Environmental Challenge
…a student team competition

2016 PROTOCOL

General Description

The Environmental Challenge is being sponsored by the Air & Waste Management Association – Upper Midwest Section (AWMA-UMS) and Central States Water Environment Association (CSWEA) – Minnesota Section, as part of their annual joint Conference on the Environment (COE). The COE will be held on November 9, 2016 at the Minneapolis Convention Center in Minneapolis, Minnesota.

The Environmental Challenge (EC) is an undergraduate student team competition to prepare and present an optimal solution to a complex "true-to-life" environmental problem. The problem presented will be of current value, representative of the location of the event, and require multidisciplinary approaches for success. The EC seeks not only technical and scientific analyses, but solutions that are presented in conjunction with the development of appropriate regulatory approaches and resolution of political and community issues.

The goals of the EC are to:

- Involve students in the annual Conference on the Environment
- Provide experience in solving complex environmental situations in a fun and supportive atmosphere
- Provide students an opportunity to display their talents
- Offer students the chance to network with environmental professionals and to find internship and job opportunities

The EC is designed to promote formation of student teams with the broadest feasible range of environmental disciplines including engineering, planning, policy, economics, and other sciences. Just as corporations and other organizations pull together teams from their staff to most effectively address any given project, so too should each student team by identifying and recruiting representatives from appropriate disciplines as needed to address the problem holistically.

Teams must research the problem background, as well as the technical, social, economic, and political aspects of the situation. Teams must stay apprised of ongoing events related to the problem so they can adjust their solutions appropriately leading up to and during the COE.

Although winning solutions to the problem must have sound engineering and technical bases, the solution does not require a full engineering design presentation. Similarly, the problem poses economic and political issues that will be addressed in a qualitative manner. Solutions are expected to provide reasonable resolutions applying basic engineering and scientific knowledge to research scenarios and critical questions.

Preparation of broad background knowledge of the challenge topic will be the key to a successful competition. At the COE, A&WMA and CSWEA conference attendees and professionals in the environmental field will be identified and available for students to approach with questions and to consult for opinions. Students should approach conference attendees and exhibitors to identify additional individuals with expertise that is germane to the EC problem. The conference offers a great networking opportunity and the EC problem provides an excellent topic for discussion and networking. The environmental professionals provide a key interaction for the EC participants by offering direct feedback on their solutions, asking questions to prepare the students for the project presentations, and enhancing the student networking experience at the COE.

Award

Team solutions are scored and the anticipated awards for the EC are as follows:

1st Place: $1,500
2nd Place: $1,000
3rd Place: $500

Eligibility

The EC competition is open to all undergraduate students.

Students must register in advance for AND attend the conference to participate in the competition. The conference cost is $25 for students. This conference fee includes lunch, access to conference sessions when teams are not participating in the EC activities, and a one-year student membership in either A&WMA-UMS or CSWEA Minnesota Section.

Student teams may not contain more than five members and are generally comprised of three to five individuals.

Expectations for Proposed Problem Solutions

Solid technical analysis, logic train, process, conceptualizations, and creativity are all important to the solution and the content of your presentation. Successful teams will offer a clear and concise presentation of their solution and the rationale behind the elements of the solution. Your team will need to make reasonable assumptions as part of the solution. The assumptions must pass the "straight-face" test. This is (almost) the real world!

Challenge Elements

Team deliverables will consist of the following three elements:

1) Written solution submitted prior to the conference
2) Table-top presentation at the conference
3) Formal presentation at the conference

Written solutions will be submitted prior to the COE. The table-top and formal presentation will be made at the conference.

Written Solution:
Each team must submit, via email to Cassidy Buckley at cassidy.buckley@awma-ums.org, a written solution by November 2, 2016. The solution should summarize the problem issues and the team's approach to the problem. The solution must identify each team member by name and the role they will have in the presentation (e.g., "Sally Smith" is the Wastewater Engineer and will address wastewater issues, "Jim Jones" is the Project Manager, "Dave Thomas" is the Water Engineer, etc. Include the disciplines that you think you need). The written solution *shall not* exceed five pages. Supporting documentation, such as detailed analyses, should be referenced as necessary and may be a part of the Table Top presentation in the form of tables and graphs.

Table-top Presentation:
Each team must prepare and bring a table-top presentation of the solution to the COE. The goal of the table-top presentation is to give teams the opportunity to present their solution and receive feedback in an interactive manner with the conference participants. Conference participants will also be scoring the table-top presentations.

EC TABLE-TOP GUIDELINES

1. The *entire team* is asked to be present for the table-top presentation at the COE.
2. Each EC team will be assigned one 8-foot folding table in the Environmental Challenge room.
3. Your table-top materials should be prepared so that they may be arranged easily on the table. There is no prescribed format for the table-top materials, but they MUST include the title and the full team listing.
4. Figures, graphs, and tables should be uncluttered and simple and arranged in the sequence in which you want them to be viewed. The written report should be prepared in Microsoft Word with analyses in Microsoft Excel (or the equivalent), with a good quality printout of hardcopy materials. Materials may also be presented on a laptop provided by the student team. Text and figures should be large enough to be read from a distance of six feet. Color may be used for emphasis.
5. Team members should be prepared to brief conference participants as they visit the team table. The brief should summarize important assumptions and conclusions and clearly articulate proposed solutions to the challenge problem. A limited number of copies of the written solution should be available for distribution to interested individuals. Additionally, creativity is important in making your solution stand out. Hand-outs and other exhibits may be used to further advertise your table-top presentation.
6. Table-top setup will follow an 8:45 a.m. orientation meeting at the conference. Judging will take place after the orientation, from approximately 9:00 - 11:00 a.m. EC participants must be available to interact with the judges during the entire table-top judging period.

Formal Presentation:
Teams will provide a formal presentation of their problem solution in the afternoon to a panel of judges who are environmental professionals. The presentation should incorporate information that may have been gained during the table-top interaction. Presentation order will be chosen randomly.

A computer and projector will be provided for the presentation (with Microsoft PowerPoint). Please bring your presentation on a data stick or disk to be transferred to the computer. Plan for no more than a 15-minute presentation followed by five minutes of questions and answers.

Presentations will be judged by a panel identified prior to the COE – the panel will meet at the COE to determine top solutions.

Scoring and Awards

The winning team presentation will be strong in approach, logic, clarity, application, and creativity. Combined scores from the written solution, table-top presentation, and formal presentation will be used to determine the winning teams.

The top three teams will be announced at an Awards Ceremony at the end of the conference.

EC Timeline Summary

EC teams are required to attend an EC orientation meeting at 8:45 a.m. the day of the conference. This meeting will be held to review the EC problem and procedures, introduce judges, and answer general EC presentation questions. Check in at the Student Welcome Booth for room information.

Milestone	**Date/Time**
Teams Provide Intent to Participate	October 14, 2016
Written Proposals Due by E-mail to Cassidy Buckley	November 2, 2016
EC Orientation Meeting at the COE	November 9, 2016 – 8:45 a.m.
EC Table-Top Presentation Setup at the COE	Before and After the Orientation Meeting
EC Table-Top Presentation/Interaction at the COE	November 9, 2016 – 9:00-11:00 a.m.
EC Formal Presentations at the COE	November 9, 2016 – 1:00-3:00
EC Awards Ceremony at the COE	November 9, 2016 – 4:30
**Schedule is subject to changes to accommodate number of teams participating.*	

Questions should be directed to: Cassidy Buckley cassidy.buckley@awma-ums.org
651.395.5207

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2016 PROBLEM

Purpose

The Student Environmental Challenge sponsored by the Upper Midwest Section of the Air & Waste Management Association and Central States Water Environment Association gives students who are interested in a career in environmental engineering and science a 'real-world' and a 'local' experience in environmental problem solving. To that end, we hope to give you a glimpse of a real-world issue in need of creative solutions. We want to hear about the issues involved, how you interpret the problem, how you arrived at your conclusions, and how well you can communicate your thoughts.

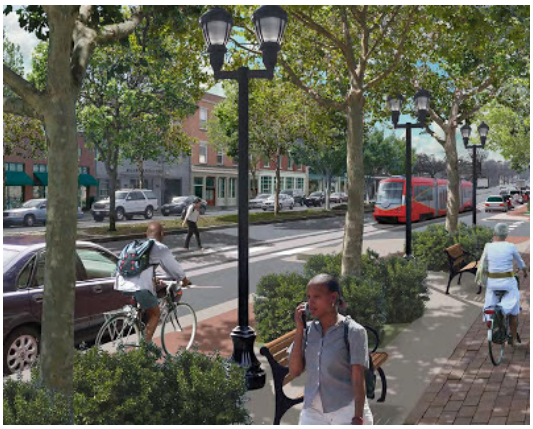
You will have the opportunity to present your problem solution to a panel of environmental professionals. We want you to have fun! This exercise provides a broad opportunity for participation and gets the professionals of tomorrow to interact with the professionals of today.

Problem Description

An investment group has hired your firm to locate, design, permit, build, and startup a turnkey metal plating operation in the Twin Cities in one of three prospective areas (fictionalized for the purposes of this problem). There are two potential designs being evaluated, one is based on a chromium plating process and one is based on a nickel plating process. The economics and environmental requirements and hurdles associated with each potential location and plating type vary. This problem focuses only on the first phase of the project: for your firm to adequately determine the specific location for the plant AND the recommended plating type, either chromium or nickel, based on economic and environmental considerations.

The customer requirements for both the chromium and nickel plating businesses require very clean steel metal parts, necessitating an advanced, large-scale, heated solvent cleaner. The solvent cleaner used is a proprietary non-hazardous air pollutant (non-HAP) solvent, known as VOCWash; however, it is still considered a VOC by EPA. Both chromium and nickel plating businesses will require a plating emissions stack and a solvent cleaner stack.

The three prospective locations each pose interesting challenges with respect to environmental considerations. The first area is the **East Metro Industrial Park**. Although specifically developed for industrial type facilities, it is currently an area of extreme non-attainment for ozone. Any facility with emissions of greater than 10 tons per year volatile organic compound (VOC) emissions will require Non-Attainment New Source Review Lowest Achievable Emission Rate (LAER) Control Technology. Uncontrolled VOC emissions from the solvent cleaner are 20 tons per year, requiring the installation of LAER control. The property site allows for stack heights as tall as 20 meters, and the closest nearby neighbor (or environmental receptor) is 20 meters from both stacks. The cost of the property is $0.5 million dollars. Because it is an industrial park, there are no additional taxes applied to facilities.



The second proposed area is known as **Pleasantville**. Pleasantville is a mixed residential and light industrial area which, in recent times, has prided itself on stopping all new industrial developments. Unlike the East Metro Industrial Park, Pleasantville is attainment for all criteria pollutants, so LAER for the solvent cleaner emissions would not be required. Although the general population is opposed to the plant, the city council of Pleasantville is hoping a light industrial facility could be achievable to boost the tax revenue. Pleasantville charges a 20% sales tax on industrial products sold applied to the plant location, i.e., applicable to the proposed area. The cost of the Pleasantville property is $1 million dollars. The property site allows for stack heights as tall as 10 meters, and the closest nearby neighbor (environmental receptor) is 30 meters from both stacks.

The third proposed area is the **West End**. The West End is a mixed residential and heavy industrial area, though much of the industry has left the area, leaving many old vacant buildings. The area is in attainment for all criteria pollutants, so LAER for the solvent cleaner emissions would not be required. Residents of the West End have been identified by the MPCA as being disproportionately impacted by negative effects of air pollution, as well as under-represented or not represented at all in the decision-making process associated with new sources of air pollution, such that the West End has been recognized as an area of concern for environmental justice by the EPA and MPCA. MPCA requires a cumulative effects analysis along with any permit documentation. Previous cumulative effects analyses have been satisfied in part by the

use of the Air Emissions Risk Analysis (AERA) Risk Analysis Screening Spreadsheet (RASS) (note: for the purposes of this problem, the RASS spreadsheet analysis is sufficient). To encourage some economic development, there are no additional taxes applied to facilities. In addition, the cost of the property is only $100,000, and the new construction cost for the facility can be reduced by one half due to re-use of vacant industrial buildings on the property. So the original costs of $2 million for a nickel plating facility and $4 million for a chromium plating facility can be reduced to $1 million for the nickel plating facility and $2 million for the chromium plating facility. However, the property is also a contaminated site under remediation, so any new owner would assume the cost of continued remediation for the next 10 years at a cost of $100,000 per year. The property site allows for stack heights as tall as 10 meters and the closest nearby neighbor (environmental receptor) is 15 meters from both stacks.

Economic and Environmental Data

To evaluate between the chromium plating process and the nickel plating process, the following economic and environmental data has been assembled:

Chromium Plating Process

Economic Data

- Material, Utility, and Labor Cost of Chromium Plating: $3 per mil of coating per square foot of part ($3/mil-ft^2) (please note a mil is a thousandth of an inch)
- Total Area of part to be coated: 0.25 square foot (ft^2)
- 2 mil thickness of chromium coating
- 250 parts per day per electroplating line
- 10 electroplating lines in the chromium plating facility
- $4 million capital cost for facility ($2 million if built in West End)
- 250 production days per year
- Sales price of $4 per finished part ($4/part), all parts sold (good market for parts)
- VOCWash will be provided at no cost by a subsidiary of the investment group

Environmental Data (Air Emissions)

- 0.12 grains of chromium compound emissions (MPCA Number 0-00-5, Chromium Compounds) per ampere per hour (0.12 grains/amp-hr)
- 120 amps per electroplating line
- Assume 12 hours per day, 250 production days per year for emissions
- 7,000 grains equals one pound (1 lb)
- One stack for the combined exhaust of all electroplating lines: exhausted at 4,000 dry standard cubic feet per minute (dscfm)
- One stack for the solvent cleaning: exhausted at 2,000 dry standard cubic feet per minute (dscfm)
- Heating for the solvent cleaning and electroplating is electric (no combustion emissions)

Nickel Plating Process

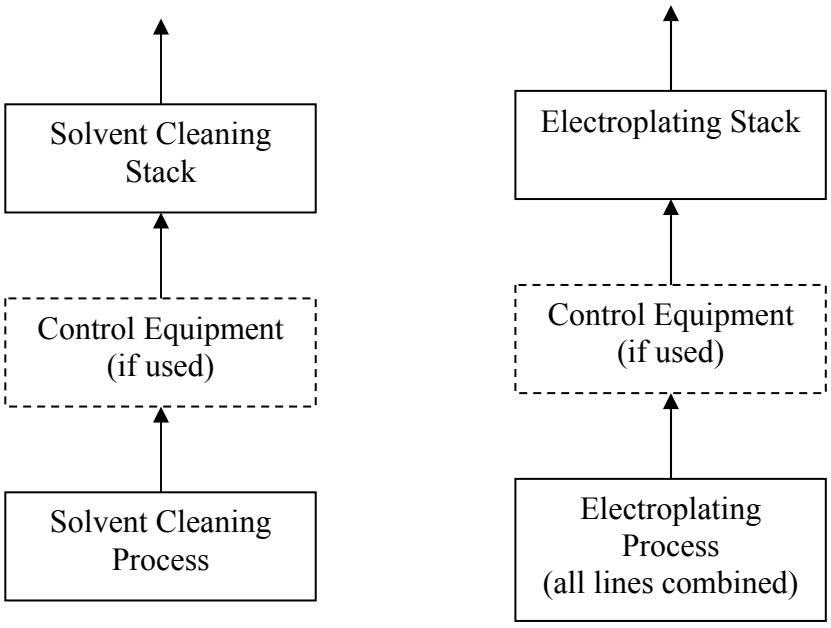
Economic Data

- Material, Utility, and Labor Cost of Nickel Plating: $2 per mil of coating per square foot of part ($2/mil-ft^2)
- Total Area of part to be coated: 0.25 square foot (ft^2)
- 0.5 mil thickness of nickel coating
- 250 parts per day per electroplating line
- 10 electroplating lines in the nickel plating facility
- $2 million capital cost for facility ($1 million if built in West End)
- 250 production days per year
- Sales price of $1 per finished part ($1/part), all parts sold (good market for parts)
- VOCWash will be provided at no cost by a subsidiary of the investment group

Environmental Data (Air Emissions)

- 0.63 grains of nickel compound emissions (MPCA Number 0-01-5, Nickel Compounds) per ampere per hour (0.63 grains/amp-hr)
- 10 amps per electroplating line
- Assume 12 hours per day, 250 production days per year for emissions
- 7,000 grains equals one pound (1 lb)
- One stack for the combined exhaust of all electroplating lines: exhausted at 4,000 dry standard cubic feet per minute (dscfm)
- One stack for the solvent cleaning: exhausted at 2,000 dry standard cubic feet per minute (dscfm)
- Heating for the solvent cleaning and electroplating is electric (no combustion emissions)

Process Flow Diagram for both Chromium and Nickel Plating Facilities



The following environmental issues must be addressed in conjunction with the economic analysis, i.e., all pollution control equipment related costs (capital and operational) should be added into the economic models. There are basically three main environmental issues driving these costs and requirements.

Issue No 1: Compliance with MACT Standards

Your team must evaluate each type of plating facility with respect to the following EPA Maximum Achievable Control Technology Standards:

- 40 CFR Part 63 Subpart N—National Emission Standards for Chromium Emissions From Hard and Decorative Chromium Electroplating and Chromium Anodizing Tanks
- 40 CFR Part 63 Subpart WWWWWW—National Emission Standards for Hazardous Air Pollutants: Area Source Standards for Plating and Polishing Operations

Because they are federal standards, they will apply to the chromium and/or nickel plating facilities at any of the three proposed locations. The team must determine what control technology is required by the MACT standards, if any, and the associated capital and operating costs.

Issue No. 2: Environmental Impact

As mentioned above, the primary concern for the West End location will be the air impacts from the plating facility as predicted by the Air Emissions Risk Analysis (AERA) Risk Analysis Screening Spreadsheet (RASS). The RASS provides the impact of emissions from the stack in terms of receptor concentration and associated acute and chronic impact versus acceptable impact levels, using the emissions, stack height, and distance to the receptor as inputs. In addition, this tool may be helpful to persuade any Pleasantville project opponents that suitable control equipment will be installed to prevent any significant environmental impact to the surrounding area. Although not strictly required for the East Metro Industrial Park, it could help confirm the control equipment design and stack height.

Issue No 3: Control Equipment Costs

For each proposed site, a different level of control equipment control efficiency (and associated costs) is anticipated. In addition, the East Metro Industrial Park location will entail an additional VOC control device for the solvent cleaner meeting LAER requirements. The capital and operating costs for these devices should be estimated as well as possible. The estimated VOC emission exhaust for the solvent cleaner for both chromium and nickel processes is categorized as follows:

- 13.33 lbs/hr VOC emissions
- 2,000 scfm exhaust flowrate
- Negligible heat of combustion of the VOC emissions

The problem: Convince the investment group that you have considered all of the economic and environmental requirements and hurdles and can recommend a specific plating type facility to be installed at one of the specific property locations. Be forthright regarding the importance of community engagement and environmental compliance associated with the selected option. Make sure you tell a convincing story to the group such that the final selected facility will make a handsome profit, while being a project the group can be proud of.

Helpful Websites for Tools and Information:

- EPA-AP42 Section on Electroplating: https://www3.epa.gov/ttnchie1/ap42/ch12/final/c12s20.pdf
- EPA RACT/BACT/LAER Clearinghouse: https://cfpub.epa.gov/rblc/
- EPA Control Equipment Costs Manual: https://www3.epa.gov/ttncatc1/dir1/c_allchs.pdf
- US EPA MACT Standards for Metal Processes: https://www.epa.gov/stationary-sources-air-pollution/clean-air-act-standards-and-guidelines-metals-production-industry
- EPA Environmental Justice Website: https://www.epa.gov/environmentaljustice
- MPCA Environmental Justice Website: https://www.pca.state.mn.us/about-mpca/mpca-and-environmental-justice
- MPCA AERA Website: https://www.pca.state.mn.us/air/air-emissions-risk-analysis-aera
- *Please note: The Risk Analysis Screening Spreadsheet (RASS) Version Number 2016-02 is recommended for this problem*

Where you will need to make assumptions, please clearly state your assumptions. A thoroughly considered project should address:

1. An economic model for each alternative to maximize investment while also being a responsible environmental partner to the surrounding community. There is no need to consider inflation, interest on loans, other non-specified taxes (other than the Pleasantville Sales Tax mentioned in the problem), or other compliance costs.
2. Consideration of innovative persuasion campaigns for selecting either the Pleasantville or West End locations.
3. Consideration of the additional costs and potential secondary pollutants associated with the solvent cleaner control equipment at the East Metro Industrial Park location.
4. Clear comparison of the various options and associated environmental risks so that the investment group is convinced of the long term benefit of the type of plating facility and location selected.
5. Public perception of, and potential opposition to, the plating facilities.

Present your recommended plan including descriptions of relative advantages and disadvantages compared to other options considered. Just as important as the economic analysis will be the analysis of the non-cost issues (e.g., public perception, political).

Thanks for participating. Good luck – we await your proposal with great anticipation!