UNDERSTANDING THERMOSYPHON FOUNDATION SYSTEMS

HEAT is lost to ambient air

CONDENSER (RADIATOR) SECTION

CONDENSATE

VAPOUR

SHALLOW BUILDING FOUNDATION

INSULATION

EVAPORATOR SECTION

GRAVEL PAD

HEAT extracted from the ground

ARE THESE THERMOSYPHONS WORKING?

MEASURE TEMPERATURE

TRACK RESULTS

* To see trends over time

CONDUCT VISUAL INSPECTIONS

* Prior to freezing season
* During freezing season
* Check for leaks

IN THE WINTER THE THERMOSYPHON FINS SHOULD BE WARMER THAN THE AIR TEMPERATURE

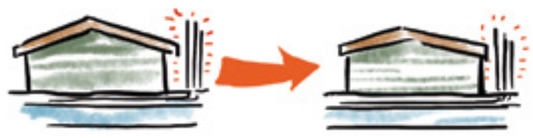
TEMPERATURE DIFFERENCE

THERMOSYPHONS HELP PROTECT AND MAINTAIN EXISTING PERMAFROST

20 YEARS

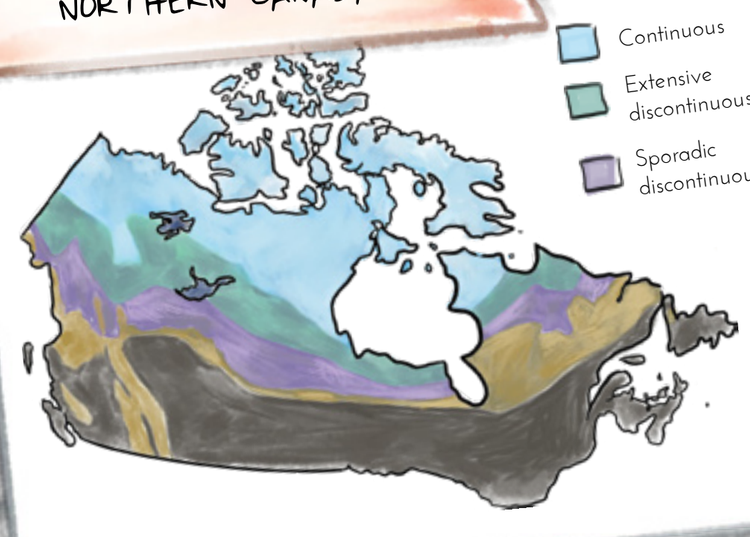
WITHOUT THERMOSYPHONS

Heat from the building can seep into the ground and cause permafrost to thaw faster



WITH THERMOSYPHONS

PERMAFROST COVERS MUCH OF NORTHERN CANADA



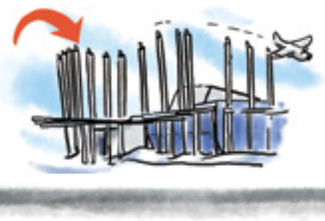
THERMOSYPHONS ARE BEING USED ACROSS THE NORTH

IQALUIT, NU

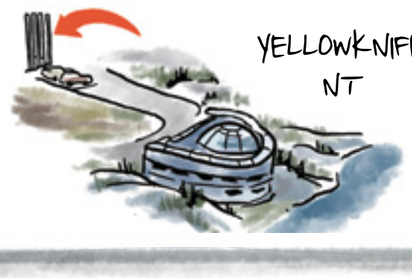
INUVIK, NT

... AND NOT JUST FOR BUILDINGS!

BURWASH LANDING, YT



KUUJJUAQ, NUNAVIK



YELLOWKNIFE, NT

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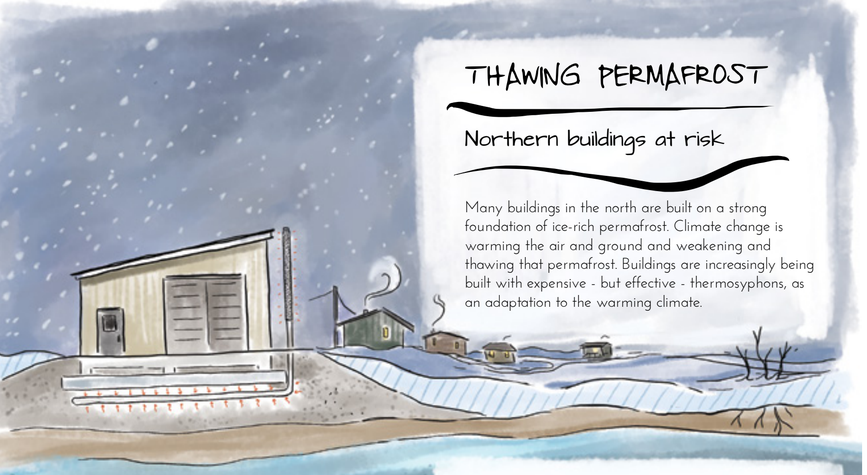

THAWING PERMAFROST

Northern buildings at risk

Many buildings in the north are built on a strong foundation of ice-rich permafrost. Climate change is warming the air and ground and weakening and thawing that permafrost. Buildings are increasingly being built with expensive - but effective - thermosyphons, as an adaptation to the warming climate.

This is a user-friendly outline of CAN/CSA S500-14 Thermosyphon foundations for buildings in permafrost regions.

This guide applies to new buildings that are being built on top of permafrost. It provides basic information about what thermosyphons are, and how and when to use them. Ecology North adapted this guide for building owners and maintainers, community decision makers and contractors across the north.

Permafrost ground that stays frozen for more than two years in a row.

Active layer the ground on top of permafrost that freezes in the winter and thaws in summer.

Thaw sensitive permafrost ground with ice-rich permafrost that settles and loses strength when it thaws.

Thaw stable permafrost ground that does not settle when it thaws.

Thermosyphon a two-phase passive refrigeration device, with a fluid that transfers heat from the ground to the air in winter.

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Contact us or visit our website for information and other guides in this series.

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BUILDING DESIGN

Incorporating thermosyphons

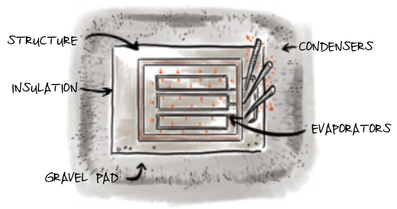
FACTORS TO CONSIDER:

* Plan for unexpected events and changes
* Review the design and construction plans
* Have documents of the full system design

FOLLOW BEST PRACTICES FOR:

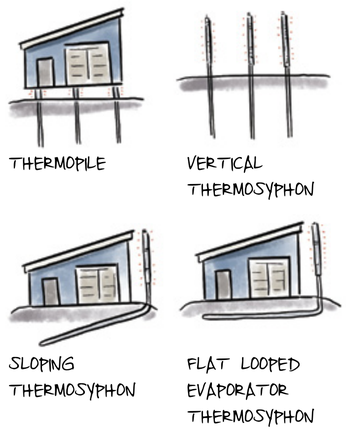
* Evaporator layout, pipes, and radiators
* Granular pads, site excavation, use of gravel
* Final site grading to reduce seepage
* Using sumps and underground services
* Water supply and waste water lines
* Building insulation
* Other features (e.g. sumps or septic tank)

PLAN VIEW FROM ABOVE



A THERMOSYPHON IS...

A passive refrigeration device



A thermosyphon takes heat out of the ground and releases it into the air. They are designed to stop heat from a building damaging the permafrost beow it, keeping the permafrost cold and solid. They work when the air is substantially colder than the ground.

Thermosyphons are effective if installed correctly. They are most ofen used when concrete floors are built over thaw sensitive permafrost.

CONSTRUCTION

Site prep; installing the system

Building in thaw sensitive permafrost areas is a challenge. Good planning is essential.

Ensure materials are ordered, shipped, and installed at the **right time of year**. Usually site preparation has to be done in the summer, when you can compact soil and gravel effectively.

Disturb permafrost as little as possible by installing thermosyphon system quickly.

Make sure ground temperature measuring **sensors** are installed with the thermosyphon system.

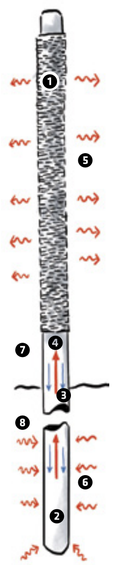
Let the prepared site **freeze for one winter** before constructing the rest of the building.

Unless absolutely necessary, **don't excavate** in a permafrost area. If it must be done, it becomes even more important to let the site freeze back for a winter.

Document the process, including any changes to the design.

HOW THEY WORK

Active in winter, not in summer



1. Condenser (radiator) section
2. Evaporator section
3. Condensate
4. Vapor
5. Heat lost to cold ambient air
6. Heat extracted from ground
7. Above ground
8. Below ground

Thermosyphons are sealed tubes that contain pressurized carbon dioxide that is partly liquid and partly gas. The liquid flows by gravity to the bottom of the tube which is buried in the ground, and the gas rises to the upper part that is above ground.

In the winter, when the ground is warmer than the air, liquid in the bottom of the tube warms up, evaporates (turns to gas), and rises to the part of the tube above ground. In the radiators above ground, the gas cools, condenses (turns back to liquid), and flows back underground. This movement of carbon dioxide continually cools the ground and permafrost as long as the air is colder than the ground.

MONITORING PLAN

Are they working?

* Before winter, inspect for damage/deterioration
* Measure radiator temps in winter
* Track ground temps during & after construction
* Monitor building for deformations or shifting

If needed, contact a professional for a more thorough investigation.

Assess thermosyphon fins with a thermometer or infrared temperature measuring device in early winter, when air temperature is 15-20° colder than suspected ground temperature.

Temperatures of the fins should be warmer than the ambient air and nearby structures – this means they are bringing heat up from the ground and dispelling it to the air!

DO YOU NEED THEM?

Ground conditions and materials

Gather information to help buildings designers confirm if thermosyphons are a good option.

USEFUL BACKGROUND INFORMATION:

* Is the building on thaw sensitive permafrost?
* Determine the ground's ice and water content
* Identify surficial geology (soil conditions)
* Identify the depth of the active layer
* Drill boreholes, install ground temp sensors
* Assess surface and groundwater flow
* Review local/traditional knowledge of site

DO NOT USE THERMOSYPHONS IF:

* The building does not sit on permafrost.
* Significant surface water is present in summer
* The ground is thaw stable permafrost
* The building is unheated*

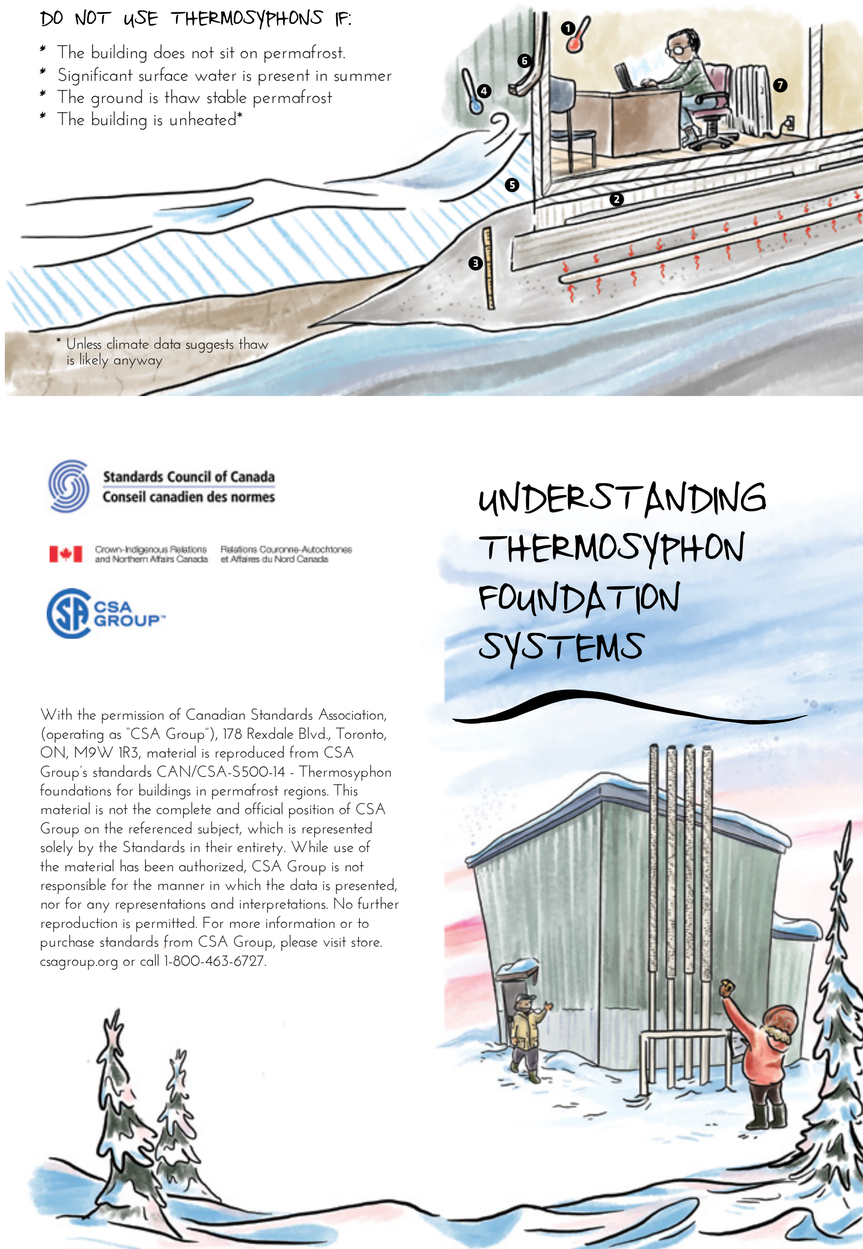
* Unless climate data suggests thaw is likely anyway

SYSTEM DESIGN

What you need to know

Consider site-specific factors that affect how well the thermosyphon system may work. There are many things to understand prior to investing in thermosyphons, this is a partial list:

1. Inside air temp during summer and winter
2. Building insulation, including below ground
3. Thickness of gravel fill
4. Projected climate over the building's life
5. Expected snow buildup, plan to manage snow
6. Management of water and good drainage
7. Building's heating system (in-floor vs. radiators)



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