



**TERRATHERM**

28900 Indian Point

Keene, CA 93531

Phone: (661) 823-1620

[gheron@terraetherm.com](mailto:gheron@terraetherm.com)

[www.terraetherm.com](http://www.terraetherm.com)

**GORM HERON, Ph.D.**

**Chief Technology Officer, Senior Vice President**

**PROFESSIONAL HISTORY**

|                                       |                      |
|---------------------------------------|----------------------|
| TerraTherm, Inc.                      | April 2004 – present |
| SteamTech Environmental Services, CA  | 1999 – 2004          |
| University of California Berkeley, CA | 1998 – 1999          |
| Rice University, Houston TX           | 1997 – 1998          |
| EPA National Research Lab, Ada OK     | 1995 – 1997          |
| Technical University of Denmark       | 1990 – 1995          |

**EDUCATION**

Ph.D. (Environmental Science and Engineering) Technical University of Denmark, 1994  
M.S. (Civil Engineering) Technical University of Denmark, 1990

**TECHNICAL SPECIALTIES**

Dr. Heron has 24 years of experience, with the following special areas of expertise:

- Contaminant plume geochemistry and characterization.
- NAPL migration, fate and transport (LNAPL and DNAPL).
- Design and implementation of in-situ thermal treatment systems for contaminated soil and groundwater.
- Bench-scale thermal treatability study design, implementation, and evaluation.
- Field-scale thermal treatability/pilot study design, implementation, and evaluation.
- Engineering design analysis of remedial alternatives.
- In-situ monitoring techniques for tracking progress during thermal remediation.

He is directing TerraTherm's international license holders and overseeing projects from a technical standpoint.

**SUMMARY OF EXPERIENCE: PROJECT DIRECTION AND TECHNICAL OVERSIGHT**

Dr. Heron was instrumental in designing, construction, operating, and documenting several field scale thermal cleanups:

- Solvents Recovery Service of New England Superfund Site, Southington, CT – Technical Director for a full-scale remediation project using ISTD with upwards of 2,000,000 pounds of chlorinated compounds, heavy metals, and polychlorinated biphenyls (PCBs) at a former solvent recovery system. Because of the potentially large mass, to control the rate of treatment rate, thermal remediation will be operated in two phases using a thermal oxidizer and scrubber package. Total project value: \$9.1M. Expected duration: construction February 2013 with operations through December 2014.
- Confidential Client, Pilot Study, NJ – Technical Director for a pilot scale thermal remediation project using ISTD to treat high concentrations of volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs), including benzene, toluene, xylenes (BTX), chlorobenzene, acetone, cyclohexane, methylacetate, chloromethane, naphthalene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, phenol, methylcyclohexane, 1,3,5-trimethylbenzene, ethylbenzene, and 1,1-biphenyl. Total project value: \$2.2M. Expected duration: construction fall 2013 with operations through May 2014.
- Confidential Client, Southeastern United States – Designer and Technical Director for a full-scale thermal system combining ISTD with steam injection (also called steam-enhanced extraction, or SEE). The thermal treatment zone encompassed an area with a footprint of approximately 70,000 square feet (ft<sup>2</sup>) extending from ground surface down to an average depth of 41 feet (ft) below ground surface (bgs). Contaminants of concern included trichloroethene (TCE), 1,1-dichloroethene (1,1-DCE), cis-1,2-dichloroethene (cis-1,2-DCE), vinyl chloride (VC), and 1,4-dioxane. Approximately 4,000 pounds of VOCs were removed in the vapor phase and another 700 pounds were removed in the water phase. Total project value: \$8M.
- Hunters Point, San Francisco, CA. Technical director for an ISTD demonstration of PCE and dichlorobenzene removal below a building (reference Tamzen MacBeth, CDM Smith).
- Silresim Chemical Corporation Superfund Site, Lowell, MA – Senior reviewer for a full-scale thermal remediation using Electro-Thermal Dynamic Stripping Process (ET-DSPTM) for remediation of chlorinated volatile organic compounds (CVOCs) at a former solvent recovery facility. The total treatment volume was ~60,000 cy, utilizing thermal oxidation and wet-scrubbing of the extracted vapors. Over 85,000 pounds of CVOCs removed. Total project value: \$7.4M.
- Groveland Wells Superfund Site, Groveland, MA – Technical Director for a full-scale thermal remediation using ET-DSPTM and SEE for remediation of CVOCs at a former manufacturing facility. Granular Activated Carbon (GAC) was used to treat extracted vapors. The total treatment volume was ~17,000 cy and ~1,300 pounds of contaminants were removed. Total project value: \$3.6M.
- ESTCP Demonstration Project at NAWC Facility in West Trenton, NJ. Technical director and designer of a small-scale pilot test of USTD in fractured mudstone.
- Confidential Client, Endicott, NY – Lead Designer for a full-scale ISTD remediation of tetrachloroethene (PCE) from subsurface soils. Remedial Action Objectives (RAO) were

that no single post-treatment soil sample would exceed 5.5 mg/Kg of PCE and the average post-treatment concentration across the site would be less than 0.56 mg/Kg of PCE. Vapors and water were treated through GAC. Approximately 450 pounds of chlorinated VOCs and over 8,100 pounds of other VOCs (primarily petroleum hydrocarbons) were removed from the target treatment zone. Combined with the pilot study, a total of over 3,100 pounds of chlorinated VOCs and over 9,000 pounds of other VOCs were removed from the site soils. Total project value: \$3M.

- Confidential Client, Taunton, MA – Technical oversight for ISTD remediation of a former drum disposal area contaminated with chlorobenzenes, BTEX, and CVOCs, including a significant amount of tarry dense non-aqueous phase liquid. Total treatment zone was ~3,000 cy to a depth of 20 ft bgs, utilizing thermal oxidation and wet-scrubbing of the extracted vapors. Total project value: \$1.2M.
- Dunn Field, Memphis Depot, Memphis, TN. Dr. Heron designed and directed the ISTD remediation of eight separate CVOC source areas with a treatment volume of 48,000 cubic yards (reference Tom Holmes, e<sup>2</sup>M, 404-237-3982).
- Santa Fe Springs, CA. Design and technical direction of large-scale thermal project for PCE DNAPL removal, using TCH and SEE (reference: Lisa van Tassell, Geosyntec, 510-836-3034).

Arnold AFB Site SWMU-10, Tullahoma, TN. Design and technical direction of large-scale thermal project for DNAPL removal, using TCH and steam injection (reference: Jason Cole, CH2MHill, 865-483-9005).

- Terminal One Site, Richmond, CA. Removal of PCE from tight clay below the water table. Dr. Heron assisted with the design, direction and interpretation of this major ISTD project (reference: Alan Wolken, Richmond Redevelopment Agency; 510-307-8140).
- NASA Marshall Space Flight Test Center, Site 13 ISTD Demonstration, Huntsville, AL. Dr. Heron designed, directed and oversaw this ISTD implementation (reference: Jason Cole, CH2M HILL, 865-483-9005).
- Confidential Brownfields Site, Syracuse, NY. Dr. Heron designed and directed this major ISTD redevelopment project where more than 300 ISTD wells were used to treat three PCE source zones, paving the way for rapid site development (reference: Thomas Barba, C&S Engineers, Syracuse, 315-455-2000).
- Harwell Site, England: Oversight if seven years of full-scale ISTD treatment of disposal pits at the former UKAEA site (work by Provectus, UK).
- Knullen, Odense, Denmark. Design and oversight of full-scale ISTD and SEE combination treatment for PCE under an active dry-cleaner.
- Skuldelev, Denmark. Design and oversight of full-scale ISTD treatment of a PCE DNAPL site next to a fire pond.

- Reerslev, Copenhagen, Denmark. Design and oversight of full-scale ISTD treatment of a PCE DNAPL site adjacent to a church and residences.
- Vadsbyvej, Denmark. Oversight of full-scale ISTD remediation.
- MOE demonstration, Japan. Pilot-scale demonstration of thermal treatment of dioxin-contaminated soils.
- Confidential site in SE US. Assistant technical director for ISTD treatment for TCE in fractured rock to a depth of 90 ft (reference: John LaChance, Arcadis).
- MGP gas holder site in North Adams, MA. Assistant operator and technical director for an ISTD system treating a gas holder in place. More than 16,000 gallons of DNAPL recovered.
- FMC Solvent facility in Carson, CA. Assistant technical director for treatment of 1,2-DCA using ISTD and hydrolysis (reference: Carol Dickerson, Astra-Zeneca).
- ISTD treatment at SCE site in Alhambra, CA. Assistant technical director during Phase 2 of a large-scale remediation of a wood-treatment site (reference Tony Landler, Southern California Edison).
- Port of Ridgefield, Vancouver, WA. Designer of a multi-stage SEE project for restoration of a large wood-treatment site (reference Brent Grening, Port of Ridgefield).
- Beale Air Force Base, Beale, CA. Lead designer for a pilot test of SEE (reference Dr. Arun Gavaskar, Battelle, Columbus, OH. 614-424-6424).
- Nike PR-58 SEE pilot test, Providence RI. Designer and lead engineer for an SEE pilot test in fractured rock.
- Edwards Air Force Base, Edwards, CA. Lead designer for an SEE pilot test in fractured rock at site 61 (reference Scott Palmer, Earth Tech, San Jose CA, 408-232-2826).
- Loring Air Force Base, Limestone, ME. Lead designer for an SEE pilot test in limestone rock (reference Naji Akladiss, Maine Department of Environmental Protection, 207-287-7709).
- Area A at Young-Rainey STAR Center, Largo, FL. Lead designer and technical director for a combined SEE and ET-DSP project for CVOCs (reference Randall Juhlin, Stoller, 970-248-6502).
- Alameda Point, Oakland, CA. SEE pilot test for removal of TCE, diesel and motor oil from Site 5 (reference Prof. Kent Udell, University of Utah).
- Portsmouth, Ohio. Designer and lead engineer for a pilot test of SEE for TCE in a water-bearing zone between clay and bedrock (reference Dr. Roger Aines, LLNL, 925-423-7184).

- Visalia Pole Yard, Visalia CA. Engineer assisting with data management and interpretation for a large-scale SEE remediation of creosote. Treatment of 400,000 cy of impacted materials – reaching goals and regulatory closure (reference: Craig Eaker, Southern California Edison).
- Hedehusene, Copenhagen, Denmark. Dr. Heron reviewed the design and assisted in developing the operational strategy.
- Oesterbro, Aalborg, Denmark. Dr. Heron assisted in review of the design, and consulted during operation to optimize the performance. This project was completed in 2001, with a ground-breaking result. The source was removed from the site, thereby this site was the first ever to have had complete removal of separate phase solvents located below the water table (reference Tom Heron, NIRAS, Aarhus, Denmark, Phone 00-45-87323232).

### SELECTED PUBLICATIONS (THERMAL REMEDIATION RELATED ONLY)

Heron, G., J. LaChance, and R. Baker. 2013. Removal of PCE DNAPL from Tight Clays using In Situ Thermal Desorption. *Ground Water Monitoring and Remediation*, 33(4): 31-43.

Lemming, G., S.G. Nielsen, K. Weber, G. Heron, R.S. Baker, J.A. Falkenberg, M. Terkelsen, C.B. Jensen and P.L. Bjerg. 2013. “Optimizing the Environmental Performance of In Situ Thermal Remediation Technologies Using Life Cycle Assessment”. *Groundwater Monitoring & Remediation*, 6 May 2013, <http://onlinelibrary.wiley.com/doi/10.1111/gwmr.12014/abstract>.

Bjerg, P.L., M.M. Broholm, G. Lemming and G. Heron (2013) Groundwater Remediation, in *Encyclopedia of Environmetrics*, A.-H. El-Shaarawi and W. Piegorsch (eds), John Wiley & Sons Ltd: Chichester, UK. DOI: 10.1002/9780470057339.vnn114. Published online 1/15/2013.

Galligan, J., D. Rentschler, G. Crisp and G. Heron. 2012 “Treatment of Vapors from In Situ Thermal Remediation: Selecting the Best Option and Operating it Properly.” Paper 341, In: *Remediation of Chlorinated and Recalcitrant Compounds – 2012*. Eighth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2012). Battelle Memorial Institute, Columbus, OH.

Lemming, G., P. Bjerg, K. Weber, J. Falkenberg, S. Nielsen, R. Baker, G. Heron, M. Terkelsen and C. Jensen. 2012. “Environmental Optimization of In Situ Thermal Remediation Technologies using Life Cycle Assessment (I).” In: *Remediation of Chlorinated and Recalcitrant Compounds – 2012*. Eighth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2012). Battelle Memorial Institute, Columbus, OH.

Griepke, N., S., P.J. Jensen, G. Heron, J. LaChance, J. Galligan, N. Plough and P. Johansen. 2012. “Soil Sampling During and After Thermal Remediation: How and When?” Paper 920, In: *Remediation of Chlorinated and Recalcitrant Compounds – 2012*. Eighth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2012). Battelle Memorial Institute, Columbus, OH.

- Swift, R., G. Crisp, G. Heron, T. Mahoney, J. Bierschenk, T. Armstrong and M. Kominek. 2012. "Three Logical Steps of Thermal Treatment (Treatability Study, Pilot Study, Full Scale Implementation)." Paper 472, in *Remediation of Chlorinated and Recalcitrant Compounds – 2012*. Eighth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2012). Battelle Memorial Institute, Columbus, OH.
- Ploug, N., M. Jensen, J. Holm, P.J. Jensen, H.E. Steffensen, S.G. Nielsen, and G. Heron. 2010. "Thermal Treatment – How Close Can You Go and Is It Safe to Humans?" Paper E-013, in K.A. Fields and G.B. Wickramanayake (Chairs), *Remediation of Chlorinated and Recalcitrant Compounds—2010*. Seventh International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2010). Battelle Memorial Institute, Columbus, OH.
- Nielsen, S.G., G. Heron, P.J. Jensen, C. Riis, T. Heron, P. Johansen, N. Ploug and J. Holm. 2010. "Thermal Treatment of Thick Peat Layers – DNAPL Removal and Shrinkage." Paper E-001, in K.A. Fields and G.B. Wickramanayake (Chairs), *Remediation of Chlorinated and Recalcitrant Compounds—2010*. Seventh International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2010). Battelle Memorial Institute, Columbus, OH.
- Heron, G., J. LaChance, J. Bierschenk, K. Parker, S. Vinci, R. Woodmansee, and J. Schneider. 2010. "Combining Thermal Treatment with MNA at a Brownfield DNAPL Site." Paper E-024, in K.A. Fields and G.B. Wickramanayake (Chairs), *Remediation of Chlorinated and Recalcitrant Compounds—2010*. Seventh International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2010). Battelle Memorial Institute, Columbus, OH.
- Heron, G., R.S. Baker, J. Galligan, T. Mahoney, G. Anderson, K. Tawara, and H. Braatz. 2010. "In-Pile Thermal Desorption for Treatment of Dioxin-Contaminated Soil in Japan." Paper E-008, in K.A. Fields and G.B. Wickramanayake (Chairs), *Remediation of Chlorinated and Recalcitrant Compounds—2010*. Seventh International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2010). Battelle Memorial Institute, Columbus, OH.
- Baker, R.S., J.M. Bierschenk, J. LaChance, G. Heron, D. Phelan, and J.A. Clock. 2010. "In Situ Thermal Treatment of MGP Waste and Creosote." Paper H-057, in K.A. Fields and G.B. Wickramanayake (Chairs), *Remediation of Chlorinated and Recalcitrant Compounds—2010*. Seventh International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2010). Battelle Memorial Institute, Columbus, OH.
- Faurbye, M., Jensen, M., Rugge, K., Nielsen, S.G., Heron, G., Baker, R.S., Johansen, P., Tolstrup Karlby L. 2009. "Thermal in-situ remediation – a sustainable choice." Green Remediation Conference, Copenhagen.
- Heron, G., K. Parker, J. Galligan and T.C. Holmes. 2009. "Thermal Treatment of 8 CVOC Source Areas to Near Nondetect Concentrations." *Ground Water Monitoring and Remediation*. 29 No. 3 / Summer 2009, pp. 56-65.



- Heron, G., R.S. Baker, J.M. Bierschenk and J. LaChance. 2008. Use of Thermal Conduction Heating for the Remediation of DNAPL in Fractured Bedrock. Paper P-003, in: Bruce M. Sass (Conference Chair), *Remediation of Chlorinated and Recalcitrant Compounds—2008*. Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH.
- Nielsen, S.G., H.E. Steffensen, T. Heron, G. Heron, M. Kuhlman, H. Skou, N. Just and L. Dissing. 2008. First Thermal Remediation Using a Combination of Steam and ISTD. Paper P-015, in: Bruce M. Sass (Conference Chair), *Remediation of Chlorinated and Recalcitrant Compounds—2008*. Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH.
- Heron, G., R.S. Baker, J.M. Bierschenk and J.C. LaChance. 2006. "Heat it All the Way - Mechanisms and Results Achieved using In-Situ Thermal Remediation." *Remediation of Chlorinated and Recalcitrant Compounds: Proceedings of the Fifth International Conference* (May 22-25, 2006). Battelle, Columbus, OH.
- LaChance, J., G. Heron and R. Baker. 2006. "Verification of an Improved Approach for Implementing In-Situ Thermal Desorption for the Remediation of Chlorinated Solvents." *Remediation of Chlorinated and Recalcitrant Compounds: Proceedings of the Fifth International Conference* (May 22-25, 2006). Battelle, Columbus, OH.
- Heron, G., S. Carroll and S. G. D. Nielsen. 2005. Full-Scale Removal of DNAPL Constituents using Steam Enhanced Extraction and Electrical Resistance Heating. *Ground Water Monitoring and Remediation* 25 (4), Fall, 92-107.
- Heron, G., R. Baker, J. LaChance and A. Kirketerp Friis. 2005. "Using Heat to Accelerate Remediation". Paper D-23, in: B.C. Alleman and M.E. Kelley (Conference Chairs), *In Situ and On-Site Bioremediation—2005. Proceedings of the Eighth International In Situ and On-Site Bioremediation Symposium* (Baltimore, Maryland; June 6–9, 2005). ISBN 1-57477-152-3, published by Battelle Press, Columbus, OH.
- SteamTech Environmental Services. 2003. *In-situ remediation to remove non-aqueous phase liquids located in the subsurface at the North-East site Area A, Young-Rainey STAR Center, Largo, Florida*. Final Report, August.
- Earth Tech and SteamTech. 2003. *Site 61 Treatability Study Report, Steam Injection. Northwest Main Base, Operable Unit 8*. Final report submitted to US Air Force Flight Test Center, Environmental Restoration Division, Edwards AFB, California.
- Heron, G., D. LaBrecque and H. Sowers. 2000. Steam Stripping/Hydrous Pyrolysis Oxidation for in-situ remediation of a TCE DNAPL Spill. In *Proceedings of the 2000 Battelle Conference on Chlorinated and Recalcitrant Compounds*, Monterey, CA, Volume C2-5 pp. 149-156. Battelle Press, Columbus, OH.
- Udell, K., G. Heron, M. McDonald and W. Mabey. 2000. *Steam Enhanced Extraction Demonstration at Site 5, Alameda Point*. Field Feasibility Demonstration for the US Navy, DO-9. Berkeley Environmental Restoration Center, University of California at Berkeley. Berkeley, CA. Final report.

Heron, G., T.H. Christensen and C.G. Enfield. 1998. Henry's Law Constant for Trichloroethylene between 10 and 95 C. *Environmental Science and Technology*, 32 (10), 1433-1437.

Heron, G., T.H. Christensen, T. Heron, and T.H. Larsen. 1998. Thermally enhanced remediation at DNAPL sites: The competition between downward mobilization and upward volatilization. In *Proceedings of The First International Conference on Remediation of Chlorinated and Recalcitrant Compounds*, May 18-21, Monterey, CA, Battelle Press 1(2): 193-198.

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