



In Situ Thermal Remediation Across the Temperature Spectrum:

Technology and implementation strategies matched to site conditions and remedial objectives

Robert D'Anjou

President, ERG





Our Team

Our Executive Team



Robert D'Anjou

President



Allen Swift

Executive Vice President



Skye Green

VP of Engineering



Danny Baysa

VP of Field Operations



Jim Keegan

Board Member, Advisor



Michael Dodson

Strategic Advisor

ERG and its team of 20(+) professionals represent more than 28 years at the forefront of thermal remediation – spanning ERH, TCH, SEE, and advanced combined in situ strategies. Our Team brings:

- ✓ 23 ERG-delivered thermal projects.
- ✓ 112 thermal systems engineered and operated by our team.
- ✓ 500+ integrated bioremediation and combined remedy implementations.
- ✓ Industry-Leading Intellectual Property – Thermal remediation patents, trademarks, and proprietary technologies

Our experience spans:

- ✓ 79 ERH projects
- ✓ 24 TCH projects – including ERG's HETR-TCH
- ✓ 10 SEE projects
- ✓ 7 advanced combined ISTR source zone remedies

From the earliest commercial ISTR deployments in the 1990s to today's hybrid energy systems, ERG continues to engineer the most advanced thermal projects in the industry.

Thermal Remediation

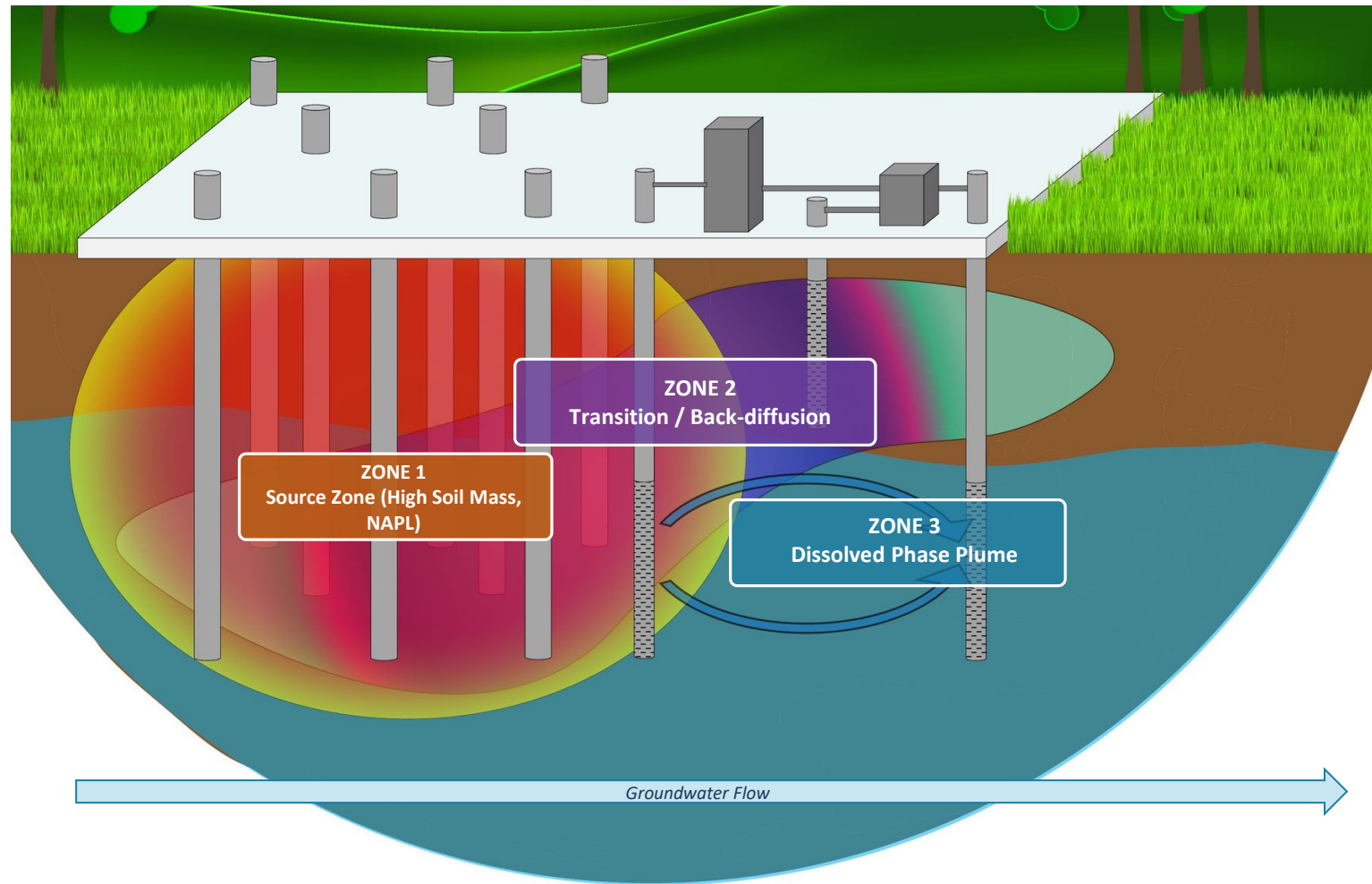
*(Not Just a Source
Zone Tool)*





Silver Bullets for Whole Plume Remediation Don't Exist

Most remedial programs are designed around the source zone. Most sites fail to close because of what happens beyond it



1 NAPL Source Zone — High Mass in Soils and NAPL

✓ **Aggressive ISTR**: Fast, reliable, >99% mass removal. Limited certainty or drawbacks to consider with other tech (ISCO, ISTT, LDA, etc).

⚠ **Limitations**: \$200–\$800/yd³ — cost-prohibitive beyond the Source. Some projects can't support ISTR.

2 Transition Zone — Back-diffusion from Low-K Lenses

✓ Low-K mass can feed a plume for decades. Multiple technologies exist that are suitable.

⚠ **Traditional** None as a standalone balances cost, risk, and timeline well.

3 Dissolved Phase Plume — Large, Diffuse, Persistent

✓ PRBs, P&T, and MNA are lower-cost options. Bio is a great option if conditions support.

⚠ All are slow — and all are sustained by Zones 1 & 2 if not addressed first.



Spatiotemporal Integration

Select right **tools** -
In the right place; At the right time.

Spatiotemporal integration: Deploying the best available technologies *spatially* — throughout the full 3-D volume of impacted subsurface — and *temporally* — across the remedial trajectory as site conditions evolve — to maximize synergistic efficiencies, minimize timeline, and reduce lifecycle cost.

◀ SPATIAL ▶

SOURCE ZONE & TRANSITION ZONE

DISSOLVED PHASE PLUME

EARLY

Remediation

High-intensity mass removal

- ISTR (TCH / ERH / SEE)
- ISCO — aggressive oxidation
- Excavation / soil mixing

Containment + baseline assessment

- Hydraulic containment / P&T/PRBs
- MNA baseline and receptor assessment
- Plume delineation and CSM refinement

LATER

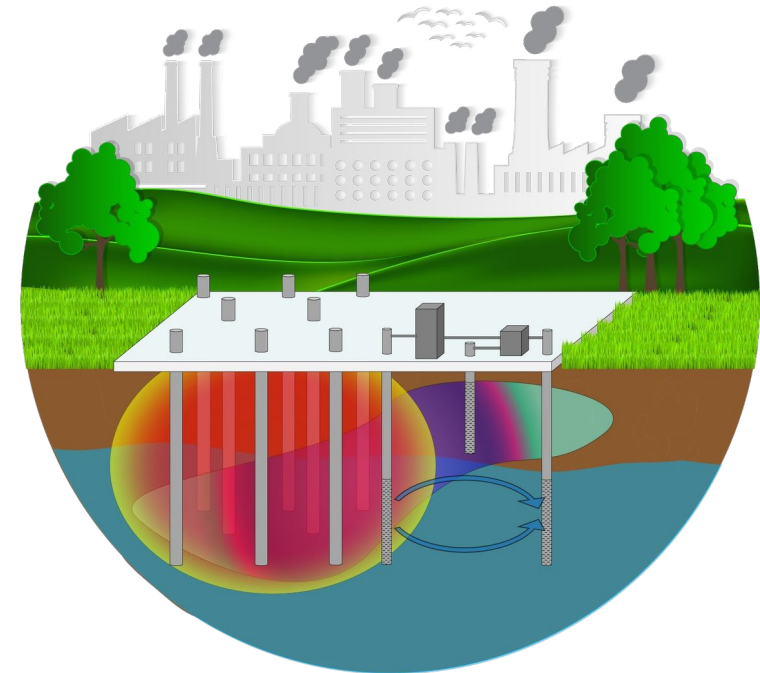
Remediation

Residual mass polishing

- Low-mid temperature recirculation
- ISB / ISCO — sustained low-dose
- Permeable reactive barriers

Plume treatment + closure

- In situ bioremediation (ISCR / EISB)
- Thermally or chemically enhanced ISB
- MNA with performance confirmation



✓ What Makes It Work

High-resolution site characterization

Real-time data and adaptive management

Engaged technical oversight throughout

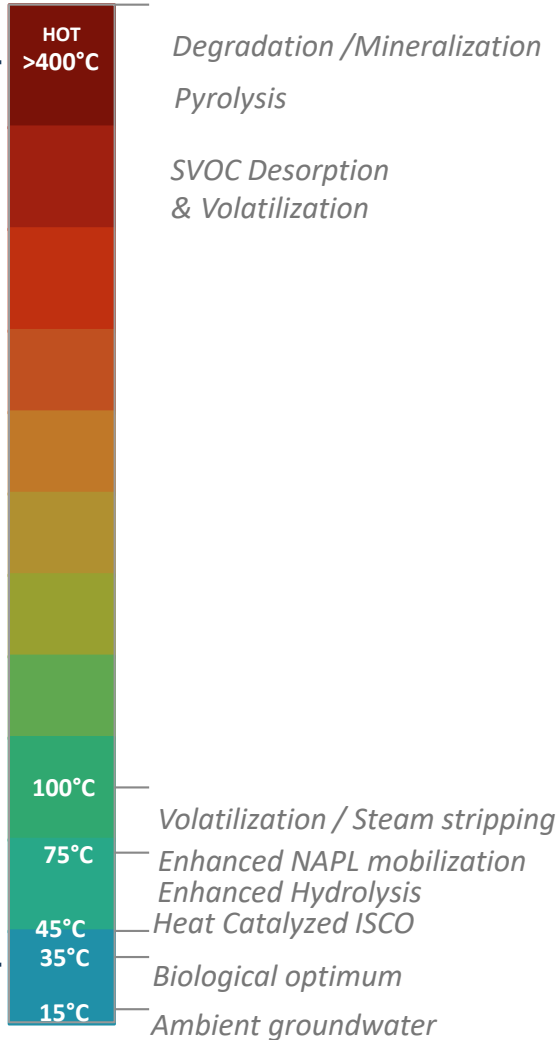
Whole-plume closure is a design objective — not an outcome of addressing the source zone alone.



Why Heat is The Right Unifying Backbone

Temperature is not a fixed condition. It is a dial.

ADJUSTABLE



1

Temperature controls physical behavior and phases

Viscosity, interfacial tension, solubility, and vapor pressure all shift with temperature — directly affecting how contaminants move, dissolve, and are recovered, regardless of how heat is delivered.

2

Temperature drives abiotic reaction kinetics

Hydrolysis, dehydrohalogenation, and thermally activated oxidation/reduction reactions accelerate with heat. Reaction rates follow Arrhenius kinetics — half-lives can shorten by orders of magnitude.

3

Temperature governs microbial metabolic rates

Biodegradation rates roughly double with every 10°C rise through the biological optimum window. The Q_{10} relationship is well established across both aerobic and anaerobic pathways.

4

The operating temperature determines which mechanisms dominate

High temperature favors volatilization and physical recovery. Mid temperature activates abiotic chemistry. Low temperature optimizes biology. The temperature target is a strategic choice, not a default.

The question is not whether to use heat. It is which temperature target — and whether the delivery system is matched to that objective.



Across the Thermal Spectrum: One Continuum, Many Mechanisms

Temperature determines which removal mechanisms activate — and how many operate simultaneously- But What Technologies are Best suited to the given temperature, contaminants and Site/Project specific considerations?

ERH

TCH

SEE

Low-to-Mid Temp Thermal Approaches?

10–25°C

50–77°F

25–45°C

77–113°F

45–75°C

113–167°F

75–100°C

167–212°F

>100°C (up to 400 °C)

>212°F

← Cooler

Hotter →

10–25°C · Ambient

Baseline biology

Ambient HEBR

DHC populations

Baseline reductive conditions - electron donors and microorganismal populations are present.

Slow at ambient temps.

25–45°C · ThermaCycle Phase 4

Heat-enhanced bioremediation

$Q_{10} \approx 2$

30–40°C optimum

Dehalo. + BTEX

Metabolic rates double every 10°C rise. Reductive dechlorination accelerates through 35- 40°C. BTEX peaks 30–40°C. Heat mobilizes electron donors from organic matter.

45–75°C · ThermaCycle Phases 2 & 3

NAPL Mob, Hydrolysis, Heat Catalyzed ISCO

60–80% viscosity drop

IFT reduction

Persulfate + ZVI

NAPL viscosity drops 60–80% → flows to extraction wells. IFT reduction lowers capillary trapping. Solubility up 2–5×. Hydrolysis half-lives shorten for TCA, CT, 1,1-DCA.

75–100°C · Abiotic window

VOC Vapor Phase Removal (ISTD - SVE/DPE)

Vapor pressure ↑

Co-boiling onset

Dual-phase extraction

Vapor pressure increases sharply → co-boiling and steam distillation of NAPLs. Dual-phase extraction captures liquid and vapor simultaneously.

>100°C · >212°F

High-temp ISTR

Volatilization

Steam distillation

>\$200/yd³

One mechanism: volatilization. Does not address the plume. Infrastructure-intensive. Limited to defined TTZ.

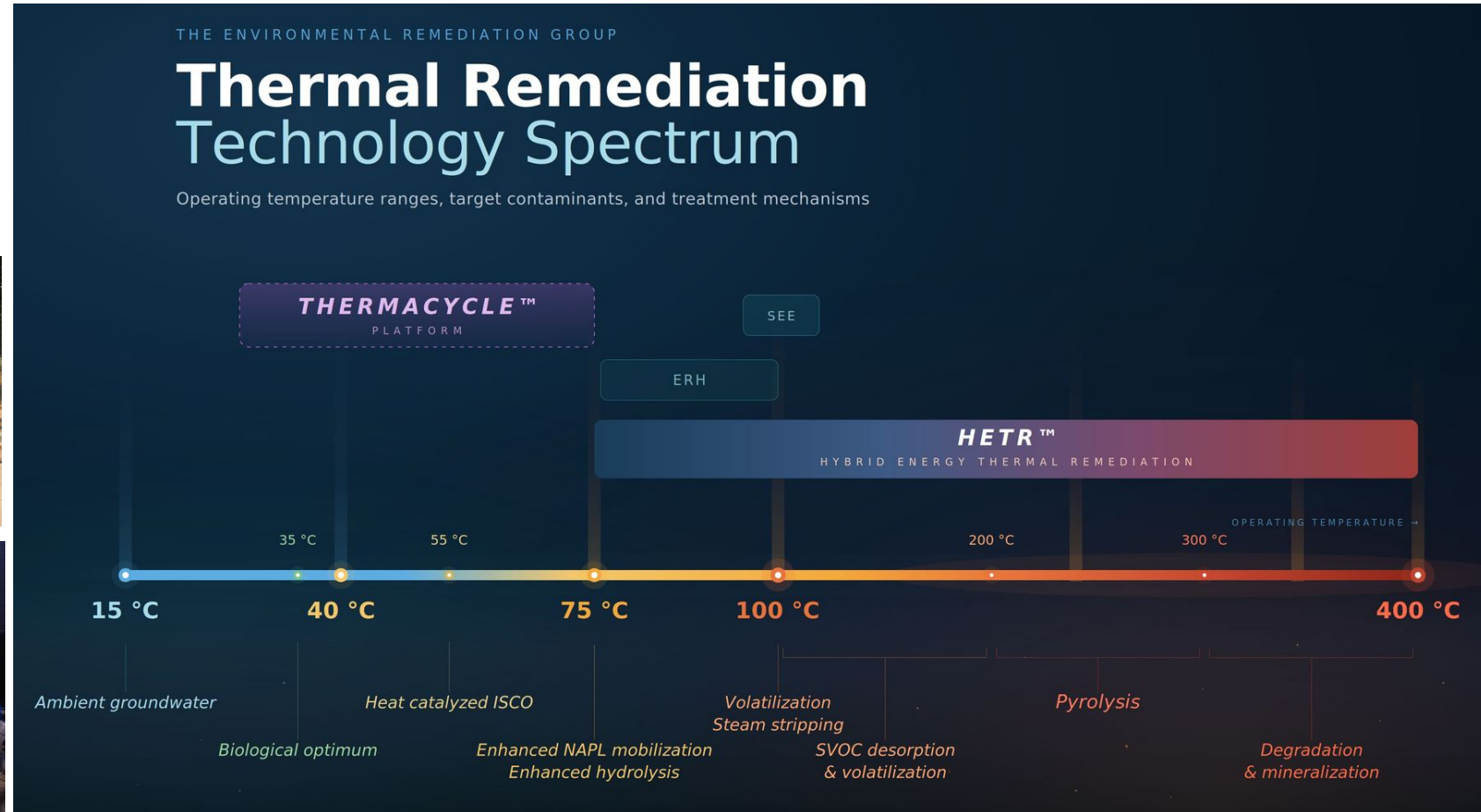
Temperature determines which removal and degradation mechanisms are active — and at any given temperature, several operate simultaneously.

ERG's Technology & Innovative Platforms





Across the Thermal Spectrum





Thermal, Reimagined

HETR
Hybrid Energy Thermal Remediation

Patented Hybrid Energy Thermal Remediation

- High-temperature thermal conductive heating (TCH) technology
- Multiform energy utilization strategy (combustive + electric = hybrid)
- Reduced lifecycle carbon intensity vs conventional systems (renewable energy integration is central to technology)

Best Applied When:

- Low K lithology (clays) limit alternative technologies/approaches
- Aggressive source removal is required, and(or) low cleanup goals require thermal **CERTAINTY**
- DNAPL or high-mass zones are present
- Infrastructure constraints demand energy flexibility

ThermaCycle™

Adaptive, Low- to Mid-Temperature Thermal Platform

- Closed-loop groundwater heating and recirculation
- Designed for 30-170°F operational ranges
- Facilitates numerous heat enhanced and combined removal mechanisms

Best Applied When:

- Lithology has higher K-value (1×10^{-4} to 1×10^{-2})
- Hydraulic control is critical
- Bioremediation can be accelerated
- Timeline has more flexibility, and project costs matter most
- Traditional ISTR just doesn't quite fit the bill

HETR

Hybrid Energy Thermal Remediation

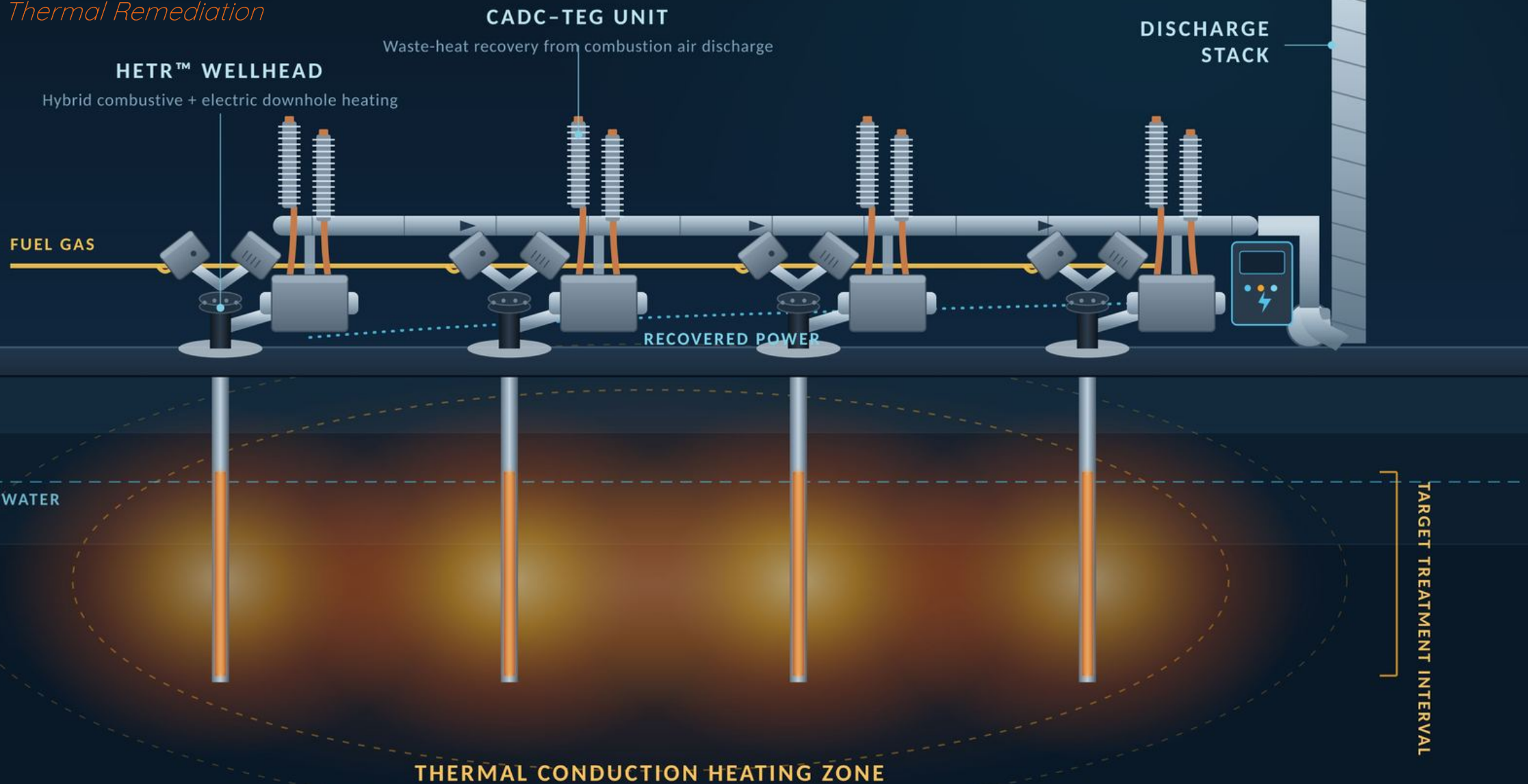
High Temperature. Lower Carbon. No Compromises.

U.S. Patent No. 12,523,373



HETR

Hybrid Energy Thermal Remediation



U.S. Patent No. 12,523,373



Hybrid Energy Thermal Remediation

Hybrid Energy Architecture

- ✓ Combustive + electric, either alone or combined.
- ✓ Grid-connected, partial-grid, or fully off-grid.
- ✓ Energy source adapts to site — not the other way around.

Thermoelectric Energy Generation

- ✓ 100–500 W per well, 24/7 — generated while heating.
- ✓ Reduces grid draw. Pairs with solar for off-grid operation.
- ✓ The system earns back energy as it remediates.

4D Heat Control

- ✓ Longitudinal and lateral differentiation within and across wells.
- ✓ Boost energy at discrete depth intervals.
- ✓ Displace heating interval — target deep zones without heating everything above.



Hybrid Energy Thermal Remediation

100–400°C

Subsurface Target

550 W/ft

Heat Flux to Formation

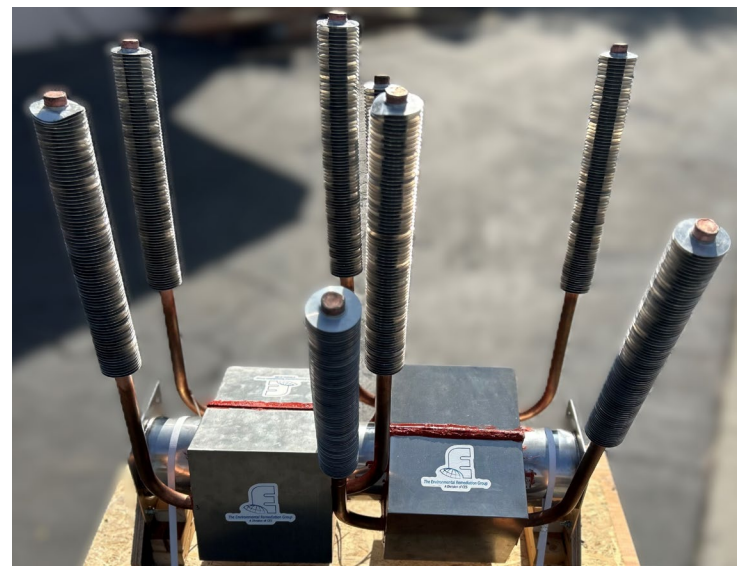
8–17 ft

Well Spacing

500+ W

Renewable per Well, 24/7

Model	Energy Output	Heat Flux to Formation	TEG Generation	Electrical Requirement	Max Length
FDG-HETR-150X	8.8–44 kW	4.5–23 kW	100–500 W	None to 115V/1Ø AC	55 ft
FDG-HETR-250X	24–74 kW	11–36 kW	200–600 W	None to 115V/1Ø AC	90 ft



Off-grid capable | Infrastructure-light | Deployable where conventional TCH cannot go

HETR

Hybrid Energy Thermal Remediation

High Temperature. Lower Carbon. No Compromises.

3

Full-scale implementations
completed or in progress

500+

HETR wells planned
across 2026 projects

US 12,523,373

Patent issued
and active

ThermaCycle™

Adaptive Low to Mid Temperature Thermal,
Engineered for Control





ThermaCycle™

A Dynamic, Multi-Mechanism Thermal Platform Designed to Evolve with the Remedial Trajectory

≤70°C

Operating Envelope

- Recirculating groundwater heating
- 90-150 °F subsurface
- 100-180 °F injection



Process Configuration

- Extraction-heating-amendment-reinjection in a single loop
- Same wellfield from source treatment through polishing
- No infrastructure changes between phases



Removal Mechanisms

Thermally Enhanced:

- ✓ Biodegradation
- ✓ Hydrolysis
- ✓ Desorption, Dissolution & Product Mobilization
- ✓ Co-solvent/surfactant/oxidant dosing for numerous other heat enhanced remediation mechanisms



Operational Phasing

- flow, temperature, and dosing are adjusted as the remedy progresses; mechanism emphasis shifts from aggressive mass removal toward biological polishing
- Backbone of thermally enhanced combined remedies



TC-1MX-001 · Confidential site, Southern California · Phase 1 deployment

ThermaCycle™ facilitates the use of the right combination of thermally enhanced mechanisms — for the site, the zone, and the stage of the remedy.



ThermaCycle™ The Thermal Mechanism Stack

Every mechanism below accessible within the single ThermaCycle™ operating envelope: 30–75°C · 90–150°F subsurface · 100–180°F injection

Mechanism	Temp (°C)	Temp (°F)	Target Contaminants	Rate / Impact
Heat-Enhanced Biodegradation	30–40°C	86–104°F	CVOCs (aerobic & anaerobic); petroleum hydrocarbons; 1,4-dioxane	Metabolic rates roughly double per 10°C (Q ₁₀); native microbial communities preserved; electron-acceptor demand drives rapid dechlorination
Accelerated Hydrolysis	35–65°C	95–150°F	1,1,1-TCA · carbon tetrachloride · 1,1-DCA · 1,1,2,2-TeCA (PCE/TCE: slow)	Half-lives shorten 1–2 orders of magnitude; >90% reductions over months to years; strong Arrhenius temperature dependence
Dehydrohalogenation	50–75°C	122–167°F	Higher-chlorinated alkanes (TCA, TeCA); some chlorinated ethenes	β-elimination pathway distinct from hydrolysis; rate doubles per 10°C; TCA → 1,1-DCE primary product
NAPL Viscosity & IFT Reduction + Enhanced Mobilization	40–70°C	104–158°F	PCE · TCE · DNAPL — all chlorinated and petroleum NAPLs	Viscosity ↓ 40–60%; IFT ↓ 25–35%; solubility ↑ 2×; desorption rate ↑ 3–5×; compounded by inline surfactant or co-solvent delivery
Thermally Activated Persulfate (ISCO)	40–60°C	104–140°F	PCE · TCE · DCEs · VC · BTEX · PAHs — broad CVOC and petroleum	Sulfate radical generation without iron activation pH issues; radical rate 2–3× per 10°C; delivered inline through same loop
Thermally Enhanced Oxidation	30–70°C	86–158°F	PCE · TCE · daughter products · carbon tetrachloride · nitroaromatics	Rate constants up significantly; passivation slowed; months → weeks timeline; same Q ₁₀ doubling relationship as biodegradation
Surfactant & Co-Solvent Enhanced Mobilization	Any	Any	NAPL — any chlorinated or petroleum free product phase	Delivered inline — thermal IFT reduction and chemical IFT reduction act simultaneously; surfactant out, electron donor in, no hardware change

WHAT THIS MEANS IN PRACTICE

Standalone remedy or backbone of a combined approach — same platform either way

Cleanup durations roughly 3 months to 3 years at far lower energy demand than high-temperature TCH

Heat and chemistry adjust in real time as concentrations, geochemistry, and hydraulic behavior evolve

Transitions between hydrolysis, bio-augmented, and surfactant-assisted NAPL phases — no remobilization, no redesign

Every mechanism on this table is accessible within a single operating window. ThermaCycle™ activates the right combination for the site, the zone, and the stage of the remedy.

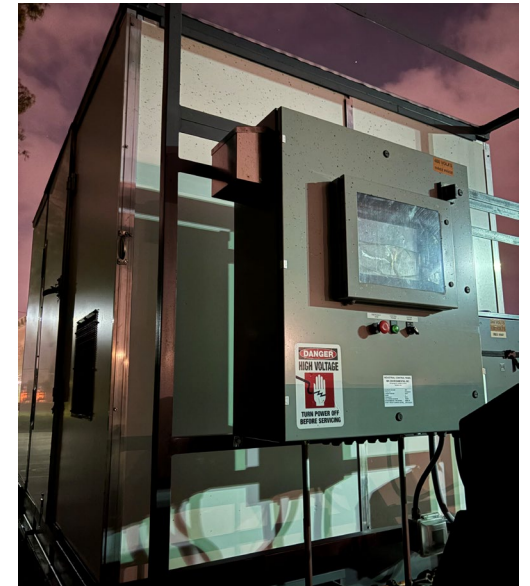
One platform. Seven mechanisms. Zero system redesigns.



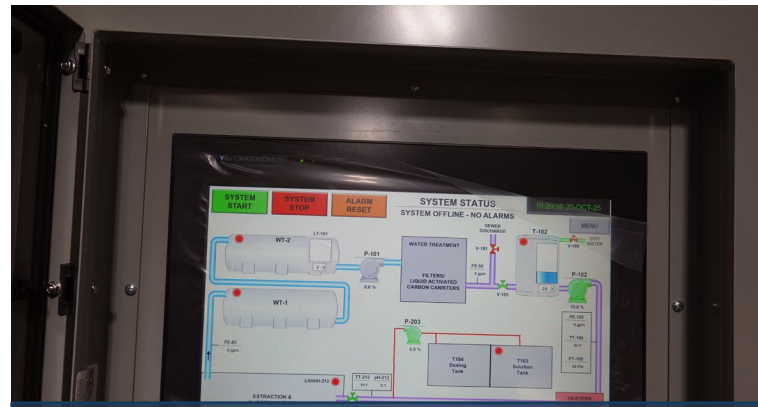
ThermaCycle™ Hardware, Features, and Design

THE HARDWARE

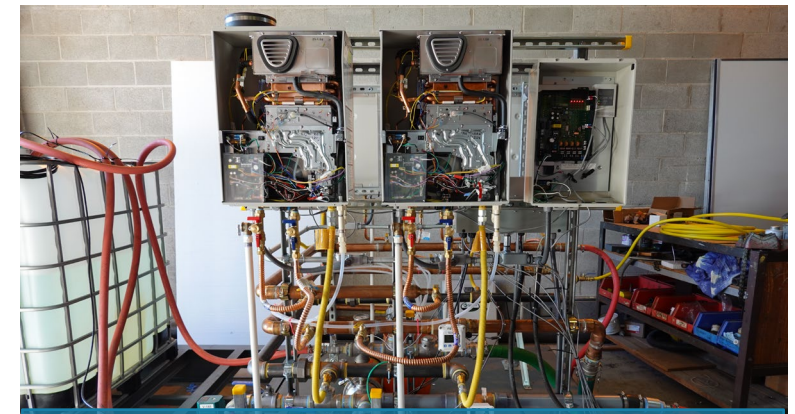
Enclosure	8.5 × 12 ft all-metal — fully piped, wired, factory-tested
Control	Allen-Bradley PLC — real-time telemetry, remote HMI, automated alarms, continuous data logging, Ignition based SCADA Backbone (option)
Flow range	5 to 50 gpm — adjustable without hardware change
Temp range	30–40°F boost (HEBR) through 105°F lift (hydrolysis / DNAPL mobilization)
Dosing	Multiple dosing tanks/pumps, Inline ports, static mixer — substrates, cultures, surfactants, co-solvents, oxidants, reductants, nutrients



Wellfield distribution manifold — individual zone flow control, instrumentation, and inline dosing integration



Allen-Bradley PLC — SCADA HMI with real-time system status, flow metering, temperature telemetry, and dosing pump control



Multi-unit on Demand Heating units provide cheap reliable heating system with redundancy and optimization controls programmed in - flexible heat capacity for each project.



ThermaCycle™ Hardware, Features, and Design



01 — External Chemical Dosing Tanks

flexible inline chemical delivery for evolving chemical dosing demands.



02 — Internal Amendment Dosing Tank

with mixer for soluble amendment injectate solutions (ie. water soluble nutrient amended carbohydrate blend).



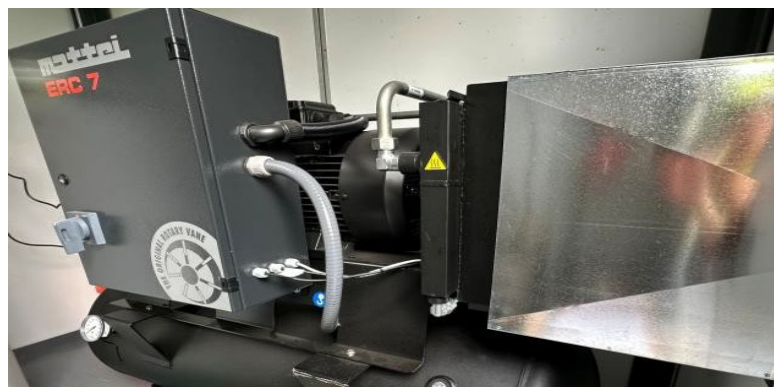
03 — Integrated Dosing

Static mixer — integrates multi-chemical dosing in-line with heated water pre-reinjection



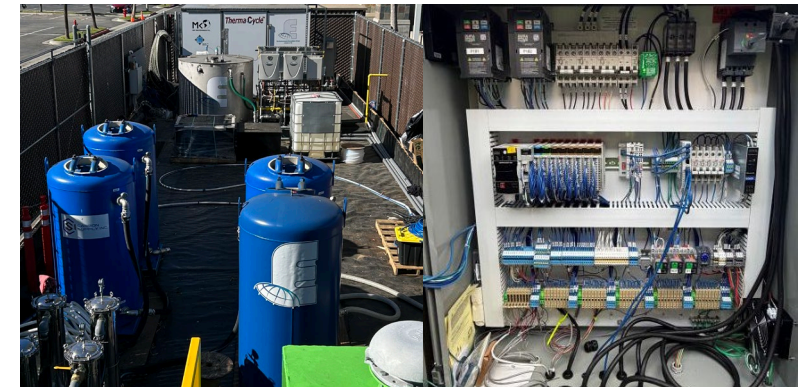
04 — Manifolding

Pre-plumbed “plug and play” injection and extraction manifolding with flow meters, inline sensors (Ph, temp, pressure, etc.)



05 — Electric or Air Actuated pumping Options

Mattei ERC 7 compressor — down well pump engine (optional for high-temp approaches/Sites, >120°F)



06 — Customizable System and Plug and Play Architecture

Integrated control panel with VFDs, transformers, and I/O modules — plug-and-play architecture supports system expansion and remedy evolution. HMI touchscreen and Ignition SCADA integration for real-time monitoring and adaptive control.

Active commercial parking lot. 12 parking stalls temporarily displaced. The entire remedial wellfield — installed, commissioned, and restored — beneath your feet.



ThermaCycle® as a Thermal Enhancement to Conventional Remedies

Moderate subsurface heating increases the rate and efficiency of established remedial technologies, optimizing existing remediation systems and projects that have stalled.

PUMP & TREAT

Enhanced Mass Recovery

Heat increases solubility and desorption rates — more mass per gallon pumped than traditional pump and treat system, shorter system runtime.

IN SITU BIOREMEDIATION

Enhanced Reductive Dechlorination

Raising groundwater into the biological optimum ($\approx 30\text{--}40^\circ\text{C}$) increases microbial activity and dechlorination rates within the mesophilic range. A $10\text{--}20^\circ\text{C}$ boost can double reductive dechlorination rates, existing microbial community and amendment program are maintained.

ISCO / CHEMICAL OXIDATION

Thermally Activated Persulfate

Elevated temperature activates persulfate without iron catalyst or pH adjustment, improving radical yield at lower oxidant loading.

HYDROLYSIS & ABIOTIC DEGRADATION

Enhanced Hydrolysis & Abiotic Degradation

Push-pull recirculation delivers heat to the target interval, better contact and lower residence time. Hydrolysis and amendment or injection driven abiotic degradation occurs more efficiently, with better contact, and hydraulic control.

Confidential Southern California Site

*Active CVOCs DNAPL
Source Zone with Large
Dissolved Plume*





Confidential So. Cal Project Update— Site & Project Overview

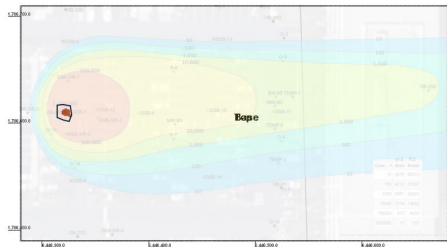
The Good Stuff

- **Bowyer Environmental** - Well informed Consultant with experience implementing ISTR and Recirc systems
- Early Engagement with ERG – Active, Versed consultant informing Client and Regulators
- VERY well defined CSM
- Project Team - Creative thinking about Spatiotemporal combined remedy, and full spectrum thermal approaches

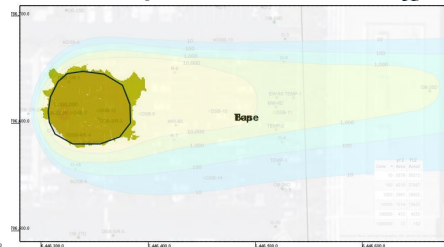
The HARD Stuff

- Active High End Shopping Center
- Concentrated Deep DNAPL at Clay Aquitard (120-ft bgs)
- Feeding large downgradient plume (down gradient bio-barrier in place as engineering control)
- 60 ft of overlying saturated zone
- Difficult Geochem, Hydrogeology, and impacts

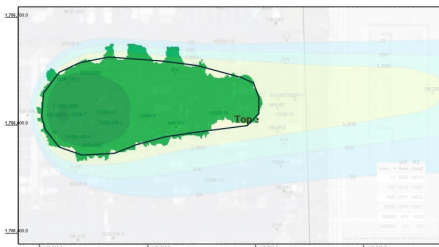
PCE/TCE - >1,000,000 ug/kg



PCE/TCE - >100,000 ug/kg



PCE >10,000 ug/kg



Conceptual site model — DNAPL source at ~120 ft bgs atop deep Clay Aquitard; sorbed mass in deep zone; dissolved plume extending downgradient sustained by clay back-diffusion

Source Zone

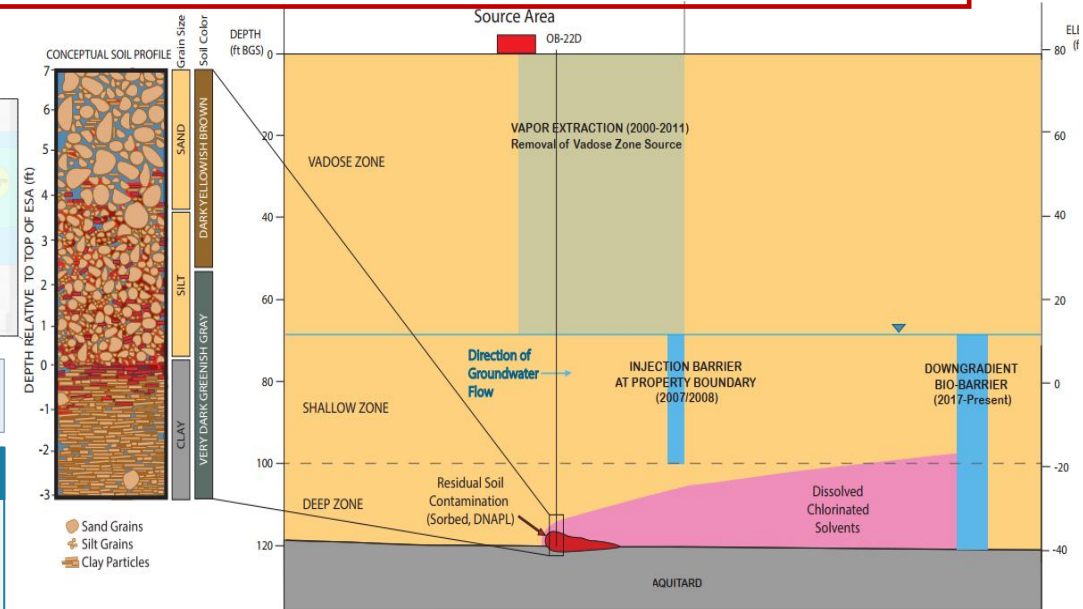
DNAPL + high-conc. sorbed mass · discrete intervals at ~110–127.5 ft bgs · >1,000,000 µg/kg PCE+TCE

Transition Zone

High dissolved-phase concentrations · sorbed mass in silt and clay · >100,000 µg/kg

Dissolved Plume

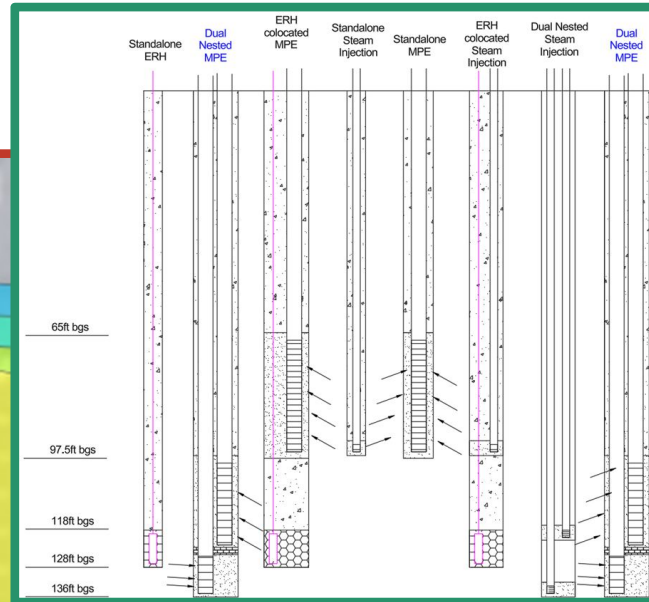
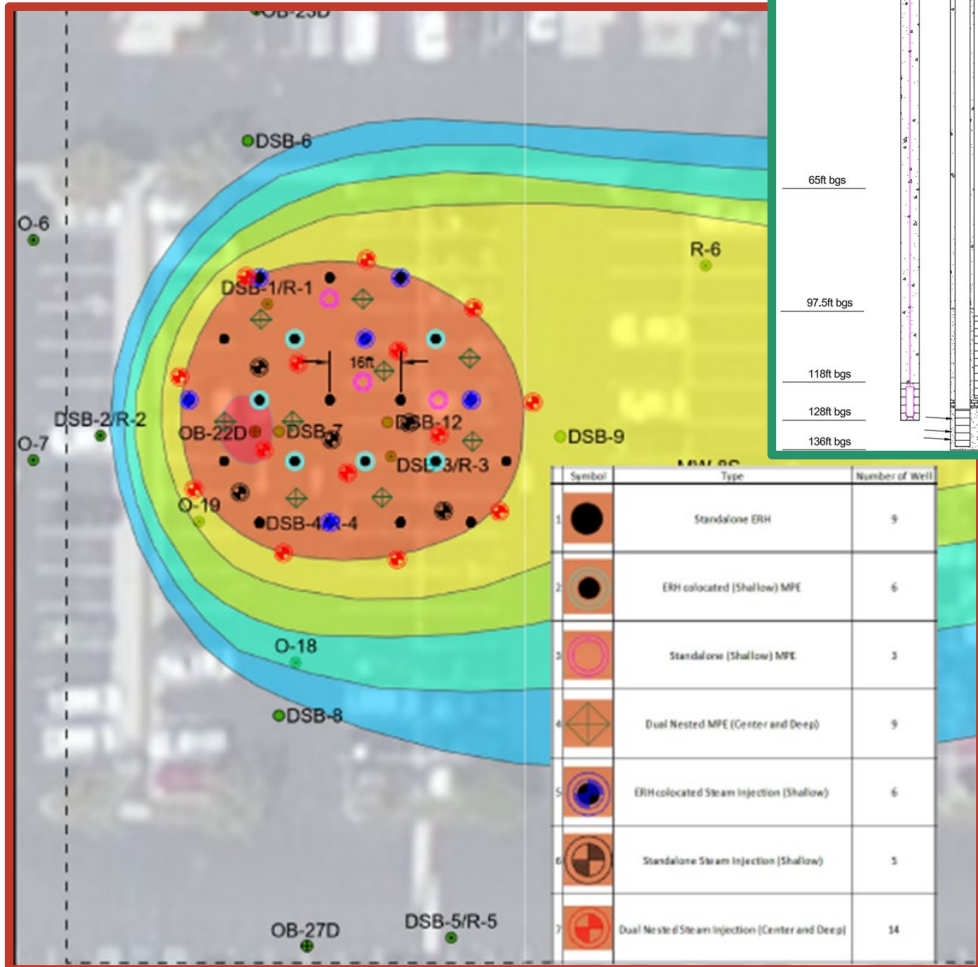
Diffuse CVOCs extending hundreds/thousands of ft downgradient · sustained by back-diffusion from low-K clays



Notes:
1. Diagram is not to scale and is a conceptual representation of site conditions.
2. BGS = below ground surface ; MSL = mean sea level
3. Red indicates the presence of chemical mass in deep soil source.

Conventional ISTR would have treated the source zone and created new risks. ThermaCycle was designed to treat the whole plume — aggressively, safely, and without remobilization.

Why Conventional ISTR Wasn't the right fit



WHY CONVENTIONAL ISTR WAS THE WRONG TOOL

Aquitard penetration risk

High-temp ISTR requires heater wells penetrating through Clay Aquitard — creating vertical pathways for downward DNAPL migration into deeper production aquifer below.

60 ft of overlying saturated zone

Full-column ISTR would require heating the entire 60-ft saturated interval above target to prevent VOC condensation and downward remobilization — massively expanding scope, cost, and risk. Possible requirement of SEE to augment heat losses in sands above & BELOW the clay aquitard.

High capital, high risk

Numerous electrode or heater well penetrations, large-footprint power infrastructure, and high energy demand — disproportionate to the objective and incompatible with active parking lot operations.

THE THERMACYCLE™ APPROACH

- ⚡ Aggressive source zone DNAPL removal via targeted hot-water recirculation — without heater wells penetrating the aquitard
- 🔄 Synergistic whole-plume combined remedy — same closed-loop platform carries treatment from DNAPL mass removal through dissolved plume closure
- ↓ Lower risk design — no aquitard penetrations, no high-voltage infrastructure, compatible with active commercial operations, subsurface install, hydraulic control
- 🕒 Expedited timeline and lower overall cost — phased intensification avoids system redesign or remobilization between phases

Conventional ISTR would have treated the source zone and created new risks. ThermaCycle was designed to treat the whole plume — aggressively, safely, and without remobilization.



Confidential So. Cal Project Update— Site & Project Overview

Conduit, piping, wellfield, controls — all trenched in and restored. You wouldn't know it exists. That's the point.



01 — Survey & marking

Wellfield layout marked on active parking surface



02 — Saw-cut & trench

Excavation of main heading and lateral trenches



03 — Conduit & piping installed

PEX conveyance lines + electrical conduits in main trench



04 — Wellfield connections

PEX supply/return lines and conduit bundles at well vaults



05 — Subsurface connections

ERG crew making final pipe connections in wellfield trench



06 — Controls commissioned

panel wiring — IO/HMI and SCADA telemetry integration



07 — Trench Backfill

Geotech compaction survey and final repaving



08 — Match existing surface conditions

The entire wellfield infrastructure is beneath this surface.

Active commercial parking lot. 12 parking stalls temporarily displaced. The entire remedial wellfield — installed, commissioned, and restored — beneath your feet.



ThermaCycle™ Built to Evolve

This project demonstrates ThermaCycle's ability to sequence multiple removal mechanisms and temperature strategies in response to evolving subsurface conditions — delivering an efficient, spatiotemporally optimized combined remedy.

Phase 1 <i>NAPL Mass Mobilization & Recovery – Pilot</i>		Phase 2 <i>NAPL Mass Mobilization & Recovery – Full DNAPL Impacts and high soil impacts</i>		Phase 3 <i>Dissolved Plume — Heat-Enhanced Bioremediation</i>	
Objective	Confirm Upgradient DNAPL boundary, identify hydraulic control, induce groundwater velocity, formation constraints on injection/extraction, shake down treatment system.	Objective	DNAPL mobilization, Soil mass Desorption solubilization, and subsequent extraction, treatment and reinjection.	Objective	Larger dissolved plume treatment and hydraulic control
Temperature	High delta — 105°F lift 130–150°F subsurface	Temperature	High delta — 105°F lift 130–150°F subsurface	Temperature	Low delta — 30–40°F boost 90–100°F subsurface
Flow	5–10 gpm Targeted, high-delta	Flow	10–25 gpm Targeted, High Delta	Flow	30–50 gpm Broad sweep
Amendments	Surfactants, co-solvents, or none	Amendments	Surfactants, co-solvents, or none	Amendments	Electron donors, nutrients, buffers, etc.
Mechanisms	Viscosity and IFT reduction Free product recovery Dissolution rate increase	Mechanisms	Viscosity and IFT reduction Free product recovery Dissolution rate increase	Mechanisms	Heat-enhanced biodegradation Hydraulic plume control Amendment co-delivery
System change	Liquids treatment system required for DNAPL and dissolved VOC removal.	System change	Change of dosing chemicals, liquids treatment system components optimized to Site conditions (lessons learned from Phase -1)	System change	No liquids treatment (or minimal if required)

From Zone-1 to Zone 3 - Remediation optimized across the spatial impacts, designed to evolve over remedial trajectory.



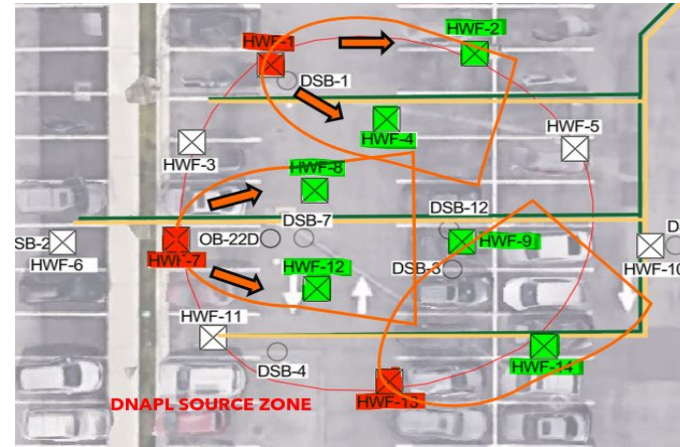
Phases 1 & 2: Full Source Zone DNAPL Removal

Hot water recirculation with co-solvent and surfactant-enhanced DNAPL recovery · Same system — expanded footprint

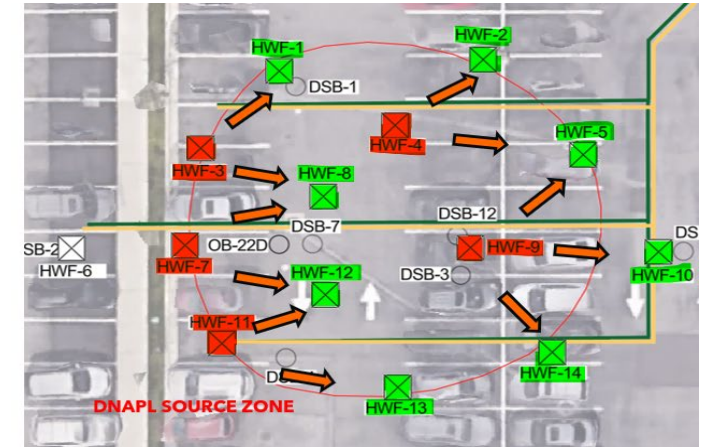
PHASE 2 — ~24 WEEKS

Wellfield	14 total recirculation wells — full DNAPL-impacted volume
Flow / Temp	✓ 15 -20 GPM ✓ Scaled to full source zone footprint at 170°F injection
Target	80%+ DNAPL mass removal from entire characterized source zone
Co-solvent	Propanol — improves relative hydraulic conductivity in tighter lower silts
Surfactant	Ethylated nonionic surfactant — deployed if DNAPL recovery drops off
Containment	Extraction at 115 to 140% of injection rate (higher if needed)
System change	Liquids Treatment Optimization. Same ThermoCycle skid and dosing infrastructure.

Week 1-8

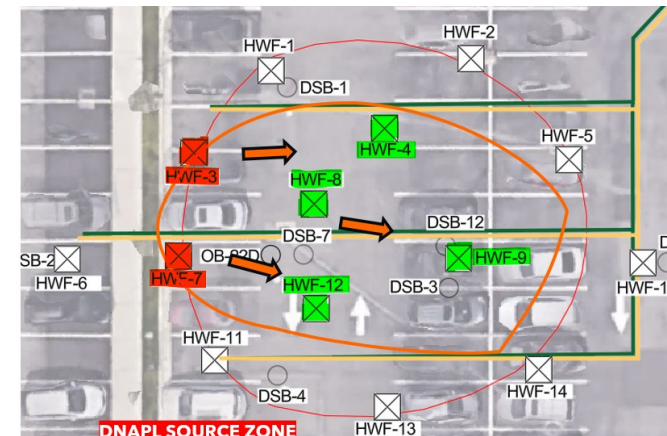


Week 8-14



Phase II - Recirculation Layout · 14 HWF wells + monitoring array · Full DNAPL source zone coverage

Weeks 14 - 24



Strategies may evolve significantly by the time the operation reaches this stage. The current configuration, serves only as an example of how the final polishing phase may be implemented

Same platform. Wider footprint. Higher flow. No redesign — the remedy scales, the system doesn't change.



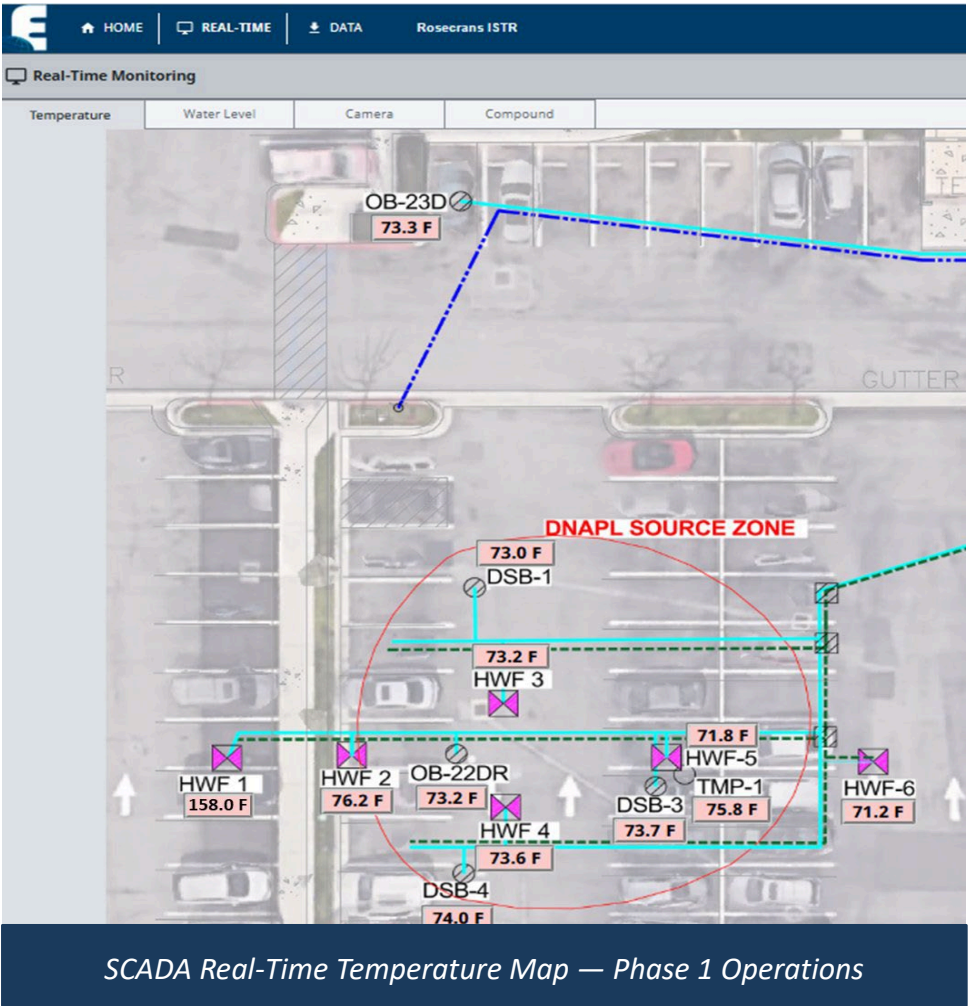
Confidential So. Cal Project Update - Phase 1: Initial Pilot Operations

Confidential Southern CA Site · PCE/TCE DNAPL at 120–127.5 ft bgs · Active commercial parking lot

SITE CONTEXT	
Contaminants	PCE + TCE — DNAPL confirmed at depth
Source depth	~110–120 ft bgs — silts, sandy silts, and silty sands – coarsening upwards from underlying clay aquitard at ~120-ft bgs
Concentrations	>1,000,000 µg/kg DNAPL; >100,000 µg/kg sorbed mass
Plume	Dissolved phase extending several thousands of ft downgradient — sustained by clay back-diffusion
Setting	Active commercial parking lot

PHASE 1 KEY RESULT

- Injection temperature sustained at ~160°F
- Residence time between extraction/injection pairings: 12–16 days
- Thermal front confirmed at ~2 ft/day through sandy silt to silty clay at 110–120+ ft bgs
- Induced hydraulic gradient confirmed; active hydraulic control verified by level transducers and thermocouples throughout wellfield
- HMI, SCADA, and telemetry fully operational
- Liquids treatment modifications required for metals precipitation and fouling control; revisions underway in advance of Stage 2 startup (April)



Phase 1 confirmed thermal front propagation and hydraulic control at depth — in an active commercial parking lot. The platform performed.



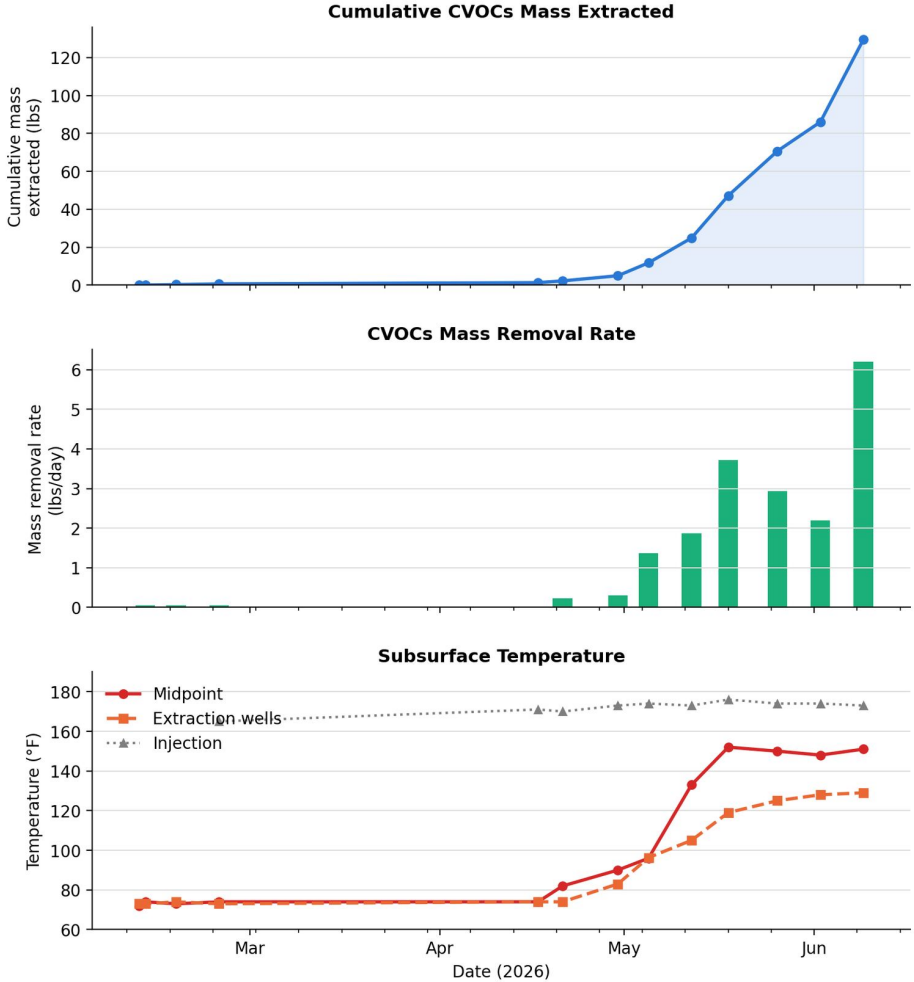
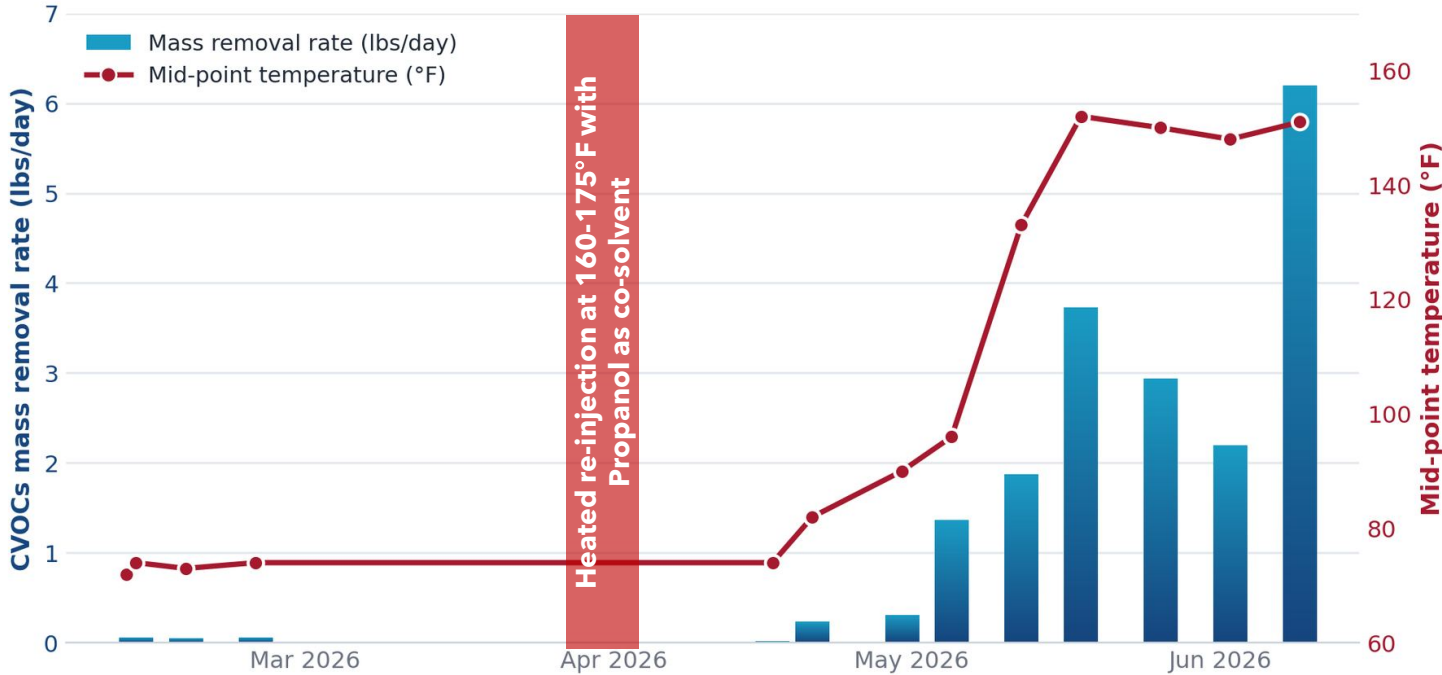
Confidential So. Cal Project Update - Phase 2: CVOC Source

Confidential Southern CA Site · PCE/TCE DNAPL at 120–127.5 ft bgs · Active commercial parking lot

CVOC Mass Removal vs. Subsurface Temperature Response

CVOCs Mass Removal Rate and Mid-Point Temperature

Mass removal response to subsurface heating | February – June 2026



600% increase in mass removal rates and climbing, not including DNAPL recovery in Weirs!



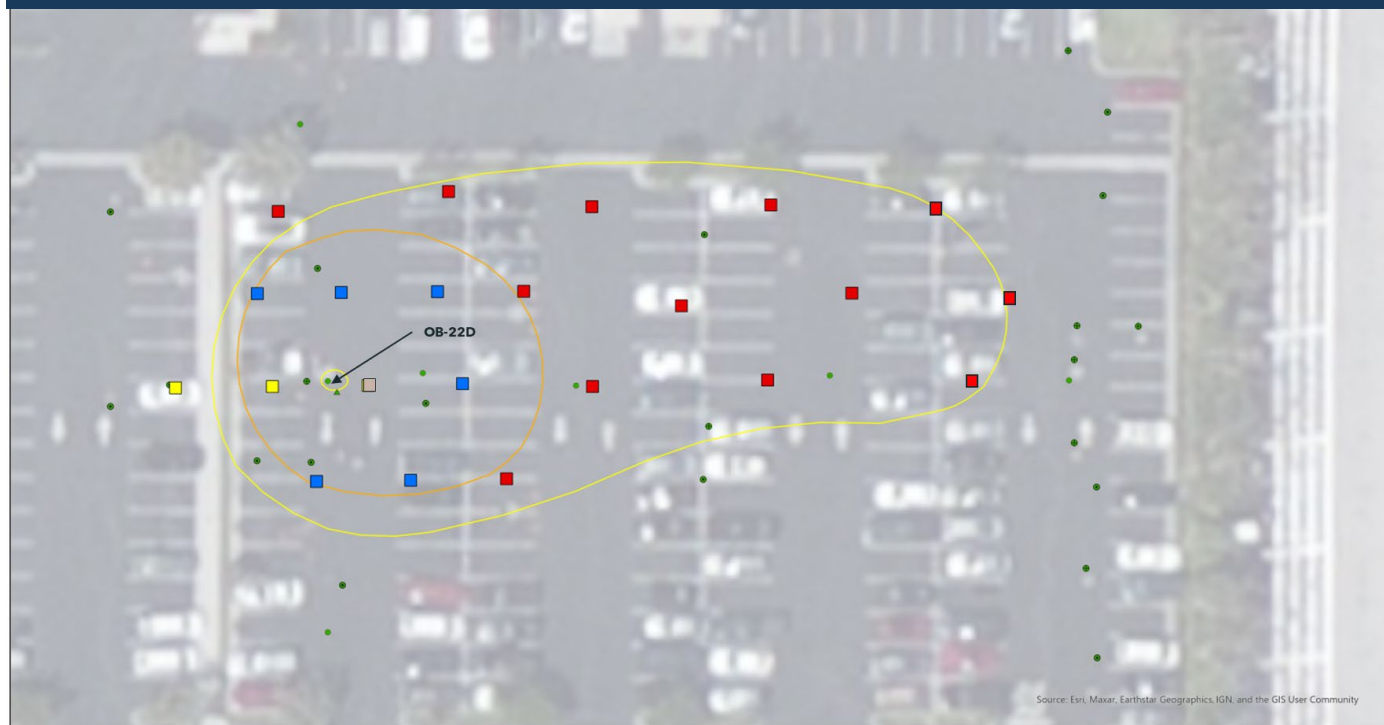
Phases 3: Plume Polishing using HEBR

Same platform — different mechanism · ~2 years · 24+ total wells · co-solvent and electron donor dosing · No remobilization

WHAT CHANGES IN PHASE 3	
Target zone	Residual soil mass and dissolved plume — beyond source zone footprint
Wellfield	10 new wells added — 24 total recirculation points
Temperature	Reduced to 30–40°C — biological optimum for dehalorespiration
Amendment	Ethyl lactate — co-solvent and electron donor for reductive dechlorination
Mechanism	Reductive dechlorination by Dehalococcoides — rate accelerated by Q_{10} relationship
Monitoring	qPCR — Dehalococcoides + functional genes; geochemical indicators

WHAT STAYS THE SAME ✓
✓ ThermaCycle™ recirculation skid
✓ Closed-loop infrastructure and piping
✓ Inline dosing system
✓ SCADA telemetry and remote monitoring
✓ Treatment liquids process

Phase 3 switches the primary mechanism from DNAPL mobilization to heat-enhanced bioremediation — no system redesign, no remobilization, no additional capital infrastructure.



Source: Esri, Maxar, Earthstar, Geographics, IGN, and the GIS User Community

Same platform. Wider footprint. Higher flow. No redesign — the remedy scales, the system doesn't change.

Some Takeaways





Lessons & Takeaways

ON MECHANISM SELECTION

Temperature is a spectrum — and there is a dial.

Between 75 and 350 C – ISTR technologies make for the most powerful, reliable, and confident approach to COMPLETE source zone remediation. Below 75°C, a recirculating hot-water system simultaneously or sequentially activates NAPL viscosity and IFT reduction, hydrolysis, dehydrohalogenation, thermally enhanced ISCO/ISCR, and heat-enhanced biodegradation. Designing for one mechanism while ignoring the others is leaving performance on the table.

ON REMEDY DESIGN

Plan the full remedial trajectory before mobilizing.

Source zone, residual, and dissolved plume have different temperature optima, amendment needs, and wellfield configurations — but they share infrastructure. Design Phase 1 knowing what Phase 4 requires. It **IS POSSIBLE** that the system you deploy is able to execute the entire trajectory.

ON SITE SELECTION & TECHNOLOGY FIT

Use traditional ISTR where it is warranted — and take full advantage of the rich thermal spectrum where it is not. Match the temperature to the mechanism, not to convention.

ThermaCycle is purpose-built for synergistic whole-plume combined remedy + lower risk design + one mobilization.



Thermal Without Strategy Is Just Expensive Heat.

Direct or Scenic Route?

Tolls?

What is the overall remaining lifecycle cost of the environmental impact/liability? Have you included tangible and intangible costs? What is the available budget to achieve closure, or lesser remedial end-point? What are the post-remediation costs to the project lifecycle?

What is the permissible timeline to remedial end-point? Most timelines are achievable, for any given remediation goal, but often at higher upfront costs (but with better lifecycle RORI).

Route(s) Selection

Anything is possible, but the selected route (remedial approach) should be the best suited to your input parameters (**goals/endpoint, timeline, and cost**). This is seldom a single technology or approach, and is where efficiencies (technical & financial) can be gained by evaluating creative combined remediation approaches.

Destination?

What are the ultimate goals that a remedial approach needs to achieve?

Wrong Way!





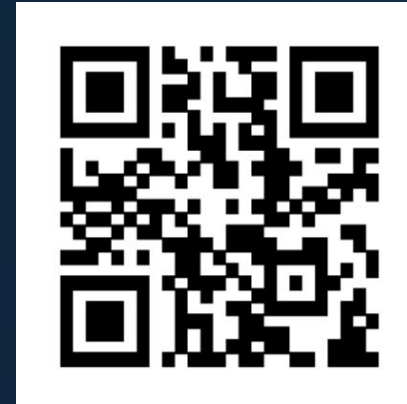
Contact ERG

Robert D'Anjou
President

Mobile: (206) 841-3284
Email: rdanjou@1erg.com
Long Beach, CA

Allen Swift
Chief Executive Officer

Mobile: (206) 271-1514
Email: aswift@1erg.com
Seattle, WA



WWW.1ERG.COM

Engineered Thermal Systems. Measurable Performance. Lower Lifecycle Costs.