**Environmental Competition Rules**

*Updated February 2, 2018*

# Overview

Two centuries of underground and surface coal mining operations have significantly deteriorated many watersheds in areas around Ohio University and southeast Ohio. In particular, abandoned coal mines from the 1800s and 1900s discharge acid mine drainage (AMD) into rivers via thousands of seeps, greatly disrupting the water quality and ecosystems for hundreds of river miles. AMD is the result of a chemical reaction between oxygen and coal materials that occurs when water flows through a mine or a pile of mine spoils. The interaction of the spoils, water, and oxygen can create a high-acidity solution with a high concentration of heavy metals that discharges to streams and rivers, sometimes to the point of making entire reaches inhabitable for fish and other aquatic organisms. Additionally, metals such as iron and aluminum can precipitate from the AMD, creating white or orange sludge that can coat every surface within the stream for miles.

While standard reclamation techniques can be used to prevent the absorption of rainwater runoff into abandoned surface coal mines, underground mines have no easy reclamation solutions as they can be in constant contact with subsurface water and endlessly generate AMD for many centuries. In the instances of AMD seeps from underground mines, active or passive treatment measures are can be utilized to treat the mine water after it discharges from a seep. Active measures include directly dosing the AMD with reagents that neutralize acidity and cause the metals to precipitate, often followed by a secondary treatment downstream to raise the pH of the water after the metals are completely out of solution. Active systems can include mechanical dosers that discharge reagents or even electrolysis systems to remove iron. Passive systems can involve running clean water via gravity through a substance such as steel slag that increases pH, and then mixing that water with AMD, or other systems such as limestone leach beds where AMD is passed through the limestone media to raise pH and trap metals within the void spaces of the bed.

# Objective

The goal of the 2018 OVSC Environmental Competition is to design a small scale treatment system that will reduce the high concentrations of iron and aluminum from a local acid mine drainage source, including raising the pH of the AMD and cleaning it of any precipitated metals. The practical objective is to develop a treatment design that is not only effective and innovative within the constraints listed below.

# Water Source

The AMD for the competition will come from the Monday Creek watershed, which is a large tributary of the Hocking River. Specifically, the AMD will originate from an abandoned underground mine seep in the vicinity of Carbon Hill, north of Nelsonville, Ohio. While trends related to acidity, metal concentrations, and other variables are generally consistent from year to year at underground mine seeps, short term fluctuations are common based on the amount of rainfall in the immediate region that impact the level of the water in the mines. From this location, it is reasonable to expect that the AMD might have the following qualities:

pH 3.6 – 4.0

Specific Conductivity (µs/cm) 1000 – 1200

Acidity (mg/l) 100 – 150

Total Dissolved Solids (mg/l) 800 – 1100

Total Suspended Solids (mg/l) 2 – 10

Sulfate (mg/l) 550 – 750

Total Calcium (mg/) 80 – 110

Total Iron (mg/l) 12 – 21

Total Aluminum (mg/l) 12 – 15

Hardness (mg/l) 400 – 500

Water sources provided to teams may vary from these typical qualities and will be unknown, so treatment systems should be developed that have the ability to adjust to the specific conditions of the AMD provided. Please note that iron in the region can be either ferric or ferrous depending on local conditions, and their impacts on pH can be *interesting* as the iron precipitates out. For a general source of AMD chemistry, please refer to [https://en.wikipedia.org/wiki/Acid\_mine\_drainage.](https://en.wikipedia.org/wiki/Acid_mine_drainage)

AMD will be collected by OVSC staff directly from the mine seep the morning of the competition and immediately sealed in airtight two-gallon buckets. One bucket will be distributed to each team by a lottery system the day of the competition.

# Deliverables

Within the first minute of the start of the competition, each team must pour a sufficient amount of AMD into their system such that two liters of treated water can be recovered. Each team must recover two liters of AMD within 45 minutes of the start of treatment time from the two-gallon bucket provided.

Treatment of the two-liter effluent will be scored on pH, iron concentration, aluminum concentration, and turbidity. OVSC judges will provide containers and extract samples from the effluent sufficient for analyzing, including a 125 ml bottle and nitric acid to preserve the iron and aluminum samples for testing.

# Materials

All materials that will be used to treat the water, whether mechanically or substances added to the AMD, must be purchased a retail store such as Lowes, Home Depot, Walmart, garden center, sand/gravel operation, etc. Pre-manufactured treatment or screening systems such as chemical cartridges or water filters are not permitted. All receipts from the purchase of materials, and equipment must be included in the appendix of the Technical Review Paper (see below). All materials must be listed with a cost associated in the technical paper. Failure to account for all items will result in a technical paper penalty. Any electric, battery, or manually operated tool may be used in the construction and operation of the apparatus and may be obtained by any means, however an estimated cost must be included in total cost. The cost should be estimated based on rate of 6.50 cents kWh.

# Construction & Treatment

* Pre-assembly of apparatus components is permitted; however, teams are advised that access is limited to standard entry doors. If transport is deemed unsafe the team will be asked to disassemble the apparatus and reassemble during the construction phase of the competition.
* Each school may enter one (1) team, consisting of up to but no more than five (5) ASCE undergraduate student chapter members. One (1) member should be designated as team captain.
* Each team will be provided with a two (2) foot deep by four (4) wide countertop area, with sources of electrical power. The treatment system must fit in the allotted space or floor area the same size.
* All team members must provide and be equipped with proper clothing (long pants, closed toed shoes), as well as protective eyewear, and latex gloves.
* Before time begins, all materials and tools must be in a designated area and not in contact with any am member.
* Teams will be given a maximum of 15 minutes to complete their set-up and teams will have a maximum of 45 minutes to complete the treatment of the water.
* Each team member used during treatment time will be listed under cost as $20.00 per person (any design that needs team member to operate apparatus during treatment must record the appropriate cost).
* All substances added to the AMD which will be presented in the final effluent must be measured to the nearest ml if liquid or nearest gram if dry and reported to the judges before addition.
* After judging is finalized each team is responsible for the cleanup and disassembling of their treatment system.

# Technical Paper and Presentation Poster

Every participating team must submit one technical review paper, **not to exceed 1,500 words** (not including references and tools list) as well as a presentation display poster. The paper should describe the teams’ preparation for the competition including design considerations, development, and proposed implementation of the treatment apparatus, and must be must be submitted at the beginning of the

captain’s meeting on the day of competition. The Technical Paper must be divided into the following labeled sections:

1. Abstract
2. Introduction
3. Materials/Methods
4. Discussion
5. References
6. Appendix (including receipts for materials and tools)

The poster must be 24” x 36” and present the final AMD treatment system description, summary of cost, and environmental impact.

# Judging

Teams will be judged by a panel of water quality professionals. Samples of the treated water will be tested for total iron, total aluminum, turbidity, and pH at the Russ College of Engineering’s laboratories.

Scoring related to the creativity and sustainability of the treatment process will be evaluated by a panel of judges. Creativity refers to the uniqueness of the system. Sustainability refers to the total life-cycle cost and environmental impact:

* What resources are used, and what is the waste generated by the system? Are the materials used safe for humans and the environment?
* Could any materials used result in any harmful byproducts in the effluent?
* What is the potential for recycling the system components at the end of its functional lifetime?

These will be ranked in order from greatest to least and awarded points accordingly. The decisions of the judges are final, and the team captain is the only team member that may interact with judges during the competition. There are a maximum of 100 points available for each team, with the judging criteria as follows:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Subcategory** | **Scoring** |
| Treated Water Quality | pH | The closest team to pH 6.5 will get 20 points, with 2 points subtracted per place thereafter |
| Treated Water Quality | Total Iron | The team with the lowest concentration will get 20 points, with 2 points subtracted per place thereafter |
| Treated Water Quality | Total Aluminum | The team with the lowest concentration will get 15 points, with 2 points subtracted per place thereafter |
| Treated Water Quality | Turbidity | The team with the lowest concentration will get 15 points, with 2 points subtracted per place thereafter |
| Time of Treatment | Minimum time to recover 2 L | The team with the shortest time will get 10 points, with 1 point subtracted per place thereafter |
| Sustainability | Life cycle cost and environmental impact | The team with the most sustainable design will get 10 points, with 1 point subtracted per place thereafter |
| Creativity | System uniqueness | The team with the most creative design will get 10 points, with 1 point subtracted per place thereafter |

# Penalties

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| --- | --- |
| Failure to pour AMD into the treatment system in the first minute | 1 point per 10 seconds over the first minute |
| Failure to account for all materials & costs in the Technical Paper | 5 points |
| Physical contact by any team member with the AMD intake, effluent, or intermediate water | 25 points |
| Failure to provide presentation display poster | 5 points |
| Failure to complete system construction in 15 minutes | 2 points per minute after the first 15 minutes |
| Failure to recover two liters in 45 minutes | 10 points |

All substances added to intake or process water must be for the purpose of treating the water. Any form of dilution is prohibited and will result in disqualification.

# Awards

An overall total of 100 points are available to be awarded for treatment quality, time needed and creativity and sustainability; the team with the most points will be deemed the overall winner. Second and third place overall awards will also be given as will awards for the sub-categories below. The sub- category awards have no impact on the overall awards and will include:

* Best Environmental Technical Paper - The team with the highest score for the Technical Review Paper will be awarded “Best Technical Review Paper”.
* Most Creative Apparatus - The team with most creative design will be awarded “Most Creative Apparatus”

# Questions

Teams may submit questions to ovsc@ohio.edu no later than March 31, 2018. Please include “OVSC 2018 Environmental Competition Question” in the subject heading. All questions and answers will be provided to all of the teams participating in the competition.

# Acknowledgements

These rules and procedures are based on previous OVSC and other environmental competitions, modified as appropriate for the specifics of this year’s challenge.