Topic PT-2

White Paper Topic: Passive Treatment - Reasons for success and failure

Team: Arthur Rose (Chair), Paul Ziemkiewicz, George Watzlaf, Hugh Bevans, Brent Means, Gwen Geidel, Joe Schueck, Jeff Skousen, Chuck Cravotta.

Date: December 20, 2005

Problem Definition:

In the past 10 to 15 years, approximately $50,000,000 has been spent by public agencies on passive treatmentsystems (Brent Means, personal comm.), and much additional money has been spent by industry. Many of these systems are functioning well, but especially among the more acidic systems and the large flow discharges, many systems have either completely failed or are performing much less well than anticipated. The few "autopsies" that have been conducted on "failed" systems show that some systems fail because of flaws in design (i.e., inappropriate technology for the water chemistry, system too small for acidity loading, built-in short circuits, inadequate vertical relief), and others fail because of construction faults (broken pipes, thin spots in compost layer). Other systems perform poorly or fail because current technology is inadequate (plugging by Al precipitate).

Despite this large investment in passive treatment systems, relatively little is known about why some systems succeed and others fail. As a result, designers continue with the conventional designs and failures re-occur. As an example of a problem, if an ALD's performance drops off, assumptions are made about the extent to which Fe or Al might have plugged it, but in at least some cases these suppositions turn out to be incorrect on more detailed study. In many cases, there are confusing correlations with causal factors. On the other hand, successful systems often receive little attention since they do not generate problems. Did one succeed because the water quality predisposed failure or did hydraulic factors such as rock size and piping determine whether plugging occurred?

The significant number of failures is leading some funding agencies to question whether passive treatment should continue to be funded. It is clear to us that passive systems are very successful in some cases, but a much better understanding of the technology by designers is needed to evaluate grant proposals and to guide designers in planning systems, so that performance matches expectations. The problem is most severe in designing passive systems for strongly net acidic mine drainage, which have recently been treated largely with vertical flow-type systems (SAPS). However, problems also exist with anoxic limestone drains, wetlands, open limestone channels, and other methods.

To improve the effectiveness of our spending on passive systems, it will be necessary to study the performance and characteristics of many successful and unsuccessful systems, and to disseminate the results of the studies to the design and funding professionals.

Course of Action:

A first step in attacking this problem is to compile a listing of passive systems, along with easily available data on the performance of these systems and their characteristics. A key aspect of this stage is to decide what information should be collected on each site. Possible parameters are system type (ALD, VFP, etc.), influent and effluent chemistry (pH, acidity, alkalinity, Fe, Al, Mn, SO4), flow rate, obvious flow problems (short circuiting, overflow, failure of the inflow structure to capture the influent), dimensions of the overall system and key components (limestone layer), and apparent problems vs. time. Cost data could be included in order to help identify the economics of passive systems. This listing would give perspective on the extent of problems with a given technology and a start on identifying important problems. A limitation will be the willingness of various individuals and groups to spend time assembling this data. However, with some effort by the compiler, a moderately complete set of data should be available.

A second phase would be to organize this information and select from it a reasonable number of successful and unsuccessful systems for more detailed study. For these sites, a more intensive effort would be made to assemble complete information. Visits to the site would probably be made, and the designer and local experts would be consulted. Comprehensive samples would be taken to extend existing data. A judgment on likely possible causes of problems might be made. An intense effort should be made to at least express a hypothesis or hypotheses as to why a given system has problems, and why similar systems were successful.

A third phase would be in-depth investigations of selected sites. These investigations would be guided by multiple hypotheses on the nature of the problem. The systems might be drained and excavated to examine for the cause of plugging or short circuiting. Special analyses might be prescribed, for example of Ca or oxidation state. Tracer tests might be conducted. The protocol would vary depending on the information available on the site, and the hypotheses to be tested.

A final phase would be a synthesis of all the information gathered in the previous steps, and development of improved guidelines for design, based on water chemistry, flow, material properties, etc. Also, a protocol for identifying problems at a site would be developed. A key part of this final phase would be technology transfer of the information to the profession. Reports on the overall set of systems, and on the detailed site investigations would be disseminated. In particular, key design factors that predict success should be identified, as should factors failing to predict success. Topics for further investigation would probably be identified.

Schedule:

The first phase, of compiling a list of systems supported by public funds, is underway at OSM, and some information is available from prior studies by Ziemkiewicz and Rose. This phase might be completed later in 2005. The second phase might involve 3 months work in organizing the data and visiting selected field sites. The third phase of in-depth field investigations might occupy a year, and would lead to a few months for synthesis and preparation of papers, short course material, web site presentations and other tech transfer approaches. The resulting improvements in design, construction and understanding should more than pay for the expenses of the investigation.

Beyond the above phases, this project should be set up to continue for future years in order to provide information on the long-term longevity of passive systems and the success or failure of improved designs.

Budget: $250,000 (est.)

Literature Survey:

- Cravotta, C.A., III, 2003, Size and performance of anoxic limestone drains to neutralize acidic mine drainage: Journal of Environmental Quality, v. 32, p. 1277-1289.
- Kepler, D.A., and McCleary, E.C., 1997, Passive aluminum treatment success: Proceedings, West Virginia Surface Mine Drainage Task Force Symposium, Morgantown, WV, April 15-16, 1997, 7 p.
- Rose, A.W., 2004, Vertical flow systems: Effects of time and acidity relations: Proc. American Soc. Of Mining and Reclamation, Morgantown, WV, April 2004.
- Rose, A.W., 2006, Long-term performance of vertical flow ponds – An update: Proceedings, International Conference on Acid Rock Drainage, St. Louis MO, Mar 27-30, 2006, ed by R.I. Barnhisel, p. 1704-1716.
- Watzlaf, G.R., et. Al., 2000, Long-term performance of alkalinity-producing passive systems for the treatment of mine drainage: Proc. Amer. Soc. for Surface Mining and Reclamation, Tampa, FL, June 2000, p. 262-274.