

TECHNICAL GUIDANCE DOCUMENT



INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

Investigative Strategies for Dry Cleaner Sites

Office of Land Quality

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Notice

The Technology Evaluation Group (TEG) completed the review of *Investigative Strategies for Dry Cleaner Sites* as a supplement to the Remediation Closure Guide (RCG) (Waste 0046-R1 NPD). Use of this guidance will aid in the development of a conceptual site model (CSM) for sites that used or are using dry cleaning solvents. This guidance may also have useful information to address chlorinated solvent releases from sources other than dry cleaning facilities. For more information on CSMs see:

http://www.in.gov/idem/cleanups/files/remediation_tech_guidance_conceptual_site_model.pdf

It does not approve any technology nor does it verify any technology's effectiveness in conditions not identified here. Mention of trade names or commercial products does not constitute endorsement or recommendation by the IDEM for use.

Introduction

When investigating a dry cleaning site, a good working knowledge of past and present operations is needed. Several key pieces of information are necessary prior to conducting any active investigation work:

- A determination of the age of the facility and periods of operation. This information will help develop a sampling plan and can provide information on potential types of contamination.
- Location of the waste handling areas (this should include the location of the trash dumpster). A well developed sampling plan will include these areas.
- Types of equipment used and how they are tied into site infrastructure (special attention should be given to sewer lines).
- Proximity to other structures (needed when conducting a vapor intrusion study).



Much of this document is based on research that includes references (intended for further reading) compiled by the State Coalition for Remediation of Drycleaners in two documents published by that organization. These documents are:

- Chemicals Used In Dry Cleaning Operations, State Coalition for Remediation of Drycleaners, January 2002 (Revised July 2009).
- Conducting Contamination Assessment Work at Dry Cleaning Sites, State Coalition for Remediation of Drycleaners, Revised October 2010.

History of Dry Cleaning Processes

Over the past 130 years a number of different chemicals were utilized as dry cleaning solvents. These included: camphor oil, turpentine spirits, benzene, kerosene, white gasoline, petroleum solvents (mainly petroleum naphtha), chloroform, carbon tetrachloride, perchloroethylene, trichloroethylene, 1,1,2-trichlorotrifluoroethane, glycol ethers, 1,1,1-trichloroethane, decamethylcyclopentasiloxane, n-propyl bromide, and liquid carbon dioxide. If the dates of operation are available, a detailed list of contaminants of concern (COCs) can be developed. The next section provides a brief history of dry cleaning operations and date ranges for when certain solvents were used. Chemistry Services has developed a Technical Guidance Document that provides additional information and can be found at:

http://www.in.gov/idem/cleanups/files/chem_guidance_contaminants_dry_cleaning.pdf

Early dry cleaning solvents were petroleum-based. In 1924 (due in part to fire risk) the petroleum-based solvents were replaced with the less flammable Stoddard solvent. This solvent was the primary chemical used from the late 1920s to the late 1950s.

In the 1930s trichloroethylene (TCE) was introduced as a replacement, but was never widely used as a primary dry cleaning solvent. TCE is still used as a pre-cleaning or spotting agent and is used in some water repellent agents.

Carbon tetrachloride was used for dry cleaning in the 1940s and 1950s. Because of its high toxicity and tendency to contribute to machinery corrosion, carbon tetrachloride is no longer used. It was phased out in the late 1950s and replaced with perchloroethylene (PCE).

1,1,2-trichlorotrifluoroethane (Freon 113) was used for a short period in the 1960s. This chemical was later found to be an ozone depleter and is no longer used.

1,1,1-trichloroethane (TCA) was introduced in the 1980s but was never widely used. One of its main uses was for leather cleaning. It has also been used as a spotting agent and in waterproofing agents and stain repellents, such as:

- Glycol ethers
- Decamethylcyclopentasiloxane (GreenEarth™),
- n-Propyl Bromide,
- PureDry™, and

- Liquid Carbon Dioxide.

In the early 1990s new petroleum-based solvents were developed. These include:

- Dry Cleaning Fluid-2000 or DF-2000
- EcoSolv[®],
- Hydroclene, and
- Shell Sol 140 HT.

Perchloroethylene (PCE) is currently the dry cleaning solvent used in most dry cleaning operations. USEPA has scheduled PCE to be phased out of use by 2030.

Pre-Cleaning / Spotting Agents

Numerous chemicals are used for pre-cleaning and spot cleaning. Prior to placement in the dry cleaning machine, heavily stained garments are pre-cleaned. Most pre-cleaning solvents are also used in the primary dry cleaning cycle. There are three main categories of pre-cleaners:

- Wet-side Spotting Agents,
- Dry-side Spotting Agents, and
- Bleaches

Drycleaners that do not use chlorinated volatile organic compounds (cVOCs) in the primary dry cleaning process (Green Drycleaners) may use spotting agents containing cVOCs to remove heavy stains from garments. It is important to evaluate not only the area where the “pre-cleaning” takes place, but also where these spotting agents are stored.

Garment Treatment Chemicals

There are a variety of chemicals that are used to treat garments for various reasons. There are four main categories of garment treating chemicals:

- Waterproofing chemicals,
- Flame retardant chemicals,
- Fabric conditioning chemicals, and
- Stain repellent chemicals.

POTENTIAL SOURCE AREAS

When evaluating a dry cleaning facility for potential source areas, many investigators assume that releases occur near the dry cleaning equipment. While this is true, other potential sources need investigation as well. These potential source areas include:

- Solvent recovery systems (distillation units, filters, traps),
- Areas around service doors,

- The sanitary sewer / septic tank and leach field,
- ASTs and USTs,
- Storm sewers,
- Dumpsters and trash cans,
- Spotting Board area,
- Blind drains or sumps,
- Air handling equipment (especially areas where these devices discharge to the outside),
- Storage buildings, and
- Unique treatment units (for example discharging separator water to the outside through a mister unit).

HOW TO INVESTIGATE

Proper planning can make the difference between collecting the information needed to develop a meaningful CSM and having to remobilize to collect additional information. Planning should start with conducting a thorough Phase I Site Assessment. Although similar, this list is not intended to include all requirements for conducting Phase I Environmental Site Assessments per 40 CFR 312.21 (AAI) and ASTM Standard E1527-05.

A Phase I Site Assessment for a dry cleaner has the following elements:

- Historical documentation, including but not limited to:
 - City directory searches (this can include crisscross and phone books),
 - Review of historical aerial photographs (these photos could be from several different sources),
 - Review of topographical maps,
 - Historical fire insurance maps (such as the Sanborn® and Baist maps),
 - Full title search back to when the property was first developed,
 - Interviews with current/past managers of the facility to identify solvent and waste handling practices.
- Review of other nearby remediation projects that are active or are complete. This information could be useful if a contributing off-site source is present.
- Review any facility as-built drawings and/or emergency plans. These will provide information about locations of processes and waste handling areas.
- Obtain utility records. Check with the city, town, or municipality for records and maps of the underground utilities (man-made preferential pathways) that may be affected by contamination from the site. Identify any current or historical septic systems.

Once the historical information is compiled, assess the on-site and near site features. A site reconnaissance should include:

- Identification of sensitive receptors that may be affected by a release from the site. Sensitive receptors can include:
 - Residences,
 - Day care centers,
 - Hospitals,
 - Nursing homes,
 - Schools,
 - Water supply wells, and
 - Natural features (like rivers, lakes, karst, and habitat of endangered species).

- Review any operation records stored on-site. These records could give clues where to conduct sampling.

- Canvas the businesses around the area to determine if other sources are present that may account for contamination found in unlikely locations.

- Review locations of the dry cleaning equipment as well as other areas where solvents may have been used. This should include:
 - The dry cleaning machine,
 - The distillation unit,
 - Solvent storage tanks,
 - Waste storage areas,
 - Spotting boards,
 - Vacuum units,
 - ASTs,
 - USTs,
 - Floor drains,
 - Sump pits,
 - Mop buckets, and
 - Dumpsters and trash cans.

- Evaluate historical waste management practices. This should include a list of wastes generated by the dry cleaning process.

- Determine how solvents were delivered to the facility and how spent solvents were managed.

- Determine how the dry cleaning machine was filled. The methods used to load and un-load a dry cleaning machine can account for most of the contamination detected at a dry cleaning facility. The method that accounted for most of these situations was the wet to wet method. The wet-to-wet method involved transferring solvent saturated garments from one machine to another. Most

processes today, the entire operation occurs in the same machine (dry-to-dry method) (Linn 2010).

- Review waste water management. This should include a detailed description on the use of drain lines and floor maintenance (floor cleaning).
- Determine the locations of air handling system vents to the outside.
- Follow all piping to the terminus and account for all discharges from them.
- Inspect the condition of flooring throughout the facility.

It may not be possible to determine much of this information if the dry cleaner is no longer operating. At this point historical records and employee interviews (if possible) are vital.

After the Phase I Investigation and the Site visit are completed, develop a CSM to best determine an investigation and sampling plan. This model will be used to guide the Phase II Site Assessment. Elements of the CSM include:

- Geological setting (this should include information on unsaturated soils, saturated soils, ground water and bedrock);
- Surface and likely ground water flow, including local conditions that alter the flow (i.e. high capacity water wells);
- Identification of preferential pathways for contaminant migration (this should include natural and man-made features);
- Identification of potential receptors (the more information provided the better the assessment will be); and
- A list of the contaminants of concern and all of their physical and chemical properties.

CONDUCTING THE SITE ASSESSMENT (Phase II Investigation)

In general, chlorinated solvent contamination plumes are larger (deeper and of greater areal extent) than contaminant plumes associated with petroleum contamination. Dry cleaning solvents are denser than water so they will sink vertically (both NAPL and dissolved phase) and spread horizontally (both NAPL and dissolved phase) until a confining unit is encountered. They are also less viscous than water so they will spread farther. The plumes can be thinner than petroleum plumes and can have a center of mass well below the water table. A majority of the time, contamination associated with dry cleaning solvents will extend off-site. This off-site extent needs to be taken into account when developing an exposure assessment and remedial strategy.

To be successful in assessing chlorinated solvent contamination, the site stratigraphy needs to be defined. Information gathered from site stratigraphy can provide information on preferential flow paths and the nature and extent of confining layers.

CONTAMINATED MEDIA

Dense Non-aqueous Phase Liquids (DNAPLs)

Chlorinated solvents (except for vinyl chloride) have a density greater than water; therefore chlorinated solvents can form dense non-aqueous phase liquids (DNAPLs) when product is released to water. When developing a sampling strategy for investigation of a dry cleaning facility the existence of DNAPLs are a possibility. Ground water sampling in areas where DNAPL is suspected needs to include shallow and deep zones in the potentially contaminated aquifer.

Soils

Soil sampling provides information about four aspects of the CSM:

- The contaminant mass in soil (needed to properly design remedial measures);
- The presence of free product in ground water;
- Needs to assess vapor intrusion and;
- Needs to assess the presence of DNAPL.

The investigator should be aware that soil source zones can be small and may appear disconnected from surface sources because cVOCs are less viscous than water and tend to follow soil fractures.

To determine if areas require further testing (soil, ground water, and vapors), there are several locations within a dry cleaning facility where soil sampling should always occur in areas where dry cleaning solvents are stored, used, disposed of, or discharged.

Ground Water

Since chlorinated solvents are denser than water, sampling at the water table may miss not only the core of the contaminant plume, but also potential DNAPLs. If free product is suspected, this material could sink to the bottom of the aquifer or may be deflected by less conductive materials. Since most dry cleaning operations use chlorinated solvents, contamination from a dry cleaner should primarily be investigated as a DNAPL. There are a few drycleaners that used petroleum based cleaners that can be investigated in the same manner as a release from a petroleum source.

A good CSM is needed to determine not only where to place monitoring wells but depth(s) where screens are needed to adequately monitor contamination. Unlike petroleum sites, monitoring well screens for chlorinated solvents should be designed to straddle contaminated intervals rather than fluctuations of the water table. Standard 10 foot screens are often inappropriate for these plumes.

Fine Grained Materials and Secondary Sources

If cVOC contamination is in contact with a low permeability layer for a sufficient length of time, the contaminants will penetrate and fill the pore spaces of the unit. Once a compound has replaced water in the pores, it will continue to slowly transmit contamination into the surrounding geologic materials.

To determine if a fine grained material can act as a secondary source of contamination, ground water samples should be collected from the zone immediately above and from within the fine grained material. Should ground water contamination be confirmed, soil samples from the fine grained material should be collected to evaluate the contaminant mass within the fine grained material. While there are no risk standards associated with these soils, the concentrations can greatly affect any proposed ground water cleanup.

Vapor Intrusion

Vapor intrusion involving chlorinated compounds is slightly different than vapor intrusion involving petroleum based contamination. For more information on attenuation factors see the Attenuation Factors Technical Guidance Document at:

http://www.in.gov/idem/cleanups/files/remedy_guidance_attenuation_factors.pdf

It is best to collect paired sub-slab and indoor air samples to evaluate the indoor air risk. In addition, soil gas samples may be necessary to delineate any vapor plume particularly if soil contamination is present. Detailed instructions concerning the collection of chlorinated vapor samples can be found in Section 5.4.2 of the 2012 RCG.

Summary and Conclusions

The information in this document was assembled from sites in Indiana, the references provided, and IDEM staff experiences. This document provides a basic outline for investigating dry cleaning sites. More in-depth evaluations should be discussed on a site by site basis. An understanding of the past and present operations and the nature of the materials associated with those operations is needed to develop an accurate CSM. In addition, working knowledge of how ground water interacts with those materials is also needed to develop an accurate CSM.

Further Information

If you have any additional information regarding Investigative Strategies for Dry Cleaner Sites or any questions about the evaluation, please contact the Office of Land Quality, Science Services Branch at (317) 232-3215. IDEM TEG will update this technical guidance document periodically or on receipt of new information.

ADDITIONAL READING AND REFERENCES

Dry Cleaning History

Doherty, Richard E. 2000. A History of the Production and use of Carbon Tetrachloride, Tetrachloroethylene, Trichloroethylene and 1,1,1-Trichloroethane in the United States: part 1 – Historical Background; Carbon Tetrachloride and Tetrachloroethylene. Environmental Forensics, Volume p. 69-81.

Johnson, Albert E. 1971. Drycleaning. Watford: Mellow.

Linn Bill, and others, 2010. Conducting Contamination Assessment Work AT Drycleaning Sites, State Coalition for Remediation of Drycleaners.

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

Michelsen, Edna M. 1957. Remembering the Years 1907 – 1957. Silver Spring: National Institute of Drycleaning.

Dry Cleaning Operation and Practices

Allsbrooks, Chris. November 2000. Use of Bleaches in Stain Removal. Silver Spring: International Fabricare Institute Industry Focus No. 2.

Andrasik, Maria J., M. Scalco. November 1989. Bleaches. Silver Spring: International Fabricare Institute Special Reporter, Vol. 17, No.4.

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

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

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

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

Enviro Tech International, Inc. 2006. Dry-Solv™ Material Safety Data Sheet. Melrose Park: Enviro Tech International, Inc.

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

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

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

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

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.

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

Mohr, Thomas K. G. 2001. Solvent Stabilizers White Paper (prepublication copy). San Jose: Underground Storage Tank Program – Water Supply Division, Santa Clara Water District.

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

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

Rynex. 2001. Rynex Fact Sheet. Woodbury: Rynex Holdings, Ltd.

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

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

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

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

Vapor Intrusion

California Air Resources Board (CARB). October 2005. California Dry Cleaning Industry Technical Assessment Report (Draft). Stationary Sources Division, Emissions Assessment Branch.

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

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

United States Environmental Protection Agency. August 1989. Locating and Estimating Air Emissions from Sources of Perchloroethylene and Trichloroethylene. Triangle Park: Office of Air Quality.

United States Environmental Protection Agency. July 27, 2006. National Perchloroethylene Air Emission Standards for Dry Cleaning Facilities: Final Rule Part II. Washington D.C.: U.S. E.P.A. Federal Register, 40 CFR Part 63.

Chemistry

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

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

Chevron Phillips Chemical Company LP. 2003. EcoSolv® Drycleaning Fluid MSDS. The Woodlands: Chevron Phillips Chemical Company LP.

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

HSIA. Perchloroethylene White Paper. 2008. Washington D.C.: Halogenated Solvents Industry Alliance, Inc.

Jackson, Richard. E. V. Dwarakanath. Fall 1999. Chlorinated Degreasing Solvents: Physical- Chemical Properties Affecting Aquifer Contamination and Remediation. Groundwater Monitoring Review. Dublin: National Groundwater Association, p. 102 – 109.

Kirk-Othmer. 1965. Encyclopedia of Chemical Technology. New York: John Wiley & Sons Inc., Volume 7.

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

Leder, A. 1999. C2 Chlorinated Solvents. Chemical Industries Newsletter. January 1999.

Risk Assessment

European Chemicals Bureau. 2005. European Union Risk Assessment Report. Tetrachloroethylene. Italy: European Communities.

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.