Managing Springs Emanating from Coal Combustion Residual Disposal Impoundments

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ABSTRACT

Impacted springs emanating from Coal Combustion Residual (CCR) disposal impoundments where “wet disposal” methods were employed is a typical issue that frequently needs addressed during the operation and management of these facilities. Identifying potential impacts to a spring is typically accomplished through regularly scheduled field reconnaissance and laboratory analyses. Analytical testing is performed to characterize the effluent’s chemical composition. The management approach employed for specific springs are developed based on several factors including: the effluent’s chemical composition and flow rate, regulatory requirements and discharge standards, available treatment technologies, facility operations, site topography, economic feasibility, and constructability issues. Management strategies may include permitting through an NPDES outfall, treatment in-place, collection and conveyance to a centralized treatment facility, collection and conveyance to a POTW, or collection and return to the CCR disposal impoundment. Spring management will often include a combined approach utilizing a combination of several methods. Examples of the selection and implementation of spring collection and conveyance system design and construction are presented below.

INTRODUCTION

Springs are locations where groundwater emanates from the ground continuously replenished from below. Seeps are a variety of spring where the water emanates through the pores of the ground over a considerable area instead of a distinct opening. Most seeps yield a small amount of water (Bryan, 1919). Springs can be perennial flowing throughout the year or intermittent flowing only during wet seasons. Figure 1 presents a photograph of two closely spaced springs. The flows from the two distinct springs converge and form a tributary stream. Figure 2 presents a photograph of a seep. The ground in the foreground is wet over a large area supporting a wetland in the center of the photograph. The ephemeral stream present in the background only flows during wetter times of the year or during rain events.
Topographic depressions provide a common mechanism for the formation of springs. These depression springs form when the water table reaches the surface (Fetter, 1988). As such, depression springs often form the headwaters of streams. The elevation and location of these springs may vary throughout the year with a seasonal rise and fall of the water table.

Contact springs often form a spring line where groundwater emanates over an area following the contact of more permeable rocks overlying rocks with lower permeabilities (Fetter, 1988). Contact springs may manifest as a long continuous spring or a series of smaller, discontinuous springs separated by drier soils.

Water monitoring programs for CCR disposal sites often require the identification, sampling and analysis of springs in areas downgradient of the disposal facility. Spring identification is most commonly performed by performing a site reconnaissance. Sampling of the identified springs is typically incorporated into the disposal facility’s water monitoring program. Potential impacts from CCR disposal can be qualified by parameter concentrations, time-trends, and major ion chemistry.

Once a spring is determined to be impacted by CCR disposal, a management approach is developed based on several factors including: the effluent’s chemical composition and flow rate, regulatory requirements and discharge standards, available treatment technologies, facility operations, site topography, economic feasibility, and constructability issues.

Management strategies may include permitting the discharge through an NPDES outfall, treatment in-place, collection and conveyance to a centralized treatment facility, collection and conveyance to a POTW, or collection and return to the CCR disposal impoundment. Spring management will often include a combined approach utilizing a
combination of several methods. Examples of the selection and implementation of spring collection and conveyance system design and construction are presented below.

SPRING COLLECTION STRATEGIES

DISCRETE SPRING COLLECTION

Discrete spring collection refers to collecting the source water for the identified spring while allowing surface water to bypass the collection system.

The example setting in Figure 3 shows a series of five distinct springs that occur along the crop line of a coal seam along a stream valley.

![Figure 3. Springs emanating along a similar elevation from a coal seam.](image)

Figure 4 shows a close-up of water emanating from one of these five distinct springs.

![Figure 4. Spring emanating from a coal seam.](image)

Each of these springs may be collected individually with the use of subsurface spring collectors installed immediately upgradient of where the spring expresses at the ground surface. Figure 5 shows an example of a subsurface spring collector that collects the groundwater immediately upgradient of the spring. Groundwater enters the perforated collector pipe through stone pipe bedding. Geomembrane beneath the pipe and along
the downgradient face of the excavation prevents collected groundwater from bypassing the system. The spring collector is sealed at the surface allowing for storm water runoff to pass over the system.

The combined flow from these springs is conveyed to drop inlets installed along an underground header pipe. In this example, the combined flow is drained by gravity to a common pump station that pumps the water back to the CCR disposal impoundment.

IN-STREAM SPRING COLLECTION

The example setting in Figure 6 shows a spring that is the headwaters to a perennial stream. The elevation of the spring is controlled by seasonal fluctuation of the water table.

Figure 5. Cross-sectional view of discreet spring collector (typical).

Figure 6. Spring location/elevation that varies with seasonal conditions.
The example setting in Figure 6 shows two springs that emanate from coal seams along a small gaining stream. Gaining streams exhibit increased flow along their path in response to groundwater gains.

Figure 7. Springs emanating along a perennial stream with additional base flow contributions from groundwater.

Discrete spring collection may not be ideal for the example in Figure 6 because the location of the spring is not fixed. Similarly, discrete spring collection may not be ideal for the example in Figure 7 because the stream receives additional flow of impacted groundwater along its flow path. In the following examples, spring collection options for the surface collection and subsurface collection within the stream bed are presented.

In-stream Surface Collection

Figure 8 shows a typical in-stream spring collector that consists of a drop inlet to collect the flow within the stream bed up to a specified design storm. There is no segregation of stormwater runoff from the springs and groundwater. Therefore, it is necessary to size the pumps to manage the peak flows during the design storm.
In-stream Surface Collection – Bypassing Diluted Flows

The example setting in Figure 9 shows an area where multiple springs flow into a perennial stream. Those springs that display impacts from the CCR disposal impoundment are shown in red. Flow rates of the stream at the downstream collection point ranged from 4 to 6,100 gallons per minute. In this example, the state permitting agency allowed the operator to collect water during lower flows when constituent concentrations were the greatest and allow the system to bypass during higher flows when the constituents are diluted with unimpacted stormwater runoff.

Figure 10 is an example of an in-stream collection system that collects stream flow behind a check dam. Water is directed to a collection manhole through a perforated
riser pipe and underground pipe. The collection manhole is equipped with an outlet to the pump station and an overflow pipe.

Figure 10. In-stream collection allowing bypass of diluted flow.

The pumps and discharge pipe are sized to handle the amount of flow that are agreeable to the state permitting agency for collection. When flows exceed the agreed upon collection design criteria, water is discharged from the collection manhole overflow pipe into the stream. During greater stream flows, water simply overtops the check dam.

In-stream Subsurface Collection

Figure 11 shows a typical in-stream spring collector installed in the subsurface that collects groundwater yet allowing surface water to bypass the collection.
The construction of subsurface in-stream collector does pose additional permitting issues because of the extensive work and related impacts required within the stream.

AREA-WIDE SEEP COLLECTION

A different strategy may be used in areas outside of stream channels where a seep emanates over an area with no distinct flow channel. Figure 12 presents a typical design to collect water along the downhill side of the seep. This design does not allow for the segregation of stormwater runoff from the seep flow.
COLLECTION AND CONVEYANCE TO A POTW

An additional alternative for management of CCR impacted seeps and springs include collecting effluent water and conveying the collected water to publicly-owned treatment works (“POTW”). This alternative may be achieved by constructing collection systems similar to those described above, and also constructing pipe and pump systems to convey flow to a POTW. This option will require entering into a contractual agreement with the POTW for receiving and treating the impacted effluent. Certain constituents of CCR impacted effluent may restrict or prohibit treatment by the POTW, and/or require upgrades to POTW treatment capabilities. This alternative will also likely require additional costs associated with land acquisitions, and/or easement agreements for routing of the conveyance pipeline system from the collection location to the POTW, engineering design, permitting and construction costs associated with installation of the conveyance piping systems.

COLLECTION AND CONVEYANCE TO A CENTRALIZED TREATMENT FACILITY

Construction of onsite treatment facilities is also a potentially viable management alternative for impacted seeps and springs. Based on the chemical composition of the effluent, an onsite treatment facility may be able to be constructed to treat the collected water and achieve applicable regulatory discharge limits. The required treatment
technologies can be inordinately expensive, and the degree of constituent removal required will create additional waste streams that will also need to be managed through alternative approved disposal methodologies. This alternative may be achieved by constructing collection systems similar to those described above, and also constructing pipe and pump systems or gravity systems to convey flow to the onsite treatment facility. This alternative will also likely require additional costs associated with land acquisitions, and/or easement agreements for routing of the conveyance pipeline system from the collection location to the treatment facility, and real estate for the treatment facility footprint. Costs will also be incurred for engineering design, permitting and construction costs associated with installation of the conveyance piping systems, design and construction of the treatment facilities, associated ongoing operation and maintenance of the facility including costs for transportation and disposal of wastes generated during the treatment process.

SUMMARY AND CONCLUSION

Management of impacted springs must consider their topographical and hydrogeological settings as wells as the regulatory goals and environment. There is no “one size fits all” for the design. CEC recommends working closely with the state permitting agency to gain an understanding of the collection system goals and future compliance obligations.

Spring collection designs should take into account the hydrogeological setting so that the groundwater flow paths that supply the spring are considered in the design.

Additional considerations should also take into account the future plans for the CCR impoundment that is the potential source of the impacts to the seep or spring. Future plans for relocation of CCR, capping the CCR in-place with a geosynthetic cap system, or performing some type of in-place dewatering of the disposed CCR may result in the improvement or elimination the impacts or flows rates of the spring allowing for temporary management alternatives to be considered that may not be feasible for a long term solution.

REFERENCES
