



**CONSERVATION HALTON WATERSHED CLIMATE CHANGE
VULNERABILITY AND RISK ASSESSMENT
EXECUTIVE SUMMARY**

Prepared for:
CONSERVATION HALTON

Prepared by:
MATRIX SOLUTIONS INC., A MONTROSE ENVIRONMENTAL COMPANY

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Mississauga, Ontario

Suite 3001, 6865 Century Ave.
Mississauga, ON, Canada L5N 7K2
T 905.877.9531 F 289.323.3785
www.matrix-solutions.com

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Fabio Tonto, P.Eng., MEPP
Senior Water Resources Engineer
Technical Lead, Climate Risk and Resilience



reviewed by
Quentin Chiotti, Ph.D.
Technical Director, Climate Risk and Resilience

CONTRIBUTORS

Name	Job Title	Role
Autumn Rafeiro, B.E.Sc.	Environmental Engineering Intern, Matrix Solutions Inc.	Report Contributor
Quentin Chiotti, Ph.D.	Technical Director, Climate Risk and Resilience, Matrix Solutions Inc.	Report Contributor Technical Advisor
Fabio Tonto, P.Eng., MEPP	Senior Water Resources Engineer, Technical Lead, Climate Risk and Resilience, Matrix Solutions Inc.	Project Manager Report Contributor Technical Reviewer

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VERSION CONTROL

Version	Date	Issue Type	Filename	Description
V0.1	22-Dec-2023	Draft	2023-12-22 DRAFT_CH Climate Change Vulnerability and Risk Assessment Report v0.1	Issued to client for draft review
V1.0	18-Jan-2024	Final	36679 CH CC Vulnerability and Risk Assessment R 2024-01-18 final v1.0.docx	Issued to client for review
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CONSERVATION HALTON TERRITORIAL ACKNOWLEDGEMENTS

We are reminded that Conservation Halton's watersheds are situated on treaty land that is steeped in rich Indigenous history and home to many First Nations and Métis people today. We have a responsibility for the stewardship of the land on which we live and work.

We acknowledge the Mississaugas of the Credit First Nation and Six Nations of the Grand River of the Anishinaabeg, Ongweh'onweh, and Hyron-wendat (Wyandot) Peoples of whose traditional territory we are situated.

ACKNOWLEDGEMENTS

The Project Team would like to acknowledge the contributions of all those who participated in the development of Conservation Halton's Climate Change Vulnerability and Risk Assessment. Extensive engagement with internal and external stakeholders was critical to the project's success, resulting in meaningful dialogue about climate change impacts through Conservation Halton and collaboration on adaptation action recommendations.

Conservation Halton Subject Matter Experts

Responsible for providing knowledge-based input on specific departments and subjects throughout the study.

- Brenna Bartley, Education Manager
- Adrian Bryant, Coordinator (Forestry)
- Glenn Farmer, Manager (Flood Forecasting and Operations)
- Ilona Feldmann, Resource Planning Coordinator
- Craig Machan, Director (Parks and Operation)
- Lesley Matich, Manager (Science and Monitoring)
- Leah Smith, Policy and Special Initiatives Lead
- Jacek Strakowski, Hydrogeologist
- Brad Rennick, GIS Analyst Lead
- Jennifer Roberts, Forest Technician Lead
- Jennifer Young, Senior Water Resources Engineer

Core Project Team

Responsible for project management, direction and decision making.

Conservation Halton

- ✦ Kim Barrett, Senior Specialist (Research and Sustainability)
- ✦ Martin Keller, Senior Manager (Watershed Planning and Source Protection)
- ✦ Barbara Veale, Senior Director (Watershed Management and Climate Change)

Matrix Solutions Inc.

- ✦ Fabio Tonto, Project Manager
- ✦ Quentin Chiotti, Technical Director
- ✦ David Van Vliet, Senior Technical Advisor
- ✦ Autumn Rafeiro, Engineering Intern

Steering Committee

Responsible for direction and decision making during the risk assessment process.

Conservation Halton

- ✦ Kim Barrett, Senior Specialist (Research and Sustainability)
- ✦ Martin Keller, Senior Manager (Watershed Planning and Source Protection)
- ✦ Barbara Veale, Senior Director (Watershed Management and Climate Change)
- ✦ Lesley Matich, Manager (Science and Monitoring)

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- ✦ Fabio Tonto, Project Manager
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- ✦ Autumn Rafeiro, Engineering Intern

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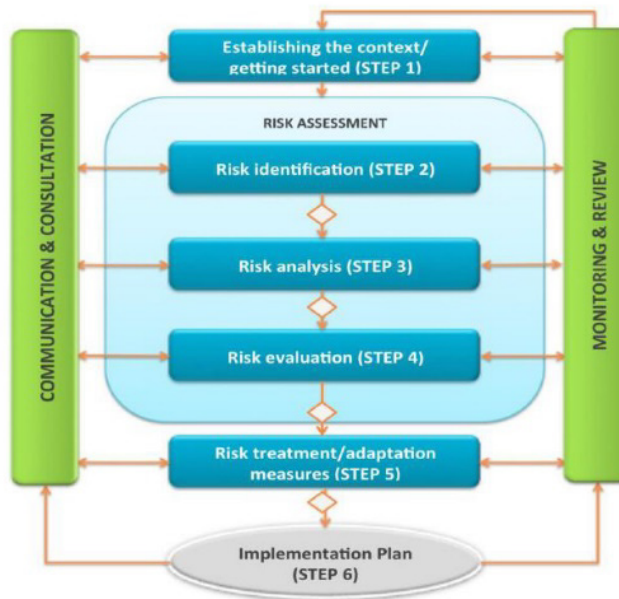
Conservation Halton serves the local community by offering essential services designed to tackle and alleviate environmental challenges, especially those intensified by climate change. These challenges, like threats to human health, property, and the well-being of terrestrial and aquatic ecosystems, are on the rise. Conservation Halton provides programs to enhance the resilience of the watershed's ecosystem. This, in turn, safeguards local communities from the adverse effects of increasingly unpredictable, warmer, and wetter weather patterns associated with climate change. Through this process it has become clear that the natural resources at the watershed level provide critical services to the residents of these watersheds and need to be maintained, protected and expanded.

This Climate Change Vulnerability and Risk Assessment, developed in collaboration with Conservation Halton, aims to evaluate the potential future climate risks to the natural resources in their watersheds. The goal is to identify where vulnerability and risk is highest to natural resources and recommend additional actions that can be taken to boost adaptive capacity and resilience. These actions will assist Conservation Halton in maintaining and protecting their jurisdiction's natural resources and the associated services that these resources provide in a changing climate. Natural resources, like forests and wetlands, act as a protective shield against climate change impacts, such as flooding, affecting residents across the watershed. By prioritizing actions that enhance the ability of these resources and employing environmental science Conservation Halton can fortify the resilience of watershed ecosystems. This is in alignment with Conservation Halton's Strategic Plan Momentum (Conservation Halton, 2024), and aims to reduce the negative effects of climate change on local communities.

Methodology

The risk assessment methodology is based on the International Organization for Standardization (ISO) 31000 risk framework (see below). This process involved continuous engagement with Conservation Halton staff. The risk management process was focused on natural resources, where the Climate Change Vulnerability and Risk Assessment offers a unique and comprehensive approach for evaluating climate risks and developing adaptation measures for these resources, which is something not frequently done on a watershed scale.

THE ISO31000 RISK MANAGEMENT PROCESS



Source: <https://www.iso.org/obp/ui/#iso:std:iso:31000:ed-2:v1:en>

The recommendations from this assessment build on existing programs and services implemented or planned by Conservation Halton. The assessment pinpoints areas where climate hazards and impacts on natural resources may affect Conservation Halton's ability to deliver services.

Communication and collaboration with stakeholders were central to the assessment process. Internal stakeholders, including those within Conservation Halton, and external stakeholders, particularly local municipalities within Conservation Halton's jurisdiction, were actively involved. The organization's in-depth understanding of its natural resources, watersheds, programming, operations, and services played a pivotal role in crafting the Climate Change Vulnerability and Risk Assessment. This internal knowledge provided valuable insights utilized throughout the assessment. It was key to understand where there has been historical experience with vulnerability in the current climate, and how existing and planned programs may enhance adaptive capacity of Conservation Halton.

A strategic review of legislative requirements and previous reports was conducted to better understand the context around climate change and adaptation within Conservation Halton's jurisdiction. This involved considering national and provincial climate change guidelines, as well as reviewing previous work by Conservation Halton in assessing the vulnerabilities of the watersheds and the inventories of natural resources. In Ontario, Conservation Halton operates under the Conservation Authorities Act, which has as its purpose "to provide for the organization and delivery of programs and services that further the conservation, restoration, development and management of natural resources in watersheds in Ontario." Section 21 of the Act sets out the range of programs and services that Conservation Authorities can provide. Specific programs and services that a conservation authority must provide includes the

consideration of climate change as set out in O. Reg. 686/21. In addition, the legislation allows for a delivery of additional programs and services provided that agreements between the conservation authority and their participating municipalities for their delivery are in place. This enables conservation authorities and their municipal partners to be responsive to natural resource issues and management needs unique to their watershed.

Conservation Halton is currently developing a Watershed-based Resource Management Strategy as required by legislation. The purpose of this initiative is to ensure compliance with the legislation, identify those issues and risks that limit the effectiveness of programs and services, and identify actions and associated costs to address the issues and mitigate risks.

Natural Resources

The selection of key natural resources for this assessment was collaboratively developed during an early workshop with Conservation Halton's staff. These resources hold substantial importance and provide various benefits across Conservation Halton's watersheds. The significant natural resources considered in the assessment include:

- forests
- groundwater
- lakeshore
- meadow
- pond/lake
- stream
- wetland – swamp
- wetland – marsh
- vernal pools

Climate Hazards

As part of the strategic context review, Matrix identified climate hazards that played a crucial role in shaping the risk assessment stage. To understand how each potential hazard might change in the future due to climate conditions, Matrix considered the historical record and utilized best practice climate change projections under a high emissions scenario. This involved selecting specific climate variables or parameters that best capture the conditions and drawing information from nationally recognized climate data portals and published material. Matrix assessed how these variables are likely to change in the mid-term (30 years) and long-term (60 years) future.

While there were subtle differences in historical records and future projections across Conservation Halton's watersheds (e.g., above and below the Niagara Escarpment), there was an overall high level of

uniformity in the changes in future climate conditions and the likelihood of occurrence between data portals and previous studies for most parameters. The following climate hazards are the ones that best quantified the impact on natural resources in Conservation Halton's watersheds:

- dry conditions
- rainfall/riverine flooding
- heat stress
- seasonal changes
- snowpack reduction
- wind

Of these hazards, Snowpack Reduction and Seasonal Changes were the only climate parameters to have a higher likelihood of occurrence scoring value in the 2080s in comparison to the 2050s, whereas for the others the projected change was similar for both future time periods.

Consequences of Climate Change

Matrix used the likelihood scores along with the consequence scores to determine the level of risk Conservation Halton faces regarding future climate conditions that could adversely impact natural resources, ecosystems, and the services dependent on them. The vulnerability and risk assessment process allowed Matrix to leverage existing knowledge and evidence concerning future climate projections and the natural functions of the watershed and helped identify and prioritize climate risks. During the risk identification step, Matrix pinpointed where climate hazards could potentially impact natural resources. Out of the 54 potential combinations of climate hazards and natural resource types, Conservation Halton staff confirmed that only one case had no interactions, while 53 cases exhibited interactions.

Consequences arise when there is an interaction between a climate hazard and a natural resource that causes a measurable shift in the natural resource's condition and performance and the level of services that they provide. The consequences were placed into seven categories used in calculating the risk rating:

- human health and property
- terrestrial ecology
- aquatic ecology
- water quality
- erosion and sedimentation
- flooding
- Conservation Halton services

These categories helped assess the magnitude, extent, or duration of consequences, providing a comprehensive framework for evaluating the overall risk associated with climate hazards and their impacts on natural resources.

Climate Change Impacts

The Project Team collaborated with subject matter experts from Conservation Halton to gather insights and assign values to consequences for interactions between natural resources and climate hazards under each of the seven categories identified. This step was crucial in harnessing the diversity of expertise across watershed managers and technical experts in assessing the potential impacts of climate change on these natural resources. Once consensus was reached on consequence scores, the next step was calculating risk scores.

The watershed level assessment considered factors like land use and vulnerable areas defined by Conservation Halton and by mapping natural resource location onto the watershed. This qualitative analysis aimed to discuss risks across the watersheds, identifying areas that might be more vulnerable than others. This comprehensive approach ensured a thorough understanding of the potential impact of climate hazards on natural resources throughout Conservation Halton's watersheds.

After assessing vulnerability and risk at the watershed level, Matrix evaluated adaptive capacity by examining programs and services already provided by Conservation Halton that enhance the resilience of the watersheds. The adaptive capacity measures are linked to the following areas:

- Conservation Halton's programs and services
- flood forecasting and warning
- flood and erosion control
- drought/low water program
- management of Conservation Authority-owned land
- Drinking Water Source Protection
- surface and groundwater monitoring programs
- ecological monitoring programs
- regulating the impacts of development and activities in hazard areas
- watershed strategies

Findings

The risk assessment findings show how natural resources may be affected by different climate hazards. In consultation with Conservation Halton staff, it was decided to focus on interactions that had a "high" (15+) or "very high" (20+) risk rating. The analysis revealed 38 interactions for 2050 climate projections and 41 interactions for 2080 projections. The only change between 2050 and 2080 was that some risks, like

Snowpack Reduction and Seasonal Changes, became more likely and received higher risk ratings. Heat stress, rainfall, and seasonal changes were the top three climate hazards associated with high and very high-risk ratings. This information helped prioritize where to focus efforts in managing climate-related risks.

Recommendations

This section provides the recommendations emerging from this risk assessment, supported by input from subject matter experts across diverse fields from Conservation Halton and Matrix. Most of these recommendations are not standalone initiatives but represent the continuation of ongoing efforts and commitments already made by Conservation Halton. Examples of ongoing and relevant programs include the 2020 *Strategic Forest Management Plan* and the 2023 report *Effects of Climate Change on Biodiversity within Conservation Halton's Watersheds*.

The recommendations considered the adaptive capacity measures and existing studies by Conservation Halton that also propose recommendations for the watersheds. The discussion includes suggestions on how Conservation Halton can enhance existing programs and studies to contribute to the development of a Watershed-based Resource Management Strategy.

General Recommendations

These initial general recommendations are provided to give overarching guidance to assist in building Conservation Halton's adaptive capacity to a changing climate. More detailed recommendations follow.

- Review all monitoring programs to integrate climate change considerations by evaluating monitoring network density, data collection methods, measurement parameters, and monitoring protocols. Identify key indicators and assess spatial and temporal scales for aligning with projected climate change impacts. Enhance monitoring efforts with emerging technologies and data sharing mechanisms to inform adaptive strategies and sustainable management practices.
- Renew Watershed Plans for each of Conservation Halton's watersheds to encompass scenarios integrating climate change projections, land use changes, and natural resource scenarios reflecting climate change impacts. These plans will anticipate hydrological shifts and ecological impacts within the watershed. Integrate land use and natural resource scenarios to assess potential stressors and inform adaptive management strategies for sustainable watershed management amidst evolving environmental conditions.
- Model hydrologic impacts of climate change on a watershed scale. Utilize climate projections and hydrological models to simulate changes in rainfall intensity, duration, and frequency over time. Incorporate Intensity-Duration-Frequency (IDF) curve shifts into planning and risk assessment frameworks to enhance resilience against extreme weather events and mitigate potential flood risks associated with climate variability.

- Continue to coordinate with municipal partners to share climate change data and develop collaborative strategies. Create a hub for climate change data and watershed-scale assessments to facilitate information sharing and decision making among stakeholders. Ensure accessibility and compatibility of data formats to allow for analysis and integration into municipal planning processes. Foster informed actions and resilience-building efforts across interconnected communities and watersheds.

Flooding

1. **Operations:**

- ✦ Consider how climate change impacts flood risk and may necessitate changes in the operation of water control infrastructure.
- ✦ Continue updating Conservation Halton’s flood forecasting and warning system to reflect any changes in seasonality or rainfall patterns that may emerge from climate change.
- ✦ Consider reviewing the operational requirements for water control infrastructure to meet the seasonal, recreational and flood mitigation needs while considering the potential of low water levels due to climate change.

2. **Monitoring:**

- ✦ Continue to monitor ice jams as seasonal changes and snowpack reduction exacerbate risks, reducing spring freshet, increasing runoff volumes, and elevating the likelihood of ice jams, erosion, and flooding.
- ✦ Expand weather station network to provide coverage over a greater area of the jurisdiction to capture high-intensity, short duration, and localized storm events to enable timely responses to flood threats. This will increase the data for flood forecasting and warning, as well as hydrologic model calibration.

3. **Manage:** Maintain and expand natural areas (forest, wetland, etc.) to help maintain the hydrologic conditions in the watersheds. The water retention services of these areas help mitigate current flood risk and will be critical in providing adaptive capacity to intensive rainfall events under future climate conditions.

4. **Modelling:** Regularly update regulatory flood hazard mapping around ponds and streams to reflect the changes due to climate change.

- ✦ Continue updating regulatory flood hazard mapping around streams to reflect the potential changes due to climate change. Consider implementing flood risk mapping to support municipal

emergency preparedness. This will reduce risks to human health and property, with increased flooding potential impacting emergency services and property damage.

- ✦ Use future climate scenarios, natural resource scenarios and hydrologic and hydraulic models to identify potential flood risk zones. This would identify possible water depth and velocity in flooded areas. This information can be used for emergency preparedness and risk management.
- ✦ Use hydrologic modelling to measure the potential impacts and help inform possible mitigation measures of climate change on wetlands. This would include reviewing ecologic impacts to wetlands and the ability of wetlands to mitigate flooding through vegetation changes and potential degradation.

Erosion and Sedimentation

1. **Monitoring:**

- ✦ Monitor the rate of shoreline erosion. Study the potential for an increase in shoreline erosion from intensified storm surges and wave action, compromising shoreline integrity. Investigate strategies to mitigate shoreline erosion.
- ✦ Monitor stream and valley slope stability to provide important information for flood and erosion control to allow for the development of effective strategies to manage the impacts of increased bankfull erosion flow events.
- ✦ Undertake regular recurring water course erosion surveys and mitigate situations that introduce or aggravate the erosion hazard and associated impacts on infrastructure and valley ecology along accessible creek reaches.

Groundwater

1. **Monitoring:** Continue monitoring groundwater quantity through the Provincial Groundwater Monitoring Program and expanded locations at selected wetlands.
2. **Groundwater Discharge:** Utilize, and where needed, enhance existing groundwater models to better understand the interactions between surface and groundwater and assess and map out important groundwater discharge reaches throughout the watersheds. Validate modelling with surface water monitoring and aquatic information.

Water Quality

1. **Planning:** Continue to incorporate groundwater quality and quantity planning in the development of the Watershed Plans for the watersheds within Conservation Halton's jurisdiction.

2. **Surface Water Monitoring:** Identify gaps in the surface water quality monitoring network and expand the monitoring network with a goal of identifying and possibly mitigating trends resulting from climate change. Assess the monitoring network for its ability to capture water quality trends. Continue monitoring surface water for the temperature impacts associated with reduced groundwater flow or the impacts of higher temperature groundwater. Continue monitoring water temperatures, water levels, erosion and pollutant loading in ponds/lakes for any negative impacts on biodiversity due to climate change.
3. **Wetlands Monitoring and Improvement:** Expand wetland monitoring, preservation, and improvement programs to mitigate against water quality impacts. Monitor outfall of swamps that have historic records of water quality monitoring for the measurement of any reduction in water quality due to the impacts of climate change on the ability of swamps to provide the service of water quality improvement. Preserve and enhance natural wetlands to maintain the water quality improvements provided by these ecosystems, wherever possible. Increase wetland habitat to increase the water quality benefits and mitigate potential impacts from climate change on existing wetlands and possibly improve the water quality by a greater degree.

Aquatic Ecology

1. **Monitoring:** Continue and adjust, if needed, various monitoring programs being executed within the watersheds and implement a process to identify climate change impacts through these programs. Specific monitoring programs include:
 - ✦ Continue and adjust, if needed, the aquatic monitoring system that includes regular assessments of stream levels, rainfall patterns, water temperature, erosion dynamics, and water quality to assess aquatic biodiversity for changes due to climate change.
 - ✦ Continue and adjust, if needed, monitoring for impacts of climate change causing a reduction in fish spawning habitats due to the degraded quality of aquatic ecosystems in marshes.
2. **Restoration:** Implement the recommendations in the report *Effects of Climate Change on Biodiversity within Conservation Halton's Watersheds 2023* to "Develop species-specific monitoring and restoration strategies for target species at risk and climate-vulnerable species on Conservation Halton lands." Implement this recommendation for species impacted by the climate change effects on aquatic habitat including vernal pools.
3. **Modelling:** Undertake modelling of future climate scenarios to better understand and predict the impacts of climate change on the thermal dynamics of streams. Identify the risk of specific streams no longer being refugia for cold-water species. This will allow for identification of reaches where targeted restoration efforts would be beneficial to maintain a cold-water status under future climatic conditions.

Terrestrial Ecology

Forests

Recommendations for forests are particularly relevant for the large tracts of forest located above the Niagara Escarpment in northern Bronte Creek and the northwestern areas of Sixteen Mile Creek. These represent the largest areas of forest cover in Conservation Halton's jurisdiction.

1. **Monitoring:** Continue monitoring forest health using the Long-term Environmental Monitoring Program (LEMP) and other monitoring initiatives, including invasive species
2. **Wetland Monitoring:** Continue and adjust, if needed, Conservation Halton's LEMP to monitor vernal pool, swamp, and marsh habitats particularly for early spring breeding amphibians due to changes in snowpack and seasonality.
3. **Habitat Corridors:** Model the impact of climate change on wildlife corridors and migration patterns by integrating species-specific habitat suitability models, climate projections, and landscape connectivity analyses. Incorporate future climate scenarios to assess potential shifts in habitat ranges and corridor effectiveness.
4. **Build Resiliency:** Continue with existing programs designed to build resilient forests within the watersheds:
 - ✦ Implement the recommendations outlined in the 2020 *Strategic Forest Management Plan* to build forest resiliency against climate change. This will be accomplished through building the forest's resilience using effective management practices and by incorporating mitigation and adaptation strategies.
 - ✦ Implement recommendations from the *Effects of Climate Change on Biodiversity within Conservation Halton's Watersheds report*, focusing on enhancing forest resilience in particular Recommendation 5: "Develop a Seed Strategy for Conservation Halton's tree planting program to ensure that planting stock is adapted to future climate conditions."
5. **Expand Forests:** Expand forested areas through strategic land acquisition, when possible, to mitigate any forest losses due to climate change or even expand forested area to improve habitat connectivity and provide high quality contiguous habitat.
6. **Protect Against Fire:** Prepare for the onset of forest fire conditions due to heat stress and precipitation changes on Conservation Halton owned lands.

Biodiversity Loss

1. **Monitoring:** Maintain ongoing wildlife habitat monitoring in the LEMP and other monitoring initiatives.

2. **Implement the recommendations in the Conservation Halton study:** *Effects of Climate Change on Biodiversity within Conservation Halton's Watersheds 2023*, pertaining to terrestrial biodiversity loss and climate change.
3. **Develop Invasive Species Strategy:** Develop an Invasive Species strategy and cooperate with other levels of government to coordinate efforts on detection, protection against, and destruction of invasive species.

Conservation Halton Services

1. Adapt services:

- ✦ Assess potential alterations to visitor experiences, considering the potential impact on park revenue due to the lack of forest cover or degraded natural areas.
- ✦ Prepare for potential impacts on Conservation Halton's services, including beach closures, infrastructure maintenance, reduction in availability of snow for skiing, and visitor experiences, due to heat stress, wind, and seasonal changes.

2. Safety:

- ✦ Continue to implement signage and safety programs warning users of Conservation Halton's trails and natural areas to inform of ticks and the potential for Lyme disease.
- ✦ Consider addressing the potential of safety concerns on lakeside authority property due to the potential for increased risk of tripping and falling due to precipitation, waves, and wind, impacting human health and safety.