2026 MCM Training

Problem A: The River Intake Shield

Photo Credit: pixabay.com

In water-supply systems, a river intake is the lifeline of a city. When an upstream spill occurs during wet weather, operators must decide whether to keep withdrawing water or temporarily shut down the intake to protect public health.

After a storm, a chemical storage tank in an agricultural area ruptures and a water-soluble contaminant enters the river. The city's water utility withdraws raw water from an intake 30 km downstream. Shutting down the intake is safe but costly; continuing withdrawal risks exceeding water-quality standards.

Your team is asked to build a continuous-time and continuous-space model for contaminant transport in a river reach and to design an operational decision strategy and a small early-warning sensor network under uncertainty.

Your team is required to develop mathematical models to address the following tasks:

The Hydrograph Reliable predictions depend on the river discharge. The spill event is assumed to occur in June 2025. A baseline hourly discharge time series for June 2025 is provided in `flow_hourly_baseline_2025_06.csv` and should be used as the primary input Q(t) for all simulations. Monthly discharge statistics from a USGS gauging station are also provided for background context and to justify whether the June condition represents a low, typical, or high-flow scenario. Teams may optionally explore alternative flow scenarios, but all assumptions must be clearly stated.

The Traveling Plume Develop a 1-D advection–dispersion (and optional decay) model for the pollutant concentration C(x,t) over the 30 km reach. Estimate and justify key parameters (cross-section area, velocity, dispersion coefficient, decay rate) and quantify the arrival time, peak concentration, and duration above thresholds at the intake. Typical ranges for key transport parameters are provided in `scenario_parameters.yaml`, and teams should perform sensitivity analysis within these ranges.

The Shutdown Decision Design an actionable intake operation rule: when to shut down, for how long, and when to reopen. Define and justify an objective function that accounts for shutdown cost, supply reliability, and water-quality risk. Evaluate robustness under hydrologic and model-parameter uncertainty.

The Early-Warning Network With a budget allowing at most 3 online concentration sensors, choose sensor locations from the provided candidate list. Sensors have measurement noise and a 5-minute reporting delay. Propose a placement method (optimization, simulation-based search, or heuristic) and quantify how much the network improves warning time and reduces expected loss.

Memo to the Utility Management Write a one-page memo to the water utility management describing your recommended decision rule and sensor placement. Explain in plain language why your strategy is better than simple fixed-threshold shutoffs or placing all sensors at the intake.

Files provided

- flow_monthly_usgs_01491000_raw.csv: monthly flow statistics (USGS station 01491000), units--cfs.
- flow_hourly_baseline_2025_06.csv: Baseline hourly discharge time series for June 2025 (units: m^3/s).
- scenario_parameters.yaml: Scenario constants (reach length, geometry, spill mass, costs, etc.).
- spill_profile_1min.csv: 1-minute mass release rate time series for the spill event.
- river_geometry_segments.csv: River geometry by 5-km segments (width, depth).
- quality_thresholds.csv: Intake water-quality thresholds.
- candidate_sensor_locations_km.csv: Candidate sensor locations (km downstream from spill point).

- water_demand_profile_relative.csv: Optional diurnal relative demand profile.

A detailed data description is provided in `Readme.md`.

Glossary

• Discharge Q: River flow rate (cfs in USGS files; convert to m^3/s as needed).

• Advection: Downstream transport driven by the mean flow velocity.

• Dispersion: Spreading of the pollutant plume due to velocity gradients and mixing.

• Intake shutdown: Temporary stop of raw-water withdrawal to avoid contaminated water.

• Alert threshold / Shutdown threshold: Concentration levels triggering warning / mandatory shutdown.

Your PDF solution of no more than 25 total pages should include:

• One-page Summary Sheet.

• Table of Contents.

• Your complete solution (models, assumptions, validation, sensitivity analysis).

• One-page memo.

• References list.

• AI Use Report (If used, does not count toward the 25-page limit).

Note: The contest has a 25-page limit. All aspects of your submission count toward the 25-page limit (Summary Sheet, Table of Contents, Reference List, and any Appendices). You must cite the sources for your ideas, images, and any other materials used in your report.

Use of Large Language Models and Generative AI Tools in COMAP Contests: Please refer to the attachment for the new policy regarding this issue.

Use of Large Language Models and Generative AI Tools in COMAP Contests

This policy is motivated by the rise of large language models (LLMs) and generative AI assisted technologies. The policy aims to provide greater transparency and guidance to teams, advisors, and judges. This policy applies to all aspects of student work, from research and development of models (including code creation) to the written report. Since these emerging technologies are quickly evolving, COMAP will refine this policy as appropriate.

Teams must be open and honest about all their uses of AI tools. The more transparent a team and its submission are, the more likely it is that their work can be fully trusted, appreciated, and correctly used by others. These disclosures aid in understanding the development of intellectual work and in the proper acknowledgement of contributions. Without open and clear citations and references of the role of AI tools, it is more likely that questionable passages and work could be identified as plagiarism and disqualified.

Solving the problems does not require the use of AI tools, although their responsible use is permitted. COMAP recognizes the value of LLMs and generative AI as productivity tools that can help teams in preparing their submission; to generate initial ideas for a structure, for example, or when summarizing, paraphrasing, language polishing etc. There are many tasks in model development where human creativity and teamwork is essential, and where a reliance on AI tools introduces risks. Therefore, we advise caution when using these technologies for tasks such as model selection and building, assisting in the creation of code, interpreting data and results of models, and drawing scientific conclusions.

It is important to note that LLMs and generative AI have limitations and are unable to replace human creativity and critical thinking. COMAP advises teams to be aware of these risks if they choose to use LLMs:

- Objectivity: Previously published content containing racist, sexist, or other biases can arise in LLM-generated text, and some important viewpoints may not be represented.

- Accuracy: LLMs can ‘hallucinate’ i.e. generate false content, especially when used outside of their domain or when dealing with complex or ambiguous topics. They can generate content that is linguistically but not scientifically plausible,

they can get facts wrong, and they have been shown to generate citations that don't exist. Some LLMs are only trained on content published before a particular date and therefore present an incomplete picture.

• Contextual understanding: LLMs cannot apply human understanding to the context of a piece of text, especially when dealing with idiomatic expressions, sarcasm, humor, or metaphorical language. This can lead to errors or misinterpretations in the generated content.

• Training data: LLMs require a large amount of high-quality training data to achieve optimal performance. In some domains or languages, however, such data may not be readily available, thus limiting the usefulness of any output.

Guidance for teams

Teams are required to:

1. **Clearly indicate the use of LLMs or other AI tools in their report**, including which model was used and for what purpose. Please use inline citations and the reference section. Also append the Report on Use of AI (described below) after your 25-page solution.

2. **Verify the accuracy, validity, and appropriateness** of the content and any citations generated by language models and correct any errors or inconsistencies.

3. **Provide citation and references, following guidance provided here.** Double-check citations to ensure they are accurate and are properly referenced.

4. **Be conscious of the potential for plagiarism** since LLMs may reproduce substantial text from other sources. Check the original sources to be sure you are not plagiarizing someone else's work.

COMAP will take appropriate action
when we identify submissions likely prepared with
undisclosed use of such tools.

Citation and Referencing Directions

Think carefully about how to document and reference whatever tools the team may choose to use. A variety of style guides are beginning to incorporate policies for the citation and referencing of AI tools. Use inline citations and list all AI tools used in the reference section of your 25-page solution.

Whether or not a team chooses to use AI tools, the main solution report is still limited to 25 pages. If a team chooses to utilize AI, following the end of your report, add a new section titled Report on Use of AI. This new section has no page limit and will not be counted as part of the 25-page solution.

Examples (this is not exhaustive – adapt these examples to your situation):

Report on Use of AI

Team Control Number: _____

Team Members: _____, _____, _____

AI Tools Used （Example）

AI Tool	Version/Model	Primary Purpose
OpenAI ChatGPT	GPT-4 / GPT-4.5	Brainstorming, debugging
Claude	Claude 3.5 Sonnet	Model discussion, writing
DeepSeek	Latest version	Code generation, verification
GitHub Copilot	IDE-integrated	Code completion

Query/Response Record

ChatGPT Query 1:

Query1: < *insert the exact wording you input into the AI tool*>

Output: < *insert the complete output from the AI tool*>

Purpose: [Brief description of use, e.g., "Understanding advection-dispersion equation formulation"]

Claude Query 1:

Query1: < *insert the exact wording you input into the AI tool*>

Output: < *insert the complete output from the AI tool*>

Purpose: [e.g., "Optimizing decision model mathematics"]

DeepSeek Query 1:

Query1: < *insert the exact wording you input into the AI tool*>

Output: < *insert the complete output from the AI tool*>

Purpose: [e.g., "Generating data preprocessing Python code"]

Human Contribution Declaration

We affirm that:

1. All final modeling decisions, algorithm designs, and interpretations were made by team members.
2. All mathematical derivations were verified by us.
3. All code was reviewed, tested, and understood by us.
4. AI was used only for brainstorming, code snippets, translations, and explanations.
5. The final solution represents our own work and understanding.

(Date: _____)

Appendix: Reference of Common AI Tools (as of 2026)

Language Models:

- **OpenAI**: ChatGPT (GPT-4, GPT-4.5, GPT-5 may be available)
- **Anthropic**: Claude (Claude 3, Claude 3.5 Sonnet)
- **Google**: Gemini (Gemini Pro, Gemini Ultra)
- **Baidu**: ERNIE Bot (ERNIE 4.0)
- **DeepSeek**: DeepSeek latest version
- **Moonshot AI**: Kimi Chat

Code Assistant Tools:

- **GitHub Copilot** (integrated in VS Code and other IDEs)
- **Amazon CodeWhisperer**
- **Tabnine**
- **Replit AI**

Other Tools:

- **Microsoft Copilot** (formerly Bing Chat)
- **Perplexity AI** (research assistance)
- **Wolfram Alpha** (computations and visualizations)

Important Notes:

1. Please truthfully record all AI usage.
2. Queries and outputs may be appropriately summarized, but key information must be retained.
3. It is recommended to record AI usage in real-time during the competition.
4. All content in the final report must undergo manual review and verification by the team.