CASE STUDY: Adaptive Vault Design in Clay Soil – Preventing Systemic Collapse at High Altitude

From the Field — CJ Sawyer, Founder & Systems Resilience Lead

When I first opened the ground in this vault, I found a system that had survived far longer than it should have — not through strength, but through stubbornness. Pipes lay shallow, wrapped in foil and heat tape, held together by decades of improvisation. The next hard freeze would have ended it.

We didn't just rebuild; we entirely redefined resilience. True resilience isn't concrete rigidity or overengineering. It's adaptability — design that moves with nature, not against her. This vault flexes with the mountain, breathes through freeze–thaw, and speaks when it's stressed. It's alive in the way all good systems should be.

This wasn't simply a project; it was proof that craftsmanship, precision, and field-hardened logic can make even the most hostile ground sustainable.

This is the TundrCore Resilience standard.

Project Overview

Client: Private RV Park, Southern Rockies
Elevation: 7,000 ft **Duration:** 14 days **Total Cost:** $20,300

A critical water distribution vault, decades old, faced imminent structural collapse. Repeated freeze–thaw cycles, shifting clay soil, and makeshift thermal protection had left the infrastructure one winter away from failure.

TundrCore Resilience Group was engaged to design and build a vault capable of surviving continual ground movement, maintaining water integrity, and remaining serviceable for decades — all within a single-day water-outage window.

Challenges

- **Dynamic Clay Soil:** Expands and contracts with moisture, exerting unpredictable lateral pressure.
- **Severe Structural Decay:** Crumbling masonry, exposed pipework, and corroded rebar threatening catastrophic failure.
- **Live Line Work:** All excavations made around existing pipework carrying 100 psi at 1.5 inches, with no mistakes permissible due to inability of line isolation.
- **Environmental Extremes:** Freeze–thaw cycles exceeding 120 °F annual variation.
- **Operational Constraint:** Continuous park water supply required; maximum shutdown — one day.

Solution — Composite Flex-Vault Design

A hybrid structure built to **absorb movement, not resist it**.

Core Engineering Principles

- **Structural Adaptability:** Pressure-treated 4×4 framework with 2×6 compression rails; insulated with R-10 foam, wrapped in vapor barrier, and backfilled with ¾-inch stone to diffuse soil load.
- **Hydrostatic Control:** French-drain foundation converting groundwater pressure into passive dispersion.
- **Breathable Preservation:** Wood treated with *PenaShield borate* and *Tung oil* — creating a living, antimicrobial envelope that flexes with humidity.
- **Thermal Regulation:** 20-amp electrical service powering permanent heat lamp; maintains positive temperatures through sub-zero nights.
- **Serviceability:** Full-access interior, modular valve layout, and clear sightlines for inspection and maintenance.

- **System Integrity:** Solvent-welded joints cured under controlled heat tents in 30–50 °F ambient conditions for full polymer fusion.

Execution

All major joins were pre-cured before live tie-in. Water service restored the same day; downstream pressure stabilized at 45 psi before full operational load.
Continuous monitoring confirmed zero solvent failures and only minor threaded seepage corrected within 24 hours.

Outcome

- **Full hydraulic stability at 48 psi** after 72-hour live flow.
- **Zero structural or thermal faults** under initial load.
- **Vault environment maintained above 40 °F** through night-time lows.
- **Minimal disturbance** to park operations and landscape rehabilitation completed immediately.

The new vault now operates as a **living node in the site's infrastructure** — a self-draining, thermally stable, field-serviceable system designed for multi-decade resilience in alpine clay conditions.

TundrCore Principle

> *Resilience is not resistance — it's the ability to move with pressure and return stronger.*

The following images are a detailed descriptive of what we found upon facility audit vs what we built for the facility to manage their mains water.

The existing order of infrastructure hierarchy made little sense, with a primary system isolation gate-valve downstream of both PVR and BFP, and a 3rd mains waterline entirely unregulated and unprotected by the PVR and BFP, and with no shutoff outside of county support, found to be feeding park infrastructure.

There was a crack in the bottom of the PVR, contributing to significant water accumulation in the clay base vault, and pipework was sitting mere inches beneath the surface, well within the frost line, protected from the freezing alpine winters by nothing more than foil wrap, heat tapes and a thin piece of deteriorating plywood.

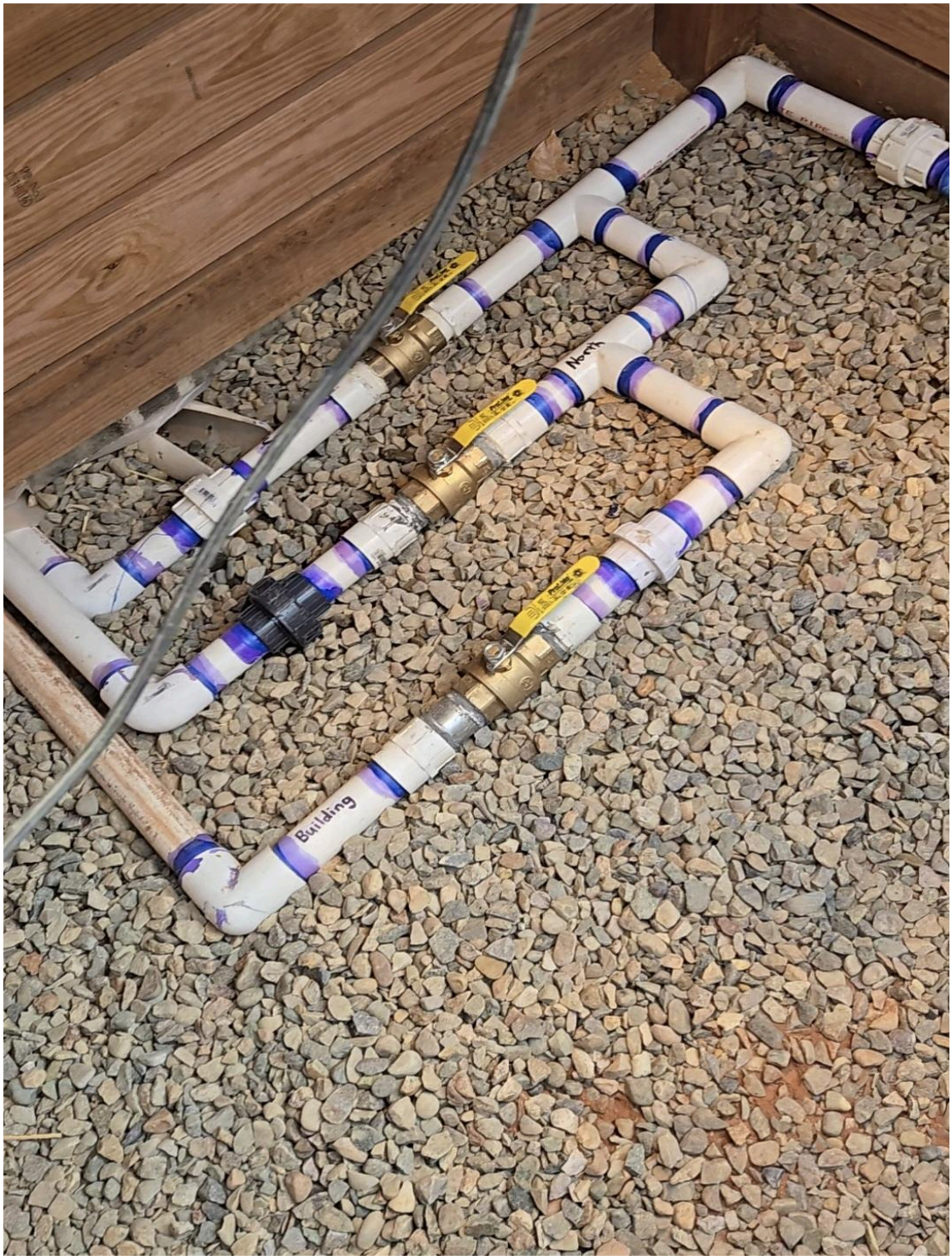
Our solution: a composite vault built from pressure-treated 2x6s — flexible, breathable, and serviceable in real time.

No direct earth contact: wrapped in R10 foam board and plastic, backfilled with ¾ stone for drainage and stability.

Every surface treated with Penashield and Tung oil for a living, breathing barrier that only strengthens with age.

The lids are composed of dual-layer marine ply, R10 insulated core, plastic inner membrane, with a polyurethane outer finish.

The vault has been wired for 20-amp service with a hard mounted heat lamp for frost protection.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Full site rehabilitation post project