ENERGY AND ENVIRONMENT CABINET

Department for Environmental Protection

Division of Waste Management

(New Administrative Regulation)

401 KAR 46:130. Groundwater assessment and corrective action for coal combustion residuals (CCR).

RELATES TO: KRS 224.1, 224.10, 224.50, 224.70, 224.99, Chapter 322, Chapter 322A, 16 U.S.C. 1531, 33 U.S.C. 1251, 42 U.S.C. 82, 40 C.F.R. 257.50-257.106

STATUTORY AUTHORITY: KRS 224.10-100, 224.50-760

NECESSITY, FUNCTION, AND CONFORMITY: KRS 224.10-100(28) authorizes the cabinet to promulgate administrative regulations not inconsistent with the provisions of law administered by the cabinet. KRS 224.50-760(1)(d) authorizes the cabinet to promulgate administrative regulations for the management of special wastes. This administrative regulation establishes the requirements for groundwater assessment monitoring, assessment of corrective measures, selection of remedy, and the implementation of corrective action incident to the disposal of coal combustion residuals (CCR) in CCR units.

Section 1. Groundwater Assessment, Remedy Selection, and Corrective Action. Except as established in this administrative regulation, the groundwater assessment, selection of remedy, and corrective action requirements for a CCR unit shall be as established in C.F.R. 257.95 through 257.98.

(1) The requirements established in 40 C.F.R. 257.96(a) shall be replaced with:

(a) Within 90 days of finding that any constituent listed in Appendix IV in 40 C.F.R. 40.257 above the maximum contaminant level (MCL) as established in 401 KAR 30:031, or significant level exceeding the groundwater protection standard established in 40 C.F.R. 257.95(h), for parameters that have no MCL. For parameters that have no maximum contaminant levels, a significant increase over background shall be determined using a statistical test established in 40 C.F.R. 257.93 or immediately upon detection of a release from a CCR unit, the owner or operator must initiate an assessment of corrective measures to prevent further releases, to remediate any releases and to restore affected area to original conditions. The assessment of corrective measures must be completed within 90 days, unless the owner or operator demonstrates the need for additional time to complete the assessment of corrective measures due to site-specific conditions or circumstances.

(b) The assessment of corrective measures shall be based upon a sitewide conceptual site model performed pursuant to 401 KAR 46:130 which discusses short-term and long-term exposure risks associated with the release and proposed remedies. Short-term risks, including a cost-benefit evaluation of any removal activities, shall consider localized and environmental impacts such as increased road hazards, increased risk of additional releases, and increased emissions.

(c) The owner or operator must obtain a certification from a qualified professional attesting that the demonstration is accurate.

(d) The 90-day deadline to complete the assessment of corrective measures may be extended for no longer than 60 days.

(e) The owner or operator shall submit the assessment required by this section to the Director, Division of Waste Management for review and approval.

(f) Upon approval by the cabinet, the owner or operator must also include the demonstration in the annual groundwater monitoring and corrective action report required by 40 C.F.R. 257.90(e).

Section 2. Karst Terrain.

(1) Karst terrain requirements shall be as established in 401 KAR 46:110, Section 9.

Section 3. Groundwater Assessment Monitoring.

(1) Except as provided in this section, the requirements for a groundwater assessment monitoring program shall be as established in 40 C.F.R. 257.95(g).

(2) To implement the requirements in 40 C.F.R. 257.95(g)(1), the following procedures are established.

(a) CCR corrective action shall reduce a concentration of Contaminants of Concern (COC) in groundwater to levels below the MCLs established by 401 KAR 8:250, Section 1, ambient background values, or risk-based levels for parameters that lack an MCL.

(b) No later than February 9, 2027, the owner or operator shall submit to the cabinet, CCR Corrective Action Plan. The CCR Groundwater Corrective Action Plan shall include:

1. The methods to be used to abate release of COCs;

2. The methods to be used to prevent further release of COCs;

3. A description of the means used to restore or replace contaminated water supplies;

4. The milestones and total time to complete corrective action as established in subsection (a) of this subsection; and5. A conceptual site model (CSM) as established in paragraph (e) of this subsection.

(c) Upon proposed approval of the Corrective Action Plan by the cabinet, a public notice shall be published as established in 401 KAR 46:120, Section 8.

(d) Corrective action measures shall be initiated and completed within the time period required in the permit.

(e) An owner or operator shall submit a CSM.

1. The CSM shall be scientifically and geologically sufficient to understand the release of the COCs and to enable a comprehensive and conceptual understanding of the impacts, impact boundaries, and fate and transport of the uppermost groundwater aquifer, and underlying hydraulically-connected aquifers.

2. The CSM shall also include:

a. The incorporation of all previous and relevant assessment, investigatory, and characterization work, data, and information related to defining the nature and extent of the COC contamination and impact;

b. A concise executive summary of the CSM report findings and recommendations;

c. To the extent known or reasonably obtained, a site description and history;

d. In accordance with C.F.R. § 257.75 and to the extent known or reasonably obtained, a comprehensive, accurate, and complete discussion regarding the identification, regulatory, operational, and investigational history of the site, and a chronology of events related to all CCR units and CCR Areas of Potential Concern (APC), releases, and potential releases. At a minimum this discussion shall include the elements of C.F.R Part 257.75 (c)(1)(i) through (xiv) and (d)(1)(i) through (xiii).

e. To the extent known or reasonably obtained, a description of the land use status of the site and adjacent properties;

f. A map depicting domestic use well, municipal well or well field, and well head protection area survey within a radius commensurate with the COCs under investigation and their characteristic fate and transport within the specific groundwater regime impacted;

g. A description and analysis of the geologic and hydrogeologic setting relevant to the release;

h. A description, discussion, and analysis of the nature and extent of the mass discharge strength of the source and plume;

i. An assessment of the applicability of the Darcy Flux concept as defined in this administrative regulation or other groundwater velocity and flow concepts, consistent with the specific geologic and hydrogeologic setting;

j. A description, discussion, and analysis of groundwater impacts that references the appropriate maps, figures, tables and appendices regarding the:

(i) COCs;

(ii) Plume source area;

(iii) Plume migration pathway;

(iv) Existing and potential future points of exposure and extraction points;

(v) Plume terminus; and

(vi) COC groundwater impact trends per monitoring point, along a cross-section of the plume's major axis length in the predominant downgradient direction, and across the plume's minor axis width;

k. A description, discussion, and analysis of the nature and extent of impacted surface and subsurface soil, as applicable;

l. A description, discussion, and analysis of the nature and extent of impacted sediment, as applicable;

m. A description, discussion, and analysis of the nature and extent of impacted surface water(s), as applicable;

n. A description, discussion, and analysis of ecological impacts, as applicable;

o. Conclusions and recommendations;

p. Figures, maps, graphs, and tables, including:

(i) Aerial photographs;

(ii) A site survey map;

(iii) A site map of the source;

(iv) Site maps of historic and recent soil sampling locations and data;

(v) Site maps of historic and existing monitoring wells;

(vi) Site maps of historic and recent monitoring wells and data;

(vii) Site maps of historic and recent groundwater potentiometric surface with flow trend direction indicated;

(viii) Site maps indicating groundwater COCs isoconcentration contours;

(ix) A map of the portion of the 7.5-minute United States Geological Survey (USGS) Topographic Map or a map providing equivalent information depicting the location of the site, name of the map, latitude and longitude labels, and a map scale;

(x) A map of the portion of the 7.5-minute USGS Geologic Quadrangle Map, or a map providing equivalent information depicting the location of the site, the name of the map, latitude and longitude labels, a map scale, and a description of the site geology from the geologic quadrangle;

(xi) Geologic and soil cross sections depicted along the major and minor axes of the contaminant plume indicating the plume source, migration pathway, exposure and extraction points, as applicable, and plume terminus, soil and lithological stratigraphy, hydraulically significant geologic features, average depth groundwater elevation, average depth to plume elevation, and other pertinent subsurface features, including underground utilities and preferred pathways;

(xii) A site bedrock contour map, as applicable;

(xiii) Hydrographs for all monitoring wells and alternative groundwater monitoring points;

(xiv) Concentration versus time plots for each monitoring well and alternative groundwater monitoring points for trend analysis;

(xv) Concentration, as average of mass across monitoring wells and alternative groundwater monitoring points along the primary major and minor axes versus time plots for trend analysis;

(xvi) Groundwater elevation data tables for all historic and existing monitoring wells and alternative groundwater monitoring points, which shall at a minimum include all relevant current and historic gauging data for each monitoring well and alternative groundwater monitoring points, all relevant monitoring well and alternative groundwater monitoring point's identification designations, groundwater gauging dates, and identification of any abandoned wells;

(xvii) Groundwater analytical data tables for all historic and existing monitoring wells and alternative groundwater monitoring points, which shall at a minimum include all relevant current and historic analytical data for each monitoring well and alternative groundwater monitoring points, all relevant monitoring well and alternative groundwater monitoring point's identification designations, sample collection dates, analytical results, and identification of any abandoned wells;

(xviii) Soil analytical data tables for all soil samples collected, which shall at a minimum include sample identification numbers, depths sampled, sample collection dates, analytical results, and identification of any excavated sampled areas;

(xix) Current photographs of the site and adjacent sites;

(xx) Copies of all boring logs, logged by a geologist; and

(xxi) Copies of all monitoring well records, including records for abandoned monitoring wells;

q. The owner or operator of any facility regulated under this Section shall obtain a certification statement, signature, and stamp or seal by a qualified Professional Geologist (PG), stating that the CSM complies with the requirements of this administrative regulation, that all geologic and hydrogeologic data, analysis, and interpretations comply with KRS Chapter 322A and has been performed, designed, utilized, and implemented by a PG or a geologist-in-training under the direct supervision and review of a PG to assess and provide for the protectiveness of public health and welfare and the environment to the fullest extent possible;

r. The owner or operator of any facility regulated under this regulation shall obtain a certification from a qualified Professional Engineer (PE) stating that the clause d. of this subparagraph meets the requirements of C.F.R, Part 257.75;

s. The owner or operator of any facility regulated under this section must provide a notarized, dated, and signed certification that all data, site evaluation, and information provided by the owner or operator to the PE and PG consultant, and contained in the PE and PG certified CSM, to the best of their knowledge and understanding, is true, accurate, and complete, with the following statement signed by the owner or operator or an authorized representative:

"I certify under penalty of law that I have personally examined and am familiar with the information submitted in this demonstration and all attached documents, and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.";

t. The Groundwater CCR Plume Geochemical Study and Analysis (GSA) Demonstration established in Section 4 shall be submitted as an appendix to the CSM.

(f)1. For CCR facilities subject to this administrative regulation, the requirements established in 40 C.F.R. 257.90(e) for the groundwater monitoring and corrective action report shall be replaced with the requirement for the owner or operator to submit an annual CCR Corrective Action Update no later than January 31.

2. The CCR Groundwater Corrective Action Update shall include:

a. Any updated information relevant to the requirements in the CSM; and

b. The requirements established by 40 C.F.R. 257.90(e).

Section 4. Groundwater Coal Combustion Residuals (CCR) Plume Geochemical Study and Analysis (GSA) Demonstration.

(1) The party or applicant shall perform and submit a GSA Demonstration Report of the CCR groundwater plume's geochemical conditions and state.

(2) A GSA Demonstration Report is a documented study and analysis performed to demonstrate the geochemical conditions and state of the CCR groundwater plume. The GSA Demonstration Report is an evaluation of geochemical plume conditions and external parameters that may limit or promote the stability or instability of metals mobilization within the groundwater aquifer

(3) The GSA Demonstration Report general provisions and core requirements shall address and at a minimum include the following scientific, geologic, and technical criteria:

(a) Data, analysis, and presentations of the plume status in space (lateral and vertical communication) and time;

1.Expansion;

2. steady-state; or

3. decay.

(b) Data, analysis, and presentations of the geochemical plume status, geochemical parameters and conditions that limit or promote stability or instability for metals mobilization in the groundwater aquifer;

1. pH conditions;

2. Redox conditions;

3. Soil sorption capacity conditions; and

4. Mineral equilibrium conditions.

(c) Data, analysis, and presentations of plume mass discharge rate (Md);

(d) Data, analysis, assessment, and presentations of existing, future likely, and future potential groundwater extraction points mass extraction rate (Me) of existing and future potential and likely groundwater extraction point receptors;

(e) Data, analysis, and designation of Plume magnitude;

(4) The GSA Demonstration Report prepared and submitted for agency review and approval to support a geochemical stability determination shall, at a minimum, include the following technical elements, supporting data, analytical evaluations, and performance metrics necessary to demonstrate and document the geochemical study:

(a) A concise executive summary of the GSA Demonstration Report's findings, conclusions, and recommendations.

(b) An evaluation of Plume Status in Space and Time, including supporting data, statistical analyses, hydrogeologic interpretation, and technical discussion addressing the following:

1. Statistically significant concentration trends for Appendix IV and other applicable Constituents of Concern (COCs) at plume boundary monitoring wells,

2. Testing, data evaluation, and analysis of downgradient groundwater conditions relative to plume expansion, steady-state behavior, or attenuation decay for Appendix IV and other applicable COCs beyond the historical plume footprint,

3. Testing, data and analysis downgradient of the groundwater plume historical footprint, including:

a. In relation to existing groundwater extraction points inducing and influencing the groundwater gradient related to the groundwater CCR plume, and

b. In relation to applicable likely future and potential future Groundwater Extraction Point(s) inducing and influencing related to the groundwater gradient on the groundwater CCR plume.

4. Characterization of upgradient natural background groundwater conditions outside areas exhibiting plume expansion, steady-state conditions, or attenuation for Appendix IV and other applicable Constituents of Concern (COCs) relative to the historical plume footprint; and

5. Demonstration and evaluation of groundwater mass flux and mass discharge for Appendix IV and other applicable COCs to determine whether the groundwater plume is expanding, stable, or decreasing.

(c) An evaluation of geochemical plume conditions and external parameters that may limit or promote the stability or instability of metals mobilization within the groundwater aquifer.

(d) The geochemical evaluation shall include supporting data, testing results, analyses, geochemical interpretation, and technical discussion addressing the following:

1. Identification and evaluation of geochemical conditions demonstrating whether site-specific conditions facilitate, limit, or arrest the mobility of Appendix IV metals and other applicable Constituents of Concern (COCs);

2. Evaluation of whether the mobility or immobility of Appendix IV and other applicable COCs is spatially and temporally stable and persistent on a seasonal and annual basis, or whether such conditions are temporally or spatially variable, uncertain, or demonstrably unstable; and

3. Geochemical testing, data evaluation, analysis, and interpretation including, at a minimum:

a. Identification of the primary source type, including the anthropogenic source matrix and relevant aquifer matrix materials;

b. Seasonal and annual testing, analysis, and evaluation of oxidation–reduction (redox) conditions and trends associated with stability or instability of Appendix IV and other applicable COCs;

c. Seasonal and annual testing, analysis, and evaluation of aerobic and anaerobic redox conditions within the subject aquifer groundwater and their relationship to Appendix IV and other applicable COCs;

d. Seasonal and annual testing, analysis, and evaluation of pH stability, variability, or instability within the subject aquifer groundwater in relation to Appendix IV and other applicable COCs;

e. Testing and analysis of pH conditions, including acidic, neutral, or alkaline conditions, within the subject aquifer groundwater and their relevance to Appendix IV and other applicable COCs;

f. Testing and analysis of soil and aquifer material sorption capacity, including pedololithic soils, anthropogenic fill materials, and aquifer matrix materials, evaluated both laterally and vertically;

g. Demonstration of whether geochemical factors associated with the CCR source are expanding laterally or downgradient within the aquifer system; and

h. Testing, analysis, and modeling evaluating geochemical mineral equilibrium conditions associated with the CCR source and the groundwater aquifer.

4. Geochemical source and groundwater conditions shall utilize the most recent published version of the United States Geologic Survey's (USGS) Ph, Redox Equilibrium (PHREEQC) model to help assess geochemical conditions at the site.

a. PHREEQC is a free public USGS geochemical reaction-transport modeling tool used to evaluate groundwater chemistry, mineral equilibrium, redox conditions, and metal mobility to support interpretations of plume behavior and stability.

b. PHREEQC is a geochemical reaction-transport modeling program used to simulate how water chemistry changes as it interacts with minerals, gases, and surfaces.

5. Analysis and demonstration of whether the first aquifer immediately beneath the upper impacted aquifer is in communication with the upper impacted aquifer, or is impacted by Appendix IV and other applicable COCs spatially, seasonally, or annually from the impacted upper aquifer.

(e) Groundwater Plume Geochemical Spatial Status (Plume Footprint). In order to demonstrate the lateral and downgradient spatial status of the groundwater plume spatial maps and figures to scale shall be prepared and submitted;

1. Prepared and submitted isoconcentration (plane view) time-sequenced plume maps for each Indicator constituent, Appendix IV metal, and other identified applicable COCs using and showing 3 to 5 representative seasonal wet period and dry period events, over 2 to 4 years.

2. Isoconcentration time-sequenced maps shall include at a minimum;

3. Consistent contour intervals,

4. The primary source area,

5. The plume core,

6. The plume's boundaries; background bounds, leading edge, and side lateral bounds,

7. Overlays of the dominant seasonal and annual groundwater flow direction,

8. The location of all sentinel and monitoring wells, and

9, the location of all existing groundwater extraction points.

10. Standard mapping components shall include:

a. Map title,

b. Compass rose or north arrow,

c. Map legend or key,

d. Inset map,

e. Locator map,

f. Map scale,

g. Data frame, and

h. Source(s).

i. Professional Geologist (P.G.) Stamp.

(f) Groundwater Plume Geochemical Vertical Status (Cross Sections). In order to demonstrate the vertical and hydrogeologic vertical communication status of the groundwater plume vertical geologic and groundwater cross-section with scaled vertical exaggeration shall be prepared and submitted.

1. Prepare hydrostratigraphic vertical concentration indicated plume cross sections for each Indicator constituent, Appendix IV metal, and other identified applicable COCs.

2. Hydrostratigraphic vertical concentration indicated plume cross sections shall include:

a. Well/boring identification;

b. Well/boring map location inset;

c. Vertical and horizontal scales;

d. Electrical logs;

e. Screened intervals;

f. Geologic data;

g. Soil type;

h. Stratigraphy;

i. Geologic features;

j. Age of geologic units;

k. Stratigraphic correlations;

l. Static groundwater level;

m. Metals concentrations by depth; and

n. Professional Geologist (P.G.) Stamp.

(g) Groundwater Plume Geochemical Temporal Status (Trend Analysis). In order to demonstrate the temporal status of the groundwater plume trend, analysis for Appendix IV and other applicable COCs shall be prepared and submitted.

1. Temporal stability trend analysis shall use;

a. Mann-Kendall non-parametric statistical determination method test to analyze if trends over time are present. Mann-Kendall determines if the COC trends are increasing, decreasing, stable, and

b. Sen's Slope non-parametric statistical tests to quantify the strength and rate of change over time of identified trend(s). Sen's Slope supports corrective action decisions and risk analysis.

2. Mann-Kendall and Sen's Slope non-parametric statistical tests shall be applied to:

a. Unit boundary wells;

b. Plume boundary wells (up, down, and side gradient);

c. Sentinel wells;

d. Monitoring wells; and

e. Highest concentration plume core wells.

3. Temporal stability trends shall be classified as:

a. Increasing;

b. Decreasing; and

c. No trend (stable).

4. Time-series plots demonstrating concentrations over time shall include:

a. Concentration vs. time for each COC for each well;

b. Overlay of applicable regulatory standards; and

c. Highlight of long-term trends.

(h) Groundwater Plume Mass Discharge Rate Estimates, Analysis, and Demonstration. In order to demonstrate groundwater plume mass discharge status, the plume shall be evaluated system-wide in both space and time to assess plume stability, rather than relying solely on discrete point measurements. The evaluation shall include supporting data, calculations, analysis, and technical interpretation sufficient to characterize plume loading conditions. Plume mass discharge demonstrations shall include, at a minimum, the following:

1. An estimate of the mass discharge rate at the groundwater plume terminus for all CCR Appendix IV Constituents of Concern (COCs) and other applicable COCs that exceed applicable regulatory or risk-based levels.

2. An estimate of the mass discharge rate at the groundwater plume terminus for all CCR Appendix IV and other applicable COCs exceeding their applicable regulatory levels, compared to an estimated mass extraction rate for all existing, likely future, and potential future groundwater extraction points using a baseline concentration of 0.002 parts per million (ppm) (mg/L), corresponding to the MCL for mercury (Hg).

3. An estimate of the daily mass discharge rate at the groundwater plume terminus for all CCR Appendix IV and other applicable COCs exceeding applicable regulatory levels, compared to the estimated daily mass extraction rates for all existing and reasonably foreseeable future groundwater extraction points calculated for each applicable regulatory level. This comparison shall determine whether the daily mass discharge rates at the plume terminus for each CCR Appendix IV and other applicable COC exceedance are greater than, equal to, or less than the estimated daily mass extraction rates for applicable existing, likely future, and potential future groundwater extraction points.

(i) In order to assess the groundwater plume mass discharge and groundwater extraction point mass extraction rates, the owner or operator shall determine:

1. The groundwater plume mass discharge rate (Md) at the plume terminus; and

2. The mass extraction rate (Me) at all applicable:

a. Existing groundwater extraction points,

b. Likely future groundwater extraction points, and

c. Potential future groundwater extraction points.

(j) Methodology.

1. The calculation of mass discharge (Md) and mass extraction (Me) may utilize the standard data tables identified as Tables 1 through 3 of this administrative regulation below:

Table 1. Kentucky Rivers Average Flow Rates as a Groundwater Extraction Point.

Kentucky River	Flow Rate (Cu.Ft./Sec.)	Flow Rate (Gal./Sec.)	Flow Rate (Gal./da.)
Beargrass Creek	103	770	66,570,640
Elkhorn Creek	677	5,064	437,556,534
Tradewater River	1,070	8,004	691,559,072
North Fork KY River	1,099	8,221	710,302,262
Salt River	1,704	12,747	1,101,323,980
Barren River	2,501	18,709	1,616,438,541

Big Sandy River	5,007	37,455	3,236,108,667
Licking River	5,694	42,594	3,680,128,370
South Fork Licking River	275	2,057	177,737,145
Kentucky River	8,924	66,756	5,767,731,924
Green River	14,574	109,021	9,419,422,350
Cumberland River	37,250	278,649	24,075,304,141
Tennessee River	70,575	527,938	45,613,814,490
Ohio	281,500	2,105,766	181,938,204,450
Ohio-Mississippi at Confluence	593,000	4,435,948	383,265,915,591

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Table 2 Stream and River Classification Average Flow Rates				
*Stream River Flow Class	Base Flow Cubic Feet per Second (cfs)	Base Flow Gallons per Day (gpd)	Kentucky Rivers and Streams Examples	Notes
Very Small Stream Headwaters	<1	<646,000	Unnamed headwater tributaries to Red River (eastern KY uplands). Small tributaries to Elkhorn Creek in Fayette/Scott counties.	**1st Order Stream.
Small Streams	1–100	0.65–64.6 million	Upper Floyd's Fork, Elkhorn Crk., Upper tributaries to Licking River.	**2nd and 3rd Order Streams.

Medium Rivers	100–10,000	64.6 million–6.46 billion	Salt, Big Sandy, Licking, Barren, and Kentucky Rivers.	**4th, 5th, and 6th Order Rivers.
Large Rivers	10,000–100,000	6.46–64.6 billion	Green, Cumberland, and Tennessee Rivers.	**7th and 8th Order Rivers.
Major Continental Rivers	>100,000	>64.6 billion	Ohio and Mississippi Rivers.	**8th Order Rivers.
References: *Based on Leopold, L, Wolman, M.G., Miller, J.P. Fluvial Process in Geomorphology. (1964). **Based on Strahler Stream Order (1952).				

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Table 3 Spring Classification Average Flow Rates				
*Stream/River Magnitude Order	Discharge Cubic Feet per Second (cfs)	Discharge Gallons per Day (gpd)	Kentucky Spring and Seep Examples	Notes
8th (Small Seep, Minor Spring)	<0.0003 cfs	<180	Minor hillside discharges, E. KY Coal Field fractured sandstones & shales, Upland residual soils over limestone.	Often seasonal; common in shallow perched systems.
7th (Small Seep, Minor Spring)	0.0003–0.002 cfs	180–1,440	Minor hillside discharges, E. KY Coal Field fractured sandstones & shales, Upland residual soils over limestone.	Often seasonal; common in shallow perched systems.
6th (Small Spring)	0.002–0.02 cfs	1,440–14,400	Farmstead springs, Spring box domestic supplies, Hillside seeps feeding small tributaries.	Typical rural domestic supply range.
5th (Small Spring)	0.02–0.22 cfs	14,400–144,000	Farmstead springs, Spring box domestic supplies, Hillside seeps feeding small tributaries.	Typical rural domestic supply range.
4th (Moderate Spring)	0.22–1 cfs	144,000–646,000	Common in central Kentucky karst belt. Captured for rural water supply or forming small perennial headwaters.	Capable of forming a perennial

				stream channel.
3rd (Large Spring)	1–10 cfs	0.65–6.46 million	Shaker, Elizabethtown.	Equivalent to a small stream baseflow.
2nd (Large Spring)	10–100 cfs	6.46–64.6 million	Crab Orchard, Lulbegrud Crk. Sp., Booneville.	Equivalent to a small stream baseflow.
1st (Regional Spring)	≥100 cfs	≥64.6 million	Mammoth Spring, Big Spring.	Regionally significant groundwater discharge points.
References: *Based on USGS Meinzer (1927)				

2. Tables 1 through 3 shall provide default or representative parameter values for groundwater flow, extraction rates, and receptor classifications where site-specific data is unavailable or insufficient.

3. Where site-specific hydrogeologic data is available, the owner or operator may use measured values in lieu of default tabulated values, unless otherwise approved by the cabinet.

(k) The calculated Md at the plume terminus and Me at all existing and applicable speculative groundwater extraction points shall be used to:

1. Classify groundwater plume magnitude;

2. Assess the plume magnitude in relation to groundwater extraction point at risk receptors and potential receptors;

3. Assess and record plume magnitude strength and status;

4. Evaluate receptor impact potential;

5. Support corrective action determinations; and

6. Evaluate and support short- and long-term risk analysis, evaluation of risk and potential risk, risk management, and institutional, engineering, and natural controls.

(l) Groundwater plume magnitude classification shall be determined based on the calculated mass discharge rate of the plume. The classification shall be derived using the mass discharge rate corresponding to the lowest applicable MCL exceedance for Appendix IV constituents or other applicable constituents of concern COCs, or the lowest applicable risk-based concentration level where an MCL is not available.

1. The mass discharge rate shall be expressed in grams per day (g/day).

2. Groundwater plume magnitude classification shall be classified according to the total calculated mass discharge (Md) at the plume terminus in accordance with Table 4 of this administrative regulation below:

Table 4. Groundwater Plume Magnitude Strength (5 Major Categories)

Plume Magnitude Category	Md – Mass Discharge Range (g/day)	First Plume Magnitude Impacting > Regulatory or Risk Exceedance Level at a Groundwater Extraction Point (Receptor)
I – De Minimis / Trace	< 0.01	Consumptive Wells: Average domestic use well (~150 gal/day).
		Streams/Rivers: Typically limited to ephemeral drainage or diffuse headwater seepage.
		Springs: 8th–7th order minor seeps and hillside discharges (Eastern KY coal field fractured sandstones & shales; upland residual soils over limestone).
II – Minor / Localized	0.01 – 1	Consumptive Wells: Small domestic or farmstead wells.
		Streams/Rivers: Very small 1st order headwater streams (e.g., unnamed tributaries to the Red River; small tributaries to Elkhorn Creek in Fayette/Scott Counties).

		Springs: 6th–5th order small springs (farmstead springs, spring box domestic supplies, hillside seeps feeding small tributaries).
III – Moderate / Developing	1 – 100	Consumptive Wells: Public supply or agricultural wells (≥100 gallons per minute).
		Streams/Rivers: Small 2nd–3rd order streams (Upper Floyd's Fork; Elkhorn Creek; upper tributaries to Licking River; Beargrass Creek).
		Springs: 4th–3rd order springs (moderate to large springs common in central Kentucky karst belt; e.g., Shaker Spring – Elizabethtown).
IV – Major / Regional	100 – 10,000	Consumptive Wells: High-capacity municipal or regional supply wells.
		Streams/Rivers: Medium 4th–6th order rivers (Salt, Big Sandy, Licking, Barren, Kentucky Rivers).
		Springs: 2nd–1st order large to regional springs (Crab Orchard Spring; Lulbegrud Creek Spring; Booneville Spring; Mammoth Spring; Big Spring).
V – Severe / Basin-Scale	> 10,000	Consumptive Wells: Regional groundwater production fields.
		Streams/Rivers: Large 7th–8th order rivers to continental-scale systems (Tennessee, Cumberland, Green Rivers; Mississippi and Ohio Rivers).
		Springs: Regional karst systems with multi-mile conduit flow and basin-scale discharge influence.
Note: Groundwater Extraction Point Examples Calculated Regulatory Extraction Exceedance Rates are based on MCL of 0.002 ppm for mercury (Hg).		

3. The determined groundwater plume magnitude shall be evaluated relative to all applicable groundwater extraction points located at, downgradient of, and side-gradient to the site and all evaluated applicable likely and potential future groundwater extraction points.

4. The groundwater plume calculated mass discharge rate shall be evaluated relative to all applicable existing groundwater extraction points mass extraction rates located at, downgradient of, and side-gradient to the site, and all evaluated applicable likely and potential future groundwater extraction points.

(5) Weight-of-Evidence Groundwater Plume Stability Evaluation.

(a) The demonstration of groundwater plume stability for the evaluation of risk and protection of human health and the environment for CCR units and areas of interest Appendix IV metals, and other applicable COCs, require the evaluation of multiple independent lines of evidence that collectively assess whether the plume has reached a stable configuration in space and time.

(b) Dissolved metals mobility or immobility, and consequential present or future risk(s), are primarily influenced by geochemical conditions and hydrogeologic factors. Plume stability cannot be determined solely based on individual concentration measurements at discrete wells or sampling events, nor are such decisions based on concentrations alone scientific, scientifically sound, robust, or legally defensible.

(c) Accordingly, the evaluation of plume stability shall be conducted using a weight-of-evidence framework that integrates spatial plume behavior, temporal concentration trends, plume mass and mass flux characteristics, geochemical controls on metals mobility, and potential receptor impacts.

(d) This approach is consistent with widely accepted regulatory practices applied under groundwater corrective action programs, including those explicitly stated and implemented under 40 CFR Part 257 (Coal Combustion Residuals), RCRA corrective action programs, and CERCLA remedial investigations.

(e) For purposes of this regulation and its gathered information, data, evaluation, and analysis: A stable groundwater plume is defined as a plume that demonstrates the following conditions:

1. No statistically significant increasing trends in concentrations at downgradient plume boundary wells or sentinel monitoring wells;

2. No lateral or downgradient expansion of the plume footprint relative to historical monitoring data;

3. Stable or declining dissolved plume mass or mass discharge; and

4. Persistent geochemical conditions that limit metals mobility through processes such as sorption, precipitation, or co-precipitation.

(f) Evaluation of plume stability based on the scientific and technical requirements of this Section shall include and yield, at a minimum, the following lines of evidence:

1. Spatial stability, demonstrated through consistent plume geometry and absence of lateral or downgradient expansion based on isoconcentration mapping and hydrostratigraphic cross sections;

2. Temporal stability, demonstrated through statistical trend analysis (e.g., Mann-Kendall or Sen's slope) and long-term time-series evaluation of COC concentrations;

3. System-scale plume behavior, demonstrated through estimates of dissolved plume mass and, where practicable, mass flux or mass discharge across downgradient transects;

4. Geochemical stability, demonstrated through evaluation of groundwater chemistry parameters that influence metals mobility and through geochemical modeling or speciation analysis where appropriate;

5. Source term conditions, including evaluation of whether the source area is controlled, removed, capped, or otherwise stabilized; and

6. Receptor protection, including confirmation that the plume remains contained on-site and does not pose a current or reasonably foreseeable future risk to downgradient receptors.

(g) The results of these evaluations are summarized for simplicity and to assist regulatory decision in the following tables;

1. Table 5. CCR Groundwater Metals Plume Stability – Decision Matrix. This decision matrix integrates multiple lines of evidence to evaluate groundwater plume behavior for metal constituents of concern associated with coal combustion residuals (CCR) units. The matrix provides a structured, weight-of-evidence framework that considers spatial plume stability, temporal concentration trends, plume mass and mass flux, geochemical controls on metals mobility, source term conditions, and potential receptor impacts. Collectively, these factors are evaluated to support a comprehensive assessment of plume stability and to provide a transparent and regulator-defensible basis for determining plume status and the justification and effectiveness of corrective action and risk management measures.

2. Table 6. CCR Geochemical Regulatory Decision Outcome. This table provides a structured, regulatory defensible framework for classifying the groundwater plume based on geochemical and hydrogeologic evaluation of metals constituents of concern. Using the weight-of-evidence approach described in Table 5, the plume is assessed across multiple lines of evidence, including spatial stability, temporal trends, plume mass and mass flux, geochemical conditions, source term control, and receptor risk to assign a final classification of Unstable, Conditionally Stable, or Stable. This decision framework ensures a transparent, consistent, and scientifically justified determination regarding CCR groundwater plume behavior and the effectiveness of corrective action and risk management measures.

Table 5. CCR Groundwater Metals Plume Stability – Decision Matrix

Line of Evidence	Unstable Condition	Conditionally Stable	Stable Condition	Decision Rule / Notes

Plume Footprint (Plan View)	Downgradient or lateral expansion beyond historical footprint	Minor footprint variability without sustained expansion	No expansion; consistent plume geometry across events	Use consistent contour levels; evaluate ≥3–5 multi wet/dry-year 2+ events.
Vertical Migration	Downward migration into deeper hydrostratigraphic units	Vertical variability within same unit	Vertically constrained within defined unit	Requires cross-sections with geology and hydrogeology showing screen intervals.
Boundary Well Trends	Statistically significant increasing trends	Mixed trends or no trend with short record	No increasing trends (no trend or decreasing)	Mann-Kendall and Sen's slope.
Sentinel Well Trends	Increasing trends	No trend with limited data	No increasing trends	Sentinel wells are high-weight evidence.
Plume Core Trends	Increasing trends at high-concentration wells	Mixed or stable trends	Stable or decreasing trends	Core trends support mass stability.
Time-Series Concentrations	Sustained increases over time	Short-term variability	Stable or declining long-term patterns	Focus on long-term signal vs noise.
Plume Mass	Increasing dissolved mass	Approximately stable mass	Stable or declining mass	System-scale metric; high weight evidence metric.
Mass Discharge	Increasing downgradient mass flux	Stable with variability	Stable or declining mass flux	Especially useful where concentrations fluctuate point to point.

Plume Magnitude Strength 1 (See Table 4)	Groundwater plume mass discharge rate (grams/day) exceeds the applicable regulatory or applicable risk-based level, expressed as a mass extraction rate (grams/day), relative to existing or potential future groundwater extraction points.	Groundwater plume mass discharge rate (grams/day) is less than or comparable to applicable regulatory and applicable risk-based levels, expressed as a mass extraction rate (grams/day), relative to existing and likely future groundwater extraction points.	Groundwater plume mass discharge rate (grams/day) is less than applicable regulatory and applicable risk level(s) calculated as a mass extraction rate in (grams/day) relative to existing likely, and potential future groundwater extraction points.	Compares plume magnitude for Appendix IV and other applicable COCs calculated mass discharge rate (grams/day) to the regulatory-level mass extraction rate (grams/day) of existing and reasonably foreseeable downgradient groundwater extraction points. This comparison considers whether plume loading is greater than or less than applicable standards at the point of extraction, and incorporates the probability of future groundwater extraction points (e.g., domestic, public water supply, or agricultural wells) occurring within the defined planning horizon (see Table 4).

Plume Magnitude Strength 2 (See Tabes 1, 2, 3 and 4)	Site groundwater plume magnitude is sufficient, greater than, to impact existing surface water, spring, and seep surface expressed drainage features characteristic of the surrounding geography.	Site groundwater plume magnitude sufficiency is varying (+/-) within one order of magnitude, with respect to potential impacts on existing surface water, spring, and seep surface expressed drainage features typical of the surrounding geography.	Site location groundwater plume magnitude is insufficient, by one magnitude or greater, to impact existing surface water, spring, and seep surface expressed drainage features typical to the geography surrounding the site.	Compares groundwater plume mass discharge (g/day) to surrounding groundwater extraction points and drainage features classifications (streams, rivers, seeps, springs) by converting annual average flow rates (gpd) to equivalent mass extraction/loading rates (g/day) using applicable COC MCLs and risk-based concentrations to evaluate relative magnitude and receptor impact. (SeeTables 1, 2, 3 and 4).
Geochemical Conditions	Shifting toward mobilizing conditions	Mixed or transitional conditions	Persistent immobilizing conditions	pH, redox, alkalinity, sulfate/sulfide, Fe/Mn.
Speciation / Solubility	Undersaturated; high mobility potential	Near equilibrium	At or near solubility limits	PHREEQC USGS or equivalent modeling.
Attenuation Mechanisms	No identified attenuation processes	Limited or uncertain attenuation	Documented sorption/precipitation/co-precipitation	Metals-specific line of evidence.
Source Term	Active or uncontrolled source	Source partially controlled	Source controlled or declining	Stability claims not demonstrable without source control.
Receptor / Compliance Risk	Active or imminent off-site impact	On-site only; future risk uncertain	On-site contained; no current or future risk	Includes surface water, domestic use wells, public

				supply wells, and agricultural use wells.

Table 6. CCR Geochemical Regulatory Decision Outcome		
Overall Weight-of-Evidence Result	Interpretation	Regulatory Action
Unstable	Multiple and majority lines of evidence or the most significant indicators, demonstrate plume expansion, increasing concentration trends, or conditions favoring contaminant mobilization.	Continued corrective action required.
Conditionally Stable	Mixed results; no clear expansion or stabilization, due to mixed results, data gaps, or uncertainty.	Continued additional monitoring or greater focused evaluation.
Stable	All multiple and critical lines of evidence indicate no expansion and stable/declining conditions and concentrations.	Plume stability demonstrated, No Further Action.

(6) The owner or operator of any facility regulated under this Section shall obtain a certification statement, signature, and stamp or seal by a qualified Professional Geologist (PG), stating that the Groundwater Coal Combustion Residuals (CCR) Plume Geochemical Study and Analysis (GSA) and report complies with the requirements of this administrative regulation, that all geologic and hydrogeologic data, analysis, and interpretations comply with KRS Chapter 322A and has been performed, designed, utilized, and implemented by a PG or a geologist-in-training under the direct supervision and review of a PG to assess and provide for the protectiveness of public health and welfare and the environment to the fullest extent possible.

Section 5. Assessment, Corrective Action, and Remedy Selection.

(1) Except as established in this section, the assessment of corrective measures, corrective action, and remedy selection shall be established in 40 C.F.R. 257.96 through 257.98.

(2) The requirements in 40 C.F.R. 257.96(e) shall be replaced with the requirement for the owner or operator to publish the approved assessment of corrective measures for notice and comment pursuant to 401 KAR 46:120, Section 8.

(3) To implement the requirements in 40 C.F.R 257.96 through 257.98, the following procedures are established.

(a) The CCR groundwater corrective action plan shall be supported by the CSM. If additional data has been obtained following submittal of the CSM, the CCR groundwater corrective action plan shall include the additional data as necessary.

(b) The groundwater corrective action plan shall include a certification statement, signature, and stamp or seal by a PE or PG that the groundwater corrective action plan was prepared to address the requirements of this administrative regulation.

(c) The responsible party shall propose one (1) of the following groundwater remedy selections in the CCR Groundwater Corrective Action Plan:

1. No action necessary in accordance with KRS 224.1-400(18)(a) if the party or applicant submits to the cabinet:

a. A demonstration that COCs do not exceed target risk levels for unrestricted groundwater use for MCLs established by 401 KAR 8:250, Section 1, ambient background values where ambient background levels are greater than MCLs, or

b. Risk-based levels for COCs that lack an MCL; and

c. A CSM that complies with this administrative regulation, and supports the demonstration that no further action is necessary;

2. Management in place in accordance with KRS 224.1-400(18)(b);

a. The responsible party shall amend as necessary and submit to the cabinet a revision of the CSM that complies with this administrative regulation, and

b. The CSM supports the demonstration that management in place is, and will remain, protective of human health and the environment in perpetuity.

3. Restoration in accordance with KRS 224.1-400(18)(c), which shall apply to sites where the responsible party restores the environment through removal of COCs to below MCLs established by 401 KAR 8:250, Section 1, ambient background values, or risk-based levels for parameters that lack an MCL through source removal, source treatment, or active groundwater remediation; or

4. A combination of options established in subparagraphs 2. and 3. of this paragraph.

(d) The cabinet shall review and approve, disapprove, or notify the applicant of any deficiencies of the groundwater corrective action plan pursuant to this administrative regulation.

Section 6. CCR Groundwater Management in Place Remedy. If the responsible party proposes management in place as the groundwater remedy selection the responsible party shall comply with this section.

(1) A groundwater management in place demonstration shall be submitted to the cabinet for a groundwater management in place remedy selection that shall include:

(a)1. The removal, reduction, or stabilization of the contamination source to the extent practicable; or

2. A demonstration that the residual contaminant source has been reduced, removed, or stabilized through previous actions or attenuation;

(b) The implementation of sustainable measures that ensure protectiveness to human health and the environment for the duration of the groundwater impact;

(c) The assessment of on- and off-site risk due to the groundwater impact's fate and transport future extents, with present and area specific future potential groundwater users and extraction points;

(d) The consideration of current and proposed or potential future land use in selecting the remedy;

(e) A plan to perform a five-year review and report to the cabinet to ensure stable and protective conditions remain in place;

(f) A demonstration of protectiveness for both current and future exposures at a potential groundwater extraction point that includes a description of the method for maintenance of engineering and institutional controls, including:

1. Annual, or other approved frequency, assessments and inspections of the engineering and institutional controls, as approved by the cabinet in the groundwater corrective action plan;

2. Annual, or other approved frequency, certification to the cabinet by the party or applicant, and a PE or PG, that the engineering and institutional controls remain protective of human health, safety, and the environment; and

3. An environmental covenant in accordance with KRS 224 Subchapter 80 as appropriate;

(g) The CCR groundwater corrective action plan shall:

1. Reduce or stabilize the plume's mass discharge below the applicable MCLs established by 401 KAR 8:250, Section 1, ambient background values, or risk-based levels for parameters that lack MCLs at the present or future potential groundwater points of extraction;

2. Permanently place the groundwater plume into a plume decay or plume steady state;

3. Prevent or control the source or plume from extending the impact further vertically or horizontally toward current or future off-site groundwater extraction points; and

4. Assess, control, or eliminate unacceptable soil vapor intrusion risk exposures as applicable to the COCs and their fate and transport.

(2) If management in place is selected as a corrective action remedy for groundwater contamination, groundwater monitoring shall be required by the cabinet. Groundwater monitoring frequency shall be based upon relevant site-specific geologic, hydrogeologic, and exposure conditions.

(3) The groundwater corrective action plan and most current version of the CSM shall include a certification statement, signature, and stamp or seal by a PE or PG, that the corrective action plan and most current version of the CSM complies with the requirements established in this administrative regulation and is protective of human health and the environment.

Section 7. CCR Groundwater Corrective Action Completion Report.

(1) The party or applicant shall submit a CCR Groundwater Corrective Action Completion Report to the cabinet which shall include:

(a) Documentation that the groundwater corrective actions were implemented, completed, and comply with the CCR Groundwater Corrective Action Plan established in Section 4 that was approved by the cabinet, and consists of;

1. Documentation of any modification from the approved CCR Groundwater Corrective Action Plan;

2. Documentation of the weight, volume, and classification of any material removed as part of the groundwater corrective action;

3. Copies of signed manifests and any other pertinent waste disposal forms;

4. Sampling procedures used for waste profile determination and restoration confirmation;

5. Sampling procedures and methods used for soil, sediment, surface water, groundwater;

6. Results from any confirmatory sampling and copies of all laboratory analytical reports; and

7. Information regarding backfill material, including where it was obtained, and any attendant analytical results;

(b) Documentation of all engineering and institutional controls implemented to contain the release, eliminate pathways of exposure, reduce exposure, or achieve a combination thereof; and

(c) A statement signed by the party or applicant certifying that the document and all attachments were prepared under the direction or supervision of the party or applicant, and the information submitted is, to the best knowledge of the party or applicant, true, accurate, and complete.

(2)(a) The party or applicant shall revise the CSM submitted pursuant to Section 3 to reflect the groundwater corrective actions implemented and completed with revised data and information, and submit with the CCR Groundwater Corrective Action Completion Report to the cabinet.

(b) The CCR Groundwater Corrective Action Completion Report and most current version of the CSM shall include a certification statement, signature, and stamp or seal by a PE or PG, comply with the requirements of this administrative regulation, and is and shall remain protective of human health and the environment within the anticipated scope of risk, potential risk, and timeframe for which it was designed and approved by the cabinet.

(3) The cabinet shall review and approve, disapprove, or notify the applicant of any deficiencies of the CCR Groundwater Corrective Action Completion Report and the CSM pursuant to KRS 224.1-522 or 224.1-400(22), and (2)(a) of this section, as applicable.

Section 8. CCR Post-Groundwater Corrective Action Implementation Long-Term Monitoring, Operation, and Management.

(1) Consistent with the continued assessment monitoring provisions of 40 C.F.R. 257.95(f), exceedance of background concentrations alone for CCR units utilizing a management-in-place closure option under this administrative regulation shall not constitute a new plume release, instability or corrective action failure, provided plume stability criteria established under this section continue to be satisfied.

(2) For CCR units and facilities electing to close pursuant to Section 5(c)2. or 5(c)4., where closure includes, in whole or in part, a management-in-place option, the responsible party shall submit to the cabinet a CCR Groundwater Corrective Action Long-Term Monitoring, Operation, and Management Plan.

(3) The CCR Groundwater Corrective Action Long-Term Monitoring, Operation, and Management plan shall include:

(a) A groundwater monitoring network sufficient to monitor groundwater quality conditions and assess groundwater plume stability, migration, attenuation, and potential expansion;

(b) Groundwater monitoring frequencies sufficient to evaluate temporal and spatial groundwater quality trends;

(c) Groundwater plume instability trigger assessment criteria; and

(d) A statistical evaluation methodology for assessment of plume stability and instability consistent with subsection (3) of this section.

(4) The statistical evaluation of plume stability shall include:

(a) Groundwater analytical data shall be evaluated periodically to determine whether monitored constituent concentrations remain consistent with stable plume conditions or indicate potential plume expansion, migration, or attenuation.

(b) Trend evaluations shall incorporate both statistical and spatial lines of evidence.

(c) Trend analyses shall utilize the Mann–Kendall (MK) nonparametric trend test in conjunction with Sen's slope estimation, unless an alternative method approved by the cabinet is demonstrated to provide equivalent or greater statistical reliability.

1. The Mann–Kendall test shall be used to evaluate the presence, direction, and statistical significance of monotonic concentration trends over time; and

2. Sen's slope estimation shall be used to evaluate the magnitude and rate of constituent concentration change over time.

(5) Trigger criteria for potential plume instability evaluation:

(a) Additional technical evaluation shall be initiated when one or more of the following conditions are identified:

1. A Mann–Kendall trend test indicates a statistically significant increasing trend with a p-value less than 0.05;

2. Sen's slope analysis indicates a sustained positive rate of constituent concentration change exceeding historical baseline conditions;

3. Sen's slope confidence interval excludes zero;

4. Constituent concentrations increase during three consecutive monitoring events following adjustment for seasonal variability, precipitation trends, and other temporally correlated hydrologic influences;

5. Constituent exceedance frequency materially increases relative to baseline conditions; or

6. Groundwater plume footprint expansion or downgradient migration is observed.

(b) The occurrence of a single trigger condition shall not alone constitute a determination of plume expansion, but shall require additional technical review and evaluation of supporting multiple statistical, hydrogeologic, and spatial lines of evidence.

(6)(a) A groundwater plume may be considered expanding when multiple lines of evidence demonstrate sustained increasing constituent concentration trends and spatial migration, including:

1. Persistent statistically significant upward concentration trends across successive monitoring periods;

2. Increasing Sen's slope values relative to historical baseline conditions;

3. Measurable expansion of groundwater plume extent or concentration contours; and

4. Evidence of downgradient plume migration toward compliance boundaries, receptors, or other sensitive environmental features.

(7)(a) Where appropriate, additional statistical methods may be utilized to evaluate temporal changes in plume behavior, including, but not limited to:

1. Rolling trend analyses;

2. Seasonal Mann–Kendall testing;

3. Modified Mann–Kendall procedures accounting for autocorrelation; or

4. Change-point detection methods.

(b) These or other selected and approved statistical methods, significance thresholds, baseline periods, and evaluation procedures shall be documented in the approved monitoring plan and applied consistently throughout the monitoring program unless otherwise approved by the cabinet.