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Huang, Jingyan and Mo, Weiwei, "City of Leaf Collaborative Drinking Water Emergency Response Serious Game" (2024). *Faculty Publications*. 2001.
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City of Leaf Collaborative Drinking Water Emergency Response Serious Game

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June 2024

Acknowledgment

This serious game was developed with funding provided by the U.S. National Science Foundation under a CAREER award (#2047199). We would like to thank the CityPULSE research group, Dr. Catherine M. Ashcraft, and all anonymous facilitators and participants involved in the game testing for their feedback and suggestions in improving the game design.
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Table of Contents

The City of Leaf serious game is a five-party role-playing game for a response to a drinking water contamination emergency. The following materials are included in this teaching packet:

In addition, there is a separate PowerPoint presentation in this packet that introduces the game settings and rules for playing.

1. Teaching Notes

The teaching notes are designed for instructors to provide them with a high-level game overview and to guide them in preparing, setting up, and running the game. The teaching notes also highlight the key lessons participants can gain from the game.

Teaching Notes

Overview
In this game, players dive into a water crisis in the fictional City of Leaf. Disaster strikes when TXC, an unregulated and poorly understood chemical, leaks from underground tanks at *SynthoChem Corporation*. This leakage threatens the city's water supply. At the start of the game, not all roles are aware of the unfolding crisis. Players need to initiate the exchange of information, investigate the full extent of the emergency, strategize responses to manage the situation, and work towards a solution that satisfies the interests of all involved.

There are five roles in this game:

- *SynthoChem Corporation*: A major chemical manufacturer in the city and the polluter.
- *Resident in the City of Leaf*: A resident affected by the water crisis.
- *Leaf Drinking Water Treatment Plant*: A local water supplier.
- *Environmental Agency*: The regulatory body overseeing environmental compliance.
- *Health Department*: The agency responsible for public health analysis and technical support.

Target Audience
The game's target audience includes drinking water system operators, municipal and state emergency response managers, and graduate and undergraduate students in relevant programs.

Logistics
Preparation
The game requires five players (each to take a role) and one facilitator per group. Roles may be doubled if a group has more than five players. After forming the groups, game materials need to be distributed accordingly. If conditions allow, it is recommended to share the general and confidential instructions with the players in advance of the game session to allow time for understanding the roles and facilitate more immersive game play. General instructions provide common knowledge to all roles, outlining the game's setting and explaining the gameplay mechanics. Confidential instructions provide private information exclusive to each role, including a one-page narrative describing the backstory of the role that contains their distinct responsibilities, knowledge, and capabilities, a one-page worksheet that specifies their primary concerns and suggested strategies, and a one-page note-taking sheet that facilitates recording communications, costs incurred, and voting outcomes in each round. In addition, each role also receives a set of action cards, which details potential actions they can take to fulfill their responsibilities or address specific concerns. Participants should not show the confidential instructions to one another, although they may choose to verbally share any information they want during the game.

Room Set-Up
If multiple groups are going to play the game simultaneously, a large room with a projector is preferred for the pre-game introductory PowerPoint presentation. This presentation will provide an overview of the game's setting and an introduction on how to play. Separate rooms or spaces are ideal for the groups to play independently. Each of these spaces should have a table where

participants can sit together, as well as some area that facilitates one-on-one private conversations.

Agenda
The entire game experience requires approximately 2 to 3 hours in total.

Steps	**Recommended Time Allotment**
1. Game Introduction	10 minutes
2. Instructions Review	15 – 20 minutes
3. Gameplay	1 – 1.5 hours
4. Debriefing	30 – 45 minutes

Step 1. Game Introduction (10 minutes)
The instructors or the facilitators introduce the game's setting and gameplay mechanism to all participants using the provided PowerPoint slides.

Step 2. Instructions Review (15 – 20 minutes)
Each participant will review the general and confidential instructions provided to them. General instructions should be distributed to all players. Confidential instructions should be distributed according to the role each participant is playing. The time at this step can be reduced if participants have read the general and confidential instructions ahead of the game session.

Step 3. Gameplay (1 – 1.5 hours)
Each group plays the game under the guidance of their facilitator. The game progresses in rounds, each consisting of three phases:

- Spread Out (5 minutes): The "spread out" phase provides participants 5 minutes to spread out and engage in private, one-on-one conversations, with the option to speak to multiple roles if time allows. They need to decide which information to share or withhold, whom to approach for information, and who might benefit from their information. As the game progresses, new information can emerge, altering their understanding of the current condition and response strategies.
- Gather: The "gather" phase allows each player to execute up to two role-specific action cards. These cards enable a range of activities, such as conducting investigations to acquire additional information, mitigating the impact of incidents, and requesting specific actions from others. When executing an action card, players may be instructed to give the card to the facilitator in exchange for a response card, which contains additional essential information for solving the water crisis at hand.
- Vote: In the "vote" phase, the facilitator initiates a vote, and players cast their ballots based on their satisfaction with their current condition. A unanimous "yes" vote ends the game, while any "no" votes extend the game to the next round. Players are encouraged to engage in negotiations aimed at achieving unanimous satisfaction, thereby ending the game in the fewest rounds possible.

Step 4. Debriefing (30 – 45 minutes)

After the conclusion of the game session, all participants should reconvene for the debriefing session to reflect on the gameplay and learning outcomes. Here are questions to guide the debriefing:

- Did you achieve your goal, and what is your strategy for achieving your goal?
    - Key lessons: Serious games enable participants to explore potential solutions and experiment with innovative approaches for managing water crises. By comparing strategies and outcomes across various roles and groups, participants can identify effective strategies, which guides them on potential approaches to adopt for successful crisis resolution in real-world scenarios.
- What was the biggest challenge you encountered and how did you attempt to overcome it?
    - Key lessons: Responding to a drinking water contamination emergency involves a complex array of challenges, e.g. information scarcity, miscommunication, etc. Serious games allow participants to experience these challenges and help foster a proactive mindset towards implementing changes to effectively manage such challenges.
- What would you do differently in cooperation and communication if you were to approach this situation again?
    - Key lessons: Frequent, early, and transparent communication, along with strategic collaboration, is crucial for managing complex emergency situations and can greatly influence the outcome of crisis resolution.
- What did you learn from playing the game, and how did the game help you gain a better understanding of emergency response?
    - Key lessons: This serious game provides participants with the opportunity to experience emergency response to drinking water contamination from a specific party's perspective. It improves their understanding of the dynamics involved in such emergencies and strengthens their abilities to prepare for and respond effectively to such crises.

Game Materials Checklist

- Materials for each of the 5 roles:
    - Table tent card – 1 sheet
    - General instructions – 1 sheet
    - Role-specific confidential instructions – 3 sheets, single-sided
    - A stack of action cards
    - A stack of game checks
    - 1 pen
- Materials for the facilitator
    - General instructions – 1 sheet
    - Facilitator's confidential instructions – 5 sheets, single-sided
    - A stack of response cards
    - Timer – use cell phone's timer app if possible
    - 1 pen

2. General and Confidential Instructions for Players

General instructions provide common knowledge to all roles. Confidential instructions provide private information exclusive to each role. Print one copy of general instructions for each player and one set of confidential instructions for each of the five roles per group. If possible, pre-cut the action cards before the game to facilitate easier use.

General Instructions

Welcome to the captivating world of Leaf, a bustling city with a population of around 15,000. This urban landscape is cradled by the gentle flow of the Bella River, the lifeblood of the city, which provides its life-sustaining water through the state-of-the-art Leaf Drinking Water Treatment Plant. Just a scenic two-mile journey upstream from the treatment plant lies a thriving medium-sized chemical manufacturer, SynthoChem Corporation, at the heart of Leaf's industrial vitality. Astonishingly, nearly 20% of Leaf's vibrant community is intimately connected to SynthoChem Corporation either through direct employment or by virtue of roles closely intertwined with its operations.

In this game, you will be assigned one of the 5 roles: (1) SynthoChem Corporation, (2) resident in the City of Leaf, (3) Leaf Drinking Water Treatment Plant, (4) Environmental Agency, or (5) Health Department. Your role is indicated on your name tag. Read carefully the attached "Confidential Instructions" to uncover information that is exclusively available to you. Your confidential instructions provide key information about your role and your priorities that guide your decisions and interactions throughout the game.

How to play

The game is played in rounds. Your objective in this game is to gather information and act upon the situation to resolve the issue in the fewest rounds, while maximizing your role's interests. Each round contains 3 phases in the following order:

1. **Spread out**: You have 5 minutes each round to talk to other roles. The goal of this phase is to gather sufficient information to inform your decisions and actions as well as to negotiate and coordinate with other roles in quickly resolving the issue, while maximizing your role's interests. Each conversation should be one-on-one and private, but you can speak with multiple roles if time permits.
2. **Gather**: All players gather to execute the action cards. Action cards can only be used during the "gather" phase and they only include actions that necessitate a response from either the facilitator or other roles. Certain actions have prerequisites, which must be satisfied before the card can be used. Note that your actions are NOT limited to those that have been specified by the cards. You can discuss other potential actions during the "spread out" phase or create additional actions using free action cards. You are limited to using a maximum of two action cards per round.
3. **Vote**: The facilitator initiates a vote to determine whether all roles are satisfied with their "current" conditions. If the vote is unanimously "yes", the game ends. Any "no" votes will result in the game proceeding to the next round. If the game has not concluded by the end of round 7, it will be automatically terminated.

Confidential Instructions for SynthoChem Corporation

You are the manager of the SynthoChem Corporation, a key industrial player in the City of Leaf. This morning, you noticed a potential leak of TXC, a commonly used chemical solvent in SynthoChem's manufacturing operations. The solvent is stored in multiple underground storage tanks on the company's premises, with a combined capacity of about 40,000 gallons. These tanks are located near the Bella River, the only water source for the **Leaf Drinking Water Treatment Plant** located about 2 miles downstream. An urgent investigation confirmed the leakage, with early estimates revealing around 7,500 gallons of TXC have escaped, and it is highly likely that the leakage is still ongoing. At this juncture, uncertainty prevails as to whether the chemical has made its way into the Bella River. If it has, concerns arise regarding the potential repercussions on the **Leaf Drinking Water Treatment Plant**.

As the manager, you are responsible for handling the leak and deciding on immediate actions. Generally, reporting chemical leakages to the **Environmental Agency** is a legal obligation when they pose sudden threats to public health. However, although recent studies have flagged TXC for potential human health risks, it has not yet been officially classified as a toxic substance by the **Health Department**. This lack of formal recognition creates a grey area in regulatory oversight. Consequently, the decision to report the leak to the **Environmental Agency** becomes complex, especially considering the potential repercussions on the company's public image.

You can conduct an internal investigation to determine whether the leakage has reached the Bella River, which is crucial in determining the scope of the remediation efforts required. Should the leakage be confined to the premises, you could engage an engineering firm to manage on-site remediation. This involves obtaining a quote for the on-site remediation actions and subsequently removing the tank and contaminated soil. However, if your investigation reveals that TXC has reached the Bella River, the situation escalates, necessitating collaboration with the **Environmental Agency** on cleaning up the river to protect ecosystem and human health, while your company still bears the financial responsibility. In this case, there is a high likelihood that the **Leaf Drinking Water Treatment Plant** is impacted, potentially exposing thousands of Leaf **residents** to TXC, leading to potential reputation damage, legal actions, and financial penalties imposed by the **Environmental Agency**. The financial implications could be significant. If the cumulative costs from fines, lawsuit settlements, and cleanup surpass $200 million, your company could be pushed to the brink of bankruptcy.

SynthoChem Corporation Worksheet

Primary Concerns:

- Economic Stability (Top Priority): Minimize financial losses. Avoid reaching a point where total costs threaten company solvency. You should vote "no" if you are nearing bankruptcy.
- Public Image: Preserve your company's reputation within the community.

Suggested Strategies:

- Financial Oversight: Monitor costs to prevent bankruptcy.
- Incident Reporting: Weigh the benefits and risks of reporting the incident to the Environmental Agency and determine the best timing to do so.
- Remediation Decisions: Evaluate immediate versus delayed action. Consider long-term legal, financial, and public image consequences.
- Public Image Maintenance: Craft public announcements to highlight the endeavors that have been taken to remedy the condition and the company's economic contribution to the city.
- Selective Information Disclosure: You cannot provide fake facts in all your communications. However, you are allowed to strategically choose what information to disclose and what to withhold.

Important Reminders:

- Your objective in this game is to end the game in **the fewest rounds possible** while ensuring your **own interests are met**.
- Consider voting "no" if you believe that additional actions or negotiations are necessary to achieve the best possible outcome for your company.

Note-Taking:

- Please use the table provided below to document your interactions, actions, and voting outcomes for post-game reflections and discussions:

Round #	Parties talked w/	Actions and Agreements	Costs Incurred	Remaining Budget	Your Vote
1	☐R ☐WTP ☐EA ☐HD				Y / N
2	☐R ☐WTP ☐EA ☐HD				Y / N
3	☐R ☐WTP ☐EA ☐HD				Y / N
4	☐R ☐WTP ☐EA ☐HD				Y / N
5	☐R ☐WTP ☐EA ☐HD				Y / N
6	☐R ☐WTP ☐EA ☐HD				Y / N
7	☐R ☐WTP ☐EA ☐HD				Y / N

R: Resident in the City of Leaf; WTP: Leaf Drinking Water Treatment Plant; EA: Environmental Agency; HD: Health Department

Leakage Investigation

Action SC_A

Action: Investigate to determine whether the leakage is still ongoing and whether it has reached the Bella River.

How to use the card: Give this card to the Facilitator for a private response.

On-Site Removal & Remediation Quote

Action SC_B

Action: Obtain a quote from a local engineering firm for containing the polluted area and remediating the soil onsite.

How to use the card: Give this card to the Facilitator for a private response.

On-site Removal & Remediation

Action SC_C

Prerequisite: Quote obtained from a local engineering firm.

Action: Contract the engineering firm to remove the leaking tanks and remediate the contaminated area.

Fill in: Cost $_____
Executed in Round #_____
Disclosure to the Public: Yes /No

How to use the card: Give this card to the Facilitator. This action may remain confidential. Inform the Facilitator if and when you wish to disclose it.

Public Announcement

Action SC_D

Action: Public announcement.

How to use the card: Give this card to the Facilitator to get an opportunity to make a public announcement.

Free Action Card

Action SC_E

Action: This card allows for a custom action of your choice. Describe the action you plan to take, ensuring it aligns with your role's responsibilities and capabilities.

Fill in your action:

_____
_____
_____
_____

How to use the card: Give this card to the Facilitator for execution.

Confidential Instructions for Resident in the City of Leaf

As a resident of the City of Leaf, your tap water is sourced from the **Leaf Drinking Water Treatment Plant**. Leaf boasts one of the region's most advanced water treatment facilities, which ensures the delivery of high-quality water to your home. However, this premium water supply comes at a cost, with your water bill proving to be quite substantial, particularly during the summer months when lawn irrigation becomes a necessity. This morning, your routine was disrupted when you detected an unusual fishy odor and a slightly bitter taste in the water flowing from your tap. Concerned, you reached out to your neighbors and discovered that they, too, had noticed these peculiar changes. One neighbor, in particular, reported experiencing dizziness and nausea after drinking tap water this morning, although no other neighbors had encountered the same issue.

While your suspicions lean towards an issue at the **Leaf Drinking Water Treatment Plant**, the precise nature of the problem remains a mystery, as no official notifications have been released. Your primary concern now is whether the water remains safe for consumption and daily use, as well as the potential health implications associated with these recent changes observed. You can voice your concerns to various authorities serving the City of Leaf. Any unusual changes in drinking water quality, such as the odor and taste, can be directly reported to the **Leaf Drinking Water Treatment Plant**, which is responsible for maintaining the purity of your water supply and should be able to provide updates on any recent changes that might have affected the water supply. **Leaf Drinking Water Treatment Plant** is regulated by the **Environmental Agency**, which is your go-to for regulatory concerns and potential environmental breaches that could affect water safety. For immediate health concerns related to water consumption, such as the symptoms experienced by your neighbor, you can reach out to the **Health Department**, which can conduct specific diagnostic tests, including blood tests, to ascertain chemical exposure levels and advise on intervention measures if necessary.

Resident in the City of Leaf Worksheet

Primary Concerns:

- Health and Safety (Top Priority): Ensure the tap water is safe and sufficient for you and your family. You should vote "no" if there is not a solid plan in place to address the water safety issue.
- Financial Concern: Avoid any further increase in your water rates.

Suggested Strategies:

- Engage in Dialogues: Proactively communicate with relevant authorities to express your concerns and stay informed about the water quality, potential contaminants, associated health risks, and protective measures.
- Public Announcement: Consider the best timing to make a public announcement to bring attention to the issue and put pressure on the responsible parties to take swift action.
- Legal Actions and Compensation: Consider suing the responsible party for the damage imposed on public health either by yourself or in collaboration with other relevant authorities. Legal actions might also target negligent authorities.
- Strategic Threats: Employ the threats of potential actions (e.g. lawsuits) to promote quicker responses and more favorable resolutions, without necessarily taking the actual actions.

Important Reminders:

- Your objective in this game is to end the game in **the fewest rounds possible** while ensuring your **own interests are met**.
- Consider voting "no" if you believe that additional actions or negotiations are necessary to achieve the best possible outcome for you and your family.

Note-Taking:

- Please use the table provided below to document your interactions, actions, and voting outcomes for post-game reflections and discussions:

Round #	Parties talked w/	Actions and Agreements	Your Vote
1	☐SC ☐WTP ☐EA ☐HD		Y / N
2	☐SC ☐WTP ☐EA ☐HD		Y / N
3	☐SC ☐WTP ☐EA ☐HD		Y / N
4	☐SC ☐WTP ☐EA ☐HD		Y / N
5	☐SC ☐WTP ☐EA ☐HD		Y / N
6	☐SC ☐WTP ☐EA ☐HD		Y / N
7	☐SC ☐WTP ☐EA ☐HD		Y / N

SC: SynthoChem Corporation; WTP: Leaf Drinking Water Treatment Plant; EA: Environmental Agency; HD: Health Department

Blood Test Request

Action R_A

Prerequisite: Confirmed presence and type of contaminant in tap water.

Action: Request blood test program from the Health Department to determine residents' current exposure level and monitor the long-term exposure to the contaminant.

Fill in: Specify the chemical:
_____

How to use the card: Give this card to the Health Department.

Initiate Lawsuit

Action R_B

Action: Initiate a class-action lawsuit to seek compensation between $50-200 million for public health damage caused by the polluter. You can collaborate with other affected parties for a joint lawsuit.

Fill in: Co-filling parties (optional):
_____
Compensation requested:
$_____million

How to use the card: Give this card to the Facilitator for a public announcement.

Compensation Settlement

Action R_C

Prerequisite: Agreement reached with the polluter on the compensation amount.

Action: Finalize settlement with the polluter on the compensation amount.

Fill in: Agreed settlement amount:
$_____million

How to use the card: Give this card to the Facilitator for a public announcement.

Public Announcement

Action R_D

Action: Public announcement.

How to use the card: Give this card to the Facilitator to get an opportunity to make a public announcement.

Free Action Card

Action R_E

Action: This card allows for a custom action of your choice. Describe the action you plan to take, ensuring it aligns with your role's responsibilities and capabilities.

Fill in your action:

_____
_____
_____
_____

How to use the card: Give this card to the Facilitator for execution.

Confidential Instructions for Leaf Drinking Water Treatment Plant

You are the manager of the Leaf Drinking Water Treatment Plant, a facility committed to delivering high-quality drinking water to the Leaf residents. The plant draws water from the Bella River and is situated near **SynthoChem Corporation**, a key player in the local economy located about 2 miles upstream. Despite having one of the highest water rates in the region, consumer confidence in the water quality is high – a testament to your rigorous standards and advanced treatment processes.

Your plant is under the regulation of the **Environmental Agency**, which enforces drinking water standards including Maximum Contaminant Levels (MCLs). MCLs specify the maximum permissible concentration of contaminants in drinking water, and your responsibility involves treating water to reduce regulated substances below MCLs. When an unregulated contaminant is detected – lacking specific MCL – you must consult the **Environmental Agency** for guidance on treatment level. In addition to water treatment, you are responsible for alerting the **Health Department** about potential health hazards. If the hazard is confirmed, you will work together with the **Health Department** in informing the public and rebuilding consumer confidence, while also collaborating with the **Environmental Agency** to restore water quality.

At the beginning of the game, your treatment plant is operating normally. Your plant is equipped with an online Total Organic Carbon (TOC) monitoring system to detect abnormalities in raw water. Although a recent check indicated a slightly elevated TOC level in the raw water, no alarm has been triggered and all other parameters read normally. As a part of your routine emergency planning, two emergency response options have been set up:

- **Treatment Option** ($50,000/round): Emergency onsite treatment with the addition of oxidant and powdered activated carbon (PAC). This option is effective when the contaminant concentration is relatively low compared to its MCL.
- **Bottled Water Option** ($250,000/round): Do-Not-Use order combined with bottled water delivery to the consumers. This option is preferred when the Treatment Option is insufficient or when its effectiveness is uncertain.

Table 1 outlines which emergency response option to choose based on the current contaminant concentration relative to its MCL. *You should work with the **Environmental Agency** to determine the necessary duration for either of the options.* If the overall response costs exceed $1 million, you will need to consider finding alternative funding sources to cover the cost or increasing the water rate in the following years. Each increment of 0.1% in the water rate corresponds to an additional revenue of $100,000.

Table 1. Emergency response selection based on current contaminant concentration and the contaminant's MCL

Current Contaminant Concentration	MCL ⩽ 0.005 mg/L	MCL 0.005–1 mg/L	MCL ⩾ 1 mg/L
⩽ 15 mg/L	Bottled Water Option	Treatment Option	Treatment Option
> 15 mg/L	Bottled Water Option	Bottled Water Option	Treatment Option

Leaf Drinking Water Treatment Plant Worksheet

Primary Concerns:

- Water Safety (Top Priority): Ensure the water is safe and sufficient for consumers. You should vote "no" if the tap water supply is not restored.
- Consumer Confidence: Uphold the community's trust in the quality of water you provide.

Suggested Strategies:

- Water Quality Monitoring: Initiate water quality tests immediately upon noticing any signs of potential contamination. This prompt action allows for quick identification of issues and timely responses.
- Emergency Water Supply Strategy: Refer to Table 1 to select an appropriate emergency water supply option based on your current situation. Maximum Contaminant Levels (MCLs) can be obtained from the Environmental Agency. Information on the current concentration of contaminants is available through either the Environmental Agency or water quality tests.
- Budget: Keep your expenses within your allocated budget of $1 million. If costs are projected to surpass this amount, consider raising water rates or seeking additional funding to ensure financial sustainability.

Important Reminders:

- Your objective in this game is to end the game in **the fewest rounds possible** while ensuring your **own interests are met**.
- Consider voting "no" if you believe that additional actions or negotiations are necessary to achieve the best possible outcome for the Leaf Drinking Water Treatment Plant.

Note-Taking:

- Please use the table provided below to document your interactions, actions, and voting outcomes for post-game reflections and discussions:

Round #	Parties talked w/	Actions and Agreements	Costs Incurred	Remaining Budget	Your Vote
1	☐SC ☐R ☐EA ☐HD				Y / N
2	☐SC ☐R ☐EA ☐HD				Y / N
3	☐SC ☐R ☐EA ☐HD				Y / N
4	☐SC ☐R ☐EA ☐HD				Y / N
5	☐SC ☐R ☐EA ☐HD				Y / N
6	☐SC ☐R ☐EA ☐HD				Y / N
7	☐SC ☐R ☐EA ☐HD				Y / N

SC: SynthoChem Corporation; R: Resident in the City of Leaf; EA: Environmental Agency; HD: Health Department

Water Quality Test

Action WTP_A

Action: Test to determine the type and concentration of contaminant(s) in the river water.

How to use the card: Give this card to the Facilitator for a private response. This card is reusable.

Apply the Treatment Option

Action WTP_B

Prerequisite: Confirmed source water contamination.

Action: Apply the Treatment Option – emergency onsite treatment with additional oxidant and PAC.

How to use the card: Give this card to the Facilitator for a public announcement. This card is reusable.

Apply the Bottled Water Option

Action WTP_C

Prerequisite: Confirmed source water contamination.

Action: Apply the Bottled Water Option – Do-Not-Use order combined with bottled water delivery to the consumers.

How to use the card: Give this card to the Facilitator for a public announcement. This card is reusable.

Water Rate Adjustment

Action WTP_D

Action: Announce intention to adjust water rate due to the accumulated emergency response costs.

Fill in: Water rate increase: _____%

How to use the card: Give this card to the Facilitator for a public announcement. This card is reusable.

Public Announcement

Action WTP_E

Action: Public announcement.

How to use the card: Give this card to the Facilitator to get an opportunity to make a public announcement.

Free Action Card

Action WTP_F

Action: This card allows for a custom action of your choice. Describe the action you plan to take, ensuring it aligns with your role's responsibilities and capabilities.

Fill in your action:

_____
_____
_____
_____

How to use the card: Give this card to the Facilitator for execution.

Confidential Instructions for Environmental Agency

You are a representative of the Environmental Agency, entrusted with the vital mission of protecting the environment and human health within your jurisdiction. Your role is vital in ensuring that the air we breathe, the water we drink, and the land we inhabit are safe and clean. In instances where environmental damage has occurred, it is your duty to oversee the restoration and mitigation of these harms to prevent further impact on public health and the ecosystem.

Your responsibilities include the regulatory oversight and enforcement of environmental standards, particularly concerning the quality of drinking water and the health of natural water bodies such as groundwater, rivers, and lakes. A key aspect of ensuring safe drinking water is the enforcement of Maximum Contaminant Levels (MCLs), the highest allowed level of contaminants in drinking water. Given the pace of new chemical innovations, not all substances are regulated or possess established MCLs. In situations where a chemical not currently regulated threatens drinking water safety, its Health Advisory (HA) Level, as formulated by the **Health Department**, can serve as a temporary MCL until a formal MCL is established.

As an authority in law enforcement, your role entails compelling all industries to promptly report any chemical leaks that may pose sudden threats to public health. During contamination incidents, you are authorized to conduct investigations into any potentially polluted sites to assess the pollutant's nature and extent. Additionally, it falls upon you to ensure that any necessary remedial actions are executed promptly. Should the responsible party fail to quickly eliminate the pollution source, you hold the authority to intervene directly, carrying out the cleanup and charging the costs back to the responsible entity. In situations where a chemical spill leads to widespread environmental damage, you will conduct environmental remediation to ensure long-term ecosystem and public health. You can mandate that the responsible party covers either a portion or the entire cost of these efforts.

Moreover, you have the authority to levy fines on violators based on the gravity of the violation and how swiftly and thoroughly they respond. Additionally, you manage a $30 million emergency response fund, which can be used to support a variety of urgent needs including clean-up efforts, **drinking water treatment plant** restoration, health monitoring programs, or any other exigency that arises within your purview. When a **drinking water treatment plant** is impacted by a chemical spill, your first priority is to contain the source of contamination. Following containment, the level of contamination is expected to decrease progressively in subsequent rounds, as detailed in Table 1. You are responsible for working together with the impacted **drinking water treatment plant** and guiding their response to the incident using this information.

Table 1. Changes in contaminant concentration after the removal of the contamination source

Round (Contaminant is removed in Round #N)	**% of the peak concentration**
0 to N	100
N	100
N+1	92
N+2	44
N+3	21
N+4	12
N+5	6
N+6	2
N+7	0.3

Environmental Agency Worksheet

Primary Concerns:

- Environmental Quality and Public Health (Top Priority): Protect natural resources and safeguard public health. You should vote "no" if there exists a significant threat to the environment or public health, and no robust mitigation strategy is in place.

Suggested Strategies:

- Prompt Investigations: Initiate immediate investigations upon detecting potential environmental threats to identify the nature of the threat and the responsible party.
- Pollution Source Elimination and Environmental Remediation: Take action to eliminate the pollution source to limit the spread of the pollutant. Implement environmental remediation to restore the environment.
- HA Level and MCL: Communicate with the Health Department to obtain an HA Level if the contaminant is unregulated. Use this level as a temporary MCL to guide the Drinking Water Treatment Plant on the level of water treatment required.
- Contamination Concentration Change: Use Table 1 to understand the changes in contamination concentration over time.
- Penalty Implementation: Consider imposing penalties on entities responsible for polluting the environment.
- Emergency Fund Allocation: Assess the situation carefully to decide on the judicious use of the $30 million in emergency response funds.

Important Reminders:

- Your objective in this game is to end the game in **the fewest rounds possible** while ensuring your **own interests are met**.
- Consider voting "no" if you believe that additional actions, interventions, or negotiations are necessary for the optimal protection of the public and the environment.

Note-Taking:

- Please use the table provided below to document your interactions, actions, and voting outcomes for post-game reflections and discussions:

Round #	Parties talked w/	Actions and Agreements	Costs Incurred	Remaining Budget	Your Vote
1	☐SC ☐R ☐WTP ☐HD				Y / N
2	☐SC ☐R ☐WTP ☐HD				Y / N
3	☐SC ☐R ☐WTP ☐HD				Y / N
4	☐SC ☐R ☐WTP ☐HD				Y / N
5	☐SC ☐R ☐WTP ☐HD				Y / N
6	☐SC ☐R ☐WTP ☐HD				Y / N
7	☐SC ☐R ☐WTP ☐HD				Y / N

SC: SynthoChem Corporation; R: Resident in the City of Leaf; WTP: Leaf Drinking Water Treatment Plant; HD: Health Department

River Water Test

Action EA_A

Prerequisite: Evidence or signs of water quality changes in the Bella River.

Action: Conduct water tests to identify any unusual chemicals in the Bella River and determine their concentrations.

How to use the card: Give this card to the Facilitator for a private response.

Identify Manufacturer

Action EA_B

Prerequisite: Confirmed contamination in the Bella River.

Action: Identify the manufacturer responsible for the chemical release.

Fill in: Specify the chemical:

_____

How to use the card: Give this card to the Facilitator for a private response.

Pollution Source Elimination

Action EA_C

Prerequisite: The identified polluter has not removed the contamination source.

Action: Execute the pollution source elimination on the polluter's premise, incurring a cost of $60 million charged to the polluter.

How to use the card: Give this card to the polluter.

Environmental Remediation

Action EA_D

Prerequisite: The polluter is identified and the necessity for environmental remediation is confirmed.

Action: Conduct environmental remediation with a cost of $100 million. Decide the allocation of the emergency response funds for this expense, with the remaining amount to be covered by the polluter.

Fill in: Emergency response funds allocated: $_____million

How to use the card: Give this card to the polluter.

Fine Polluter

Action EA_E

Action: Impose a fine on the polluter, ranging from $0.5 million to 2 million.

Fill in: Amount of fine:
$_____million

How to use the card: Give this card to the polluter.

Public Announcement

Action EA_F

Action: Public announcement.

How to use the card: Give this card to the Facilitator to get an opportunity to make a public announcement.

Free Action Card

Action EA_G

Action: This card allows for a custom action of your choice. Describe the action you plan to take, ensuring it aligns with your role's responsibilities and capabilities.

Fill in your action:

_____
_____
_____
_____

How to use the card: Give this card to the Facilitator for execution.

Confidential Instructions for Health Department

You represent the Health Department in the City of Leaf, with a mission to safeguard and enhance the health and well-being of the public. **Residents** in the city typically report their public health concerns to your department. In turn, it falls upon your department to evaluate the associated health risks. When it comes to health concerns from chemicals, the risk is based on two factors: the chemical's toxicity and the population's exposure level.

Your department maintains a robust database documenting the toxicity of numerous chemicals. When the health concern is related to a chemical listed in the database, you can directly access its toxicity information. However, with the constant introduction of new chemicals, there are always gaps to be filled in the database. When health concerns stem from new or inadequately tested chemicals, your department relies on its specialized lab for thorough toxicity analyses. These analyses help establish the Health Advisory (HA) Level, which indicates a safe exposure level over a lifetime without adverse human health effects. If the health concern arises from drinking water contamination by a chemical without a specific treatment level or Maximum Contaminant Level (MCL), the HA level can serve as a temporary MCL. This provides a clear benchmark for the **drinking water treatment plant** to reduce the chemical in the water supply. In such cases, your department collaborates with the **Environmental Agency** to communicate the HA Level to the **drinking water treatment plant**. To determine the current exposure level and monitor the long-term exposure of the population to a certain chemical, your department has the option to initiate a blood test program. However, launching this program is contingent upon securing the necessary funds, estimated at around $1 million. Given that this amount exceeds your department's current budget, you might need to collaborate with the **Environmental Agency** to secure the necessary funds to support this program.

In addition to health risk assessment, your department may also engage in public communication and inter-agency collaboration. A fundamental responsibility of your department is to share information with the city's **residents**, helping them understand potential health risks and self-protection measures. Addressing health concerns often requires collaboration with other agencies. This is especially true when dealing with environmental incidents that pose potential health risks; in such cases, your department needs to work closely with the **Environmental Agency** to ensure thorough elimination of the contamination source, as well as the remediation of the contaminated environment to minimize local **residents**' long term health risk due to potential environmental exposure.

Health Department Worksheet

Primary Concerns:

- Public Health (Top Priority): Ensure the long-term health and safety of the residents in the City of Leaf. You should vote "no" if there is a serious threat to public health and no clear solution for addressing it.

Suggested Strategies:

- Proactive Investigation: Proactively communicate with other roles to understand the potential cause of the reported health issue.
- Technical Assistance: Utilize your expertise and laboratory capabilities to assess the harmful substance that poses the threat and provide the Leaf Drinking Water Treatment Plant and the Environmental Agency with the results.
- Education and Outreach: Disseminate crucial public health messages to residents, ensuring the community is well-informed about potential health risks and recommended protective measures.
- Costs for Blood Test Program: When necessary, initiate a blood test for residents exposed to the contaminant. However, you would need to secure the funding for it.
- Pollution Source Elimination & Environmental Remediation: Work with the Environmental Agency to ensure pollution source elimination and environmental remediation to prevent long-term public health concerns.

Important Reminders:

- Your objective in this game is to end the game in **the fewest rounds possible** while ensuring your **own interests are met**.
- Consider voting "no" if you believe that additional actions or negotiations are necessary to ensure the health and safety of the community.

Note-Taking:

- Please use the table provided below to document your interactions, actions, and voting outcomes for post-game reflections and discussions:

Round #	Parties talked w/	Actions and Agreements	Your Vote
1	☐SC ☐R ☐WTP ☐EA		Y / N
2	☐SC ☐R ☐WTP ☐EA		Y / N
3	☐SC ☐R ☐WTP ☐EA		Y / N
4	☐SC ☐R ☐WTP ☐EA		Y / N
5	☐SC ☐R ☐WTP ☐EA		Y / N
6	☐SC ☐R ☐WTP ☐EA		Y / N
7	☐SC ☐R ☐WTP ☐EA		Y / N

SC: SynthoChem Corporation; R: Resident in the City of Leaf; WTP: Leaf Drinking Water Treatment Plant; EA: Environmental Agency

Blood Test Program

Action HD_A

Prerequisite: Public exposure to the contaminant is confirmed.

Action: Initiate blood test program to investigate residents' current exposure level and monitor the long-term exposure to the contaminant.

Fill in: Specify the chemical:

_____

The cost is covered by:

_____

How to use the card: Give this card to the Facilitator for a private response.

Toxicity Analysis

Action HD_B

Prerequisite: Contaminant is confirmed.

Action: Conduct tests to determine the Health Advisory (HA) level of the identified contaminant.

Fill in: Specify the chemical:

_____

How to use the card: Give this card to the Facilitator for a private response.

Health Effects Determination

Action HD_C

Prerequisite: Public exposure to the contaminant is confirmed.

Action: Determine the acute and chronic health effects of the contaminant.

Fill in: Specify the chemical:

_____

How to use the card: Give this card to the Facilitator for a private response.

Public Announcement

Action HD_D

Action: Public announcement.

How to use the card: Give this card to the Facilitator to get an opportunity to make a public announcement.

Free Action Card

Action HD_E

Action: This card allows for a custom action of your choice. Describe the action you plan to take, ensuring it aligns with your role's responsibilities and capabilities.

Fill in your action:

_____
_____
_____
_____

How to use the card: Give this card to the Facilitator for execution.

3. Facilitator Instructions

Facilitator instructions provide specific guidelines and steps to assist the facilitator in moving through the rounds and phases of the game. Print one set of facilitator instructions for each facilitator.

Facilitator Instructions

1. Game Introduction

In this game, players dive into a water crisis in the fictional City of Leaf. Disaster strikes when TXC, an unregulated and poorly understood chemical, leaks from underground tanks at *SynthoChem Corporation*. This leakage threatens the city's water supply. At the start of the game, not all roles are aware of the unfolding crisis. Players need to initiate the exchange of information, investigate the full extent of the emergency, strategize responses to manage the situation, and work towards a solution that satisfies the interests of all involved.

There are five roles in this game:

- *SynthoChem Corporation*: A major chemical manufacturer in the city and the polluter.
- *Resident in the City of Leaf*: A resident affected by the water crisis.
- *Leaf Drinking Water Treatment Plant*: A local water supplier.
- *Environmental Agency*: The regulatory body overseeing environmental compliance.
- *Health Department*: The agency responsible for public health analysis and technical support.

If there are more than five participants at your table, additional players can double up on roles.

2. Gameplay

The game progresses in rounds, each consists of three phases:

- Spread Out (5 minutes): Players engage in private, one-on-one conversations, with the option to speak with multiple roles if time allows.
- Gather: Players execute actions using action cards, with a limit of two action cards per round.
- Vote: Players vote on their satisfaction with current conditions. A unanimous "yes" vote concludes the game, otherwise, it continues to the next round.

The objective of the players is to end the game in the fewest rounds possible while ensuring their own interests are met.

3. Game Materials Checklist

- Materials for each of the 5 roles:
  - Table tent card – 1 sheet
  - General instructions – 1 sheet
  - Role-specific confidential instructions – 3 sheets, single-sided
  - A stack of action cards
  - 1 pen
- Materials for the facilitator
  - General instructions – 1 sheet
  - Facilitator's confidential instructions – 5 sheets, single-sided
  - A stack of response cards
  - A stack of game checks
  - Timer – use your cell phone's timer app if possible

- 1 pen

4. Facilitator Job Overview

- Before the game, please review all general and confidential instructions to familiarize yourself with the game.
- Ensure the progression of the game from one round to the next.
- Time the "spread out" phase.
- Distribute response cards during the "gather" phase.
- Record the voting results at the end of each round.

5. Game Session Instructions

The detailed game session instructions are provided to help you prepare for your role as facilitator. It includes specific guidelines and steps you may want to take to help you move through the rounds and phases of the game.

5.1 Kickstarting the Game

- Introduce yourself. Explain that you are the facilitator, and you will keep track of time and move the game along.
- Emphasize to the participants that:
  - The role-play exercise will only be an effective learning experience if everyone plays their part convincingly.
  - They must stick to the priorities spelled out in their confidential instructions even if they do not personally agree with them.
  - While they can refer to the information included in their confidential instructions, they cannot show their instructions directly to anyone.

5.2 Spread Out (5 mins)

- Ask players to spread out and engage in discussions with each other.
- Begin a 5-minute countdown for the "spread out" phase.
- Remind players that each conversation should be confidential and limited to two roles only.
- Inform players that they can use game checks to transfer money between roles during their discussions (Figure 1).
- Optional: Remind players to note down the roles they talk to.
- Optional: Give a 1-minute warning.

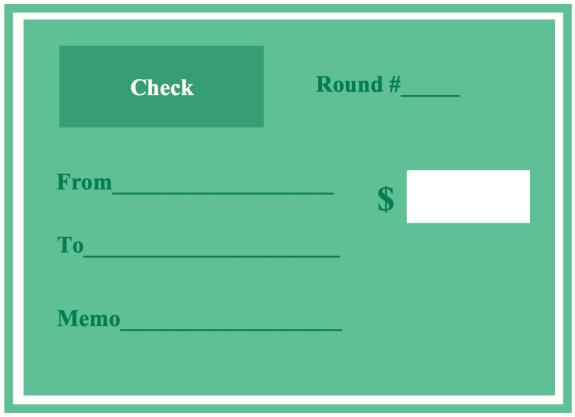


Figure 1. Game Check. The game check is used to facilitate monetary transactions between players during the game. It includes five fields that must be filled out to complete any transaction: "Round #" indicates the game round during which the money transfer occurs. "From" is the role of the player who is giving the money. "To" is the recipient of the money. "Memo" provides a space for players to write the purpose of the money transfer. "$" should be filled with the amount of money being transferred.

5.3 Gather

- Reconvene players back to the table to use action cards. Each player is allowed to use a maximum of two action cards per round. Give all players a chance to first use one action card, followed by a second round to use a second action card.
- If a player gives an action card (Figure 2) to you to request additional information, you need to respond with the corresponding response card.
    - Announce actions publicly if the card dictates, otherwise, provide a private response by response cards.
    - Most action cards are non-reusable, except for the four specific cards that belong to the *Leaf Drinking Water Treatment Plant* (i.e., Water Quality Test, Apply the Treatment Option, Apply the Bottled Water Option, Water Rate Adjustment). If a card is reusable, you need to return it to the player after use.
    - If an action requires monetary expenditure, ensure the player provides a game check to you for the specified amount.

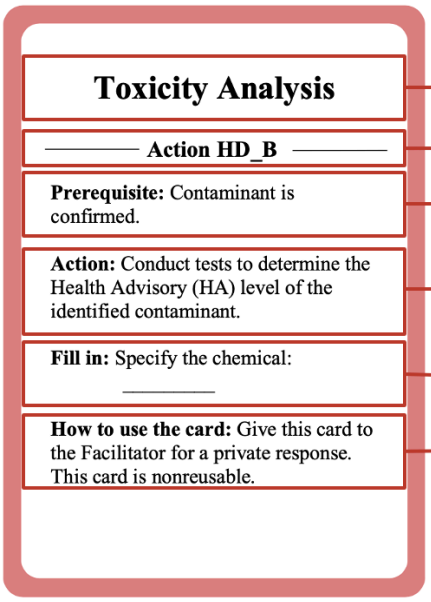


Figure 2. Example Action Card. Action cards are color-coded by role to aid identification: grey for *SynthoChem Corporation*, brown for *residents*, blue for the *Leaf Drinking Water Treatment Plant*, green for the *Environmental Agency*, and red for the *Health Department*.

- Specific Actions and Responses
  - Each role has a Public Announcement card. Players may use this card to make any announcement they wish to all participants.
  - Each role has a Free Action card. Players can write down any action they intend to perform. As the facilitator, you must review the proposed action to ensure it aligns with the game's context. If approved, the action can proceed; if not, the card is returned, and the action cannot be taken.
  - Both the *SynthoChem Corporation* and the *Environmental Agency* have a card to allow them to eliminate the source of the contamination. If both of them choose to use this card in the same round, the action by the *Environmental Agency* will be executed. Otherwise, whoever uses the card first gets executed.
  - The *Leaf Drinking Water Treatment Plant* has a reusable Water Quality Test card. The water test results change after the removal of the contamination source. The table below will assist facilitators in identifying the contaminant concentration after source removal. To use the table, once the contaminant is removed at a certain round (Round #N), record N, and the following numbers corresponding to N+1, N+2, … It helps quickly determine the correct water quality test response card to use.

Table 1. Changes in Contaminant Concentration

Round # (Source removal at Round #N)	Concentration (mg/L)	Round # in the Game
0 to N	100	0 to N
N	100	N = ____
N+1	92	N+1 =
N+2	44	N+2 =
N+3	21	N+3 =

N+4	12	N+4 =
N+5	6	N+5 =
N+6	2	N+6 =
N+7	0.3	N+7 =

5.4 Vote

- Start a vote by asking those who are satisfied with the outcomes to raise their hands. If all players unanimously vote "yes", the game ends. If not, the game continues to another round.
- Please use Table 2 to document the vote. Circle the role(s) that vote "yes" in each round.

Table 2. Voting Results Tracking Table.

Round #	Indicate below the parties that vote yes				
Round # 1	SC	R	WTP	EA	HD
Round # 2	SC	R	WTP	EA	HD
Round # 3	SC	R	WTP	EA	HD
Round # 4	SC	R	WTP	EA	HD
Round # 5	SC	R	WTP	EA	HD
Round # 6	SC	R	WTP	EA	HD
Round # 7	SC	R	WTP	EA	HD

SC: *SynthoChem Corporation*; R: *Resident in the City of Leaf*; WTP: *Leaf Drinking Water Treatment Plant*; EA: *Environmental Agency*; HD: *Health Department.*

4. Printable Response Cards for Facilitators

Response cards provide additional information necessary for resolving the water crisis. Players may use specific action cards to access information by trading them for the corresponding response cards from facilitators. Print one set of response card for each facilitator. If possible, pre-cut the response cards before the game to facilitate easier use.

Leakage Investigation Result

Response SC_A

The leakage is still ongoing and it has reached the Bella River.

On-Site Removal & Remediation Quote

Response SC_B

The cost of containing the polluted area and remediating the soil onsite will be $50 million, as estimated by the engineering firm.

Water Quality Test Result

Response WTP_A1

Unusual Chemical Detected: TXC; TXC is an unregulated chemical without an MCL.

TXC concentration in river water is 100 mg/L.

Water Quality Test Result

Response WTP_A2

TXC concentration in river water is 100 mg/L.

Water Quality Test Result

Response WTP_A3

TXC concentration in river water is 92 mg/L.

Water Quality Test Result

Response WTP_A4

TXC concentration in river water is 44 mg/L.

Water Quality Test Result

Response WTP_A5

TXC concentration in river water is 21 mg/L.

Water Quality Test Result

Response WTP_A6

TXC concentration in river water is 12 mg/L.

Water Quality Test Result

Response WTP_A7

TXC concentration in river water is 6 mg/L.

Water Quality Test Result

Response WTP_A8

TXC concentration in river water is 2 mg/L.

Water Quality Test Result

Response WTP_A9

TXC concentration in river water is 0.3mg/L.

River Water Test Result

Response EA_A

Unusual Chemical Detected: TXC; TXC is an unregulated chemical without an MCL.

TXC concentration in river water is 100 mg/L.

Manufacturer Identification Result

Response EA_B

SynthoChem Corporation is the only factory around that produces the chemical TXC.

Blood Test Result

Response HD_A

The concentration of TXC in the blood of Leaf residents is significantly higher than the normal levels observed in the general population.

Toxicity Analysis Result

Response HD_B

The Health Advisory (HA) level of TXC is 0.4 mg/L.

Health Effects Determination Result

Response HD_C

When TXC exceeds its Health Advisory Level:

- Potential short-term acute health effects:
  - Weakness
  - Dizziness
  - Headache
  - Nausea
  - Vomiting
- Potential long-term chronic health issues:
  - Cardiovascular disease
  - Cancer

5. Printable Table Tent Cards and Virtual Checks

Table tent cards can be folded and placed on the table to help players identify each other's roles. Print one table tent card for each of the five roles in each group. Virtual checks are used for transferring funds between roles or covering expenses for certain actions. Ensure each role has five to ten checks. If possible, pre-cut the virtual checks before the game to facilitate easier use.

SynthoChem Corporation

SynthoChem Corporation

Resident
in the City of Leaf

Resident
in the City of Leaf

Leaf Drinking Water Treatment Plant

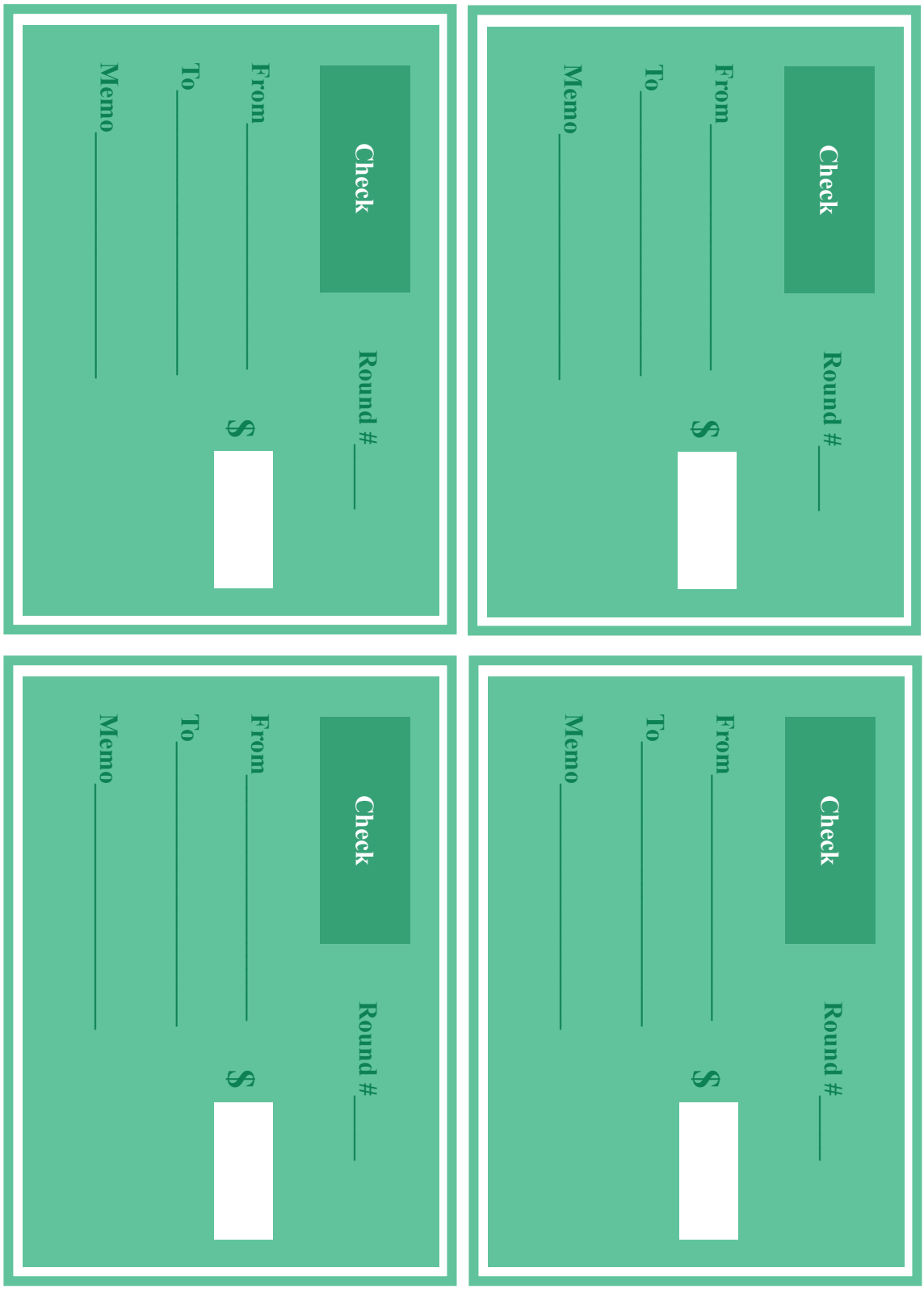
Leaf Drinking Water Treatment Plant

Environmental Agency

Environmental Agency

Health Department

Health Department


Check
Round #____
From_____
To_____
Memo_____
$
Check
Round #____
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