Large quantities of by-products are produced annually during the process of steel/iron production. Steel slag is one of these by-products. There is a growing interest in reusing steel slag in highway structural fills although concerns have been raised for its reuse due to its high pH and metal leaching behavior under alkaline conditions. In case steel slag material is used in a highway embankment fill, the percolating rainwater would either leach through the underlying subgrade and merge with groundwater, or it would come out of the embankment and leach into the nearby surface waters such as rivers and streams. In order to evaluate the surface water impacts of trace metal leaching from both virgin and treated steel slag samples, an experimental study was conducted through a series of sequential water leach tests and sequential column leach tests. In addition, the extent of surface water contamination in typical highways was simulated with a recently developed numerical model. The results indicate that encapsulating the pure or treated steel slag material within a clay soil decreases the metal concentrations within the effluent leachates significantly. Moreover, the results of the numerical model analysis showed that once the slag leachate merges with the surface waters, the concentrations decrease further with increasing distance from embankment corner.