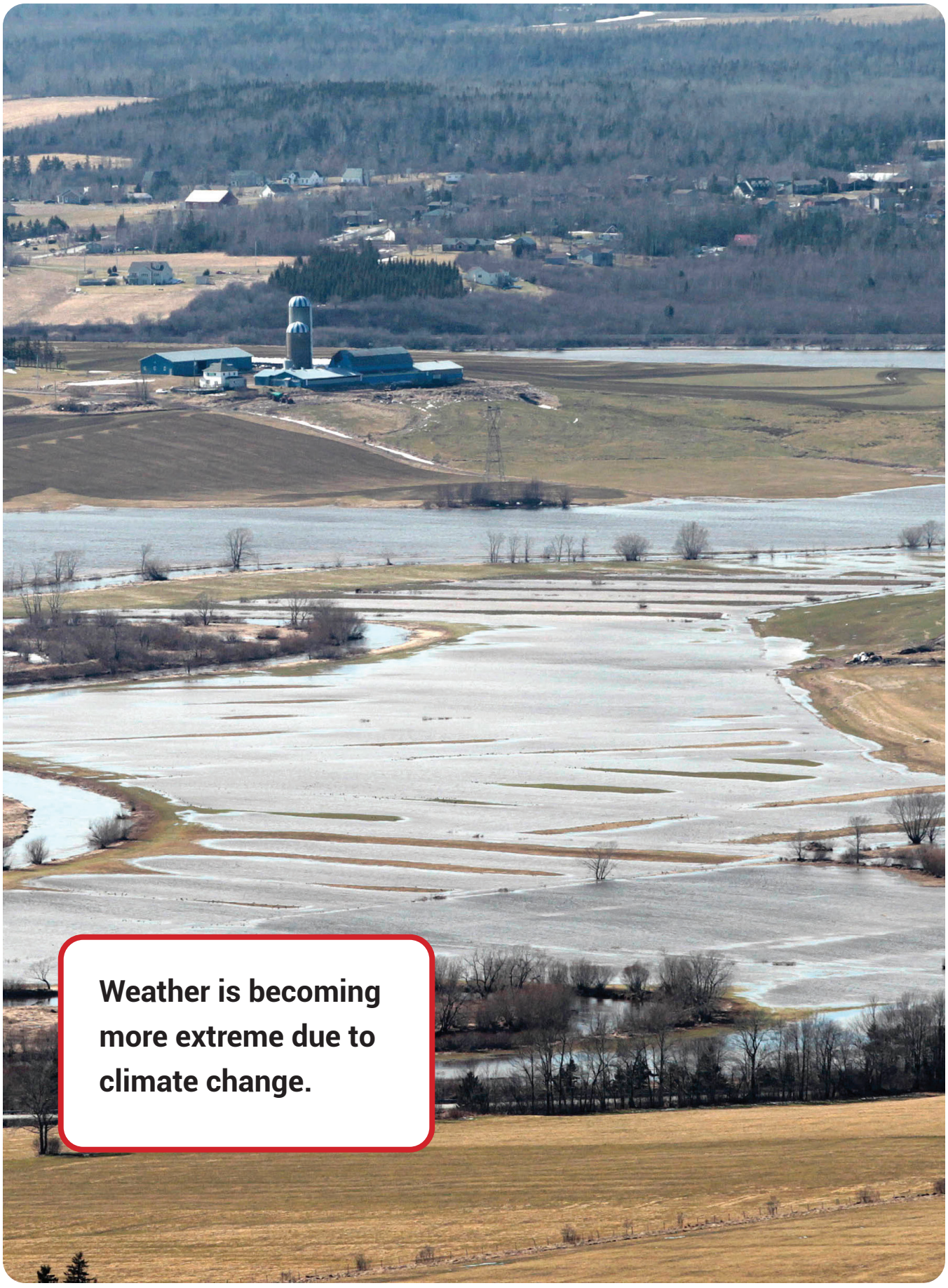
ADAPTING TO CLIMATE CHANGE

Flooding & Severe Weather Events:

# Mitigating Risk to **Underground** Petroleum Storage Tanks

2020

NOVA SCOTIA


Weather is becoming more extreme due to climate change.

Nova Scotia is almost completely surrounded by the ocean and covered in rivers, lakes, and streams. Environmental issues naturally arise when leaks or spills from petroleum storage tanks and facilities have the opportunity to enter water resources. Climate change and extreme weather have real and continuing impacts on local infrastructure and residents, due to our settlement patterns, our geographical location, and geographical features in local areas.

**Settlement patterns:** Waterways were the original highways, so people tended to settle on natural floodplains and in coastal areas. The lushness of soil and often flat topography with easy access or attractive sightlines to water has led to extensive residential settlements and associated commercial development in these low-lying areas. Areas with high water tables have also attracted residential and agricultural development. High water tables present challenges to underground systems.

**Geographic location:** Nova Scotia lies near strong wind and water currents that tend to bring tropical storms and hurricanes up from the Caribbean. Since 2000, one hurricane makes landfall every other year in Canada with post-tropical storms common during hurricane season. Weather events are becoming more severe due to climate change.

To increase resiliency and mitigate against impacts to human health or the natural environment by releases of petroleum products during floods or groundwater surges, specific actions should be taken to improve the quality of infrastructure and adapt operating procedures to mitigate impacts.

***Disclaimer:*** *The following information is intended for general guidance and education only. Since site requirements and equipment will vary widely, users are encouraged to consult a qualified professional to determine specific designs and actions best suited to reflect the environmental protection needs of the particular location and proposed service before designing, installing or operating any equipment or plans intended to diminish potential risks of climatic events.*

# Key risks for underground tanks

## Buoyancy risk in saturated soil

Tanks are buoyant. Air and petroleum are both lighter than water. When the surrounding soil becomes saturated, the tank can lift upwards. The buoyancy risk accelerates as the amount of water surrounding the tank increases.

When these lifting forces overcome both the gravitational force of the weight of the tank and its contents and the weight and resistance of the fill on top of the tank, the system floats upwards. The tank may even break out of the ground. This movement may cause the tanks or connected piping and dispensers to break, releasing petroleum into the environment.

Buoyancy force can be experienced by trying to hold a sealed bottle of air under water.

## Erosion and scour risk in rapidly moving water

Rapidly moving water can wear away soil and backfill covering underground tanks and piping systems. This can cause systems to float or can remove supporting backfill. The loss of soil and backfill may cause strain and collapse of storage systems. Exposed tanks and piping or dispensing equipment may suffer impacts from floating or falling debris.

## Product displacement risk when water enters tanks

Water is heavier than many petroleum products. If water can enter a storage tank — through a loose joint or failing tank feature — it can quickly fill the tank. Water sinks in the tank and pushes the petroleum product up and out through any unsealed openings.

## Risk of electrical system damage

Extended contact with water can cause electrical shorting or corrosion of electrical systems, such as pumps or level gauges. Damage may be obvious (pumps that don't work, valves that stick open or shut) or subtle (systems that leak, short circuits that start smoldering fires). Impacts may appear immediately with systems unable to operate or over extended periods as equipment wears out prematurely or accidents begin to occur.

# Ways to mitigate risk

## Avoid flood zones

Avoid installing underground storage systems in flood zones to prevent liability. Known flood zones are generally well mapped. Find information on potential exposures at municipal planning offices. Make sure to use an up-to-date flood map and wherever possible consider projected precipitation, sea level rise and storm surge. Information on climate change can be found on https://climatedata.ca/ and on the Nova Scotia Climate Change website at www.novascotia.ca/nse.

## Anchor tanks securely

Design and install supplemental anchoring to reduce or counter potential buoyancy forces and decrease the risk of tank movement.

Measures that reduce or counter buoyancy forces and decrease tank movement:

- Increase the burial depth of underground tanks from the common 1 m to up to 2 m. Avoid greater depths unless the tank is specifically designed and constructed to allow for the increased weight. Beyond two metres the weight of the soil may crush the tank.
- Install heavier asphalt or concrete paving above the buried tank system.
- Install hold-down straps around the tank, attached either to a concrete pad under the buried tank or to deadman anchors installed along the length of the tank.

Supplemental anchoring methods and measures should conform with

- information from the tank manufacturer
- applicable standards
- good engineering practice

## Install safety features

Prevent environmental damage and product loss by installing and maintaining safety features:

- Install automatic shut-off valves on all underground piping to prevent loss of product if the lines break.
- Add an extension to the vent pipe to a level well above estimated flooding levels to prevent surface water from entering and displacing product.
- Ensure that all sumps and spill buckets have tight-fitting gaskets to reduce water infiltration.

## Redesign or re-enforce systems with significant legal, financial, or social liability risks

Purchasing decisions should factor in potential legal, financial, and social liability risks — as well as ongoing operational and maintenance costs — for a more complete picture.

Focussing on initial capital outlay may seem logical in the short term. However, operational and liability concerns can increase costs over the life of the system. Leaks, spills, and injuries will ultimately affect both overall profitability and company goodwill and reputation. The cheapest option may not be the wisest option when all costs and risks are calculated.

Storage tanks and related equipment are designed, constructed, and installed to meet specific needs and operating parameters. Those involved in specifying, purchasing, and installing the equipment need to adequately predict all reasonable circumstances under which the equipment will operate. They also need the expertise to balance competing concerns and technical parameters.

Standards and codes for storage tank systems incorporate detailed safety factors:

- variations in material type and quality
- operating pressures
- exposures and repetitive stresses
- environmental protection
- fire protection
- staff protection

When making decisions about new or updated storage facilities, consider the following in your cost-benefit analysis:

- how the capital cost of safety features protects against future liability claims and clean-up costs
- how the type of use has varied since initial installation, including the volume of product the system is designed to handle versus current volumes and anticipated future volumes
- how well the system adapts to changes in extreme weather events, both experienced locally and projected

## Manage risk operationally

Create contingency management plans to manage operational-related risk in areas prone to excessive water from storms, floods, and other predictable events:

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**Risk**

Excessive water predicted due to storm or flood.

**Mitigation measures**

Fill tanks with petroleum product up to about 70% of capacity to assist in weighing it down. Do not fill the tank completely. Allow space for possible containment of material should water enter through fittings.

Take a final product inventory and water reading on all tanks.

Turn off all electrical power to dispensers, pumps, automatic tank gauges, and any other associated system.

Secure all fill caps and make sure they are in good condition and locked.

Close the shear valve below dispensers on any pressurized piping.

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**Risk**

Spills can occur even when all precautions were taken to prevent a release of petroleum to the environment.

**Mitigation measure**

Update contingency management plans regularly. Communicate with and train people responsible for responding to spills.

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**Risk**

Tank use has changed since installation so that it no longer meets specific needs and operating parameters. For example storing a different type of petroleum product, such as changing from diesel to gasoline or increasing additives such as methanol, ethanol or biofuels. This can degrade the tank, its components or the operability of the tank system.

**Mitigation measure**

Assess current needs against existing codes and standards and local conditions. Consult with a qualified professional engineer or the manufacturer for recommended upgrades.

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## Maintain systems regularly and strategically

Schedule regular inspections of storage tank systems by persons trained to know applicable standards and codes and capable of recognizing signs of damage or potential failure before they impact operations or safety:

- Check vent pipes to ensure they are functioning and are secured to prevent movement. Make sure all fill pipes can be securely closed. Make sure all sump

buckets have water-proof seals. Test automatic shut-off valves to ensure they work properly.

- Service regularly and repair damage promptly to ensure safe operation during normal and adverse conditions.
- Keep detailed records of inspections, assessments, and repairs for each petroleum storage system.
- When issues arise with a tank system, assess all equipment of similar age, manufacture, or service.
- Assess overall system performance against current usage needs, current standards and codes, and changing climate conditions.

## After elevated groundwater or flooding

Inspect your storage tank systems to ensure that no damage has occurred and no product has been lost.

Immediately assess the tank, associated piping, and related infrastructure for evidence of floating or deflection.

If the system has floated out of the ground or been significantly displaced — generally about 2% deflection for fiberglass tanks — take immediate steps to stabilize the site.

Copy the action and inspection checklists and use them to track completed actions and when follow-up action is needed.

## ACTION CHECKLIST FOR STABILIZING THE SITE

- [ ] Report spills or leaks to Nova Scotia Environment as required under the Environmental Emergency Regulations
- [ ] Notify local emergency response authorities, usually local fire department
- [ ] Secure the affected area
- [ ] Contain any released product
- [ ] Collect and remove any released product
- [ ] Send spilled product to a facility authorized for treatment of these materials
- [ ] Remove all remaining contents from the affected tank system
- [ ] Arrange for a petroleum installer to remove and repair or dispose of the affected storage tank system
- [ ] Recertify the system to CAN/ULC-S676-15, "Standard for Refurbishing of Storage Tanks for Flammable and Combustible Liquids"

## INSPECTION CHECKLIST

| AREA | Action complete | ACTIONS | Follow-up required | FOLLOW UP ACTIONS | Follow-up complete |
|---|---|---|---|---|---|
| **FACILITY** | ☐ | **INSPECT** for evidence of release of petroleum product; if spills or leaks are evident | ☐ | **REPORT** spills or leaks to Nova Scotia Environment as required under the Environmental Emergency Regulations | ☐ |
| **DISPENSING FACILITY** | ☐ | **INSPECT** for visible damage to the dispensing facility; if any evidence of tank or line movement or breakage | ☐ | **CONDUCT** more extensive checks and **REPLACE** if needed | ☐ |
| **TANKS & PIPING** | ☐ | **CHECK** for water contamination; if contaminated | ☐ | **REMOVE WATER & DISPOSE** of at a facility approved for that purpose | ☐ |
| **INTERSTITIAL SPACE** in systems with intrinsic secondary containment | ☐ | **CHECK** to ensure no leakage or ingress of water has occurred; if any evidence of leakage or intrusion | ☐ | **REPAIR & RESTORE** before reuse | ☐ |
| **ELECTRICAL SYSTEM** | ☐ | Have a **QUALIFIED ELECTRICIAN CHECK** for damage or presence of water | ☐ | **CONDUCT NECESSARY REPAIRS** before restarting the power | ☐ |
| **EQUIPMENT:**<br>• pumps<br>• shear valves<br>• fill pipes<br>• vent lines | ☐ | **CHECK** equipment for proper operation:<br>• no water, debris, or silt intrusion<br>• items open and close or turn on or off smoothly<br>• no blockages | ☐ | **CLEAN** any signs of corrosion, **LUBRICATE** moving parts, and **REPLACE** failed parts | ☐ |
| **SPILL BUCKETS & SUMPS,** if any | ☐ | **CLEAN & EMPTY** spill buckets and sumps, including those under dispensers and above the tanks | ☐ | **DISPOSE** of any cleaned-out material at a facility approved for that purpose by the authority having jurisdiction | ☐ |
| | ☐ | **CHECK** dispenser filters and submersible check-valve screens | ☐ | **REPLACE** any clogged filters and screens | ☐ |
| | ☐ | **INSPECT** for damage or possible leaks | ☐ | **CONDUCT** a tightness test | ☐ |
| | ☐ | **FLUSH** the piping and dispensers | ☐ | **DISPOSE** of any rinse product and water at a facility approved for that purpose | ☐ |
| **CATHODIC PROTECTION** | ☐ | **TEST** to ensure it is working properly; if concerns arise | ☐ | Bring in a **CORROSION EXPERT** to conduct a more thorough test **SERVICE** as needed | ☐ |

## Resources

United States Environmental Protection Agency,
EPA 510-R-10-002, “Underground Storage Tank Flood Guide":
https://www.epa.gov/sites/production/files/2014-03/documents/ustfloodguide.pdf

Washington State Department of Ecology,
Publication #07-05-125, “Underground Storage Tank System Restart After Flooding."



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