumping system.

Table 4-1. Number of Wells for Each Waste Management Unit’s Groundwater Pumping System

Cross-Sectional Width (ft)	n_{well}
< 500	5
500 – 1,500	10
1,501 – 2,500	15
2,501 – 4,000	20
4,001 – 6,000	30
> 6,000	40

Abbreviations: ft (feet); n_{well} (number of wells).

For waste management units located above shallow aquifers, the maximum drawdown at the wells could approach or exceed the thickness of the aquifer, meaning that the well would run dry. For those sites, the EPA added more wells to the pumping system until the maximum drawdown was less than 90 percent of the aquifer thickness.

The distance d between two sequential wells is calculated by dividing the downgradient cross-sectional width w by n_{well} as shown in Equation [2]:

$$d = \frac{w}{n_{well}} \quad [2]$$

Where:

w = Downgradient cross-sectional width (ft).

d = Distance between two sequential wells (ft).

To establish adequate capture of leachate, the EPA assumed that enough groundwater must be pumped to maintain a drawdown of at least one foot across the entire downgradient cross-sectional width of the

⁶ Table 4-1 does not represent the total number of wells installed that are associated with treatment of unmanaged CRL from the 219 surface impoundments that are potentially discharging unmanaged CRL. Table 4-1 shows the number of wells expected that would be associated with a waste management unit’s downgradient cross-sectional width. As outlined in Section 4.1 and 4.2, the EPA used site-specific parameters for waste management units where available, such as hydraulic conductivity and aquifer thickness. The EPA also considered the proximity of multiple surface impoundments when determining the number of overall groundwater pumping systems. The EPA assumed a single groundwater pumping system would be used when surface impoundments are in sufficiently close proximity to each other. The EPA excluded groundwater pumping designs that did not meet the minimum threshold of 0.5 gpm, because pumping and treating groundwater at flow rates lower than 0.5 gpm is generally considered impractical and not cost effective.

landfill. The EPA used the Theis equation (Equation [3]) to calculate drawdown as a function of distance r (feet) from a well and time t (days) that the pumping system operates (Maclead, 1995):

$$s(r, t) = \frac{114.6 \times \dot{Q}_{well} \times W(u)}{T} \quad [3]$$

Where:

$s(r, t)$	=	Drawdown (ft).
\dot{Q}_{well}	=	Pumping rate per well (gallons per minute; gpm).
T	=	Aquifer transmissivity (gallons per day per foot; gpd/ft); see Equation [4], below.
$W(u)$	=	Well function of u (dimensionless); see Equation [5] below.

Aquifer transmissivity T is equal to the hydraulic conductivity of an aquifer multiplied by its thickness, as shown by Equation [4]:

$$T = k_h \times b \quad [4]$$

Where:

k_h	=	Hydraulic conductivity (gallons per day per square foot; gpd/ft ²).
b	=	Aquifer thickness (ft).

Both hydraulic conductivity k_h and aquifer thickness b are location-specific parameters. The EPA used data available in the CCR compliance website documents to estimate the average hydraulic conductivity and aquifer thickness at each unit.⁷ These CCR documents reported hydraulic conductivity values ranging from approximately 10^{-7} centimeters per second (cm/sec) to approximately 10^{-1} cm/sec and aquifer thickness values ranging from several feet to several hundred feet. If aquifer thickness was not specifically quantified in the CCR documents for a waste management unit, the EPA approximated aquifer thickness using data from the plant's groundwater monitoring wells available from other information available in the documents. The EPA used one of five different methods, depending on information available in the CCR documents, to approximate the average aquifer thickness b :

1. Aquifer thickness specifically quantified in CCR documents
2. Difference between deepest well and most shallow well
3. Average depth to water subtracted from average well depth

⁷ The EPA's review of CCR compliance website documents was conducted during the 2024 Rule.

4. Average depth of multiple wells
5. Difference in deepest and most shallow measured groundwater elevations

The well function $W(u)$ in Equation [3] can be calculated by evaluating the exponential integral for a given value of u , or using the tables that provide $W(u)$ based on the value of u (see Attachment 2 of *Evaluation of Unmanaged CRL - DCN SE11501*). The EPA calculated $W(u)$ using a Python script by evaluating the exponential integral function included in the SciPy library (ERG, 2023a). In the well function, u is a dimensionless argument that is calculated using Equation [5] (Maclead, 1995):

$$u = \frac{1.87r^2S}{Tt} \quad [5]$$

Where:

- | | | |
|-----|---|--------------------------------------|
| r | = | Distance from the well (ft). |
| S | = | Aquifer storativity (dimensionless). |
| T | = | Aquifer transmissivity (gpd/ft). |
| t | = | Time of operation (days). |

Because $S(r, t)$ decreases with distance r from a given well, the drawdown will be minimized at the points along the downgradient cross-sectional width where the local depression of one well intersects with the local depression of the next well. The EPA assumed that the wells will be spaced equidistantly, so the drawdown $S(r, t)$ at a distance r from a given well was set to the desired drawdown value of one foot, and r was set equal to $d/2$, which was calculated using Equation [2]. This estimate for r will result in higher pumping rates as it does not account for the cumulative drawdown that multiple wells would have at a point between them.

For this analysis, time t represents the length of time that the groundwater pumping systems would be designed to operate until the minimum drawdown of one foot is achieved across the downgradient cross-sectional width. The time value t for each system would be designed to achieve the minimum drawdown expeditiously after start-up without requiring the system to be significantly oversized for maintaining the minimum drawdown as the system approaches a quasi-steady state.⁸ The EPA estimated pumping rates assuming a time value t of 1,000 days to achieve the minimum drawdown, which was judged to balance achieving adequate drawdown expeditiously while not requiring oversized pumping and treatment equipment.

The Theis equation (Equation [3]) was developed for modeling the behavior of a groundwater pumping system in a confined aquifer but can be expected to behave similarly for unconfined aquifers over sufficiently long timescales (Kruseman et al., 1990). The EPA previously explored the impact of this assumption by examining the required total groundwater pumping rate for t values ranging from 100 days to 10,000 days (See Attachment 3 of the *Evaluation of Unmanaged CRL Memorandum - DCN SE11501*).

⁸ A groundwater pumping system approaches a quasi-steady-state condition when changes to the groundwater elevation profile over time become insignificant relative to the timescale that the system is expected to operate.

To use the Theis equation for estimating pumping rates, the EPA needed to approximate storativity, S , the capacity of an aquifer to store or release water, for all aquifers in the analysis. Although the EPA determined that some landfills and surface impoundments in the analysis are situated over confined aquifers, the EPA assumed all of the aquifers are unconfined (*i.e.*, without a confining layer above them) for the unmanaged CRL analysis. Impacts due to leachate from a landfill may be less likely to occur in confined aquifers, so assuming the landfills are all situated over unconfined aquifers will yield higher pumping rate estimates. To demonstrate that the results of this analysis are minimally impacted by whether the aquifers are confined or unconfined, the EPA applied a mathematical correction that was developed for using the Theis equation in the case of an unconfined aquifer (see Attachment 3 of the *Evaluation of Unmanaged CRL Memorandum – SE11501*) (U.S. EPA, 2024a).

The storativity of an unconfined aquifer is equal to the specific yield plus specific storage. In most cases, specific storage is negligible, so the EPA assumed that storativity is equal to specific yield for this analysis. In unconfined aquifers, specific yield, and therefore storativity, ranges from 0.1 (10 percent) to 0.3 (30 percent) and averages about 0.2 (Lohman, 1972). Since detailed information about the type of each aquifer was not typically available, the EPA used the average value of $S = 0.2$ for the aquifers at all waste management units.

Using the above-described assumptions, Equations [3], [4], and [5] can be combined and rearranged to calculate the pumping rate required to maintain a minimum drawdown of one foot along the downgradient cross-sectional width of the landfill or surface impoundment, shown in Equation [6]:

$$\dot{Q}_{Well} = \frac{k_h b}{114.6 * W(u)} \quad [6]$$
$$u = \frac{4.11 * 10^{-4} * r^2}{k_h b}$$

Once \dot{Q}_{Well} is calculated using Equation [6], the EPA used Equation [1] to calculate the total pumping rate for each groundwater pumping system with sufficient data available from the CCR compliance documents.

4.2 Groundwater Pumping Rate Estimates

The EPA was able to gather the data necessary to estimate unit-specific groundwater pumping rates (*i.e.*, data available on aquifer thickness, hydraulic conductivity, and downgradient cross-sectional width) for 65 landfills and 168 surface impoundments. The EPA modeled 65 groundwater pumping systems for the landfills with unit-specific data. During the review of CCR compliance documents, the EPA determined 28 plants had more than one surface impoundment in close proximity to each other, accounting for 86 of the 168 surface impoundments. The EPA assumed these plants would use a single groundwater pumping system for all the surface impoundments at the plant. As a result, the EPA modeled 110 groundwater pumping systems for surface impoundments, consisting of 82 systems for singular surface impoundments and 28 systems for multiple surface impoundments (ERG, 2024a, 2024b).

If aquifer thickness was not specifically quantified in CCR documents, the EPA approximated aquifer thickness using data from the facilities' groundwater monitoring wells. Table 4-2 shows the number of waste management units by aquifer thickness approximation method.

Table 4-2. Summary of Aquifer Thickness Approximation Methods

Method	Landfill Groundwater Pumping Systems	Surface Impoundment Groundwater Pumping Systems	Total
1. Aquifer thickness specifically quantified in CCR documents	46	77	123
2. Difference between deepest well and most shallow well	4	18	22
3. Average depth to water subtracted from average well depth	9	6	15
4. Average depth of multiple wells	5	6	11
5. Difference in deepest and most shallow measured groundwater elevations	1	3	4
Total	65	110	175

The EPA then applied the methodology described in Section 4.1.2 to calculate groundwater pumping rates for the 65 landfill groundwater pumping systems and 110 surface impoundment groundwater pumping systems. *Unmanaged CRL Calculation File – DCN SE11501A1* contains the EPA’s pumping rate estimates for each groundwater pumping system for which sufficient data were available (ERG, 2024c).

Table 4-3 provides summary statistics for the pumping rate estimates after excluding wells with well pumping rates less than 0.5 gallons per minute (gpm). The EPA excluded wells with flow rate less than 0.5 gpm from the groundwater pumping rate estimates as these minimal flow rates would not impact the groundwater pumping system design. Of the 65 groundwater pumping systems for landfills that the EPA modeled, 22 would have wells with an average pumping rate of less than 0.5 gpm. Of the 110 groundwater pumping systems for surface impoundments that the EPA modeled, 20 would have wells with an average pumping rate of less than 0.5 gpm. Pumping and treating groundwater at flow rates less than 0.5 gpm is possible but requires specialized configurations (*e.g.*, intermittent pump operation) due to the limitations of hydraulic conductivity. The 22 landfill groundwater pumping systems and 20 surface impoundment groundwater pumping systems that were excluded due to low pumping rates account for approximately one-quarter of the total number of systems where pumping rates were estimated. The plants that these systems would be located at are spread across 18 states/territories and do not appear to be concentrated in any single region of the U.S.⁹ Therefore, in the absence of more data, a reasonable approximation may be that one-quarter of facilities nationwide have groundwater flow characteristics that may not be conducive to groundwater pumping.¹⁰

⁹ TX, LA, AZ, IL, KY, GA, TN, UT, PA, MO, OK, ND, NC, PR, VA, CO, MN, SD.

¹⁰ As explained in Section 5, the EPA did not calculate cost and pollutant loadings for these plants.

Table 4-3. Summary of Groundwater Pumping Rate Estimates

Parameter	Landfill Groundwater Pumping Systems	Surface Impoundment Groundwater Pumping Systems
Number of Units Included in Analysis	43	90
Average Total Flow Rate (gpm)	150	793
Minimum Total Flow Rate (gpm)	5.05	6.66
10th Percentile (gpm)	11.4	16.4
25th Percentile (gpm)	23.5	31.4
Median Total Flow Rate (gpm)	56.1	148
75th Percentile (gpm)	138.6	494
90th Percentile (gpm)	331	2,170
Maximum Total Flow Rate (gpm)	1,400	8,950

Sources: (U.S. EPA, 2024a; ERG, 2024b)

For the remaining surface impoundments and landfills without sufficient public data to estimate site-specific groundwater pumping rates at the time of the analysis, the EPA applied the median pumping rate estimates shown in Table 4-3 (56.1 gpm for landfills, 148 gpm for surface impoundments).

5. Regulatory Options and Bounding Analysis Considered for the 2026 Proposed ELG

The remainder of this document discusses the compliance costs, pollutant loadings, and NWQEI associated with the EPA’s proposed regulatory options. The EPA defines two types of unmanaged CRL for these analyses, specifically for discharges of unmanaged CRL to a WOTUS that: (1) leached from a landfill or impoundment into the subsurface and mixed with groundwater before being captured and pumped to the surface for discharge directly (i.e., discharges of pumped unmanaged CRL) and (2) are the functional equivalent of a direct discharge of unmanaged CRL, as determined by the permitting authority). Table 5-1 presents the technology basis associated with the proposed regulatory options.

As described in the preamble for the proposed ELG (Section VII), the EPA is not determining that all discharges through groundwater from landfills and surface impoundments in this analysis are the functional equivalent of a direct discharge from a point source to a WOTUS. Rather, the EPA is establishing limitations that apply to any discharge of this kind that a permitting authority, plant owner or plant operator determines to be the functional equivalent of a direct discharge from a point source to a WOTUS, and thus requires a National Pollutant Discharge Elimination System (NPDES) permit. The threshold standard for what discharges are subject to NPDES permitting is outside the scope of the proposed ELG.

Table 5-1. Technology Basis for EPA’s Proposed Regulatory Options

Regulatory Option	Discharge Pumped Unmanaged CRL	Functionally Equivalent to Direct Discharge of Unmanaged CRL
Regulatory Option 1	CP	BPJ

Table 5-1. Technology Basis for EPA’s Proposed Regulatory Options

Regulatory Option	Discharge Pumped Unmanaged CRL	Functionally Equivalent to Direct Discharge of Unmanaged CRL
Regulatory Option 2 ^b	CP	Pumping + CP
Regulatory Option 3	SDE	Pumping + SDE

Abbreviations: BPJ (Best professional judgment); CP (Chemical precipitation); CRL (Combustion residual leachate); SDE (spray dray evaporator)

a – The EPA assumed facilities that have discharge unmanaged CRL mixed with groundwater will already have pumping infrastructure installed.

b – Regulatory Option 2 is equivalent to the technology basis for unmanaged CRL in the Final 2024 Steam Electric Rule (i.e., baseline).

5.1 Bounding Analysis for the Proposed ELG

For the proposed ELG, the EPA estimated a lower and upper bound population of plants to evaluate the potential compliance costs, pollutant loadings, and NWQEI. This bounding analysis builds on the EPA’s analysis for the 2024 ELG (U.S. EPA, 2024a). For the bounding analysis, the EPA considered factors that may indicate which plants have waste management units that generate unmanaged CRL. The EPA is not making a determination about whether or not a single waste management unit meets the definition of unmanaged CRL; rather, the EPA used reasonable assumptions to estimate a range of costs, pollutant loadings, and NWQEI associated with the proposed ELG.

The EPA excluded plants where all EGUs ceased coal combustion as of December 31, 2025. The EPA did not exclude plants with reported plans to retire or transition to other fuel sources at a future date. See the preamble for further discussion about the uncertainty of planned retirements in the steam electric generating industry due to increasing energy demands in the United States (Section VI.4). The EPA also excluded plants with an average groundwater well pumping rate less than 0.5 gpm as discussed in section 4.2. The EPA assumed that each landfill and surface impoundment would have a separate treatment system except for 28 cases where multiple surface impoundments were located in close proximity to each other at the same plant.

The EPA assumes that waste management units are more likely to generate unmanaged CRL if they have documented groundwater exceedances based on groundwater monitoring reported in the CCR database. Table 5-2 presents the number of waste management units identified as potentially discharging unmanaged CRL and undergoing corrective action for groundwater exceedances based on the site’s most recent groundwater monitoring reported in the CCR database as of 2021 (U.S. EPA, 2022).

Table 5-2. Waste Management Units Used to Determine Lower and Upper Bound Populations

Type of Waste Management Unit	Total Unlined and Not Clean Closed	Total Excluding Flows < 0.5 gpm	Total Excluding Retirements ^a	Remaining Undergoing Corrective Action
Landfills	105	93	53	22
Surface Impoundments	203 ^b	197	118	69

a - The EPA regularly tracks which plants have indicated plans to retire or permanently cease combustion of coal for the purposes of updating plant population. This table is in reference to the exclusion of plants that have indicated retirement before December 31, 2025.

b - As discussed in Section 4.1, the EPA assumed that some surface impoundments in close proximity to each other would share a groundwater pumping system. The counts presented here treat these grouped surface impoundments as a single unit.

5.1.1 Lower Bound Population

For the lower bound estimation of waste management units that may be determined to generate unmanaged CRL, the EPA included plants with waste management units that met the following criteria: 1) not composite-lined, 2) not clean closed, and 3) undergoing corrective action for groundwater exceedances based on the site’s most recent groundwater monitoring reported in the CCR database. Waste management units undergoing corrective action may be an indication that the units are actively leaking and more likely to be discharging unmanaged CRL; inclusion of this criterion creates a more targeted population. The EPA identified a total of 63 plants with waste management units that fit these criteria.

Seven of the 63 plants operate waste management units undergoing corrective action where the selected remedy is pump and treat or groundwater extraction. The EPA assumes discharges from these 16 waste management units (three landfills and 13 surface impoundments) meet the EPA’s definition for pumped unmanaged CRL (*discharges of CRL that has leached from a waste management unit into the subsurface and mixed with groundwater before being captured and pumped to the surface for discharge directly to a WOTUS*). The EPA assumes that these plants have already assessed all waste management units at the plant to determine whether they require corrective actions. Therefore, only these 16 waste management units are included in the lower bound population for these seven plants.

For the remaining 54 plants, the EPA included all waste management units that meet the above criteria (not composite-lined, not clean closed, undergoing corrective action). As a result, 91 total waste management units were included in the lower bound population.

5.1.2 Upper Bound Population

For the upper bound estimation of waste management units that may be determined to discharge unmanaged CRL, the EPA identified plants with at least one waste management unit that met the following criteria: 1) not composite-lined and 2) not clean closed. Unlike the lower bound population, the EPA did not limit the scope of waste management units that were undergoing corrective action for groundwater exceedances. Because all waste management units that are not composite lined and not clean closed have the potential to be discharging unmanaged CRL, regardless of corrective action, exclusion of this criterion is reasonable for the upper bound population. Further, the EPA included all waste management units associated with these plants, regardless of the liner status or closure method, in

the upper bound population. For the purpose of the upper bound, the EPA assumed that if one waste management unit is unlined or not clean closed, other units at the plant may have the potential to leak unmanaged CRL. The EPA identified a total of 111 plants with waste management units that fit these criteria.

As stated above, the EPA identified seven plants with operating a pump and treat or groundwater extraction corrective action remedy. The EPA assumes that these seven plants have already assessed all waste management units at the plant to determine whether they require corrective actions. Therefore, only the 16 waste management units (three landfills and 13 surface impoundments) identified above are included in the upper bound population for these plants.

For the remaining 104 plants, the EPA included all 279 waste management units in the upper bound population. In total, 295 waste management units were costed in the upper bound estimation at 111 plants.

5.1.3 Summary of Lower and Upper Bounds

Table 5-3 presents the number of waste management units and plants included in the lower and upper bound populations for the rulemaking estimates. *Unmanaged CRL Units in Bounded Engineering Analyses – DCN SE12134* contains the full list of the waste management units included in the upper and lower bounds for rulemaking analyses and their calculated or assigned flowrates (ERG, 2026a).

Table 5-3. Population of Plants and Waste Management Units in EPA’s Unmanaged CRL Bounded Engineering Analyses

Type of Waste Management Unit	Lower Bound (63 Plants)	Upper Bound (111 Plants)
Landfills with discharges of pumped unmanaged CRL	3	3
Surface Impoundments with discharges of pumped unmanaged CRL	13	13
Landfills with unmanaged CRL that is a potential functional equivalent of a direct discharge	19	98
Surface Impoundments with unmanaged CRL that is a potential functional equivalent of a direct discharge	56	181
Total Waste Management Units	91	295

Table 5-4 combines the information from Table 5-1 and Table 5-3 and presents an overview of the technology basis and number of plants included under each proposed regulatory option. The EPA used these technologies to estimate the option level compliance costs, pollutant loadings, and NWQEI. The EPA assumes that the seven plants with discharges of pumped unmanaged CRL will already have pump infrastructure installed and will therefore not incur additional costs or NWQEI for pumping. Additionally, the EPA did not estimate compliance costs, pollutant loading reductions, or NWQEI associated with the

proposed Option 1 for BPJ technology installed by plants with unmanaged CRL determined the functional equivalent of a direct discharge by the permitting authority (*i.e.*, the EPA set these values equal to zero for the Option 1 totals). Option 1 is based off site-specific BPJ analyses conducted by permit writers, and plants may have very different sets of requirements that impact compliance costs, pollutant loading reductions, or NWQELs. As a result, the EPA cannot feasibly predict these factors for Option 1. Therefore, the lower and upper bound estimates for compliance costs, pollutant loadings reductions, and NWQEI for under Option 1 are equivalent.

Option 2 is equal to the final 2024 ELG for unmanaged CRL (*i.e.*, the baseline); the EPA applied the 2024 ELG technology basis to the updated waste management unit population. Incremental changes from the baseline for Option 2 are therefore equal to zero.

Table 5-4. Plant Count and Technology Basis for the Proposed Regulatory Options

Count of Plants			Basis for Regulatory Option		
			Option 1	Option 2 (Baseline)	Option 3
Lower Bound	Discharges of pumped unmanaged CRL	7	CP	CP	SDE
	Functional equivalent of a direct discharge of unmanaged CRL	56	BPJ	CP + Pumping	SDE + Pumping
Upper Bound	Discharges of pumped unmanaged CRL	7	CP	CP	SDE
	Functional equivalent of a direct discharge of unmanaged CRL	104	BPJ	CP + Pumping	SDE + Pumping

Abbreviations: BPJ (Best professional judgment); CP (Chemical precipitation).

5.2 Updates to the Bounding Analysis from the 2024 ELG

The EPA defined a more comprehensive universe of plants that may be discharging unmanaged CRL in its upper bound and lower bound estimation than was considered for the 2024 Final ELG. Previously, the EPA considered an upper bound estimation of three different scenarios. These three scenarios considered plants that (1) have waste management units that are not composite lined, (2) not clean closed, or (3) reported undergoing corrective action to meaningfully represent possible discharges of unmanaged CRL. These three scenarios differ from each other in terms of the number of waste management units per plant and the number of treatment systems per plant that were evaluated for compliance costs. The number of plants between these three upper bound scenarios ranged from 61 to 113. For its lower bound estimation in 2024, the EPA first estimated the percentage of plants and waste management units undergoing corrective action with selected remedies that include pump and treat or other groundwater extraction and collection methods. The EPA then multiplied this percentage to the costs estimated in the upper bound scenarios to calculate new costs in the lower bound scenarios.

The EPA is proposing that the methodology previously applied for the lower bound in the 2024 ELG was inappropriate. Previously, the EPA applied a percentage based on the proportion of plants or waste management units with corrective action with selected remedies specifying pumping or extracting groundwater. This estimation could be appropriate for estimating the number of plants with discharges of

pumped unmanaged CRL, but may exclude the plants with a functional equivalent of a direct discharge of unmanaged CRL. The EPA expects that by incorporating this percentage and focusing on plants that may require groundwater extraction or pump and treat, the EPA underestimated costs for treating unmanaged CRL in the lower bound estimation during the 2024 ELG. In this proposed ELG, the EPA considers the inclusion of plants with a functional equivalent of a direct discharge in the lower bound estimate to be necessary for costing a model BAT technology.

Additionally, the EPA has refined its analysis relative to 2024 by having a more consistent universe of plants between the proposed regulatory options and treatment technologies. Previously in the 2024 ELG, the EPA calculated costs associated with chemical precipitation of unmanaged CRL for 61 to 113 plants; however, when conducting similar analyses for spray dry evaporators, the EPA calculated total treatment costs associated with 181 plants. This difference in plant population led to inconsistent comparisons between different treatment technology options for unmanaged CRL and potentially overestimated costs associated with spray dry evaporator technology relative to chemical precipitation (U.S. EPA, 2024a).

The EPA does not expect that all plants within the revised upper and lower bound universe will have discharges of unmanaged CRL, and the EPA acknowledges the number of plants and waste management units included within the bounding analysis may be an overestimation. However, because the EPA does not have data to determine which plants are discharging unmanaged CRL, the EPA is proposing to conduct a bounding analysis based on a worst-case-scenario costing analysis, which is appropriate for the purpose of the rulemaking analyses, by assuming that all plants with waste management units that could potentially be discharging unmanaged CRL are doing so and are costed for capture and treatment of unmanaged CRL¹¹.

6. Estimated Compliance Costs

The EPA estimated bounded compliance costs for landfills and surface impoundments to install the technology basis for each regulatory option discussed in the preamble. The compliance costs include capital costs to install the technology and annual operation & maintenance (O&M) costs.

6.1 Treatment Cost Calculations

The EPA estimated the cost to implement the technologies that make up the three regulatory options evaluated in the 2026 proposed ELG. These treatment technologies include chemical precipitation (CP) wastewater treatment and spray dryer evaporator (SDE) wastewater treatment. The EPA additionally estimated the cost to install and operate groundwater pumping wells that would be necessary prior to sending the unmanaged CRL to CP or SDE treatment.

¹¹ In 2024, the EPA costed 61 to 113 plants, while in this (2026) updated analysis, the EPA is costing 63 to 111 plants. The EPA considers this the worst-case scenario for costing analysis because within the lower and upper bounds, all waste management units that could potentially be discharging unmanaged CRL are, in fact, discharging unmanaged CRL. All waste management units are subsequently assigned costs for capture and treatment of unmanaged CRL, which is likely an overestimation because not all waste management units are expected to have a functional equivalent of a discharge.

6.1.1 Chemical Precipitation and Spray Dray Evaporator Costs

The EPA estimated the costs for plants to install and operate CP and SDE treatment using the cost equations presented in Table 6-1. The EPA used cost equations and assumptions from Section 5.3 of the *Technical Development Document for Final Supplemental Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category* (2024 Final Rule TDD) (U.S. EPA, 2024).

Table 6-1. Industry-level Groundwater from Unmanaged CRL Wastewater Technology Option Cost Curves

Technology Option	Transportation/ Disposal	Capital Cost Curve (2023\$)	O&M Cost Curve (2023\$/yr)
CP	On-site	$51.31 \times \dot{Q}_{Total} \text{ (gpd)} + 10,334,835$	$5.94 \times \dot{Q}_{Total} \text{ (gpd)} + 337,016$
CP	Off-site	$50.40 \times \dot{Q}_{Total} \text{ (gpd)} + 10,906,368$	$8.11 \times \dot{Q}_{Total} \text{ (gpd)} + 321,529$
SDE	On-site	<i>Up to 150 gpm:</i> $128 \times \dot{Q}_{Total} \text{ (gpd)} + 14,717,560$	<i>Up to 150 gpm:</i> $12.1 \times \dot{Q}_{Total} \text{ (gpd)} + 144,207$
		<i>Between 150 and 1,000 gpm:</i> $77.2 \times \dot{Q}_{Total} \text{ (gpd)} + 18,411,535$	<i>Between 150 and 1,000 gpm:</i> $10.2 \times \dot{Q}_{Total} \text{ (gpd)} + 843,692$
		<i>Greater than 1,000 gpm^a:</i> $n \times (77.2 \times \dot{Q}_{Total} \text{ (gpd)} / n + 18,411,535)$	<i>Greater than 1,000 gpm^a:</i> $n \times (10.2 \times \dot{Q}_{Total} \text{ (gpd)} / n + 843,692)$
SDE	Off-site	<i>Up to 150 gpm:</i> $124 \times \dot{Q}_{Total} \text{ (gpd)} + 14,717,560$	<i>Up to 150 gpm:</i> $18.1 \times \dot{Q}_{Total} \text{ (gpd)} + 144,207$
		<i>Between 150 and 1,000 gpm:</i> $69.4 \times \dot{Q}_{Total} \text{ (gpd)} + 18,462,172$	<i>Between 150 and 1,000 gpm:</i> $19.5 \times \dot{Q}_{Total} \text{ (gpd)} + 844,091$
		<i>Greater than 1,000 gpm^a:</i> $n \times (69.4 \times \dot{Q}_{Total} \text{ (gpd)} / n + 18,462,172)$	<i>Greater than 1,000 gpm^a:</i> $n \times (19.5 \times \dot{Q}_{Total} \text{ (gpd)} / n + 844,091)$

a – Where *n* in this equation is equal to the minimum number of spray dryer evaporation units that would be required so the capacity of no individual unit exceeds 1,000 gpm.

The EPA scaled the cost estimates to 2024\$ using Equation [7] and the RS Means Historical Cost Indexes (RS Means, 2026).

$$Cost (2024\$) = Cost (2023\$) \times \left(\frac{2024 \text{ Index Value}}{2023 \text{ Index Value}} \right) \quad [7]$$

The CP system includes an in-line mercury analyzer. This process control mechanism has an expected life of six years. To estimate the recurring cost of replacing the mercury analyzer every six years, the EPA used costs originally obtained for the 2015 ELG and adjusted them to 2024 dollars. The recurring cost was estimated at \$145,342 (2024\$) per unit.

6.1.2 Groundwater Pumping Costs

The EPA also estimated groundwater pumping and well costs for landfills and surface impoundments that are not already under corrective action with pump and treat or groundwater extraction as the selected remedy. The EPA assumes that facilities with units undergoing corrective action using pump and treat are already incurring the cost of pumping and would not incur additional pumping costs from the proposed ELG. The EPA estimated the capital costs associated with pumping unmanaged CRL using Equation [8] below.

$$\text{Pumping Capital Cost (\$)} = (30,000 \left(\frac{\$}{\text{well}}\right) \times n_{\text{well}} + 160 \left(\frac{\$}{\text{ft}}\right) \times y(\text{ft})) \times 1.3 \quad [8]$$

Where:

- n_{well} = Total estimated number of wells
- y = Conveyance pipe length required in feet, estimated as the cross-sectional width (w) + 1,000 ft
- 1.3 = 30% engineering contingency factor

The cost per well includes drilling, well casing, well pump and motor, and basic electrical set up. The annual operational and maintenance cost of pumping at the waste management units consists of energy costs associated with pumping and annual maintenance associated with the well units themselves. The EPA first estimated the well pump power required for the estimated flow rate using Equation [9].

$$\text{Well Pump Power (hp)} = \frac{\dot{Q}_{\text{Total}} \times TDH}{3960 \times \eta} \quad [9]$$

where:

- Well Pump Power = Well pump power in horsepower (hp)
- \dot{Q}_{Total} = Total pumping rate in gallons per minute (gpm)
- TDH = Well pump total dynamic head, estimated at 120 ft
- η = Well pump efficiency, estimated at 63%
- 3,960 = Conversion factor

The EPA assumed a minimum well pump power of 0.5 hp. The well pump power is used to estimate the energy required to power the well pumps, as shown in Equation [10].

$$\begin{aligned}
 \text{Well Energy Cost} \left(\frac{\$}{\text{year}} \right) & \\
 &= \text{Well Pump Power} (\text{hp}) \times 0.746 \left(\frac{\text{kW}}{\text{hp}} \right) \times 8670 \left(\frac{\text{hours}}{\text{year}} \right) \times 0.133 \left(\frac{\$}{\text{kWh}} \right)
 \end{aligned}
 \tag{10}$$

The EPA estimated annual O&M costs as the Well Energy Cost plus 5 percent of the total capital costs for annual maintenance, as shown in Equation [11].

$$\begin{aligned}
 \text{Pumping Annual O\&M Cost} (\$) & \\
 &= \text{Well Energy Cost} + 0.05 \times (\text{Pumping Capital Cost})
 \end{aligned}
 \tag{11}$$

6.2 Total Regulatory Option Costs

The lower and upper bound industry-level cost estimates for each regulatory option are shown in Table 6-2. See *Unmanaged CRL Regulatory Options Cost File – DCN SE12097* for the unit level cost estimates for each regulatory option (ERG, 2026b)¹². The units and plants included in each regulatory option are discussed in Section 5. For the relative change in costs compared to baseline and additional details on the EPA’s costs and benefits analysis, see the *Economic Analysis Memorandum for the Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category - Unmanaged Combustion Residual Leachate – DCN SE12127*¹³.

Table 6-2. Upper and Lower Bound Industry-level Costs for Regulatory Options
 (in Millions of Pre-tax 2024 Dollars)

Regulatory Option	Capital Cost (2024\$)		Annual O&M Cost (2024\$/year)		6 Year Cost (2024\$/year)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Regulatory Option 1	735	735	91.2	91.2	2.33	2.33
Regulatory Option 2	3,820	9,070	403	826	13.2	42.9
Regulatory Option 3	6,330	15,600	815	1,520	NA	

Source: (ERG, 2026b)

¹² Option 1 includes seven plants the EPA determined have discharges of pumped unmanaged CRL. Under Option 1, these seven plants have numerical limits for arsenic and mercury based on chemical precipitation. These seven plants are being costed for treatment of unmanaged CRL for these limits, which are reported in Table 6-2. These seven plants are identical in both the lower bound and upper bound estimation in Option 1. The remaining plants (56 plants in the lower bound and 104 plants in the upper bound) are expected to have a functional equivalent of a direct discharge of unmanaged CRL, which would be subject to BPJ requirements that may result in no action by the regulated entities. Thus, costs of BPJ for these remaining plants are not included in the analysis.

¹³ The cost analysis reflects the timing and frequency of costs in the economic analysis. For example, some technologies, such as an in-line mercury analyzer for chemical precipitation systems, have an expected life of 6 years, and thus costs for replacements occurring every 6 years are modeled. For the analysis of social costs, the EPA models these costs as incurred 6-years after the technology installation year for each plant, and every 6 years thereafter within the period of analysis. For the private cost analysis, the EPA annualizes the costs over 6 years and adds this value to the annual O&M and to the annualized capital costs (which are annualized over 20 years), to obtain the total annualized compliance costs. The total 6-year costs represent 3 to 5 percent of total annual O&M costs depending on the option and scenario. These costs are usually small relative to the annual O&M and annualized capital costs.

6.3 Updates to the Costing Methodology from the 2024 Final ELG

The EPA received petitions received after the 2024 ELG effective date that assert, amongst other things, that the EPA's cost methodology was flawed (EEI, 2024b, 2024a; UWAG, 2025). Petitioners from environmental groups commented that the EPA did not accurately represent the costs of different treatment technologies and used an inconsistent population of plants that would incur costs when comparing application of chemical precipitation and zero-discharge technologies. Petitioners from industry further commented that the EPA underestimated costs for chemical precipitation of unmanaged CRL. The petitions assert that, because of these costing issues, the costs of the BAT requirements were not properly considered. After additional review of the 2024 ELG methodology for unmanaged CRL, the EPA has revised its methodology for the proposed ELG to conduct a more thorough and appropriate cost analysis that encompasses all relevant aspects associated with treatment of functional equivalent of a direct discharge of unmanaged CRL. Specifically, the EPA adjusted its analysis by (1) including cost estimations associated with pumping unmanaged CRL and (2) revising the population of waste management units in the EPA's bounding analysis to be more comprehensive as discussed in section 5.2.

In the 2024 ELG, for purposes of estimating the 2024 ELG compliance costs and pollutant loadings, the EPA assumed that the leachate-laden groundwater (*i.e.*, the mixture of unmanaged CRL with groundwater) would be subject to further treatment. The EPA assumed that leachate-laden groundwater would be pumped from the ground prior to treatment by chemical precipitation or spray dry evaporation. Once the EPA estimated the flow rates of leachate-laden groundwater as outlined in Section 4, the EPA then used these flow rates to estimate costs of treatment for each option. The costing methodology for chemical precipitation, spray dry evaporators, and thermal evaporators are described in Section 5.3 of the *Technical Development Document for Final Supplemental Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category* (U.S. EPA, 2024c).

For the proposed ELG, the EPA has revised the 2024 analysis for pumping unmanaged CRL. Specifically, the cost analysis has been revised to include pumping equipment, pumping costs, and pumping well installation based on the estimated volume of leachate-laden groundwater. While the EPA estimated the volume of contaminated groundwater that might be pumped for purposes of costing treatment, the pumping costs themselves were not included for the 2024 ELG. The inclusion of the pumping costs reflects what the Agency views as a more complete costing analysis to match the model BAT technology for treatment of functional equivalent of a direct discharge of unmanaged CRL.

The EPA proposes that it is appropriate to include the pumping costs when evaluating the proposed BAT options for functional equivalent of a direct discharge of unmanaged CRL. The EPA evaluated chemical precipitation and spray dry evaporation as treatment technologies, both of which cannot be implemented and are not available without first pumping and capturing the leachate-laden groundwater. The EPA is aware of *in situ* technologies that can limit discharges within the subsurface such as certain permeable/nonpermeable barriers; however, the EPA is not aware of practical and available methodologies to apply chemical precipitation or spray dry evaporation as a treatment technology to a wastestream when it is entirely in the subsurface. Therefore, the Agency is proposing to revise its analysis to include the costs associated with pumping and capturing the wastestream. It is the EPA's view that these costs are appropriate to include to accurately estimate the costs and impacts of the proposed BAT technology basis.

Beyond the modeling conducted for today's proposal, the EPA is aware of at least one plant that currently uses dozens of wells to push large volumes of water into the aquifer, and several other wells situated to pump contaminated groundwater to the surface (U.S. EPA, 2026a). As another example, a power plant is located in the coastal plains with a shallow aquifer that experiences changes in the direction of flows, and it is plausible in the Agency's view that the EPA's pumping costs would essentially be incurred twice (*i.e.*, once at each extreme edge of the plant's most peripheral waste management units) to ensure the leachate-laden groundwater has been collected. The EPA does not know how prevalent similar issues may exist at other plants. The EPA solicits data demonstrating site-specific conditions where pumped volumes would be in considerable excess of those assumed by the EPA in today's proposal, or where an entire aquifer would need to be pumped for treatment.

In both the 2024 ELG and the 2026 proposed ELG for unmanaged CRL, the EPA modeled groundwater pump and capture to meaningfully represent treatment of unmanaged CRL. The EPA made reasonable assumptions based on site characteristics (hydraulic conductivities, aquifer widths, etc.) to capture a large portion of discharged pollutants associated with unmanaged CRL. The EPA does not have information on what volume is necessary to fully capture the entirety of the pollutants associated with unmanaged CRL, which may constitute a functional equivalent of a direct discharge. Where the permitting authority has determined the unmanaged CRL constitutes a functional equivalent of a direct discharge to waters of the United States through groundwater, the EPA expects in the majority of cases the full body of groundwater that has mixed with unmanaged leachate could not reasonably be pumped out and treated. In the case of pump and capture per a plant's Corrective Action Plan, the 2015 CCR rule expects the primary plume of contaminated groundwater would be collected. The EPA does not have the data to demonstrate that, after a sufficient volume of groundwater has been captured, there would no longer be a functional equivalent of a direct discharge of unmanaged CRL left to treat. The estimates of the volume of groundwater that will require pumping may not be high enough to fully capture the pollutants present in CRL that is mixed with the groundwater depending on the conditions in the subsurface. Moreover, the 2024 ELGs require that a functional equivalent of a direct discharge remaining after pump and capture operations would still be subject to the numeric limits for unmanaged CRL, and the EPA does not have data to demonstrate that any remaining functional equivalent of a direct discharge of unmanaged CRL would meet these numeric limits as promulgated in the 2024 ELG. As a result, the EPA's revised costing methodology, though it is refined relative to the 2024 ELG, may still underestimate costs associated with treating the functional equivalent of a direct discharge of unmanaged CRL. See preamble for further discussion.

7. Pollutant Loadings Estimates

As described in Section 6 of the 2024 Final Rule TDD, pollutant loading and removal estimates for unmanaged CRL build on the calculations used to estimate CRL loadings and removals for the 2015 ELG. The EPA transferred the untreated and chemical precipitation treated average pollutant concentrations for total suspended solids (TSS) and total dissolved solids (TDS) from the CRL collection system pollutant loadings analysis. These concentrations are presented in Table 7-1.

Table 7-1. Average Untreated and Chemical Precipitation-Treated Pollutant Concentrations Used in Loadings Analysis for Unmanaged CRL

Pollutant	Average Untreated Concentration (µg/L)	Average Chemical Precipitation-Treated Concentration (µg/L)
Total Suspended Solids (TSS)	33,900	8,590
Total Dissolved Solids (TDS)	3,570,000	3,500,000

Abbreviations: µg/L (micrograms per liter)

Source: (ERG, 2023b)

The EPA collected 2025 groundwater monitoring data from waste management units likely discharging unmanaged CRL and determined that the CRL collection system pollutant concentrations in Table 7-1 are an appropriate transfer to unmanaged CRL for the purpose of estimate loadings (ERG, 2026c). The untreated average pollutant concentrations represent current conditions at each landfill or surface impoundment as there is no existing treatment in place. For the SDE treatment option (Regulatory Option 3), the EPA assumed that the pollutant loadings would be reduced to zero because this technology would facilitate zero discharge.

The EPA calculated landfill- and impoundment-level pollutant loadings and removals (both TSS and TDS) for the waste management units included in the lower and upper bound populations described in Section 5. Pollutant loadings are calculated using the following equation:

$$\begin{aligned}
 \text{Pollutant Loading} \left(\frac{\text{lb}}{\text{year}} \right) & & [12] \\
 &= \text{Flow rate} \times \text{Discharge Days} \times \text{Conc}_{\text{pollutant}} \times \left(\frac{2.20462 \text{ lb}}{109 \mu\text{g}} \right) \times \left(\frac{1,000 \text{ L}}{264.17 \text{ gallons}} \right)
 \end{aligned}$$

Where:

Flow rate = Reported flow rate of the wastestream being discharged, in gallons per day.

Discharge days = Number of days per year the wastestream is discharged.

Conc_{pollutant} = Concentration of a specific pollutant in the wastestream, in micrograms per liter (µg/L).

The resulting industry-level loadings and removals for the three regulatory options are given in Table 7-2¹⁴. See the EPA's *Unmanaged CRL Regulatory Option Loads File – DCN SE12099* for the unit-level pollutant loading estimates for each regulatory option (ERG, 2026d).

¹⁴ Option 1 captures the pollutant loadings and removals that are associated with the seven plants that were identified as having discharges of pumped unmanaged CRL, which are subject to numerical limitations for mercury and arsenic based on chemical precipitation. The remaining 56 to 104 plants in Option 1 are subject to BPJ-based limitations, and the EPA is not able to quantify pollutant removals associated with these plants. This is different from Option 2 (the baseline), where all plants are subject to numerical limitations for mercury and arsenic based on chemical precipitation.

Table 7-2. Estimated Lower and Upper Bound Industry-Level Pollutant Loadings and Removals for Unmanaged CRL by Regulatory Option

Regulatory Option	Estimated Total Industry Loadings (Million lbs/yr)		Estimated Total Industry Removals (Million lbs/yr)		Incremental Change in Pollutant Reductions from Baseline ^a (Million lbs/yr)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Regulatory Option 1 ^b	597	1,220	3.41	3.41	-12.9	-29.8
Regulatory Option 2	584	1,190	16.3	33.2	0	0
Regulatory Option 3	0	0	600	1,220	+584	+1,190

Abbreviations: lbs/yr (pounds per year)

a – The baseline is defined as equal to the final 2024 ELG and is equivalent to Option 2.

b – Pollutant loadings and removals are from seven plants with discharges of pumped unmanaged CRL.

Source: (ERG, 2026d)

8. Non-Water Quality Environmental Impacts

The process of eliminating or reducing one form of pollution has the potential to aggravate other environmental problems, an effect frequently referred to as cross-media impacts. Under sections 304(b) and 306 of the Clean Water Act, the EPA is required to consider NWQEI in developing ELGs. Accordingly, the EPA estimated NWQEI on a plant-specific basis for each of the technologies and activities that make up the three regulatory options considered relative to baseline conditions. These technologies and activities include chemical precipitation, spray dryer evaporators, and groundwater pumping.

As discussed in section 5, the EPA assumes that facilities with units already undergoing corrective action using pump and treat or groundwater extraction would not cause additional NWQEI from pumping due to the proposed ELG. The EPA did not calculate NWQEI associated with technologies selected for BPJ limitations.

The EPA used a methodology consistent with the 2024 ELG to estimate the NWQEI associated with the proposed ELG. The EPA’s memorandum *Methodology for Estimating NWQEI for the 2024 Final Steam Electric ELGs – DCN SE11782* presents the background and development of the NWQEI methodology (U.S. EPA, 2024d).

8.1 Energy Usage

The EPA estimated the plant-specific change in annual energy consumption associated with chemical precipitation, spray dry evaporators, and groundwater pumping as outlined below.

8.1.1 Chemical Precipitation

For all plants expected to install CP to comply with the proposed ELG, the EPA applied the methodology for CP power and energy requirements that was used in the 2024 ELG. The EPA used Equation [13] to calculate the annual energy consumption for chemical precipitation.

$$Energy_{CP} = (3 \times 10^{-7} \times Flow_{uCRL} + 0.0145) \times 24 \left(\frac{hours}{day}\right) \times 365 \left(\frac{days}{year}\right) \quad [13]$$

Where:

- $Energy_{CP}$ = Estimated annual energy consumption to operate CP system (MWh/yr).
- 3×10^{-7} = Energy requirement per unit flow rate (gpd) of unmanaged CRL wastewater (MWh/gpd).
- $Flow_{uCRL}$ = Estimated unmanaged CRL flow rate of unit (gpd).

8.1.2 Spray Dry Evaporators

The EPA estimated the energy usage associated with SDEs for unmanaged CRL treatment using the same energy consumption curve used in the 2024 ELG. The EPA used Equation [14] to calculate the annual SDE energy consumption.

$$Energy_{SDE} = 0.0404 \times Flow_{uCRL}(gpd) + 13.2 \quad [14]$$

Where:

- $Energy_{SDE}$ = Estimated annual energy consumption to operate SDE system (MWh/yr).
- 0.0404 = Energy requirement per unit flow rate (gpd) of unmanaged CRL wastewater (MWh/gpd).
- $Flow_{uCRL}$ = Estimated unmanaged CRL flow rate of unit (gpd).

8.1.3 Groundwater Pumping

The EPA calculated the annual energy consumption for groundwater pumping using the well pump power estimated in Section 5.2.

$$\begin{aligned} & \text{Well Pumping Annual Energy Consumption (MWh)} \\ & = \text{Well Pump Power (hp)} \times 0.746 \left(\frac{kW}{hp}\right) \times 0.001 \left(\frac{MW}{kW}\right) \times 8670 \left(\frac{hours}{year}\right) \quad [15] \end{aligned}$$

8.1.4 Energy Usage

Table 8-1 presents the annual energy consumption associated with operating the treatment basis for the regulatory options considered in the proposed ELG.

Table 8-1. Energy Consumption (MWh/year) by Regulatory Option – Lower and Upper Bounds

Regulatory Option	Lower Bound	Upper Bound
Regulatory Option 1	32,100	32,100
Regulatory Option 2	165,000	351,000

Table 8-1. Energy Consumption (MWh/year) by Regulatory Option – Lower and Upper Bounds

Regulatory Option	Lower Bound	Upper Bound
Regulatory Option 3	2,220,000	4,510,000

Source: (ERG, 2026e)

Abbreviations: megawatt-hour (MWh).

8.2 Solid Waste Generation

The EPA determined the unmanaged CRL solids generated from CP treatment by multiplying a flow-normalized dewatered sludge generation rate (expressed in tons per day of sludge per gallon per minute unmanaged CRL flow) by the waste management unit’s unmanaged CRL flow rate¹⁵. The EPA determined the CRL solids generated from SDE by multiplying an aggregate solids generation rate by the unit-specific unmanaged CRL flowrate (expressed in gpd). The solids generation rates are considered confidential business information (CBI) and are therefore not presented in this memo. The solid waste production associated with the regulatory options is shown in Table 8-2.

Table 8-2. Industry-Level Solid Waste (tons/year) by Regulatory Option – Lower and Upper Bounds

Regulatory Option	Lower Bound	Upper Bound
Regulatory Option 1	347,000	347,000
Regulatory Option 2	1,660,000	3,380,000
Regulatory Option 3	5,990,000	12,200,000

Source: (ERG, 2026e)

8.3 Fuel Consumption

The EPA estimated the fuel consumption associated with transporting the solid waste generated from the technology options considered as part of the 2026 proposed ELG (e.g., CP and SDE) to on-site or off-site landfills using open dump trucks. The frequency and distance of transport depend on a plant’s operation and configuration. For example, the volume of waste generated per day determines the frequency with which trucks will be travelling to and from the storage sites. The availability of either an on-site or off-site nonhazardous landfill and the distance from the plant to the landfill determine the length of travel time. The EPA used the same equations and assumptions used in the 2024 ELG to estimate fuel consumption per plant (U.S. EPA, 2024d). The EPA used Equation [16] to calculate fuel usage, as gallons of diesel fuel used, associated with the increased transportation.

$$\begin{aligned}
 Fuel_{plant} = & \left[\left((Time_{Loading} + Time_{Unloading}) \times Fuel_{Idling} \right) \right. \\
 & \left. + (Dist_{Transport} \times Fuel_{Transport}) \right] \times N_{trips}
 \end{aligned}
 \tag{16}$$

where:

¹⁵ As explained elsewhere, the EPA has previously determined that coal combustion residuals and related sludge are non-hazardous.

- $Time_{Loading}$ = The estimated time to load an open dump truck with sludge and/or ash per trip. The EPA estimates the loading time to be 0.1667 hours (10 minutes) per trip (hours/trip).
- $Time_{Unloading}$ = The estimated time to unload an open dump truck with sludge and/or ash per trip. The EPA estimates the unloading time to be 0.1667 hours (10 minutes) per trip (hours/trip).
- $Fuel_{Idling}$ = The estimated fuel consumption while the truck is idling (gal/hr). The EPA estimates the idle fuel consumption to be 0.77 gal/hr.
- $Dist_{Transport}$ = The estimated round-trip distance (miles/round trip) to and from the landfill. Distance varies based on plants with on-site versus off-site landfills. For on-site landfills, the EPA estimates a round trip to be 2.6 miles. For off-site landfills, the EPA estimates a round trip to be 40 miles.
- $Fuel_{Transport}$ = The estimated fuel consumption (gal/mile) while the truck is in drive. Consistent with the transportation cost methodology, the EPA estimates the fuel consumption to be 0.153 gal/mile during highway transport and 0.159 gal/mile during local transport.
- N_{trips} = The calculated number of trips for one year (trips/year), based on the amount of solids generated by the treatment in tons per year (see section 8.2) divided by the estimated solids capacity of the truck. The EPA estimates a truck has a solids capacity of 16.11 tons.

The annual fuel consumption associated with operating the treatment basis for the regulatory options are shown in Table 8-3.

Table 8-3. Fuel Usage (Gallons/year) by Regulatory Option – Lower and Upper Bounds

Regulatory Option	Lower Bound	Upper Bound
Regulatory Option 1	109,000	109,000
Regulatory Option 2	295,000	406,000
Regulatory Option 3	1,060,000	1,460,000

Source: (ERG, 2026e)

8.4 Air Emissions

The EPA estimated air emissions for the following two mechanisms for the proposed ELG:

1. Changes in power requirements by steam electric power plants to operate technologies needed to comply with the regulatory options.
2. Changes to transportation-related emissions due to the trucking of treatment solids from CP and SDE to onsite or offsite landfills.

The EPA utilized the same methodologies and assumptions for these calculations as in the 2024 ELG (U.S. EPA, 2024d). As described in Section 8.1, the EPA estimated the energy usage associated with the operation of CP, SDE, and groundwater pumping systems to treat unmanaged CRL. The EPA used these estimates to calculate the total energy requirements associated with operating the treatment basis for the regulatory options considered for the proposed ELG.

The EPA calculated air emissions resulting from the change in power requirements¹⁶ using year-explicit emission factors estimated by the Integrated Planning Model (IPM)¹⁷ for nitric oxide and nitrogen dioxide (NO_x) and sulfur dioxide (SO₂) in 2035. The EPA used IPM emission factors for North American Electric Reliability Corporation (NERC) regions calculated for the 2024 Final Rule to estimate changes in power requirements air emissions for the proposed regulatory options (U.S. EPA, 2024d). Table 8-4 lists the electricity generation emission factors for each air pollutant considered in the NWQEI analysis.

Table 8-4. NERC Emission Factors for Electricity Emissions in 2024

	NO _x (U.S. ton/MWh)	SO ₂ (U.S. ton/MWh)
NERC Emission Factors	0.0005	0.00005

Source: Derived from IPM run parsed output "WebReady EPA723_BC_1j_Iter 2035" (ERG, 2024d).
 Abbreviations: MWh (megawatt-hour); NO_x (nitrogen oxides); SO₂ (sulfur dioxide).

To estimate air emissions associated with operation of transport vehicles, the EPA used the MOVES4.0 model to generate air emission factors for NO_x and SO₂ (U.S. EPA, 2024e). The EPA assumed the transport vehicle would be a 2010 diesel-fueled, long-haul truck operating in 2024. The EPA also used the annual mileage accumulation by vehicle class to develop these factors (ERG, 2024e). Table 8-5 lists the transportation emission factors for each air pollutant considered in the NWQEI analysis.

Table 8-5. MOVES4.0 Emission Rates for Diesel-fueled, Long-haul Trucks Operating in 2024

Roadway Type	NO _x (U.S. ton/mile)	SO ₂ (U.S. ton/mile)
Highway	3.20E-06	5.72E-09
Local	4.04E-06	5.93E-09

Source: (U.S. EPA, 2024e).
 Abbreviations: NO_x (nitrogen oxides); SO₂ (sulfur dioxide).
 Vehicle types: Single and Combination Unit Long-haul Trucks, together. Road types: Restricted Access Roads are "Highway" and Unrestricted Access are "Local."

Using the transportation emission rates per mile, the EPA calculated the air emissions associated with the solids transportation for each option considered in the proposed rule using Equation [17].

$$Emission_{pollutant} = EF_{pollutant} \times (Distance_{Transport} \times N_{Trips}) \quad [17]$$

Where:

¹⁶ Auxiliary electricity refers to the electricity required to operate CRL wastewater treatment. Plants may generate this electricity on site or purchase the electricity from alternate sources.

¹⁷ IPM is a comprehensive electricity market optimization model that can evaluate cost and economic impacts within the context of regional and national electricity markets. IPM is used to analyze the projected impact of environmental policies on the U.S. power sector.

- $Emission_{pollutant}$ = Estimated pollutant emissions associated with transportation (U.S. tons/year)
- $EF_{pollutant}$ = The transportation emission factor for each pollutant presented in Table 8-5 (tons/mile).
- $Distance_{Transport}$ = The estimated round-trip distance to/from the landfill. Distance varies based on plants with on-site versus off-site landfills. For on-site landfills, the EPA estimated a round trip to be 2.6 miles. For off-site landfills, the EPA estimated a round trip to be 40 miles.
- N_{Trips} = The calculated number of trips for one year, based on the amount of solids generated by the treatment in tons per year (see Section 8.2) divided by the estimated solids capacity of the truck. The EPA estimates a truck has a solids capacity of 16.11 tons.

The EPA used these estimates to calculate the air emissions for the proposed ELG. Table 8-6 presents the air emissions associated with additional power requirements and transportation for the proposed ELG.

Table 8-6. Industry-Level Air Emissions Associated with Power Requirements and Transportation by Regulatory Option – Lower and Upper Bound

Regulatory Option	NO _x Production (tons/year)		SO ₂ Production (tons/year)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Regulatory Option 1	3.79	3.79	1.61	1.61
Regulatory Option 2	14.0	25.2	8.24	17.6
Regulatory Option 3	132	253	111	226

Source: (ERG, 2026e)

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