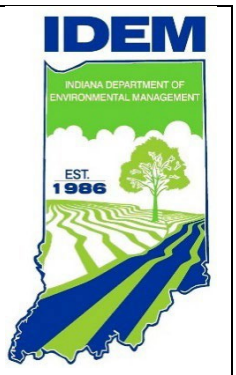
INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT	**STATUS:** Effective	**POLICY NUMBER:** *WASTE-0072-NPD*	
AGENCY NONRULE POLICY DOCUMENT **SUBJECT:** Supplemental Characterization Guidance	**AUTHORIZED:** *Bruno L. Pigott, Commissioner*		
	SUPERSEDES: New	**ISSUING OFFICE(S):** Office of Land Quality, Science Services Branch	
	ORIGINALLY EFFECTIVE: Date December 10, 2021	**RENEWED/REVISED:** Date N/A	

Disclaimer: *This Nonrule Policy Document (NPD) is being established by the Indiana Department of Environmental Management (IDEM) consistent with its authority under IC 13-14-1-11.5. It is intended solely to provide guidance and shall be used in conjunction with applicable rules or laws. It does not replace applicable rules and laws, and if it conflicts with these rules or laws, the rules or laws shall control. Pursuant to IC 13-14-1-11.5, this policy will be available for public inspection for at least 45 days prior to presentation to the appropriate State Environmental Board and may be put into effect by IDEM 30 days afterward. If the nonrule policy is presented to more than one board, it will be effective 30 days after presentation to the last. IDEM also will submit the policy to the Indiana Register for publication.*

1.0 PURPOSE

This NPD identifies information on how to better organize a procedure for investigating specific geologic environments and specific types of source facilities. Investigations adequately characterize the nature and extent of release-related chemicals or evaluate the effectiveness of a remedy or removal as required for remedial actions and removal under IC 13-25-5-8.5, IC 13-11-2-185, and IC 13-11-2-187. Appendices, A to H provide most investigative procedures for specific situations mentioned. The appendices are not intended to be a compendium of all environmental investigative procedures and other procedures may be approved as part of an approved remedial action.

2.0 SCOPE

This NPD applies to adequately characterizing the nature and extent of release-related chemicals or evaluating the effectiveness of a remedy or removal relating to the release.

3.0 SUMMARY

This NPD identifies various investigative procedures for specific geologic environments including Aquitard and Fine-Grained Sediment Characterization, Proper Investigative Techniques in Karst, Investigation of Manmade Preferential Pathways, Proper Investigative Techniques for Shallow Bedrock, and Use of High-Resolution Site Characterization Tools. Also identifies investigative procedures for specific types of source facilities including for Dry Cleaner Sites, Lead Issues at Small Arms Firing Ranges, and Vapor Intrusion Investigation Documentation.

4.0 DEFINITIONS

4.1. “Agency” – The Indiana Department of Environmental Management (IDEM).

4.2. “Characterization” – A determination of the source, nature, and extent of release-related chemicals.

4.3. “Environmental consultant” – Person providing technical, legal, or procedural advice regarding environmentally related statutes, rules, requirements, or processes while under a compensatory arrangement.

4.4. “Extent” – The volume or two-dimensional projection in horizontal space of a volume of media containing release-related chemicals at concentrations or risk levels exceeding unconditional remediation objectives.

4.5. “Nature” – The identity and concentrations of release-related chemicals in various media.

4.6. “Nonrule policy” – The term assigned by the Indiana Department of Environmental Management (IDEM) to those policies identified in IC 13-14-1-11.5 as any policy which: A. Interprets, supplements, or implements a statute or rule; B. Has not been adopted in compliance with IC 4-22-2; C. Is not intended by IDEM to have the effect of law; and D. Does not apply solely to the internal IDEM organization, an administrative policy.

4.7. “OLQ technical staff” – Positions requiring specialized knowledge pertaining to a particular occupation or field of study such as chemistry, geology, engineering, and risk assessment.

4.8. “Release-related chemicals” – A substance placed on the land or in the subsurface, which by virtue of its nature or quantity, is subject to regulation by IDEM’s Office of Land Quality. The term also includes regulated breakdown products.

4.9. “Source facility” – The building, land, or enterprise used for one or more purposes (e.g., gasoline sales and storage, dry cleaning, manufacturing, etc.,) where a release occurs.

5.0 ROLES

5.1. Environmental consultants shall:

A. Use the various investigative procedures specified in this NPD to characterize release-related chemicals in environmental media.
B. Determine nature and extent of release-related chemicals or evaluate the effectiveness of a remedy or removal relating to the release.

5.2. OLQ technical staff shall:

A. Review work plans using the specific investigative procedures.
B. Make recommendations regarding the investigative procedure proposed by the consultant depending on the site-specific situation.

6.0 POLICY

6.1. The specific investigative procedures listed in Appendices A to H, shall be reviewed and used, as applicable.

6.2. IDEM shall review the consultants’ work plans and remedy proposals.

6.3. IDEM shall evaluate the work plans and remedy proposals on their merits.

6.4. A determination of the nature and extent of release-related chemicals or an evaluation of the effectiveness of a remedy or removal relating to the release shall be made using the work plans and remedy.

6.5. The Appendices in this NPD should be used in conjunction with the Remediation Closure Guide, the Risk-based Closure Guide, or then-applicable current guidance.

7.0 REFERENCES

7.1. Federal Laws and Rules:

A. (US EPA 2006) Federal Register, 40 CFR Part 63, Subpart M, National Perchloroethylene Air Emission Standards for Dry Cleaning Facilities: Final Rule Part II. July 27, 2006 United States Environmental Protection Agency. Washington D.C, https://www.ecfr.gov/cgi-bin/text-

idx?SID=a3519508c406fb9888d5652dc9028c82&mc=true&node=pt40.11.63&rgn=div5#sp40.11.63.m

B. Federal Register Vol. 62, No. 29 Wednesday, February 12, 1997, Rules and Regulations, Military Munitions Rule: Hazardous Waste Identification and Management, Explosives Emergencies; Manifest Exemption for Transport of Hazardous Waste on Right-of-Ways on Contiguous Properties, https://www.govinfo.gov/content/pkg/FR-1997-02-12/html/97-3218.htm

7.2. Indiana Statutes:

A. IC 13-11-2-185 Environment, Definitions, Definitions, Remedial action, http://184.175.130.101/legislative/laws/2020/ic/titles/013/articles/010/

B. IC 13-11-2-187 Environment, Definitions, Definitions, Removal, http://184.175.130.101/legislative/laws/2020/ic/titles/013/articles/010/

C. IC 13-14-1-11.5 Environment, Powers and Duties of Department of Environmental Management and Boards, Duties of Department, Use by Department, http://184.175.130.101/legislative/laws/2020/ic/titles/013/articles/010/

D. IC 13-25-5-8.5 Environment, Hazardous Substances; Voluntary Remediation of Hazardous Substances and Petroleum; Voluntary remediation work plan objectives; additional action to protect human health and the environment not necessary under certain circumstances; risk-based remediation objectives and proposals, http://184.175.130.101/legislative/laws/2020/ic/titles/013/articles/010/

E. IC 4-22-2 State Offices and Administration, Administrative Rules and Procedures, Adoption of Administrative Rules, http://184.175.130.101/legislative/laws/2018/ic/titles/004/articles/015/chapters/013

7.3. Indiana Rules:

A. IDNR Well Rule, 312 IAC 13, Water Well Drillers and Water Well Pump Installers, http://www.in.gov/legislative/iac/T03120/A00130.PDF?

7.4. Agency Policies:

A. Remediation Closure Guidance, https://www.in.gov/idem/cleanups/files/remediation_closure_guide.pdf.

7.5. Other Sources:

Aquitard and Fine-Grained Sediment Characterization

A. (US EPA 2015) OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air, June 2015, OSWER Publication 9200.2-154. 267 pages, https://www.epa.gov/sites/production/files/2015-09/documents/oswer-vapor-intrusion-technical-guide-final.pdf

B. Aquitard and Fine-Grained Sediment Characterization, Technical Guidance Document IDEM, 100 N. Senate Ave., Indianapolis, IN, 46204 Aquitard and Fine-Grained Sediment Characterization

C. (OH EPA 2009) Assessment of an Aquitard during a Ground Water Contamination Investigation, https://epa.ohio.gov/portals/30/remedial/docs/groundwater/TGM%20Supp%20Aquitard%20Assess%20Final,%2011-2009.pdf

D. Chapter 8, Technical Guidance Manual for Ground Water Investigations, Monitoring Well Development, Maintenance, and Redevelopment, Ohio EPA, Division of Drinking and Ground Waters, Columbus, Ohio, https://www.epa.state.oh.us/portals/28/documents/TGM-8.pdf

E. ASTM International. 2009. Standard D6913. Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis, 1850 M Street, NW, Suite 1030, Washington, DC 20036

F. Bennet, M and Glasser, N: Glacial Geology: Ice Sheets and Landforms, p 262. John Wiley and Sons, 111 River Street, Hoboken, NJ 07030 1997.

G. Bradbury, K.R., et al. (2006), Contaminant transport through aquitards: Technical guidance for aquitard assessment, p 144 AWWA Research Foundation, 6666 W. Quincy Ave. Denver, CO 80235.

H. Donahue, Miller, Shickluna (1977), Soils: An Introduction to Soils and Plant Growth, 4th edition. Prentice Hall, Inc. 900 Sylvan Ave., Englewood Cliffs, New Jersey

I. Einarson, M.D. (2006), Multilevel Ground Water Monitoring, 2nd ed, chapter 11, ed. D. Nelson, 808 – 848. Boca Raton, Florida: CRC Press.

J. Fortin, G., et al. (1991), Hydrogeology and hydrochemistry of an Aquifer Aquitard System within Glacial deposits, Saskatchewan, Canada, Journal of Hydrology, vol 126, pp 265-292, https://www.sciencedirect.com/science/article/abs/pii/002216949190160J

K. Hantush, M.S. and C.E. Jacob, 1955. Non-steady radial flow in an infinite leaky aquifer, Am. Geophys. Union Trans., vol. 36, no. 1, pp 95-100, https://www.sciencedirect.com/science/article/abs/pii/0022169474900857

L. Harrison, B., et al. (1992), Numerical Analysis of Solute Migration Through Fractured Clayey Deposits into Underlying Aquifers, Water Resources Research, vol 28, pp 515 – 526, https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/91WR02559

M. J.A. Cherry and B.L. Parker, (2004) Role of Aquitards in the Protection of Aquifers from Contamination: A State of the Science Report, University of Waterloo, Waterloo, Ontario, Canada, p 144, https://link.springer.com/article/10.1007/s11242-016-0719-6?shared-article-renderer

N. Cherry, J. A., et al., (2006), Contaminant transport through aquitards; A State-of-the-Science Review, p 152, AWWA Research Foundation, Denver, CO., https://clu-in.org/download/contaminantfocus/dnapl/Chemistry_and_Behavior/Aquitard_State_of_Science_Reportfor_AWWARF_draft_of1-3-05.pdf

O. Kueper, B.H., and D.B. McWhorter (1991), The behavior of Dense, Nonaqueous Phase Liquids in Fractured Clay and Rock, Ground Water, vol 29, pp 716-728, https://ngwa.onlinelibrary.wiley.com/doi/10.1111/j.1745-6584.1991.tb00563.x

P. Midwest GeoSciences Group, Assessing Ground Water Movement and Contaminant Migration Through Aquitards: From Field Investigations to Hydrogeologic Characterization, 3_Day Short Course, May 8-10, 2007, https://midwestgeo.com/pastcourses/fermi2007gallery.php.

Q. Parker, B.L., (2004), Field Study of TCE diffusion profiles below DNAPL to access aquitard integrity, Journal of Contaminant Hydrology.

R. Rowe, R.K., and P. Nadarajah (1993), Evaluation of the Hydraulic Conductivity of Aquitards, Canadian Geotechnical Journal, vol 30, pp 781 – 800. Tarbuck, E and Lutgens, F: Earth, p 351. Prentice Hall, Inc. 900 Sylvan Ave., Englewood Cliffs, New Jersey, 2002.

S. Thrupp, Gallinatti, and Johnson, 1996. Tools to Improve Models for Design and Assessment of Soil Vapor Extraction Systems. In Sub-Surface Fluid Flow (Groundwater and Vadose Zone) Modeling, By Joseph D. Ritchey, James O. Rumbaugh, Published ASTM, pp 268 to 285, https://www.astm.org/DIGITAL_LIBRARY/STP/PAGES/STP38391S.htm.

T. Van der Kamp, G (2001), Methods for Determining the in situ Hydraulic Conductivity of Shallow Aquitards, Hydrogeology Journal, vol 9, pp 5 – 16, https://clu-

in.org/download/contaminantfocus/dnapl/Chemistry_and_Behavior/Aquitard_State_of_Science_Reportfor_AWWARF_draft_of1-3-05.pdf

U. Zheng, C., and G.D. Bennett, 1995. Applied Contaminant Transport Modeling: Theory and Practice. New York, Van Norstrand Reinhold, 115 Fifth Ave., New York, New York 10003.

Proper Investigative Techniques in Karst:

A. (US EPA 1988) Application of dye-tracing techniques for determining solute transport characteristics of ground water in karst terranes, https://karstwaters.org/wp-content/uploads/2015/04/dye-tracing.pdf

B. (US EPA 2013) Design and Installation of Monitoring Wells, SESDGUID-101-R2, January 16, 2018, https://www.epa.gov/sites/production/files/2016-01/documents/design_and_installation_of_monitoring_wells.pdf January 29, 2013

C. (USGS 1970) A Glossary of Karst Terminology, USGS Water Supply Paper 1899-K, 26 pages. U.S.G.S. Monroe, W.H. (Compiler). U.S. Government Printing Office. Washington, D.C., https://pubs.usgs.gov/wsp/1899k/report.pdf

D. (IDEM 2016) Vapor Intrusion Investigation Documentation Guidance Document, State of Indiana, Indiana Department of Environmental Management, Office of Land Quality, 100 N. Senate Ave., Indianapolis IN 46204, https://www.in.gov/idem/cleanups/files/remediation_tech_guidance_vi_investigation.pdf

E. (IDEM) Technical Guidance Document, Indiana Department of Environmental Management, Office of Land Quality, 100 N. Senate Ave. Indianapolis, IN 46204 Proper Investigative Techniques in Karst

F. State of Minnesota. 1986. Draft Guidelines for Investigation of Groundwater Contamination at Petroleum Sites in Karst Areas, fact sheet #3.42. Minnesota Pollution Control Agency, 520 Lafayette Rd, St Paul, Minnesota 55155

G. Fleming, A. H., Brown, S. E., and Ferguson, V. R., 2000, Geologic and hydrogeologic framework, in Brown, S. E., and Laudick, A. J., eds., 2003, Hydrogeologic framework of Marion County, Indiana-a digital atlas illustrating hydrogeologic terrain and sequence: Indiana Geological Survey Open-File Study 00-14, https://igws.indiana.edu/bookstore/details.cfm?Pub_Num=OFS00-14

H. UNESCO. 1972. Glossary and Multilingual Equivalents of Karst Terms. United Nations Educational. Scientific. And Cultural Organization. Paris. France. 72 pages, http://www.buex.org/index2.php?option=com_docman&task=doc_view&gid=111&Itemid=28

Investigation of Manmade Preferential Pathways:

A. (US EPA 1988) Application of dye-tracing techniques for determining solute-transport characteristics of ground water in karst terranes, https://karstwaters.org/wp-content/uploads/2015/04/dye-tracing.pdf

B. (US EPA 2013) Design and Installation of Monitoring Wells January 29, 2013, SESDGUID-101-R1, https://www.epa.gov/sites/production/files/2016-01/documents/design_and_installation_of_monitoring_wells.pdf

C. (US EPA 1997) Expedited Site Assessment Tools for Underground Storage Tank Sites: A Guide For Regulators: Chapter 3 Surface Geophysical Methods, (EPA 510-B-97-001). https://www.epa.gov/ust/expedited-site-assessment-tools-underground-storage-tank-sites-guide-regulators

D. (IDEM) Investigation of Manmade Preferential Pathways, Technical Guidance Document, Indiana Department of Environmental Management, Office of Land Quality, 100 N. Senate Ave. Indianapolis, IN 46204 Investigation of Manmade Preferential Pathways

E. (IGS 1978) Shaver, R.H., The search for a Silurian reef model--Great Lakes area: Special Report # 15, 36 Pages, 1978; Indiana Geological Survey (IGS), https://igws.indiana.edu/bookstore/details.cfm?Pub_Num=SR15

F. (WI DNR 2000), Guidance for Documenting the Investigation of Human-made Preferential Pathways Including Utility Corridors; PUBL-RR-649, 9 pages 2000 Wisconsin Department of Natural Resources, https://dnr.wisconsin.gov/sites/default/files/topic/Brownfields/rr/RR649_PCa.pdf

G. State Coalition for the Remediation of Dry Cleaners, 2010: Conducting Contamination Assessment at Dry cleaning Sites, CONDUCTING CONTAMINATION ASSESSMENT WORK AT DRYCLEANING SITES (astswmo.org)

H. Citizens Energy Group Sanitary Standards Manual 2019: https://www.citizensenergygroup.com/Documents/Standards/SanitaryStandardsManual

Proper Investigative Techniques for Shallow Bedrock:

A. Pinsak, A.P., Shaver, R.H.; 1964; Indiana Geological Survey (IGS), Bulletin #32, 87 pages, https://igws.indiana.edu/bookstore/details.cfm?Pub_Num=B32

B. Davis, S.N., 1988, Sandstones and Shales, in Back, William, Rosenchein, J.S., and Seaber, P.R., eds., Hydrogeology: Bolder Colorado., Geological Society of America, The Geology of North America, v. O-2, pp 323-332.

C. Heath, R.C., Hydrogeologic Setting of Regions, in Back, William, Rosenchein, J.S., and Seaber, P.R., eds., Hydrogeology: Bolder Colorado., Geological Society of America, The Geology of North America, v. O-2, pp 15-23, https://pubs.geoscienceworld.org/books/book/816/chapter/4845035/Hydrogeologic-setting-of-regions

Vapor Intrusion Investigation Documentation:

A. (IDEM) Vapor Intrusion Investigation Documentation, Technical Guidance Document, Indiana Department of Environmental Management, Office of Land Quality, 100 N. Senate Ave., Indianapolis, IN 46204 Vapor Intrusion Investigation Documentation

Investigative Strategies for Dry-Cleaner Sites:

A. (US EPA 1989) Locating and Estimating Air Emissions from Sources of Perchloroethylene and Trichloroethylene. August 1989 United States Environmental Protection Agency. Triangle Park: Office of Air Quality, https://www.epa.gov/sites/production/files/2020-11/documents/perchloroethylene-trichloroethylene.pdf

B. Sciences International, Inc. 1995. Toxicological Profile for Stoddard Solvent. Washington D.C.: U.S. Department of Health and Human Services Public Health Service, Agency for Toxic Substances and Disease Registry, https://wwwn.cdc.gov/TSP/ToxProfiles/ToxProfiles.aspx?id=416&tid=73

C. (IDEM) Investigative Strategies for Dry-Cleaner Sites, Technical Guidance Document, Indiana Department of Environmental Management, Office of Land Quality, 100 N. Senate Ave, Indianapolis, IN 46204 Investigative Strategies for Dry Cleaner Sites

D. California Environmental Protection Agency. January 2007. News Release. Sacramento: California Air Resources Board.

E. California Air Resources Board (CARB). October 2005. California Dry Cleaning Industry Technical Assessment Report, Stationary Sources Division, Emissions Assessment Branch, https://ww2.arb.ca.gov/sites/default/files/classic//toxics/dryclean/finaldrycleantechreport.pdf

F. California Air Resources Board (CARB), March 2008. Dry Cleaning Alternative Solvents: Health and Environmental Impacts. Sacramento, California Air Resources

Board Fact Sheet, https://ww2.arb.ca.gov/sites/default/files/classic//toxics/dryclean/notice2015_alt_solvents.pdf

G. Doherty, Richard E. 2000. A History of the Production and use of Carbon Tetrachloride, Tetrachloroethylene, Trichloroethylene and 1,1,1-Trichlroethane in the United States: part 1 – Historical Background; Carbon Tetrachloride and Tetrachloroethylene. Environmental Forensics, Volume pp 69-81, https://www.tandfonline.com/doi/abs/10.1006/enfo.2000.0010

H. Johnson, Albert E. 1971. Dry cleaning. Watford: Merrow.

I. Martin, Albert R., G. P. Fulton. 1958. Drycleaning Technology and Theory. New York: Textile Book Publishers, Inc., New York, New York

J. Michelsen, Edna M, 1957, Remembering the Years 1907 – 1957, Silver Spring: National Institute of Dry cleaning, 1206 Remington Rd, Schaumburg, IL 60173

K. Allsbrooks, Chris. November 2000. Use of Bleaches in Stain Removal. Silver Spring: International Fabricare Institute Industry Focus No. 2, 1206 Remington Rd, Schaumburg, IL 60173

L. Andrasik, Maria J., M. Scalco. November 1989. Bleaches. Silver Spring: International Fabricare Institute Special Reporter, Vol. 17, No.4, International Fabricare Institute 12251 Tech Road, Silver Spring, MD 20904

M. Calleja, Jay. January 2000. Stain Removal Chemicals: From A (Amyl Acetate) to Z (Zuds).

N. Dembovsky, Len. 1991. Preventing Drycleaning Machine Corrosion by Solvent Maintenance. Caringbah: The Australian National Drycleaner. October 1991, pp 6-8.

O. Enviro tech International, Inc. 2007. DrySolv Material Safety Data Sheet. Melrose Park: Enviro Tech International, Inc.

P. Eisenhauer, Paul. 1985. Use of Sizing in Drycleaning. Silver Spring: International Fabricare Institute Bulletin Reprint – Practical Operating Tips No. 199.

Q. Enviro Tech International, Inc. 2006. Dry-Solv™ Material Safety Data Sheet. Melrose Park: Enviro Tech International, Inc., 1800 25th Ave, Melrose Park, IL 60160

R. Faig, Ken. November 1988. Boiler Feed Water Treatment. Silver Spring: International Fabricare Institute Bulletin Reprint – Technical Operating Information No. 605.

S. Faig, Ken. November 1990. Maintaining Your Boiler. Silver Spring: International Fabricare Institute Bulletin Reprint – Special Reporter, Vol. 18, No. 4.

T. Hayday, William. 2007. E-mail from William Hayday, Rynex Holdings, Ltd. To William J. Linn, Florida Department of Environmental Protection.

U. International Fabricare Institute. 1995. Flame Retardant Finishes. Silver Spring: International Fabricare Institute Bulletin – Technical Operating Information No. 658.

V. International Fabricare Institute. November 1994. Stain and Soil Repellents on Upholstery Fabrics: Do They Protect or Harm? Silver Spring: International Fabricare Institute Industry Focus, No. 6.

W. Leppin, Betty. March 1992. Corrosion in Drycleaning Machines. International Fabricare Institute. Silver Spring: Focus on Drycleaning, Volume 16, No. 1.

X. Mohr, Thomas K. G. 2001. Solvent Stabilizers White Paper (prepublication copy). San Jose: Underground Storage Tank Program – Water Supply Division, Santa Clara Water District, https://semspub.epa.gov/work/09/2129332.pdf

Y. Phillips, Lorraine. February 1992. What Is Pre-spotting? Silver Spring: International Fabricare Institute Bulletin Reprint – Technical Operating Information No. 637.

Z. Rising, Jane, Schwartz, S. 1997. Water/Stain Repellents. Silver Spring: International Fabricare Institute Bulletin – Technical Operating Information No. 666.

AA. Rynex. 2001. Rynex Fact Sheet. Woodbury: Rynex Holdings, Ltd, Woodbury, New York 11797

BB. Schreiner, James. 2001. Petroleum Solvent – What Am I Buying? Lyons: National Coalition of Petroleum/Hydrocarbon Dry Cleaners. April Newsletter.

CC. Van Den Berg, J.H. December 1984. Corrosion Problems with the Cleaning Machine. Delft: Institute for Cleaning Techniques.

DD. Van Den Berg, J.H. October 1985. Neutralizing of Acid PERC. Delft: Institute for Cleaning Technologies.

EE. Wentz, Manfred. Keith R. Beck & V. Monfalcone III. 2001. Colorfastness of Fabrics Cleaned in Liquid Carbon Dioxide. American Association of Textile Chemists and Colorists, Vol. 1, No. 5. Research Triangle Park, North Carolina, 27709

FF. Chemical Week, 1953. Tri, Per and Carbon Tet. 72, 56.

GG. Chemical Engineering News. 1963. New Dry-Cleaning System Under Field Test. Chemical Engineering New. November, 41, 28.

HH. Chevron Phillips Chemical Company LP. 2003. EcoSolv® Drycleaning Fluid MSDS. The Woodlands: Chevron Phillips Chemical Company LP, https://www.cpchem.com/sites/default/files/2020-08/01583549.pdf

II. Eastern Research Group. 2005. Control and Alternative Technologies Memorandum. Morrisville: Memorandum, Eastern Research Group to U.S. E.P.A.

JJ. HSIA. Perchloroethylene White Paper. 2008. Washington D.C.: Halogenated Solvents Industry Alliance, Inc., 3033 Wilson Boulevard, Suite 700, Arlington, VA 22201

KK. Jackson, Richard. E. V. Dwarakanath. Fall 1999. Chlorinated Degreasing Solvents: Physical- Chemical Properties Affecting Aquifer Contamination and Remediation. Groundwater Monitoring Review, pp 102 – 109, Dublin National Groundwater Association, 601 Dempsey Road, Westerville, OH 43081

LL. Kirk-Othmer. 1965. Encyclopedia of Chemical Technology, Volume 7, New York: John Wiley & Sons Inc., 10475 Crosspoint Blvd STE 100, Indianapolis, IN 46256

MM. Knight, Don B. 1969. Perchloroethylene Corrosion. Presentation at International Fabricare Institute Technical Conference, November 1969.

NN. Leder, A. 1999. C2 Chlorinated Solvents. Chemical Industries Newsletter. January 1999. European Chemicals Bureau. 2005' https://www.sciencedirect.com/science/article/abs/pii/S1527592200900107

OO. European Union Risk Assessment Report. Tetrachloroethylene. Italy: European Communities, https://echa.europa.eu/documents/10162/130bc4f2-68a8-45d8-88d7-e6db88f76a98

Investigating Lead at Small Arms Firing Ranges:

A. (US EPA 2005) Best Management Practices for Lead at Outdoor Shooting Ranges. EPA-902-B-01-001, U. S. Environmental Protection Agency. Updated June 2005, https://www.epa.gov/sites/production/files/documents/epa_bmp.pdf

B. (US HHS 1992) Impact of Lead-Contaminated Soil on Public Health Xintaras, C. 1992. U.S. Department of Health and Human Services, https://wonder.cdc.gov/wonder/prevguid/p0000015/p0000015.asp

C. (IDEM) Investigating Lead at Small Arms Firing Ranges, Technical Guidance Document, Indiana Department of Environmental Management, Office of Land Quality, 100 N. Senate Ave., Indianapolis, IN 46204 Investigating Lead at Small Arms Firing Ranges

D. Colorado Department of Health (1990). Leadville Metals Exposure Study. University of Colorado at Denver, Agency for Toxic Substances and Disease Registry., https://semspub.epa.gov/work/08/196006.pdf

E. J. L. Clausen, B. Bostick & N. Korte (2011) Migration of Lead in Surface Water, Pore Water, and Groundwater With a Focus on Firing Ranges, Critical Reviews in Environmental Science and Technology, 41:15, 1397-1448, https://www.researchgate.net/publication/233195444_Migration_of_Lead_in_Surface_Water_Pore_Water_and_Groundwater_With_a_Focus_on_Firing_Ranges

F. EA Engineering, Science, and Technology, Inc. January 1996. Lead Mobility at Shooting Ranges. Sporting Arms and Ammunition Manufacturers Institute, Newtown, CT, https://saami.org/wp-content/uploads/2018/05/Lead-Mobility.pdf

G. Hardison D.W. Jr., et. al. December 2004. Lead contamination in shooting range soils from abrasion of lead bullets and subsequent weathering. Science of the Total Environment 328 (2004) 175-183, Soil and Water Science Department, University of Florida, P.O. Box 110290, Gainesville, FL 32611-0290, USA, https://www.sciencedirect.com/science/article/abs/pii/S0048969704000713

H. ITRC (Interstate Technology & Regulatory Council). February 2005. Environmental Management at Operating Outdoor Small Arms Firing Ranges. SMART-2. Washington, D.C.: Interstate Technology & Regulatory Council, Small Arms Firing Range Team. Available on the Internet at https://www.itrcweb.org/GuidanceDocuments/SMART-2.pdf.

I. Kelebemang R., et. al. 2017. Speciation and mobility of lead in shooting range soils, Chemical Speciation &Bioavailability, 29:1, 143-152, https://www.tandfonline.com/doi/full/10.1080/09542299.2017.1349552

J. Mielke, H.W. 1999. Lead in the Inner Cities. American Scientist 87: 62-73, https://www.jstor.org/stable/27857784?seq=1

Use of High-Resolution Site Characterization Tools:

A. (US EPA 2010) Best Management Practices: Use of Systematic Project Planning Under Triad Approach for Site Assessment, https://semspub.epa.gov/work/HQ/152762.pdf

B. (US EPA 2017) Brownfields Road Map to Understanding Options for Site Investigation and Cleanup, Sixth Edition, 542-R-17-003, https://www.epa.gov/sites/production/files/2017-11/documents/brownfieldsroadmapepa542-r-12-001.pdf

C. (US EPA 2018) Course manual for Groundwater High-Resolution Site Characterization USEPA June 2018 pp 4-107 thru 4-112

D. (US EPA 2019) Green Remediation Best Management Practices: Sites with Leaking Underground Storage Tanks, Office of Land and Emergency Management EPA 542-F-19-001 August 2019 Update, https://www.epa.gov/sites/production/files/2019-08/documents/ust_gr_fact_sheet.pdf

E. (IDEM) Use of High-Resolution Site Characterization Tools, Technical Guidance Document, Indiana Department of Environmental Management, Office of Land Quality, 100 N. Senate Ave., Indianapolis, IN 46204 Use of High-Resolution Site Characterization Tools

F. (API 2016) API Publication 4762 API LNAPL Transmissivity Workbook: A Tool for Baildown Test Analysis. American Petroleum Institute API Publishing Services, Washington, DC, https://www.api.org/oil-and-natural-gas/environment/clean-water/ground-water/lnapl/transmissivity-workbook

G. (ASTM D7352 2017) Standard Practice for Direct Push Technology for Volatile Contaminant Logging with the Membrane Interface Probe (MIP). American Society for Testing and Materials (ASTM) International, West Conshohocken, PA. www.astm.org

H. (ITRC 2018) LNAPL Site Management: LCSM Evolution, Decision Process, and Remedial Technologies. LNAPL-3. Washington, D.C.: Interstate Technology and Regulatory Council. LNAPL Update Team. https://lnapl-3.itrcweb.org/

I. (ITRC 2019) Implementing the Use of Advanced Site Characterization Tools. (ASCT). Washington, D.C.: Interstate Technology and Regulatory Council, Advanced Site Characterization Tools Team. https://asct-1.itrcweb.org

J. McCall, W., T. M. Christy, and M. K. Evald, 2017. Applying the HPT-GWS for Hydrostratigraphy, Water Quality and Aquifer Recharge Investigations. Groundwater Mon. & Rem. Vol. 37, no. 1. pp 78-91, https://www.researchgate.net/publication/315075532_Applying_the_HPT-GWS_for_Hydrostratigraphy_Water_Quality_and_Aquifer_Recharge_Investigations

K. Personal Communication John Sohl, Columbia Technologies, March 19, 2018

8.0 SIGNATURES

Bruno L. Pigott, Commissioner
Indiana Department of Environmental Management

6/18/21
Date

Peggy Dorsey, Assistant Commissioner
Office of Land Quality

6/1/2021
Date

Nancy King, General Counsel

6/8/21
Date

This policy is consistent with agency requirements.

Quality Assurance Program
Office of Program Support
Indiana Department of Environmental Management

21 Jun 2021
Date

9.0 APPENDICES

A. Aquitard and Fine-Grained Sediment Characterization
https://www.in.gov/idem/cleanups/files/remediation_tech_guidance_aquitard.pdf

B. Proper Investigative Techniques in Karst
https://www.in.gov/idem/cleanups/files/remediation_tech_guidance_karst_memo.pdf

C. Investigation of Manmade Preferential Pathways
https://www.in.gov/idem/cleanups/files/remediation_tech_guidance_mpp_guidance.pdf

D. Proper Investigative Techniques for Shallow Bedrock
https://www.in.gov/idem/cleanups/files/remediation_tech_guidance_shallow_bedrock.pdf

E. Vapor Intrusion Investigation Documentation
https://www.in.gov/idem/cleanups/files/remediation_tech_guidance_vi_investigation.pdf

F. Investigative Strategies for Dry Cleaner Sites
https://www.in.gov/idem/cleanups/files/remediation_tech_guidance_dry_cleaners.pdf

G. Investigating Lead at Small Arms Firing Ranges
https://www.in.gov/idem/cleanups/files/remediation_tech_guidance_lead_small_arms_ranges.pdf

H. Use of High-Resolution Site Characterization Tools
https://www.in.gov/idem/cleanups/files/remediation_tech_guidance_hrsc_technical.pdf