

Recommendations for Pre-Mine Assessment of Selenium Hazards
Associated With Coal Mining in West Virginia

prepared by

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Background on Selenium

Selenium gained recognition among research scientists, regulatory authorities, and fisheries managers in the late 1970's when the landmark pollution episode took place at Belews Lake, North Carolina. Selenium released in the waste from a coal-fired power plant entered the lake, killed the fish community, and caused residual impacts for many years after selenium inputs were stopped (Cumbie and Van Horn 1978; Lemly 1985a, 1997a, 2002a). The primary lessons learned from Belews Lake were: (1) Even small increases in waterborne selenium can lead to devastating effects on aquatic life, and (2) Once selenium bioaccumulation in the aquatic food chain begins it is too late to intervene — pre-pollution assessment and management are key to preventing impacts. The lessons from Belews Lake were instrumental in the development of USEPA's current national freshwater criterion for selenium (5 µg/L [micrograms per liter]). Since the Belews Lake episode, a tremendous amount of research on the toxicology, environmental cycling, and hazard assessment of selenium has taken place (e.g., Frankenberger and Engberg 1998, Lemly 2002b). In addition to learning about its toxic potential, much information has been gained on the sources of selenium and how it reaches the aquatic environment, particularly with respect to coal mining and the coal industry (Lemly 1985b, 2004, Dreher and Finkelman 1992, Vance et al. 1998).

Need for Pre-Mine Assessment

The lessons from Belews Lake, supported by over two decades of research findings from many other locations throughout North America (Lemly 1997b, 1999, 2002b; Skorupa 1998a, Hamilton 2004), underscores the need to take a preventive approach to selenium pollution rather than attempting to deal with it after contamination has taken place. With respect to coal mining this means pre-mine assessment. Failure to adopt this approach can only worsen the selenium pollution and associated ecological risks that have emerged in West Virginia. Selenium-related violations of the federal Clean Water Act need not occur if careful pre-mine assessment is used to guide mine permit decisions. Clearly, much attention is focused on management and regulatory authorities in the state, and it is imperative that environmentally sound actions be taken in order to stem the escalating threat of widespread selenium pollution. Using pre-mine evaluation can safeguard natural resources by allowing site-specific risk assessment and risk management to take place. This is the prudent, environmentally responsible course of action.

Adopting this approach will benefit the state and the mining industry by demonstrating that all activities are being developed and implemented with the goal of preventing selenium pollution, thereby minimizing water quality issues that may lead to litigation by federal agencies and conservation groups.

Recommended Procedure

Geological assessment is the first step to understanding the environmental risk of selenium at prospective coal mines. It is essential to determine selenium concentrations of coal and overburden that are to be moved because once these materials are exposed to air and precipitation they can leach substantial quantities of selenium (e.g., Davis and Boegly 1981, Heaton et al. 1982), which begins the mobilization process and threat to aquatic life. Because selenium concentrations vary widely in coal and waste rock at a mine site (e.g., Heaton and Wagner 1983, Desborough et al. 1999), a thorough representation of the geographic area and depth of disturbance must be made. This entails making a minimum of one core drilling per 5 acres, extending into the coal bed that is to be extracted. Two samples (about 450 grams each) are taken from each core: one consisting of overburden material and one of the coal itself. Each sample is evaluated using a passive leaching test (see Heaton et al. 1982, Desborough et al. 1999). The first step is to crush the coarse sample with a hammer to produce approximately pea-size or smaller material. The resultant material is mixed and some is put into a beaker with deionized water (pH 5.0-6.0) in a ratio of 1 part sample to 20 parts water (use 5-20 grams of sample and 100-400 milliliters of water). Let stand for 48 hours, decant and filter (0.45 micrometer mesh) the liquid, acidify it to pH <2.0, and analyze the liquid for selenium concentration using a method with a detection limit <1 µg/L (part-per-billion). The results of these tests will generate a spatial profile of selenium mobility at the prospective mine site and allow a screening-level evaluation of hazards to aquatic life that can be used to guide subsequent assessment and regulatory decisions.

Evaluating Selenium Concentrations

The traditional approach to evaluate waterborne selenium concentrations is to compare them to the USEPA national freshwater criterion (5 µg/L). Concentrations exceeding the criterion should be viewed as posing unacceptable risk to aquatic life because of the likelihood

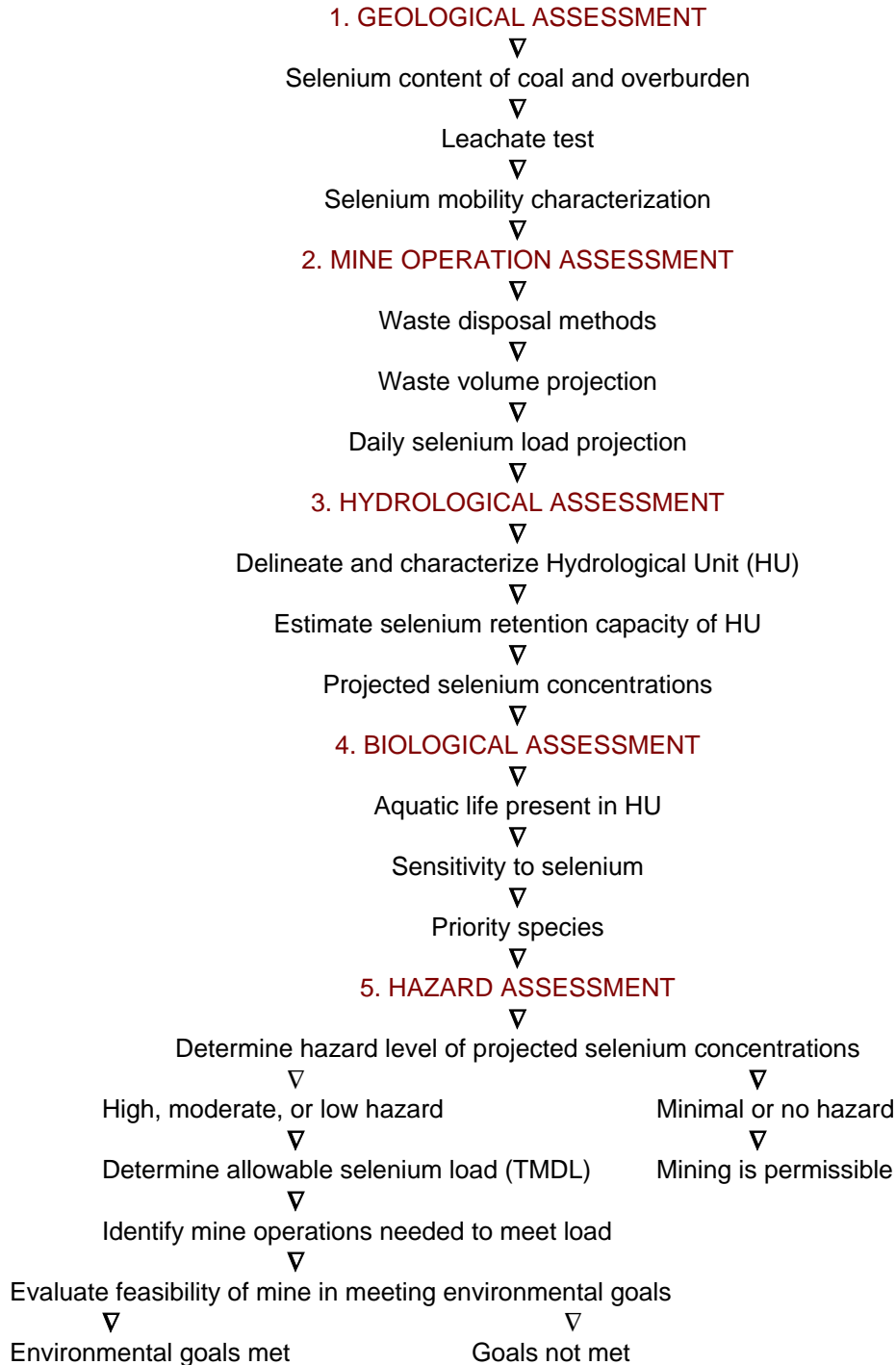
of bioaccumulation in the food chain. However, there is a growing body of scientific information which indicates that toxic impacts to aquatic life can occur when selenium levels reach 2 µg/L, particularly if the selenium is predominantly in the selenite form (which is the case for coal mine selenium), and the contaminated water enters a wetland, pond, reservoir, or other impoundment (Frankenberger and Engberg 1998, Skorupa 1998a, Hamilton and Lemly 1999, Lemly 2002b). Because of these findings, a value of 2 µg /L has been recommended by several selenium experts as the concentration limit necessary to protect fish and wildlife (Peterson and Nebeker 1992, Maier and Knight 1994, Skorupa 1998b, Hamilton and Lemly 1999, Lemly 2002b, Hamilton 2004), and USEPA has begun a review/revision process for their national freshwater criterion (USEPA 1998, Hamilton 2003). Moreover, based on broad experience dealing with a variety of selenium contamination issues, including coal mining wastes, the U.S. Fish and Wildlife Service and a number of state water quality agencies have adopted a value of 2 µg/L as their management or regulatory standard (see Engberg et al. 1998, Skorupa 1998b, Hamilton and Lemly 1999). I recommend that 2 µg /L be adopted as the maximum acceptable concentration of selenium in wastewater, drainage, and leachate associated with coal mining activities in West Virginia.

Comprehensive Assessment

By examining the results of the leach tests and applying a 2 µg Se/L water quality objective, field sites whose disturbance by mining would pose a hazard to aquatic life can be quickly identified. If clear dangers are evident — i.e., leachate selenium concentrations exceed 2 µg/L — then it is desirable to examine the operational characteristics of the proposed mine in the context of a 5-step comprehensive assessment that includes provisions for altering mine operations, establishing TMDLs for discharges and, in one scenario, not permitting the proposed mine to be developed at all (see page 5). This approach will allow site-specific hazard evaluation based on local hydrology and biological conditions, and provide a precise fine-tuning of the screening-level assessment generated by the leach tests. The methods used for hydrological, biological, and hazard assessment are techniques that have been field tested and published in the peer-reviewed literature (Lemly 2002b). Technical guidance is available for those unfamiliar with specific components of the procedure (email contact: dlemly@vt.edu).

Comprehensive assessment will provide the information necessary for policy makers to reach environmentally sound, scientifically defensible decisions on mine permit applications.

PRE-MINE ASSESSMENT OF SELENIUM HAZARDS



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