ATSDR
Health Consultation

Public Health Evaluation of Volatile Organic Compounds in Indoor air of Five Buildings Above The Calle Chavez Groundwater Plume

Española, Rio Arriba County, NM

September 25, 2025

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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About ATSDR

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency of the U.S. Department of Health and Human Services (HHS). ATSDR works with other agencies and tribal, state, and local governments to study possible health risks in communities where people could come in contact with dangerous chemicals. For more information about ATSDR, visit the ATSDR website, ATSDR website.

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Public Health Evaluation of Volatile Organic Compounds in Indoor Air of Five Buildings Above the Calle Chavez Groundwater Plume

Española, New Mexico
Rio Arriba County

Prepared By:

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About ATSDR

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency of the U.S. Department of Health and Human Services (HHS). ATSDR works with other agencies and tribal, state, and local governments to study possible health risks in communities where people could come in contact with dangerous chemicals. For more information about ATSDR, visit the ATSDR website at www.atsdr.cdc.gov/.

List of Acronyms and Abbreviations

- ADAF — age-dependent adjustment factor
- ADS — Associate Director of Science
- APPLETREE — ATSDR's Partnership to Promote Local Efforts to Reduce Environmental Exposure
- ATSDR — Agency for Toxic Substances and Disease Registry
- bgs — below ground surface
- CCGP — Calle Chavez Groundwater Plume
- CR — lifetime excess cancer risk
- CREG — lifetime excess cancer risk evaluation guide
- CV — comparison value
- D&D — D&D Mountain Air Cleaners Facility
- EF — exposure factor
- EMEG-a — acute environmental media evaluation guide
- EMEG-c — chronic environmental media evaluation guide
- EPA — U.S. Environmental Protection Agency
- EPC — exposure point concentration
- ft — feet
- GRASP — Geospatial Research, Analysis, and Services Program
- HQ — hazard quotient
- ID — identification
- IUR — inhalation unit risk
- LOAEL — lowest observed adverse effect level
- MDL — method detection limit
- MRL — minimal risk level
- NA — not applicable
- NHL — Non-Hodgkin's Lymphoma
- NMDOH — New Mexico Department of Health
- NMED — New Mexico Environment Department
- NPL — National Priorities List
- NRAP — North Railroad Avenue Plume
- PHA — public health assessment
- PHAGM — Public Health Assessment Guidance Manual
- PHAST — Public Health Assessment Site Tool
- RfC — reference concentration
- RI — remedial investigation
- SME — subject matter expert
- µg/L — micrograms per liter
- $\mu g/m^3$ — micrograms per cubic meter
- VICV — vapor intrusion comparison value
- VOC — volatile organic compound

Table of Contents

List of Tables

List of Figures

1.0. Summary

1.1. Introduction

As shown on Figure 1, the Calle Chavez Groundwater Plume (CCGP) site is a volatile organic compound (VOC) contaminated shallow groundwater plume[1] located under residential and commercial buildings in the eastern portion of downtown Española, Rio Arriba County, New Mexico [NMED/EPA 2023].

The CCGP is next to the North Railroad Avenue Plume (NRAP) National Priorities List (NPL) site (EPA Facility ID: NMD986670156). Since 2019, both the U.S. Environmental Protection Agency (EPA) and New Mexico Environment Department (NMED) determined that additional contaminants (found in the CCGP are coming from a separate source that is not related to the source of VOC contaminants in the NRAP [NMED 2019; NMED/EPA 2020]. Therefore, the CCGP is not considered to be part of the NRAP site.

NMED determined that the D&D Mountain Air Cleaners facility (D&D facility) is the source of the VOC contaminants in the CCGP plume and currently regulates the D&D facility under its state cleanup program [NMED 2020].

During a community meeting about the NRAP site on December 11, 2019 in Española, New Mexico, community members asked the EPA to request the Agency for Toxic Substances and Disease Registry (ATSDR) to provide a public health evaluation of indoor air sampling data collected at five different buildings in the CCGP and new indoor air and surface soil samples collected at the NRAP site since ATSDR last released its public health assessment for NRAP in 2003 [ATSDR 2003].

In July 2020, EPA told ATSDR that because CCGP is under NMED's jurisdiction, NMED would make the request. NMED made the request to the New Mexico Department of Health (NMDOH), a state public health department with whom ATSDR has a state cooperative agreement[2].

After consulting with NMDOH, ATSDR is responding to NMED's request with this health consultation report. This health consultation will:

- Provide a public health evaluation of indoor air sampling data from four buildings collected by EPA in 2018[3] and at the D&D facility collected by D&D representatives during a site investigation in 2021. All buildings are located above the CCGP shallow plume. The purpose of the public health evaluation is to determine whether the levels (concentrations) of VOCs in each building could be harmful to people breathing indoor air in each of these buildings.
- Provide an evaluation of the available crawlspace air and outdoor air data collected by EPA from 2017–2018 and the subslab soil gas and outdoor air data collected by D&D representatives in 2021–2022 to determine if there could be a potential for vapor intrusion in the five buildings above the CCGP plume where indoor air sampling data were collected. A vapor intrusion

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[1] EPA defines a groundwater contaminant plume as "a three-dimensional, dynamic (i.e., may vary temporally), potentially irregular distribution of contaminants dissolved or suspended in groundwater" [EPA 2014].

[2] As NMDOH has a cooperative agreement with ATSDR under ATSDR's Partnership to Promote Local Efforts to Reduce Environmental Exposure (APPLETREE) Cooperative Agreement Program to conduct public health assessment (PHA) activities, NMED reached out to NMDOH directly in order to request a public health evaluation of indoor air sampling data collected at the CCGP. To learn more about the APPLETREE Cooperative Agreement Program, please visit this link: https://www.atsdr.cdc.gov/state-cooperative-agreements/php/about/index.html.

[3] Concurrent crawlspace air and outdoor air samples were only collected at Buildings A and B.

pathway evaluation is helpful for making informed public health conclusions and recommendations.

- Provide an evaluation of the shallow groundwater sampling data collected from 2017–2019 by NMED and from 2022–2024 by D&D representatives, as well as exterior soil gas samples collected by EPA in 2017, to recommend additional buildings where NMED may prioritize vapor intrusion sampling (the collection of concurrent indoor air, outdoor air, and subslab soil gas/crawlspace air samples) so that a public health evaluation of the sampling data can be provided.

ATSDR is responding to EPA's request to provide a public health evaluation of the new NRAP environmental sampling data collected by EPA and NMED in a separate health consultation report that has not yet been finalized.

1.2. Conclusion and Next Steps

1.2.1. Conclusion

ATSDR cannot conclude whether levels of contaminants detected in the indoor air of Buildings A, B, C, and D and the D&D facility could harm the health of people breathing the indoor air. This is because there isn't enough indoor air sampling data to evaluate potential health effects from exposure to the VOC levels (concentrations) in indoor air over time.

1.2.1.1 Basis for Conclusion

- Indoor air samples were collected during a single sampling event held on December 11, 2018 for commercial Buildings A and B, February 15–16, 2018 for residential Buildings C and D, and on December 16, 2021 for the D&D commercial facility.
- ATSDR's evaluation of the limited indoor air sampling data determined that breathing the levels (concentrations) of contaminants detected in these five buildings is not expected to result in a potential for adverse noncancer health effects or a potential for increased lifetime excess cancer risk. However, concentrations of VOCs in indoor air can vary by time and season, even if collected from the same building. Indoor air samples that are collected in a single sampling event that only occurred during the winter months do not provide enough information to accurately estimate the indoor air VOC concentrations that a person could breathe inside of a building. There were no indoor air samples collected in hot weather during summer months when windows and doors would be kept closed, air exchange rates are low, and indoor air concentrations may be higher [ATSDR 2016a; EPA 2015]. Therefore, it isn't possible to use the available data to determine if breathing VOC contaminants in any of these five buildings over time could harm the health of people.

1.2.1.2 Next Steps

Based on the public health evaluation of indoor air sampling data provided in this health consultation, ATSDR recommends the following next steps for NMED:

- continue to monitor the CCGP over time and space, as the CCGP plume could migrate further from the D&D facility over time and potentially be a source of contaminants entering buildings by seeping from the ground into the air of the buildings (vapor intrusion).

- collect additional concurrent, seasonal indoor air, crawlspace air or subslab soil gas, and outdoor air samples. Seasonal (hot and cold weather) indoor air samples are required to make health determinations. Concurrent, seasonal samples may be collected from the following buildings:
    - Buildings A, B, C, and D, and the D&D facility.
    - All buildings within the CCGP boundary as well as those located within a horizontal distance of 100 feet around the CCGP boundary. In section 5.4. ATSDR's Recommendations for Additional Buildings to Prioritize Vapor Intrusion Sampling, ATSDR provides information about how NMED may prioritize sampling based on an evaluation of shallow groundwater and soil gas data.
- At minimum, it is recommended that NMED consider collecting samples during two sampling periods such as one in July (summer) and another in December (winter) to best capture indoor air concentrations during "closed-building" conditions.
- ATSDR recommends following EPA guidance when collecting samples [EPA 2015]. This includes the following:
    - Using time-integrated sampling methods to account for varying contaminant concentrations in air over time.
    - Collecting indoor air samples within the building's breathing zone, the area where people are most likely to breathe contaminants.
    - Consider using ITS (indicators, tracers, and surrogates)[4] to provide information on whether vapor intrusion is active or dormant during the sampling event.

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[4] https://iavi.rti.org/assets/docs/Temp_Measurement_Fact_Sheet_int.pdf, https://iavi.rti.org/assets/docs/Pressure_Measurement_Fact_Sheet_Int.pdf, https://iavi.rti.org/assets/docs/Radon_methods_fact_sheet_int.pdf

2.0. Background

2.1. Statement of Issue and Purpose

During a community meeting about the NRAP site on December 11, 2019 in Española, New Mexico, community members asked the EPA to make a request to ATSDR to provide a public health evaluation of indoor air sampling data collected at five different buildings in the CCGP and new indoor air and surface soil samples collected at the NRAP site since ATSDR last released its public health assessment for NRAP in 2003 [ATSDR 2003].

In July 2020, EPA told ATSDR that as CCGP is under NMED's jurisdiction, NMED would make the request. NMED made the request to the New Mexico Department of Health (NMDOH), a state public health department with whom ATSDR has a state cooperative agreement.

After consulting with NMDOH, ATSDR is responding to NMED's request with this health consultation report.

To respond to EPA's request to provide a public health evaluation of the new NRAP environmental sampling data collected by EPA and NMED, ATSDR is preparing a separate health consultation report.

2.2. Site Description and Timeline

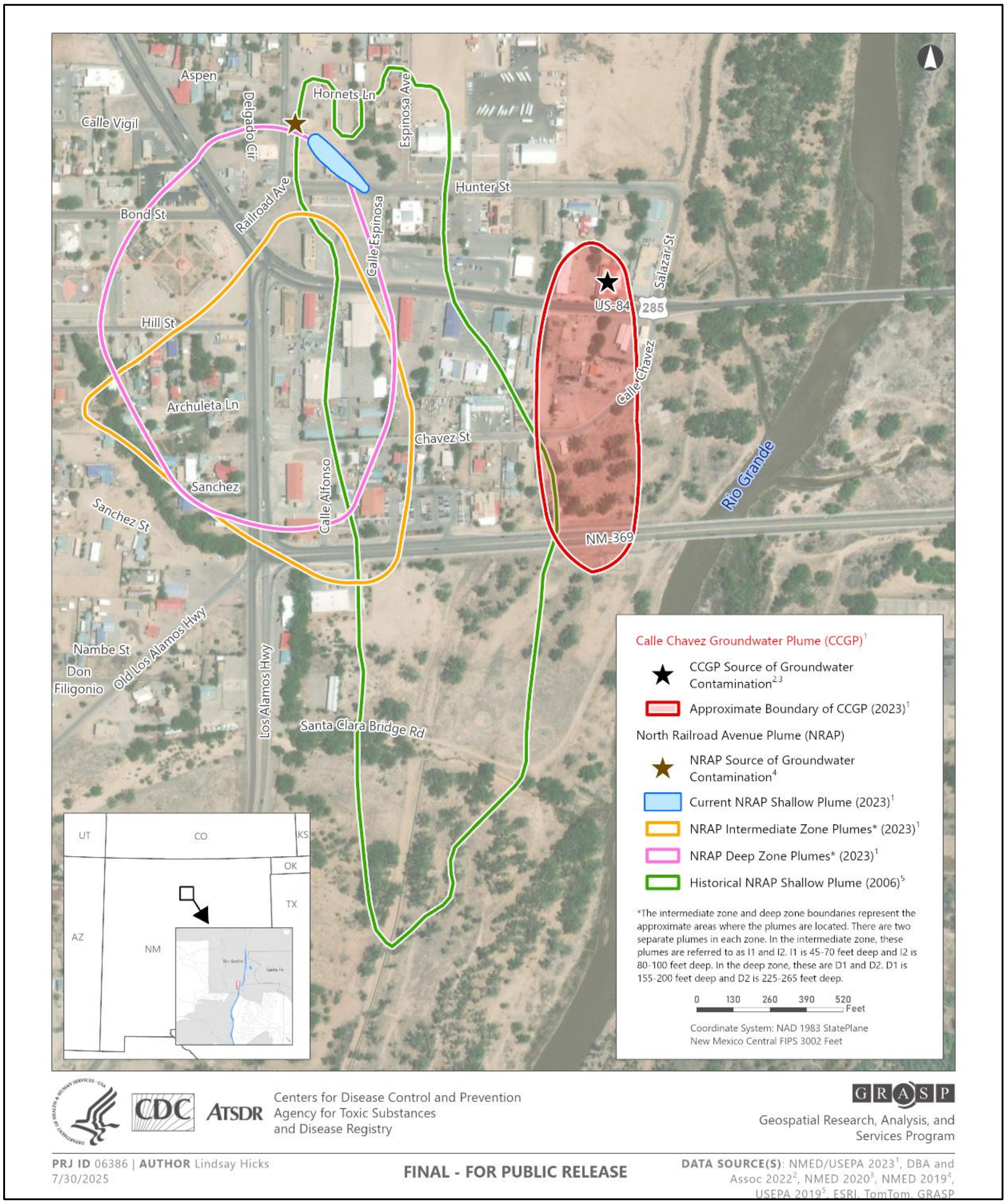
The CCGP is a shallow VOC-contaminated groundwater plume located 6–30 feet underground in the eastern portion of downtown Española, Rio Arriba County, New Mexico and extending into undeveloped Santa Clara Pueblo restricted fee lands (trust lands) located west of the Rio Grande [NMED 2019; NMED/EPA 2023]. The approximate boundary of the CCGP shallow plume provided to ATSDR by NMED in 2023 is presented in Figure 1.

The area above the CCGP plume is occupied by residential and commercial buildings. Nobody in these buildings obtains drinking water from private drinking water wells, and there are no public water wellheads in the CCGP shallow plume. Therefore, residents, employees, other building occupants, and building visitors cannot be exposed to VOC contaminants in the CCGP shallow plume from drinking water.

As shown on Figure 1, the CCGP is next to the NRAP, another VOC-contaminated groundwater plume site added to the NPL in 1999 by EPA [EA 2020a].

As of late 2019, EPA and NMED determined that the source of VOC contaminants in the CCGP shallow plume is the D&D Mountain Air Cleaners facility (D&D facility), located at 309 South Paseo de Oñate in Española [EPA 2019; NMED 2020]. The D&D facility is an approximately 6000-square-foot building which has existed since the late 1930s but wasn't operating as a dry cleaner until 2003. Although the D&D facility is currently still operating as a dry cleaner, the use of tetrachloroethylene was discontinued in approximately 2012 [DBS&A 2022]. Using its enforcement authority under state cleanup program regulations, NMED requires D&D representatives to perform further characterization and cleanup of the CCGP shallow plume [NMED/EPA 2020].

Figure 1. Calle Chavez Groundwater Plume and North Railroad Avenue Plume * †



*The intermediate zone and deep zone boundaries represent the approximate areas where the plumes are located. There are two separate plumes in each zone. In the intermediate zone, these plumes are referred to as I1 and I2. I1 is 45–70 feet deep and I2 is 80–100 feet deep. In the deep zone, these are D1 and D2. D1 is 155–200 feet deep and D2 is 225–265 feet deep [NMED/EPA 2023].

†NMED and EPA sources were used by ATSDR's Geospatial Research, Analysis, and Services Program (GRASP) to generate the approximate plume boundaries [DBS&A 2022; EPA 2019; NMED 2019; NMED/EPA 2020].

3.0. Community Description and Concerns

3.1. Community Demographics

In 2020, approximately 187 and 1,034 people live inside and within a quarter mile and half mile radius around the CCGP shallow plume, respectively (Figure 2). Additionally, there are approximately 88 and 488 housing units inside and within a quarter mile and half mile radius around the CCGP shallow plume, respectively. Due to commercial activity, the daytime population inside and within a quarter mile radius of CCGP shallow plume increases sixfold, and the population inside and within a half mile radius of the CCGP shallow plume more than doubles (Table 1).

Figure 2 shows how within the CCGP shallow plume and either a quarter mile or half mile radius around the CCGP shallow plume:

- Approximately 20 percent of the population are females aged 15 to 44 and more than 20 percent are children younger than 6 years or adults older than 65 years. These groups are often more sensitive to potential health effects from exposure to contaminants.
- The ethnic composition is as follows: approximately 30 percent of the people are White alone, about 5 percent American Indian & Alaska Native, and the remaining percent are Black, Asian, multiracial, or another race. About 80 percent of people of any race identify as Hispanic or Latino.

Table 1. 2020 Estimated Daytime and Nighttime Population and Housing Unit Statistics for Calle Chavez Groundwater Plume

Radius Around Calle Chavez Groundwater Plume	Housing Units*	Daytime Population†	Nighttime Population†
Quarter mile (one-fourth mile)‡	88	778	121
Half mile‡	488	1,928	882

*These statistics are based on the 2020 United States Census. ATSDR's Geospatial, Research, Analysis, and Services Program (GRASP) used an area-proportion spatial analysis method to obtain the demographic statistics provided in this table. **It is important to emphasize that the demographics calculated using the area-proportion spatial analysis methods are estimates and do not represent actual population statistics provided in the 2020 United States Census.** The area-proportion spatial analysis method involves extracting data from one geographic area (e.g., census 2020 blocks) and allocating it to another area (e.g., quarter mile radius around and including a groundwater plume) based on the proportion of area they share in common. This method calculates the overlap between areas, determining how much of one area is covered by another. Data from the original area is then distributed to the overlapping area in proportion to the extent of this overlap.

†These values were obtained from Oak Ridge National Laboratory LandScan for year 2019: https://landscan.ornl.gov/.

‡The population and housing unit statistics also include people and housing units located within the Calle Chavez Groundwater Plume approximate plume boundary (Figure 1). See Figure 2 for a depiction of the one-fourth and one-half mile radii around the CCGP shallow plume.

Figure 2. Calle Chavez Groundwater Plume Site and Demographic Snapshot

Calle Chavez Groundwater Plume (CCGP)[1]

Española, Rio Arriba County, NM

INTRODUCTORY MAP SERIES
SITE & DEMOGRAPHIC SNAPSHOT
EPA FACILITY ID NOT AVAILABLE

Site of Interest[1] | Park[3] | Airport[3] | Neighboring County[3]
Site of Interest Buffers[2] | Industrial[3] | Military Base[3]

0 | 0.28 | 0.55 Miles

Demographic Statistics[4,5]

The table represents people who live ¼ and ½ mile around and within the approximate boundary

Measure	1/4 mile	1/2 mile	Measure	1/4 mile	1/2 mile
Total Population	187	1,034	Two or More Races	59	333
White Alone	61	342	Hispanic or Latino[6]	153	832
Black Alone	0	9	Children Aged 6 and Younger	13	67
Am. Indian & AK Native Alone	9	67	Adults Aged 65 and Older	31	213
Asian Alone	0	9	Females Aged 15 to 44	34	181
Native Hawaiian & Other Pacific Islander Alone	0	0	Housing Units	88	488
Some Other Race Alone	55	272	Housing Units Pre-1950	20	56

Data Sources: NMED/USEPA 2023[1], ATSDR GRASP[2], TomTom 2021Q3[3], US Census 2020[4], NMED 2020, ESRI **Notes:** [5]Calculated using area-proportion spatial analysis method, [6]Individuals identifying origin as Hispanic or Latino may be of any race. **Coordinate System:** NAD 1983 StatePlane New Mexico Central FIPS 3002 Feet

ATSDR Agency for Toxic Substances and Disease Registry

GRASP Geospatial Research, Analysis, and Services Program

PRJ ID 06386 | **AUTHOR** Lindsay Hicks

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3.2. Community Concerns

ATSDR attended a community meeting hosted by the Santa Clara Pueblo on September 20, 2023. The next day, ATSDR attended an Open House and Community Meeting hosted by the EPA and NMED. During the same week, ATSDR also met with the following officials:

- Rio Arriba County Health and Human Services Director
- Santa Clara Pueblo Governor, Lieutenant Governor, and Environmental Director
- City of Española Mayor Pro Tempore, District Two Councilor, and acting City Manager

Although these meetings were primarily focused on the NRAP site, some community members expressed concerns that CCGP was not getting enough attention. ATSDR listened to these concerns and assured community members that a thorough public health evaluation would be provided of the indoor air sampling data collected at five buildings located above the CCGP.

Although child health issues pertaining to buildings in the CCGP were not specifically brought up by community members, ATSDR has special considerations for these. Child exposures are accounted for in the health effects evaluations where applicable.

4.0. Sampling Data

4.1. Indoor Air, Outdoor Air, Crawlspace Air, and Subslab Soil Gas Samples from Five Buildings

Table 2 lists the number of indoor air, outdoor air, and crawlspace air or subslab soil gas samples collected at each of the five buildings in the CCGP for which data are available.

On February 15–16, 2018, EPA collected indoor air samples at Buildings C and D. Outdoor air and crawlspace air samples were not collected at these buildings. Because both of these buildings are used for residential purposes, indoor air samples were collected in 6-liter summa canisters over an approximately 24-hour period and analyzed using EPA Method TO-15 [EA 2020a; WESTON 2018].

On December 11, 2018, EPA collected concurrent indoor air and crawlspace air samples at Buildings A and B as part of a Phase 2 focused Remedial Investigation. A concurrent outdoor air sample was only collected at Building B. Because both of these buildings are used for commercial purposes, indoor air samples were collected in 6-liter summa canisters over an approximately 8-hour period and analyzed using EPA Method TO-15 [EA 2020c].

On December 16, 2021, D&D representatives collected concurrent indoor air, outdoor air, and subslab soil gas samples as part of a site investigation at NMED's request [DBS&A 2022]. The indoor and outdoor air samples were collected in 6-liter summa canisters over an approximately 8-hour period and analyzed using EPA Method TO-15. The subslab soil gas samples were collected in 1-liter stainless steel containers for approximately 5–10 minutes depending on the sample and also analyzed using EPA Method TO-15 [DBS&A 2022].

Table 2. Number of Indoor Air, Outdoor Air, Crawlspace Air, and Subslab Soil Gas Samples Collected in 2018 and 2021 from Five Buildings Above the Calle Chavez Groundwater Plume

Building	Building Use Type	Sampling Event Date	Number of Indoor Air Samples	Number of Outdoor Air Samples	Number of Crawlspace Air or Subslab Soil Gas Samples
Building A	Commercial	December 11, 2018	3	Not collected	2 (crawlspace air)
Building B	Commercial	December 11, 2018	4	1	3 (crawlspace air)
Building C	Residential	February 15–16, 2018	3	Not collected	Not collected
Building D	Residential	February 15–16, 2018	4	Not collected	Not collected
D&D Mountain Air Cleaners Facility	Commercial	December 16, 2021	4	1	4 (subslab soil gas)

4.2. Groundwater and Exterior Soil Gas Sampling Data

The following section provides further information about the groundwater and exterior soil gas samples that ATSDR evaluated in order to recommend to NMED additional buildings above or around the CCGP shallow plume which NMED is recommended to prioritize for vapor intrusion sampling. This evaluation is discussed in section 5.4. ATSDR's Recommendations for Additional Buildings to Prioritize Vapor Intrusion Sampling.

Groundwater samples were collected from June 2017 to September 2024 from the nine wells described in Table 3. At each of these wells, the screened interval (the area between the depth to top of screen and depth to bottom of screen) is within or a few feet below the depth to water table, which makes these groundwater samples ideal for assessing the potential for vapor intrusion [EPA 2015].

From November 1–2, 2017, EPA collected 31 exterior soil gas samples within 100 feet of the approximate CCGP plume during a Phase 1 sampling event [EA 2020b]. These samples were collected in 6-liter summa canisters over an approximately 30-minute period and analyzed using EPA Method TO-15. Samples were collected at a depth of no less than 5 feet below ground surface (bgs).

Twenty-five exterior soil gas samples collected by D&D representatives in December 2021 and October 2023 are not included in ATSDR's evaluation [DBS&A 2022; DBS&A 2024a]. This is because these samples were collected from approximately 2 feet bgs. Collecting exterior soil gas samples at a depth that is shallower than 5 feet bgs does not provide an accurate representation of subsurface vapor conditions because any vapors that are present in the sample may have been diluted by ambient air and affected by biodegradation. These factors may result in lower contaminant concentrations in the exterior soil gas samples which may not accurately reflect the subsurface vapor conditions that could potentially impact indoor air quality through vapor intrusion. Due to this uncertainty, it's not appropriate to screen these samples with ATSDR soil gas vapor intrusion comparison values (VICVs). Therefore, these shallower soil gas samples weren't included when considering buildings for NMED to prioritize vapor intrusion sampling as discussed in section 5.4. ATSDR's Recommendations for Additional Buildings to Prioritize Vapor Intrusion Sampling.

Table 3. Calle Chavez Groundwater Plume Wells from which Groundwater Samples Were Evaluated*

Well Location	Minimum Depth to Water (feet)	Maximum Depth to Water (feet)	Year of Minimum Depth to Water	Year of Maximum Depth to Water	Depth to Top of Screen (feet)	Depth to Bottom of Screen (feet)
R-03 (S2)	5.26	8.64	2010	1999†	14	24
BC-6	8.02	10.2	2017	2024	9	29
PASMW-01	10.20	10.47	2019	2023	8	23
PASMW-02	5.82	8.02	2019	2024	8	28
PASMW-03	5.00	6.84	2019	2023	8	23
MAMW-1	8.42	9.63	2024	2023	4	19
MAMW-2	7.86	9.13	2024	2023	4	19
DBS-1	7.24	8.18	2023	2024	4.1	19.1
DBS-2	5.74	6.69	2024	2024	4.3	19.3

*Data were obtained from the 2024 Summary of Field Activities and Analytical Results Fourth Quarterly Groundwater Monitoring Event report for D&D, 2022 Site Investigation Report for D&D, and from New Mexico

Environment Department Groundwater Database provided to ATSDR [DBS&A 2022; DBS&A 2024b; NMED 2023].
†The most recent depth to water (in year 2021) is 6.45 ft [NMED 2023].

5.0. Scientific Evaluations

5.1. Exposure Pathway Analysis

Contaminants released into the environment have the potential to cause harmful health effects, but a release does not always result in exposure. If no one comes in contact with a contaminant—if there is no completed exposure pathway—then exposure does not occur, and thus adverse health effects do not result. The route a contaminant takes from its source (where it began) to its exposure point (where it ends), and how people can contact it (how people get exposed) is called the exposure pathway.

A completed exposure pathway has five elements:

1. a source of contamination,
2. an environmental medium (such as soil, groundwater, or air) through which a chemical is transported,
3. a point of exposure,
4. a route of exposure,
5. and an exposed population (receptor population).

The source is the place where the chemical was released to the environment. The environmental media transports the contaminant. The point of exposure is the place where a person comes into contact with the media. The route of exposure (for example, inhalation, ingestion, or dermal contact) is the way the contaminant enters the body. The people exposed are the receptor population.

A potential exposure pathway exists when one or more of the elements is missing, but available information suggest that exposure is possible. For completed or potential exposure pathways, ATSDR will evaluate the magnitude, frequency, and duration of exposures.

Both ingestion and dermal contact with groundwater are incomplete exposure pathways and have not been further evaluated in the health consultation (Table 4). According to NMED and EPA, nobody in buildings above the CCGP shallow plume obtain drinking water from private drinking water wells, and there are no public water wellheads in the CCGP shallow plume. Therefore, residents, employees, other building occupants, and building visitors cannot be exposed to VOC contaminants from the CCGP plume from drinking water.

However, vapor intrusion is a potential pathway of exposure. Vapor intrusion occurs when volatile contaminants in shallow groundwater seep upward through the ground surface into indoor air of overlying or nearby buildings. Figure 3 shows volatile contaminants in the form of vapors migrating from contaminated groundwater and soil:

1. through openings associated with utility lines, and
2. through gaps and cracks in the building's foundation, which leads to these volatile contaminant vapors accumulating in the building's indoor air.

EPA guidance states that “a buffer zone of approximately 100 feet (laterally or vertically from the ‘boundary’ of subsurface vapor concentrations of potential concern) generally has been used in determining which buildings to include in vapor intrusion investigations” [EPA 2015].

Therefore, residential and commercial buildings that are located within 100 feet horizontally of the approximate CCGP boundary and whose bottom floors are within 100 feet of the top of the CCGP could be potential points of exposure.

When vapor intrusion occurs, the residents or workers inside the building are exposed to these volatile contaminants by breathing them in. ATSDR typically assumes indoor air residential exposure is for 24 hours a day and worker exposure in commercial buildings is for 8.5 hours a day. ATSDR also evaluates sensitive populations such as children and women of child-bearing age.

Volatile contaminants can also seep from the ground surface and be released to outdoor air. However, vapors disperse more quickly in outdoor air. Therefore, high concentrations are uncommon outdoors.

Figure 3. Migration of Vapors into Indoor Air*

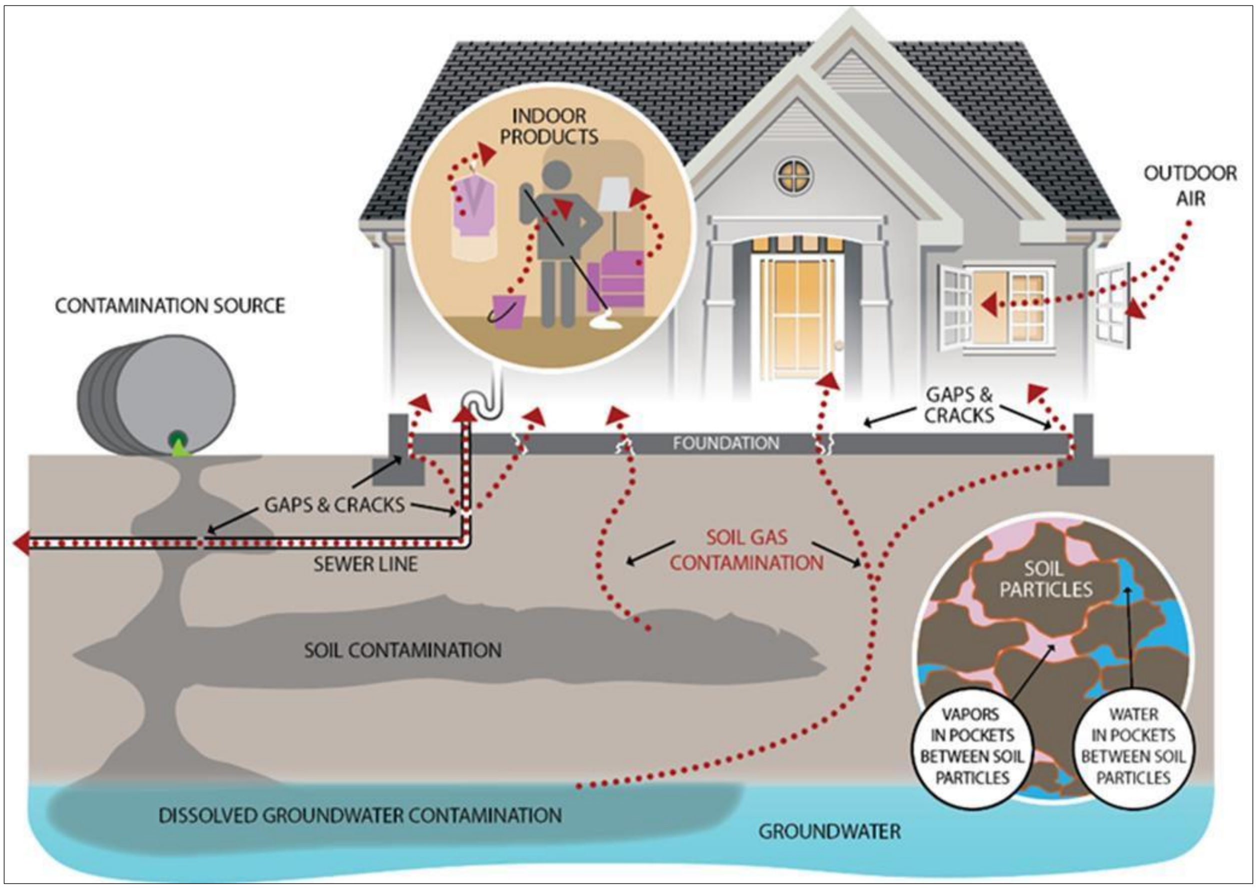

Table 4. Exposure Pathways Relevant to the Calle Chavez Groundwater Plume

Contaminant Source	Environmental Medium	Transport Mechanisms	Point of Exposure	Route of Exposure	Pathway Conclusion Category
D&D Mountain Air Cleaners	Groundwater	Public or private water supply wells	Residential and commercial buildings that obtain water from public or private water supply wells located within the Calle Chavez Groundwater Plume	Ingestion (drinking groundwater) Dermal (direct contact with skin during showering and bathing)	Incomplete
D&D Mountain Air Cleaners	Indoor air	Vapor intrusion—Vapors from groundwater move through vadose zone into buildings	Residential and commercial buildings above or around 100 feet of the Calle Chavez Groundwater Plume approximate boundary	Inhalation (breathing indoor air)	Potential

5.2. Indoor Air Evaluation

5.2.1. Screening Contaminant Concentrations in Indoor Air from Five Buildings Above the CCGP Shallow Plume

ATSDR selects chemicals for further evaluation by comparing the maximum concentration of each VOC detected in indoor air to recommended ATSDR health-based indoor air inhalation comparison values (CVs). The maximum concentration of each VOC is used as a conservative measure even though we know that people are exposed to a range of concentrations and not just to the maximum reported concentrations.

Comparison values (CVs) are developed by ATSDR from available scientific literature concerning exposure and health effects. CVs are derived and reflect a concentration that is not expected to cause harmful health effects for a given contaminant, assuming a standard daily contact rate (for example the amount of air breathed). Because CVs reflect concentrations that are much lower than those that have been observed to cause adverse health effects, CVs are protective of public health in essentially all exposure situations. As a result, harmful health effects aren't expected from exposures to contaminant concentrations detected at or below ATSDR's CVs. Therefore, indoor air concentrations below air CVs aren't considered to pose a public health hazard and are not evaluated further for a given medium.

While concentrations at or below the respective CV can be considered safe, it does not automatically follow that any air concentration exceeding a CV would be expected to produce adverse health effects. CVs are not health effect thresholds. ATSDR CVs represent concentrations that are many times lower than concentrations at which no effects were observed in experimental studies on animals or in human epidemiologic studies.

The likelihood that adverse health outcomes will actually occur depends on site-specific conditions, individual differences, and factors that affect the route, magnitude, and duration of actual exposure. If contaminant concentrations are above comparison values, ATSDR further analyzes exposure variables (such as site-specific exposure duration and frequency) and health studies, including toxicologic and epidemiologic studies to obtain information about the toxicity of the chemicals, to better understand the public health implications of exposure.

To screen contaminant concentrations in indoor air, ATSDR uses indoor air inhalation CVs. ATSDR calculates CVs for three different exposure time periods:

- Acute CVs correspond to exposures of 1–14 days.
- Intermediate CVs are for 15–364 days.
- Chronic CVs are for a year (365 days) or longer.

These health protective CVs are calculated using reasonable maximum exposure (RME) assumptions for children (more sensitive to exposure than adults), noncancer health guidelines (ATSDR-developed inhalation minimal risk levels [MRLs], EPA-derived reference concentrations [RfCs]), and lifetime excess cancer risk values, including EPA-derived inhalation unit risks (IURs). ATSDR obtained the most current recommended indoor air inhalation CVs from the Public Health Assessment Site Tool (PHAST), which helps health assessors evaluate exposure to contaminants at hazardous waste sites by generating adjusted air exposure point concentrations (EPCs), hazard quotients, and lifetime excess cancer risks [ATSDR 2023a; Burk et. al. 2022].

Table 5 presents maximum indoor air concentrations of contaminants at five buildings located above the CCGP shallow plume that exceed their respective ATSDR indoor air inhalation CVs. These samples were collected in 2018 or 2021. Because all of the contaminants exceed their respective CVs, further evaluation of health effects from inhalation of indoor air is conducted on these contaminants. However, it is important to point out that maximum benzene indoor air concentrations are less than typical North American residential indoor air background concentrations [EPA 2011a].

Table 5. Contaminants with Maximum Concentrations in Indoor Air from Five Buildings Above the CCGP Shallow Plume that Exceed Health-Based Indoor Air Inhalation CVs and Selected for Further Evaluation*

Indoor Air Contaminant	Frequency of Detection	Range of Detected Indoor Air Concentrations (micrograms per cubic meter)	Recommended Indoor Air Inhalation CV (micrograms per cubic meter)	Indoor Air Inhalation CV Type	Indoor Air Background Study Concentration (micrograms per cubic meter)†
Tetrachloroethylene	13 out of 13	0.064 J–190	3.8	CREG‡	2.2
Benzene	11 out of 11	0.57–2.2	0.13	CREG	4.7
Trichloroethylene	5 out of 17	0.077 J–5.6	0.21	CREG	1.1
Chloroform	3 out of 4	2.4–2.6	0.043	CREG	2.4

*CCGP = Calle Chavez Groundwater Plume; CREG = lifetime excess cancer risk evaluation guide; CV = ATSDR comparison value; J = indoor air concentration is an estimated value.

†Indoor air background study concentrations represent the upper 50th (fiftieth) percent indoor air concentration measured in North American residences between 1990–2005 [EPA 2011a].

‡CREGs are conservative, health-based media-specific comparison values unlikely to result in an increase of cancer rates in an exposed population. CREGs are developed for screening environmental concentrations to identify concentrations of cancer-causing substances for further health effects evaluation.

5.2.3. Determining Indoor Air Exposure Point Concentrations

For each indoor air contaminant requiring further evaluation of breathing indoor air, ATSDR calculated an indoor air exposure point concentration (EPC). EPCs are calculated for each contaminant in each completed and potential exposure pathway (by exposure unit, if appropriate).

To consider uncertainties associated with environmental sampling data, ATSDR typically uses robust statistical procedures to generate reasonable, health protective EPCs [ATSDR 2023b]. However, as there are fewer than eight indoor air samples at each building, the maximum indoor air contaminant concentration at each building is selected as the EPC (Table 6, Table 7, Table 8, Table 9, and Table 10). Each building is treated as an individual exposure unit because the buildings evaluated in this health consultation are not connected to each other [ATSDR 2023b].

5.2.4. Determining Which Buildings Require More Thorough Evaluation Based on Comparison of EPCs with Indoor Air Inhalation CVs

ATSDR compared building specific indoor air EPCs for tetrachloroethylene, trichloroethylene, chloroform, and benzene with their respective indoor air inhalation CVs to identify buildings that require a more thorough exposure evaluation.

For commercial Building A (Table 6), the tetrachloroethylene EPC was below its respective indoor air inhalation CV. This suggests that concentrations of tetrachloroethylene in indoor air based on limited sampling during a single sampling event in 2018 aren't expected to result in a potential for harmful health effects to employees, visitors, or other building occupants breathing air in Building A. Trichloroethylene was analyzed (tested for) in all indoor air samples collected at Building A but wasn't detected in any of the samples (this means that the laboratory which tested the indoor air samples couldn't determine whether trichloroethylene is present in indoor air at Building A). Because the trichloroethylene detection limit (the level above which the laboratory can determine trichloroethylene was present in an indoor air sample) was below the respective trichloroethylene indoor air inhalation CV, this suggests that if trichloroethylene was present in indoor air at Building A, it wouldn't have been at a concentration high enough to result in a potential for harmful health effects to employees, visitors, or other building occupants breathing air in Building A. Benzene and chloroform weren't tested for in any indoor air sample collected at Building A. Therefore, ATSDR doesn't have any information to assess benzene and chloroform health effects at Building A. No further evaluation of contaminants in indoor air at Building A is provided in this health consultation. However, ATSDR can't determine whether breathing indoor air at Building A could harm people's health because not enough indoor air sampling data are available to evaluate potential health effects from exposure to the VOC concentrations in indoor air over time. Therefore, ATSDR recommends NMED conduct further vapor intrusion sampling at Building A in hot weather.

For commercial Building B (Table 7), both the trichloroethylene and tetrachloroethylene EPCs were below their respective indoor air inhalation CVs. This suggests that concentrations of trichloroethylene and tetrachloroethylene in indoor air based on limited sampling during a single sampling event in 2018 are not expected to result in a potential for harmful health effects to employees, visitors, or other building occupants breathing air in Building B. Benzene and chloroform weren't tested for in any indoor air samples collected at Building B. Therefore, ATSDR doesn't have any information to assess benzene and chloroform health effects at Building B. No further evaluation of contaminants in indoor air at Building B is provided in this health consultation. However, ATSDR can't determine whether breathing indoor air in Building B could harm people's health because not enough indoor air sampling data are available to evaluate potential health effects from exposure to the VOC concentrations in indoor air over time. Therefore, ATSDR recommends NMED conduct further vapor intrusion sampling at Building B in hot weather.

For residential Building C (Table 8), the maximum concentration of trichloroethylene in indoor air was below its indoor air inhalation CV. This suggests that concentrations of trichloroethylene in indoor air based on a single sampling event in 2018 are not expected to result in a potential for harmful health effects to residents breathing indoor air in Building C. Chloroform wasn't tested for in any indoor air samples collected at Building C. Therefore, ATSDR doesn't have any information to assess chloroform health effects at Building C. No further evaluation of trichloroethylene and chloroform in indoor air is provided in this health consultation. However, tetrachloroethylene and benzene EPCs are above their respective indoor air inhalation CVs. Therefore, ATSDR has further evaluated both tetrachloroethylene and benzene at Building C. However, ATSDR can't determine whether breathing indoor air in Building C could harm people's health because not enough indoor air sampling data are available to evaluate potential health effects from exposure to the VOC concentrations in indoor air over time. Therefore, ATSDR recommends NMED conduct further vapor intrusion sampling at Building C in hot weather.

For residential Building D (Table 9), trichloroethylene wasn't detected in any indoor air sample collected at the building. Because the trichloroethylene detection limit (the level above which the laboratory can determine trichloroethylene was present in an indoor air sample) was below the respective trichloroethylene indoor air inhalation CV, this suggests that if trichloroethylene was present in indoor air at Building D, it wouldn't have been at a concentration high enough to result in a potential for harmful health effects to employees, visitors, or other building occupants breathing air in Building D. Chloroform wasn't tested for in any indoor air sample collected at Building D. Therefore, ATSDR doesn't have any information to assess chloroform health effects at Building D. No further evaluation of trichloroethylene and chloroform in indoor air is provided in this health consultation. However, tetrachloroethylene and benzene EPCs are above their respective indoor air inhalation CVs. Therefore, ATSDR has further evaluated both tetrachloroethylene and benzene at Building D. However, ATSDR can't determine whether breathing indoor air in Building D could harm people's health because not enough indoor air sampling data are available to evaluate potential health effects from exposure to the VOC concentrations in indoor air over time. Therefore, ATSDR recommends NMED conduct further vapor intrusion sampling at Building D in hot weather.

For the D&D facility (Table 10), all contaminant EPCs are above their respective air CVs. Therefore, ATSDR has further evaluated tetrachloroethylene, trichloroethylene, benzene, and chloroform in indoor air at the D&D facility. However, ATSDR can't determine whether breathing indoor air in the D&D facility could harm people's health because not enough indoor air sampling data are available to evaluate potential health effects from exposure to the VOC concentrations in indoor air over time. Therefore, ATSDR recommends NMED conduct further vapor intrusion sampling at the D&D facility in hot weather.

Table 6. Frequency of Detection, Recommended Indoor Air Inhalation CV, and Exposure Point Concentrations for Indoor Air Contaminants, Building A (commercial)*

Indoor Air Contaminant	Frequency of Detection	Recommended ATSDR Indoor Air Inhalation CV (micrograms per cubic meter)	EPC (micrograms per cubic meter)	Is Contaminant Selected for Further Evaluation?[†]
Tetrachloroethylene	3 out of 3	3.8	0.13 J	No
Benzene	Not analyzed[‡]	0.13	Not analyzed	No
Trichloroethylene	0 out of 3	0.21	<0.089	No
Chloroform	Not analyzed	0.043	Not analyzed	No

*CV = comparison value; EPC = exposure point concentration; J = indoor air concentration is an estimated value; < = less than

†Contaminants that are not selected for further evaluation ("No" answer in the column) include: contaminants whose EPC is below their respective indoor air inhalation CV, contaminants that are not detected (laboratory cannot determine whether the contaminant was present in the indoor air at the building) but where the detection limit is below their respective indoor air inhalation CV, and contaminants that were not analyzed (tested for) in any indoor air sample collected at the building. If a contaminant did not meet any one of the aforementioned criteria, a "Yes" answer in the column was added to indicate that the contaminant was selected for further evaluation. The question of further evaluation only relates to the indoor air sampling data evaluated in this health consultation and not regarding any future indoor air sampling data which may be collected at the building.

‡"Not analyzed" means that in all the indoor air samples collected at the building and which are evaluated in this health consultation, the contaminant was not tested in any of them. Therefore, ATSDR does not have any information which can be used to evaluate potential health effects of exposure to the particular contaminant at the building.

Table 7. Frequency of Detection, Recommended Indoor Air Inhalation CV, and Exposure Point Concentrations for Indoor Air Contaminants, Building B (commercial)*

Indoor Air Contaminant	Frequency of Detection	Recommended ATSDR Indoor Air Inhalation CV (micrograms per cubic meter)	EPC (micrograms per cubic meter)	Is Contaminant Selected for Further Evaluation?[†]
Tetrachloroethylene	3 out of 3	3.8	0.12 J	No
Benzene	Not analyzed[‡]	0.13	Not analyzed	No
Trichloroethylene	1 out of 3	0.21	0.079 J	No
Chloroform	Not analyzed	0.043	Not analyzed	No

*CV = comparison value; EPC = exposure point concentration; J = indoor air concentration is an estimated value

†Contaminants that are not selected for further evaluation ("No" answer in the column) include: contaminants whose EPC is below their respective indoor air inhalation CV, contaminants that are not detected (laboratory cannot determine whether the contaminant was present in the indoor air at the building) but where the detection limit is below their respective indoor air inhalation CV, and contaminants that were not analyzed (tested for) in any indoor air sample collected at the building. If a contaminant did not meet any one of the aforementioned criteria, a

"Yes" answer in the column was added to indicate that the contaminant was selected for further evaluation. The question of further evaluation only relates to the indoor air sampling data evaluated in this health consultation and not regarding any future indoor air sampling data which may be collected at the building.
‡"Not analyzed" means that in all the indoor air samples collected at the building and which are evaluated in this health consultation, the contaminant was not tested in any of them. Therefore, ATSDR does not have any information which can be used to evaluate potential health effects of exposure to the particular contaminant at the building.

Table 8. Frequency of Detection, Recommended Indoor Air Inhalation CV, and Exposure Point Concentrations for Indoor Air Contaminants, Building C (residential)*

Indoor Air Contaminant	Frequency of Detection	Recommended ATSDR Indoor Air Inhalation CV (micrograms per cubic meter)	EPC (micrograms per cubic meter)	Is Contaminant Selected for Further Evaluation?†
Tetrachloroethylene	3 out of 3	3.8	4.6	**Yes**
Benzene	3 out of 3	0.13	1.1	**Yes**
Trichloroethylene	1 out of 3	0.21	0.077 J	No
Chloroform	Not analyzed‡	0.043	Not analyzed	No

*CV = comparison value; EPC = exposure point concentration; J = indoor air concentration is an estimated value
†Contaminants that are not selected for further evaluation ("No" answer in the column) include: contaminants whose EPC is below their respective indoor air inhalation CV, contaminants that are not detected (laboratory cannot determine whether the contaminant was present in the indoor air at the building) but where the detection limit is below their respective indoor air inhalation CV, and contaminants that were not analyzed (tested for) in any indoor air sample collected at the building. If a contaminant did not meet any one of the aforementioned criteria, a "Yes" answer in the column was added to indicate that the contaminant was selected for further evaluation. The question of further evaluation only relates to the indoor air sampling data evaluated in this health consultation and not regarding any future indoor air sampling data which may be collected at the building.
‡"Not analyzed" means that in all the indoor air samples collected at the building and which are evaluated in this health consultation, the contaminant was not tested in any of them. Therefore, ATSDR does not have any information which can be used to evaluate potential health effects of exposure to the particular contaminant at the building.

Table 9. Frequency of Detection, Recommended Indoor Air Inhalation CV, and Exposure Point Concentrations for Indoor Air Contaminants, Building D (residential)*

Indoor Air Contaminant	Frequency of Detection	Recommended ATSDR Indoor Air Inhalation CV (micrograms per cubic meter)	EPC (micrograms per cubic meter)	Is Contaminant Selected for Further Evaluation?†
Tetrachloroethylene	4 out of 4	3.8	5.3	**Yes**
Benzene	4 out of 4	0.13	0.75	**Yes**
Trichloroethylene	0 out of 4	0.21	<0.014	No
Chloroform	Not analyzed‡	0.043	Not analyzed	No

*CV = comparison value; EPC = exposure point concentration; J = indoor air concentration is an estimated value; < = less than

†Contaminants that are not selected for further evaluation ("No" answer in the column) include: contaminants whose EPC is below their respective indoor air inhalation CV, contaminants that are not detected (laboratory cannot determine whether the contaminant was present in the indoor air at the building) but where the detection limit is below their respective indoor air inhalation CV, and contaminants that were not analyzed (tested for) in any indoor air sample collected at the building. If a contaminant did not meet any one of the aforementioned criteria, a "Yes" answer in the column was added to indicate that the contaminant was selected for further evaluation. The question of further evaluation only relates to the indoor air sampling data evaluated in this health consultation and not regarding any future indoor air sampling data which may be collected at the building.

‡"Not analyzed" means that in all the indoor air samples collected at the building and which are evaluated in this health consultation, the contaminant was not tested in any of them. Therefore, ATSDR does not have any information which can be used to evaluate potential health effects of exposure to the particular contaminant at the building.

Table 10. Frequency of Detection, Recommended Indoor Air Inhalation CV, and Exposure Point Concentrations for Indoor Air Contaminants, D&D Mountain Air Cleaners Facility*

Indoor Air Contaminant	Frequency of Detection	Recommended ATSDR Indoor Air Inhalation CV (micrograms per cubic meter)	EPC (micrograms per cubic meter)	Is Contaminant Selected for Further Evaluation?†
Tetrachloroethylene	4 out of 4	3.8	190	**Yes**
Benzene	4 out of 4	0.13	2.2	**Yes**
Trichloroethylene	3 out of 4	0.21	5.6	**Yes**
Chloroform	3 out of 4	0.043	2.6	**Yes**

*CV = comparison value; EPC = exposure point concentration; J = indoor air concentration is an estimated value

†Contaminants that are not selected for further evaluation ("No" answer in the column) include: contaminants whose EPC is below their respective indoor air inhalation CV, contaminants that are not detected (laboratory cannot determine whether the contaminant was present in the indoor air at the building) but where the detection limit is below their respective indoor air inhalation CV, and contaminants that were not analyzed (tested for) in any indoor air sample collected at the building. If a contaminant did not meet any one of the aforementioned criteria, a "Yes" answer in the column was added to indicate that the contaminant was selected for further evaluation. The

question of further evaluation only relates to the indoor air sampling data evaluated in this health consultation and not regarding any future indoor air sampling data which may be collected at the building.

5.2.5. Derivation of Adjusted EPCs for Indoor Air Contaminants Requiring Further Evaluation

For contaminants in buildings that require further evaluation (residential Building C, residential Building D, and commercial D&D facility), ATSDR evaluated noncancer and cancer health effects by adjusting the EPC by a residential or commercial exposure factor depending on chronic (365 days and longer), intermediate (15–364 days), or acute (0–14 days) exposure durations.

To derive adjusted EPCs, ATSDR multiplied the EPC by an exposure factor (EF). The EF is a ratio that expresses how often (frequency) and how long (duration) a person could contact a contaminant in the environment over a certain amount of time (averaging time) [ATSDR 2022].

While the EPC represents the indoor air concentration of the contaminant within the building (i.e., at the point of exposure), an EF is used to adjust the EPC to represent the concentration of a contaminant that a person is assumed to breathe in indoor air for a specific duration of exposure.

As explained in the next two paragraphs, ATSDR calculated the EF using default reasonable maximum exposure (RME) exposure parameters when available. RME refers to people who are at the high end of the exposure distribution (approximately the 95th percentile), a scenario intended to assess exposures that are higher than average, but still within a realistic exposure range [ATSDR 2022]. An RME exposure does not represent exposure to the typical (average) individual. Therefore, use of RME exposure parameters results in the calculation of adjusted EPCs that are health protective.

As site-specific residential exposure parameters are not available, ATSDR assumed that an adult resident could breathe indoor air for 24 hours per day, 7 days per week, 52.14 weeks per year, and for an RME residential occupancy period of 33 years[5]. It was assumed that a child resident could breathe indoor air for 24 hours per day, 7 days per week, 52.14 weeks per year, and for up to 21 years, which indicates a scenario where a child is residing in the residence until the age of 21 [ATSDR 2021b]. As standard residential assumptions are used, the frequency and duration of exposure is the same as the averaging time for noncancer exposure, which results in an EF of 1 for acute (0–14 days), intermediate (15–364 days), and chronic (365 days or longer) exposures [ATSDR 2022]. Therefore, the adjusted EPCs at residential Buildings C and D are the same as the EPCs listed in Table 8 and Table 9.

As site-specific occupational exposure parameters are not available for the D&D facility, ATSDR assumed that all D&D facility employees are full-time and could breathe indoor air for 8.5 hours per day, 5 days per week, 50 weeks per year (two weeks' vacation), and for an RME employment tenure of 20 years[6].

[5] 33 years is the 95th percentile residential occupancy period that ATSDR uses as a default residential exposure duration. This value was determined from a study of 500,000 men and women cited in EPA guidance [EPA 2011b]. It is important to emphasize that this value does not reflect the average (typical) amount of time a resident spends at their household.

[6] 20 years is the minimum amount of time that the U.S. Department of Labor determined that the top 10% of the longest employed workers are employed at a business [ATSDR 2021b]. It is important to emphasize that this value does not reflect the average (typical) amount of time an employee remains at a job. ATSDR conservatively uses 20 years to avoid underestimating occupational hazard quotients (HQ) and lifetime excess cancer risks even though use of this exposure assumption may overestimate these values.

[ATSDR 2021b]. Please refer to Appendix A. Full-Time Worker Exposure Factors for more information on how EFs are derived for full-time workers and D&D facility visitors.

D&D facility visitors (e.g., drycleaning customers) would spend much less time in the building than a full-time employee. Therefore, visitors are likely to breathe much lower concentrations of contaminants in indoor air than a full-time employee. ATSDR did not calculate adjusted EPCs for visitors because neither a potential for adverse noncancer health effects nor a concern for increased lifetime excess cancer risk was found in D&D facility full-time employees with more exposure to contaminants in indoor air.

5.2.6. Indoor Air Inhalation Exposure Noncancer Health Effects Evaluation

ATSDR compared the adjusted EPC to contaminant-specific health guidelines (used to evaluate noncancer health effects) to assess whether harmful noncancer health effects are expected. Health guidelines are ATSDR-developed inhalation minimal risk levels (MRLs) and EPA-derived reference concentrations (RfCs). Health guidelines are derived from data in the epidemiologic and toxicologic literature with appropriate uncertainty or safety factors applied to ensure they are set at concentrations below those that could result in harmful health effects. The values do not represent thresholds of toxicity. For reference, an explanation of the health guidelines that are used to evaluate noncancer health effects is provided in Table 11. The health guidelines used for noncancer health effects evaluation of contaminants in the CCGP are provided in Table 12.

Table 11. Inhalation Health Guidelines Used to Evaluate Noncancer Health Effects

Health Guidelines	Definition
ATSDR-Developed Inhalation Minimal Risk Levels (MRLs)	Represent estimates of the daily human exposure to a contaminant that, based on ATSDR evaluations, are not expected to cause noncancer health effects during a specified exposure duration. Are set below levels that might cause harmful health effects in most people, including sensitive populations. Are derived for acute (0–14 days), intermediate (15–364 days), and chronic (365 days and longer) exposure durations. A complete list of the available MRLs can be found at https://www.atsdr.cdc.gov/minimal-risk-levels/about/index.html.
EPA-Derived Reference Concentrations (RfCs)	Are estimates of daily inhalation exposures to a contaminant not likely to have a discernible risk of deleterious effects to the general human population, including sensitive subgroups, during a lifetime of exposure. A complete list of EPA's available RfCs can be found at https://www.epa.gov/iris.

ATSDR calculated a hazard quotient (HQ) to evaluate the potential for noncancer health hazards to occur from exposure to a contaminant with available noncancer health guidelines. ATSDR obtained the HQ by dividing the adjusted EPC by the appropriate health guideline (Equation 1):

Equation 1. Equation for Deriving Hazard Quotients

$$Hazard\ Quotient\ (HQ) = \frac{Adjusted\ EPC}{Health\ Guideline}$$

All HQs were compared to 1. HQs less than or equal to 1 indicate a noncancer hazard that is not expected to be an issue (i.e., there isn't a potential for adverse noncancer health effects). If a contaminant HQ is greater than 1, ATSDR further evaluates the contaminant in an in-depth toxicological evaluation.

As shown in Table 13 and Table 14 for residential Buildings C and D respectively, all HQs for acute, intermediate, and chronic residential exposures to tetrachloroethylene and benzene at Buildings C and D are below 1. Therefore, a potential for adverse noncancer health effects is not expected for residents breathing indoor air with concentrations of benzene and tetrachloroethylene determined based on a single indoor air sampling event in 2018 at each building. However, it is unclear whether breathing indoor air at Buildings C or D over time could harm people's health because not enough indoor air sampling data are available to evaluate potential health effects from exposure to the VOC concentrations in indoor air. Therefore, ATSDR recommends NMED conduct further vapor intrusion sampling at Buildings C and D in hot weather.

As shown in Table 16 for the D&D facility, all acute, intermediate, and chronic HQs for benzene, trichloroethylene, and chloroform are below 1 (adjusted EPCs calculated at the D&D facility are provided in Table 15). Therefore, a potential for adverse noncancer health effects is not expected for D&D employees breathing indoor air with concentrations of benzene, trichloroethylene, and chloroform determined based on a single indoor air sampling event in 2021 at the D&D facility. The hazard quotients for visitors would be even lower than that of D&D facility full-time employees, meaning that a potential for adverse noncancer health effects would also not be expected for visitors. However, it is unclear whether breathing these contaminants in indoor air at the D&D facility over time could harm people's health because not enough indoor air sampling data are available to evaluate potential health effects from exposure to the VOC concentrations in indoor air.

As shown in Table 16 for the D&D facility, all acute, intermediate, and chronic HQs for tetrachloroethylene are above 1. Therefore, an in-depth toxicological evaluation has been provided in 5.2.7. Further In-Depth Toxicological Effects Evaluation for Tetrachloroethylene.

Table 12. Health Guidelines Used for Noncancer Health Evaluation*

Indoor Air Contaminant	Acute Health Guideline (micrograms per cubic meter)	Intermediate Health Guideline (micrograms per cubic meter)	Chronic Health Guideline (micrograms per cubic meter)
Tetrachloroethylene	41	41	41
Benzene	29	22	6.4
Trichloroethylene	Not available†	2.1	2.1
Chloroform	4.9	3.9	2.0

*All health guidelines are ATSDR Minimal Risk Levels (MRLs) and are current as of May 2025.
†"Not available" means that ATSDR did not derive an MRL for this exposure duration.

Table 13. Adjusted Exposure Point Concentrations and Noncancer Hazard Quotients, Building C (residential)

Indoor Air Contaminant	Adjusted Exposure Point Concentration (micrograms per cubic meter)	Acute Hazard Quotient	Intermediate Hazard Quotient	Chronic Hazard Quotient
Tetrachloroethylene	4.6	0.1	0.1	0.1
Benzene	1.1	0.04	0.05	0.2

Table 14. Adjusted Exposure Point Concentrations and Noncancer Hazard Quotients, Building D (residential)

Indoor Air Contaminant	Adjusted Exposure Point Concentration (micrograms per cubic meter)	Acute Hazard Quotient	Intermediate Hazard Quotient	Chronic Hazard Quotient
Tetrachloroethylene	5.3	0.1	0.1	0.1
Benzene	0.75	0.03	0.03	0.1

Table 15. Acute, Intermediate, and Chronic Adjusted Exposure Point Concentrations, D&D Mountain Air Cleaners Facility*

Indoor Air Contaminant	Acute Adjusted Exposure Point Concentration (micrograms per cubic meter)	Intermediate Adjusted Exposure Point Concentration (micrograms per cubic meter)	Chronic Adjusted Exposure Point Concentration (micrograms per cubic meter)
Tetrachloroethylene	67	48	46
Benzene	0.78	0.56	0.53
Trichloroethylene	2.0	1.4	1.4
Chloroform	0.92	0.66	0.63

*Please refer to Appendix A. Full-Time Worker Exposure Factors for more information on how the exposure factors (EFs) used to adjust the EPC were derived.

Table 16. Noncancer Hazard Quotients, D&D Mountain Air Cleaners Facility*

Contaminant	Acute Hazard Quotient	Intermediate Hazard Quotient	Chronic Hazard Quotient
Tetrachloroethylene	1.6	1.2	1.1
Benzene	0.03	0.03	0.08
Trichloroethylene	Not calculated because there is no acute health guideline	0.7	0.7
Chloroform	0.2	0.2	0.3

*A contaminant is selected for a further in-depth toxicological effects evaluation if the hazard quotient is greater than 1.

5.2.7. Further In-Depth Toxicological Effects Evaluation for Tetrachloroethylene

Tetrachloroethylene is a VOC that is released into the environment from building and consumer products and from industrial emissions. Though it is being phased out, tetrachloroethylene is used as a dry cleaning solvent. It is well known that people working in dry cleaning industries or living near dry cleaning facilities may be exposed to higher levels of tetrachloroethylene than the general population [ATSDR 2019]. At the D&D facility, tetrachloroethylene was used as a dry cleaning solvent until 2012.

It is well known that VOCs like tetrachloroethylene can migrate from contaminated groundwater up through the ground and into an overlying building through vapor intrusion [ATSDR 2019]. Although NMED identified the D&D facility as the source of VOCs including tetrachloroethylene in the CCGP shallow plume, it is unclear whether the tetrachloroethylene detected in the indoor air in 2021 is a result of vapor intrusion from the CCGP plume or from another indoor or outdoor source (please refer to the section 5.3. Evaluation of Concurrent Outdoor Air, Crawlspace Air, and Subslab Soil Gas Samples to Determine Vapor Intrusion Potential for more information).

To determine if adverse noncancer health effects are likely from breathing indoor air with concentrations of tetrachloroethylene detected in the indoor air of the D&D facility during a single sampling event in 2021, ATSDR conducted an in-depth toxicological effects evaluation by comparing the adjusted acute, intermediate, and chronic tetrachloroethylene EPCs in Table 15 with the lowest observed adverse effect level (LOAEL) obtained from the critical studies used to derive the respective inhalation acute, intermediate, and chronic duration MRLs [ATSDR 2022].

The LOAEL is the lowest tested concentration of a substance that has been observed in a study to cause harmful (adverse) health effects in people or animals [ATSDR 2022]. ATSDR determined that the tetrachloroethylene LOAEL is 12,000 micrograms per cubic meter, based on a human epidemiological study showing a positive association between tetrachloroethylene exposure and decreased color vision in dry cleaning workers exposed to tetrachloroethylene for about nine years [ATSDR 2019]. ATSDR calculated that the adjusted tetrachloroethylene EPCs are 179–261 times lower than the LOAEL. Because adjusted EPCs calculated for full-time workers, child visitors, and adult visitors are two orders of magnitude lower than the LOAEL, ATSDR does not expect that noncancer health effects from tetrachloroethylene exposure would occur at concentrations observed at the D&D facility.

However, the adjusted EPCs were calculated using maximum concentrations based on only one round of indoor air sampling at the D&D facility in December 2021. Therefore, it is unclear whether breathing indoor air at the D&D facility over time could harm people's health because not enough indoor air sampling data are available to evaluate potential health effects from exposure to the VOC levels (concentrations) in indoor air. ATSDR recommends NMED conduct additional vapor intrusion sampling at the D&D facility in hot weather.

5.2.8. Indoor Air Inhalation Exposure Cancer Health Effects Evaluation

For each carcinogenic indoor air contaminant requiring further evaluation (tetrachloroethylene and benzene at residential Building C; tetrachloroethylene and benzene at residential Building D; and tetrachloroethylene, benzene, trichloroethylene, and chloroform at the commercial D&D facility), ATSDR calculated lifetime excess cancer risks by first multiplying the estimated indoor air exposure concentration (the chronic adjusted EPC) by the inhalation unit risk (IUR), as shown in Equation 2. The IUR, which is developed by EPA, is an upper-bound lifetime excess cancer risk estimated to result from continuous exposure to a contaminant at a concentration of 1 microgram per cubic meter in air [EPA 2024]. This result was then multiplied by the exposure duration (ED) divided by the average lifetime years (LY). For each contaminant, ATSDR used the exposure concentration based on the RME scenario and maximum concentration detected in the indoor air at residential Building's C and D and the D&D commercial facility.

For adult residents in Buildings C and D, the exposure duration to contaminants in the indoor air is 33 years based on the RME scenario. For child residents (children are assumed to be from birth to less than 21 years of age) in residential Buildings C and D, the ED is 21 years [ATSDR 2021b]. This conservatively assumes that children live in the same residence for the entire 21 years of childhood.

For D&D facility full-time employees, the exposure duration to contaminants in the indoor air is 20 years, based on the RME scenario [ATSDR 2021b].

Equation 2. General Equation to Estimate Inhalation Lifetime Excess Cancer Risk

$$Cancer\ Risk = (Chronic\ Adjusted\ EPC\ \times Inhalation\ Unit\ Risk) \times \frac{Exposure\ Duration}{Lifetime\ Years}$$

For both children and adults, an average lifetime of 78 years was assumed based on the default value in ATSDR guidance [ATSDR 2016b].

For each building, ATSDR multiplied the IUR for each contaminant by the respective estimate of lifetime exposure to obtain estimated lifetime excess cancer risks for each contaminant. ATSDR summed the individual lifetime excess cancer risks to obtain a total lifetime excess cancer risk estimate for the building.

The calculated RME inhalation lifetime excess cancer risks for each building are provided in Table 17 for Building C, Table 18 for Building D, and Table 19 for the D&D facility.

The highest total lifetime excess cancer risk is 9 in 1 million for full-time employees of the D&D facility. Given the conservative nature of the lifetime excess cancer risk evaluation for these contaminants (using maximum concentrations and RME exposure parameters to estimate the exposure concentration), ATSDR does not consider breathing tetrachloroethylene and benzene in residential Buildings C and D and breathing tetrachloroethylene, benzene, trichloroethylene, and chloroform in the D&D commercial facility to pose a concern for increased lifetime excess cancer risk. Note that these estimates are a theoretical estimate of lifetime excess cancer risk that ATSDR uses as a tool for deciding whether public health actions are needed to protect health—they are not an actual estimate of cancer cases in a community.

The lifetime excess cancer risks for D&D facility visitors would be lower than that of D&D facility full-time employees because visitors are exposed to the indoor air less frequently and for shorter durations. For full-time D&D employees, lifetime excess cancer risks are well below 100 in 1 million and aren't considered to pose a concern for increased lifetime excess cancer risk (if a contaminant's calculated lifetime excess cancer risk is above 100 in 1 million, ATSDR considers that contaminant to pose a concern for increased lifetime excess cancer risk).

Although the available data suggest that concentrations of carcinogenic VOCs measured in 2018 in residential Buildings C and D and in 2021 in the D&D commercial facility do not pose a concern for increased lifetime excess cancer risk, the calculated lifetime excess cancer risks are based on limited indoor air sampling data from a single sampling event at each building. Therefore, it is unclear whether breathing indoor air at residential Buildings C and D and the D&D commercial facility over time could harm people's health because not enough indoor air sampling data are available to evaluate potential health effects from exposure to the VOC levels (concentrations) in indoor air. Thus, ATSDR recommends NMED conduct further vapor intrusion sampling at each of these buildings to determine whether indoor air concentrations pose a health concern.

Table 17. Calculated Child and Adult Reasonable Maximum Exposure Lifetime Excess Cancer Risks from Long-Term Inhalation of Carcinogenic Contaminants in Indoor Air from Building C (residential)

Indoor Air Contaminant	Inhalation Unit Risk (per 1 micrograms per cubic meter)	Child Resident Reasonable Maximum Exposure Estimated Cancer Risks (per million)	Adult Resident Reasonable Maximum Exposure Estimated Cancer Risks (per million)
Tetrachloroethylene	0.00000026	0.32	0.51
Benzene	0.0000078	2.3	3.6
	Total Cancer Risk (reported to 1 significant figure)*	3	4

*If the total calculated lifetime excess cancer risk exceeds 100 in 1 million, ATSDR considers the combined exposure to all contaminants listed in the table to pose a concern for increased lifetime excess cancer risk, even if the individual contaminants do not exceed that level on their own.

Table 18. Calculated Child and Adult Reasonable Maximum Exposure Lifetime Excess Cancer Risks from Long-Term Inhalation of Carcinogenic Contaminants in Indoor Air from Building D (residential)

Indoor Air Contaminant	Inhalation Unit Risk (per 1 micrograms per cubic meter)	Child Resident Reasonable Maximum Exposure Estimated Cancer Risks (per million)	Adult Resident Reasonable Maximum Exposure Estimated Cancer Risks (per million)
Tetrachloroethylene	0.00000026	0.37	0.58
Benzene	0.0000078	1.6	2.5
	Total Cancer Risk (reported to 1 significant figure)*	2	3

*If the total calculated lifetime excess cancer risk exceeds 100 in 1 million, ATSDR considers the combined exposure to all contaminants listed in the table to pose a concern for increased lifetime excess cancer risk, even if the individual contaminants do not exceed that level on their own.

Table 19. Calculated Full-Time Employee Reasonable Maximum Exposure Lifetime Excess Cancer Risks from Long-Term Inhalation of Carcinogenic Contaminants in Indoor Air from the D&D Mountain Air Facility

Indoor Air Contaminant	Inhalation Unit Risk (per 1 microgram per cubic meter)	Full-Time Employee Reasonable Maximum Exposure Estimated Cancer Risk (per million)
Tetrachloroethylene	0.00000026	3.1
Benzene	0.0000078	1.1
Trichloroethylene	0.0000041	1.4
Chloroform	0.000023	3.7
	Total Cancer Risk (reported to 1 significant figure)*	9

*If the total calculated lifetime excess cancer risk exceeds 100 in 1 million, ATSDR considers the combined exposure to all contaminants listed in the table to pose a concern for increased lifetime excess cancer risk, even if the individual contaminants do not exceed that level on their own.

5.3. Evaluation of Concurrent Outdoor Air, Crawlspace Air, and Subslab Soil Gas Samples to Determine Vapor Intrusion Potential

Whenever available, ATSDR evaluated contaminant concentrations in indoor air samples to determine whether there is a health concern as they best represent the concentrations of contaminants that people could breathe inside of a building [ATSDR 2016a]. However, ATSDR also evaluated outdoor air, crawlspace air, and subslab soil gas samples that were collected concurrently with indoor air samples to understand whether the concentrations found in indoor air are attributable to vapor intrusion or are a result of background indoor or outdoor air sources. This helps to provide relevant sampling recommendations to NMED.

In concurrent outdoor air samples collected at both commercial Building B and the D&D facility during a single sampling event at each building, concentrations were at lower levels relative to indoor air, and no detected contaminants exceeded their respective ATSDR air CVs. Based on these samples, it does not appear that outdoor air in and around commercial Buildings B and the D&D facility is a significant background source of contaminants in indoor air. However, there aren't any outdoor air samples collected concurrently with indoor air samples around Building A (commercial), Building C (residential), and Building D (residential). Although Buildings B and the D&D facility are close to Buildings A, C, and D, the outdoor air samples collected near Buildings B and the D&D facility weren't collected on the same day as the indoor air samples that were collected at Buildings A, C, and D. There is uncertainty as to whether these indoor air samples are representative of typical ambient outdoor air concentrations in eastern Española. These limited data do not provide enough information to say whether indoor air concentrations are a result of outdoor air sources. Therefore, ATSDR recommends that for all five buildings, NMED collect additional outdoor air samples concurrent with indoor air, crawlspace, and subslab gas samples to better characterize the source of contaminants found in indoor air.

Crawlspace air samples were collected concurrently with indoor air samples at commercial Buildings A and B and were screened using ATSDR indoor air inhalation CVs based on EPA guidance indicating that there is limited attenuation between crawlspaces and living spaces inside of a residence [EPA 2015]. ATSDR found that crawlspace air concentrations were at lower levels relative to indoor air, and no detected crawlspace air contaminants exceeded their respective ATSDR indoor air inhalation CVs. Therefore, it is not likely that crawlspace air could contribute to elevated indoor air contaminant concentrations, which were also below their respective indoor air inhalation CV (Table 6 and Table 7). Crawlspace air samples weren't collected in hot weather during summer months when windows and doors would be kept closed and air exchange rates are low. These limited data do not provide enough information to determine whether indoor air concentrations in Buildings A and B are a result of vapor intrusion from the CCGP shallow plume or due to background sources. Therefore, ATSDR recommends that NMED collect additional concurrent crawlspace air samples to better characterize the source of contaminants found in indoor air at Buildings A and B in hot weather.

Concurrent indoor air and subslab soil gas samples were only collected at the D&D commercial facility. Of the contaminants detected in the four subslab soil gas samples collected at the D&D facility, maximum concentrations of only tetrachloroethylene and trichloroethylene exceeded their respective soil gas vapor intrusion comparison values (VICVs), as shown in Table 20. Therefore, further evaluation of vapor intrusion potential of these two contaminants in the D&D facility was conducted.

For subslab soil gas samples that are collected concurrently with indoor air samples, ATSDR uses attenuation factors as a line of evidence to support whether the source of detected indoor air contaminants is vapor intrusion or other indoor or outdoor sources. A subslab soil gas attenuation factor can be calculated by dividing the indoor air concentration of a contaminant by the concurrent subslab soil gas concentration [ATSDR 2024]. As shown in Table 20 for the D&D facility, the subslab soil gas attenuation factor for tetrachloroethylene and trichloroethylene is two to three orders of magnitude less than one. Because contaminants move from areas of higher concentration to areas of lower concentration, this suggests that vapor intrusion is a likely source of the tetrachloroethylene and trichloroethylene concentrations observed in indoor air at the D&D facility [ATSDR 2024; EPA 2015].

However, **this analysis is based on a limited dataset from a single sampling event and can't determine whether concentrations of VOCs in indoor air are a result of contaminants entering into the D&D facility from the CCGP shallow plume through vapor intrusion over time**. To better understand the source of indoor air contamination, ATSDR recommends that NMED collect additional subslab soil gas samples concurrently with indoor air and outdoor air samples at the D&D facility in hot weather.

Table 20. Maximum Detected Indoor Air Concentrations of Tetrachloroethylene and Trichloroethylene at D&D Mountain Air Cleaners Facility along with Concentrations of Concurrent Subslab Soil Gas Samples and Calculated Subslab Soil Gas Attenuation Factors

Indoor Air Contaminant	Maximum Detected Indoor Air Concentration (micrograms per cubic meter)	ATSDR Recommended Indoor Air Inhalation Comparison Value (micrograms per cubic meter)	Concurrent Subslab Soil Gas Concentration (micrograms per cubic meter)	ATSDR Recommended Soil Gas Vapor Intrusion Comparison Value (micrograms per cubic meter)	Subslab Soil Gas Attenuation Factor
Tetrachloroethylene	190	3.8	12,000	130	0.016
Trichloroethylene	5.6	0.21	2,200	7	0.003

5.4. ATSDR's Recommendations for Additional Buildings to Prioritize Vapor Intrusion Sampling

To determine which buildings to include in a vapor intrusion investigation, EPA guidance identifies a horizontal and vertical distance of 100 feet from a plume boundary as an acceptable buffer zone [EPA 2015]. Therefore, ATSDR recommends that NMED collect additional concurrent, seasonal (hot and cold weather) indoor air, crawlspace air or subslab soil gas, and outdoor air samples at all buildings within the CCGP shallow plume boundary as well as those located within a horizontal distance of 100 feet around the CCGP shallow plume boundary.

ATSDR identified 12 buildings (11 commercial and one residential) located in and around the CCGP shallow plume boundary where ATSDR recommends NMED prioritize their vapor intrusion sampling. ATSDR will work with NMED on which specific buildings to sample. To identify these 12 buildings, ATSDR compared shallow groundwater and exterior soil gas sample concentrations with the respective VICVs and then determined which buildings are located within a horizontal or vertical distance of 100 feet from any sample where one or more contaminants exceeded their VICVs. ATSDR also included some buildings that were located slightly more than 100 feet away from a groundwater or exterior soil gas sample. This is based on studies demonstrating that subslab soil gas and indoor air concentrations can be elevated several hundred feet beyond the boundary of a plume [ATSDR 2016a]. The VICVs used for this evaluation are listed in Table 21 and Table 22. ATSDR will use comparison values to identify any contaminants requiring further evaluation from future sampling and analysis of all contaminants.

ATSDR emphasizes that if a contaminant concentration exceeds a VICV, **it does not mean that health effects will occur, just that more evaluation is necessary**.

Table 21. List of ATSDR Groundwater VICVs Used for Screening Groundwater Samples to Determine Additional Buildings NMED May Prioritize for Vapor Intrusion Sampling*

Contaminant	ATSDR Recommended Groundwater VICV (ppb)	ATSDR Groundwater VICV Type
Tetrachloroethylene	5.3	CREG
Trichloroethylene	0.52	CREG
Cis-1,2-dichloroethene	31,000†	EMEG-a
Trans-1,2-dichloroethene	31,000	EMEG-a
1,1-Dichloroethene	3.7	EMEG-c
Benzene	0.57	CREG
Vinyl chloride	0.097	CREG

*CREG = cancer risk evaluation guide; EMEG-a = acute environmental media evaluation guide; EMEG-c = chronic environmental media evaluation guide; ppb = parts per billion; VICV = vapor intrusion comparison value
†VICV for trans-1,2-dichloroethene is used as a surrogate VICV in absence of a VICV for cis-1,2-dichloroethene

Table 22. List of ATSDR Soil Gas VICVs Used for Screening Exterior Soil Gas Samples to Determine Additional Buildings NMED May Prioritize for Vapor Intrusion Sampling*

Contaminant	ATSDR Recommended Soil Gas VICV (micrograms per cubic meter)	ATSDR Soil Gas VICV Type
Tetrachloroethylene	130	CREG
Trichloroethylene	7	CREG
Cis-1,2-dichloroethene	400,000†	EMEG-a
Trans-1,2-dichloroethene	400,000	EMEG-a

*CREG = cancer risk evaluation guide; EMEG-a = acute environmental media evaluation guide; VICV = vapor intrusion comparison value
†VICV for trans-1,2-dichloroethene is used as a surrogate VICV in absence of a VICV for cis-1,2-dichloroethene.

5.5. Limitations of the Evaluation

Several limitations in the indoor air sampling data have been identified that could affect uncertainty and influence the findings and overall conclusions. However, whenever possible, ATSDR accounts for these limitations by using the following health protective methods and values when determining whether harmful health effects are possible:

- maximum concentration of contaminants detected,
- protective, reasonable upper-bound exposure assumptions resulting in likely overestimates of exposure,
- protective noncancer health guidelines with uncertainty factor(s), and
- upper-bound inhalation unit risk.

Although not all limitations are significant individually, their collective impact could influence the findings of this document. ATSDR notes the following limitations of the information and data available for this site:

1. **Limited Sample Size.** Indoor air samples were only collected from each building during a single sampling period in February 2018 for Buildings A, B, C and D and in December 2021 for the D&D facility. ATSDR guidance recommends collecting indoor air samples during multiple seasons in hot and cold weather (during closed-building conditions) to determine if there are seasonal differences in contaminant levels in the indoor air [ATSDR 2016a]. The CCGP dataset does not have any samples collected in the summer months, though studies suggest that vapor intrusion could be higher during the summer months in southern states [ATSDR 2016a].
2. **VOCs Not Analyzed in All Samples.** Benzene was not analyzed in indoor air samples collected at commercial Buildings A and B, and chloroform was only analyzed in indoor air samples collected at the D&D commercial facility. Thus, ATSDR cannot evaluate these contaminants in the other buildings. Due to the limited dataset, it is uncertain whether levels of contaminants detected in the indoor air of Buildings A, B, C, and D, and the D&D facility could harm the health of people breathing indoor air in any of these buildings.
3. **No Supporting, Concurrent Vapor Intrusion Sampling in Some Buildings.** There are no concurrent outdoor air and crawlspace air samples at residential Buildings C and D. There is no concurrent outdoor air sample at Building A (commercial). These samples could help to rule out other indoor or outdoor sources of vapors unrelated to vapor intrusion.
4. **No Building Surveys.** ATSDR was not able to locate any detailed building surveys about the construction of Buildings A, B, C, or D nor the D&D facility to determine whether these buildings could be prone to vapor intrusion.
5. **No Sewer Gas Sampling**. Sewer gas was not sampled although sewers can serve as preferential pathways for vapors to migrate into buildings through plumbing fixtures [ATSDR 2021a; DOD 2020].

6.0. Conclusion

ATSDR cannot conclude whether levels of contaminants detected in the indoor air of Buildings A, B, C, and D and the D&D facility could harm the health of people breathing the indoor air. This is because there isn't enough indoor air sampling data to evaluate potential health effects from exposure to the VOC levels (concentrations) in indoor air over time.

6.1. Basis for Conclusion

- Indoor air samples were collected during a single sampling event held on December 11, 2018 for commercial Buildings A and B, February 15–16, 2018 for residential Buildings C and D, and on December 16, 2021 for the D&D commercial facility.
- ATSDR's evaluation of the limited indoor air sampling data determined that breathing the levels (concentrations) of contaminants detected in these five buildings is not expected to result in a potential for adverse noncancer health effects or a potential for increased lifetime excess cancer risk. However, concentrations of VOCs in indoor air can vary by time and season, even if collected from the same building. Indoor air samples that are collected in a single sampling event that only occurred during the winter months do not provide enough information to accurately estimate the indoor air VOC concentrations that a person could breathe inside of a building. There were no indoor air samples collected in hot weather during summer months when windows and doors would be kept closed, air exchange rates are low, and indoor air concentrations may be higher [ATSDR 2016a; EPA 2015]. Therefore, it isn't possible to use the available data to determine if breathing VOC contaminants in any of these five buildings over time could harm the health of people.

7.0. Next Steps

Based on the public health evaluation of indoor air sampling data provided in this health consultation, ATSDR recommends the following next steps for NMED:

- continue to monitor the CCGP over time and space, as the CCGP plume could migrate further from the D&D facility over time and potentially be a source of contaminants entering buildings by seeping from the ground into the air of the buildings (vapor intrusion).
- collect additional concurrent, seasonal indoor air, crawlspace air or subslab soil gas, and outdoor air samples. Seasonal (hot and cold weather) indoor air samples are required to make health determinations. Concurrent, seasonal samples may be collected from the following buildings:
  - Buildings A, B, C, and D, and the D&D facility.
  - All buildings within the CCGP boundary as well as those located within a horizontal distance of 100 feet around the CCGP boundary. In section 5.4. ATSDR's Recommendations for Additional Buildings to Prioritize Vapor Intrusion Sampling, ATSDR provides information about how NMED may prioritize sampling based on an evaluation of shallow groundwater and soil gas data.
- At minimum, it is recommended that NMED consider collecting samples during two sampling periods such as one in July (summer) and another in December (winter) to best capture indoor air concentrations during "closed-building" conditions.
- ATSDR recommends following EPA guidance when collecting samples [EPA 2015]. This includes the following:
  - Using time-integrated sampling methods to account for varying contaminant concentrations in air over time.
  - Collecting indoor air samples within the building's breathing zone, the area where people are most likely to breathe contaminants.
  - Consider using ITS (indicators, tracers, and surrogates)[7] to provide information on whether vapor intrusion is active or dormant during the sampling event.

[7] https://iavi.rti.org/assets/docs/Temp_Measurement_Fact_Sheet_int.pdf, https://iavi.rti.org/assets/docs/Pressure_Measurement_Fact_Sheet_Int.pdf, https://iavi.rti.org/assets/docs/Radon_methods_fact_sheet_int.pdf

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Appendix A. Full-Time Worker Exposure Factors

The exposure factor (EF) "expresses how often (frequency) and how long (duration) a person could contact a contaminant in the environment over a certain amount of time (averaging time)" [ATSDR 2022].

Exposure factors were derived in accordance with using the following equations and assuming that full time employees could breathe indoor air for 8.5 hours per day, 5 days a week, 50 weeks per year, and for up to 20 years [ATSDR 2021b].

The cancer exposure factor would be derived using equation 3 and a denominator of 78 years instead of 20 years to represent cancer risk over a lifetime.

Equation 3. Equation for Deriving Full-Time Worker Chronic Exposure Factor

$$EF = \frac{8.5\,\frac{hours}{day}\ x\ 5\,\frac{days}{week}\ x\ 50\frac{weeks}{year}\ x\ 20\ years}{24\,\frac{hours}{day}\ x\ 7\,\frac{days}{week}\ x\ 52.14\frac{weeks}{year}\ x\ 20\ years}$$

Equation 4. Equation for Deriving Full-Time Worker Intermediate Exposure Factor

$$EF = \frac{8.5\,\frac{hours}{day}\ x\ 5\,\frac{days}{week}\ x\ 50\frac{weeks}{year}}{24\,\frac{hours}{day}\ x\ 7\,\frac{days}{week}\ x\ 50\frac{weeks}{year}}$$

Equation 5. Equation for Deriving Full-Time Worker Acute Exposure Factor

$$EF = \frac{8.5\,\frac{hours}{day}\ x\ 5\,\frac{days}{week}}{24\,\frac{hours}{day}\ x\ 5\,\frac{days}{week}}$$

Chronic, intermediate, and acute exposure factors for evaluation of full-time workers are listed in Table 23.

Table 23. Full-Time Worker Chronic, Intermediate, Acute, and Cancer Exposure Factors

Scenario	Chronic Noncancer Exposure Factor	Intermediate Noncancer Exposure Factor	Acute Noncancer Exposure Factor	Cancer Exposure Factor
Full-time worker	0.24	0.25	0.35	0.062

Addendum

For figures, tables, and equations that require more than 120 characters of alt text, a text description is provided in this section. Text descriptions are provided in the order the figures, tables, and equations appear from the beginning to the end of the Calle Chavez Groundwater Plume health consultation.

Figure 1. Calle Chavez Groundwater Plume and North Railroad Avenue Plume*†

The approximate boundary of the Calle Chavez Groundwater Plume from 2021 is highlighted and circled in red. The map also depicts the current approximate boundary of the shallow North Railroad Avenue Plume based on 2023 data in shaded light blue and outlines the approximate boundaries of the North Railroad Avenue Plume intermediate and deep zone plumes based on 2023 data using yellow and pink colors, respectively. The approximate boundary of the North Railroad Avenue Plume historical shallow plume based on data from 2006 is also shown outlined in green.

Table 1. 2020 Estimated Daytime and Nighttime Population and Housing Unit Statistics for Calle Chavez Groundwater Plume

Estimated population and housing unit for quarter-mile (one-fourth-mile) and one half mile radius around the Calle Chavez Groundwater Plume.

Figure 2. Calle Chavez Groundwater Plume Site and Demographic Snapshot

The approximate boundary of the Calle Chavez Groundwater Plume is surrounded by green circles depicting a one-fourth-mile radius around the Calle Chavez Groundwater Plume approximate boundary and a one-half-mile radius around the Calle Chavez Groundwater Plume approximate boundary. The table shows the demographic data and number of housing units.

Table 2. Number of Indoor Air, Outdoor Air, Crawlspace Air, and Subslab Soil Gas Samples Collected in 2018 and 2021 from Five Buildings Above the Calle Chavez Groundwater Plume

Buildings A and B and D&D Mountain Air Cleaners Facility are all commercial buildings. Buildings C and D are residential buildings. At Building A, three indoor air samples, no outdoor air samples, and two crawlspace air samples were collected on December 11, 2018. At Building B, four indoor air samples, one outdoor air sample, and three crawlspace air samples were collected on December 11, 2018. Three indoor air samples were collected at Building C, and four indoor air samples were collected at Building D both during February 15–16, 2018; no outdoor air, crawlspace air, nor subslab soil gas samples were collected at either Building C or D. At D&D Mountain Air Cleaners Facility, four indoor air samples, one outdoor air sample, and four subslab soil gas samples were collected on December 16, 2021.

Table 3. Calle Chavez Groundwater Plume Wells from which Groundwater Samples Were Evaluated*

Well locations, minimum and maximum depths to water in feet, the years when the minimum and maximum depth to water were measured, and depth to top and bottom of screen are provided for nine well locations.

Figure 3. Migration of Vapors into Indoor Air*

Contaminated groundwater and soil vapors rise through drier soil and enter into a house as soil gas moves through gaps and cracks in the building foundation. Sewer gas moves in through plumbing fixtures. Indoor sources include household items and cleaning products. Outdoor air can enter the house through an open window.

Table 4. Exposure Pathways Relevant to the Calle Chavez Groundwater Plume

For two exposure pathways, the contaminant source, environmental medium, transport mechanisms, point of exposure, route of exposure, and pathway conclusion category are provided.

Table 5. Contaminants with Maximum Concentrations in Indoor Air from Five Buildings Above the CCGP Shallow Plume that Exceed Health-Based Indoor Air Inhalation CVs and Selected for Further Evaluation*

The name, frequency of detection, range of detected indoor air concentrations, recommended indoor air inhalation comparison value, indoor air inhalation comparison value type, and associated background study concentration are provided for four indoor air contaminants.

Table 6. Frequency of Detection, Recommended Indoor Air Inhalation CV, and Exposure Point Concentrations for Indoor Air Contaminants, Building A (commercial)*

For four indoor air contaminants found to be above air comparison values, the frequency of detection, recommended indoor air inhalation comparison value, exposure point concentration, and whether the contaminant is selected for further evaluation for Building A are provided.

Table 7. Frequency of Detection, Recommended Indoor Air Inhalation CV, and Exposure Point Concentrations for Indoor Air Contaminants, Building B (commercial)*

For four indoor air contaminants found to be above air comparison values, the frequency of detection, recommended indoor air inhalation comparison value, exposure point concentration, and whether the contaminant is selected for further evaluation for Building B are provided.

Table 8. Frequency of Detection, Recommended Indoor Air Inhalation CV, and Exposure Point Concentrations for Indoor Air Contaminants, Building C (residential)*

For four indoor air contaminants found to be above air comparison values, the frequency of detection, recommended indoor air inhalation comparison value, exposure point concentration, and whether the contaminant is selected for further evaluation for those contaminants at Building C are provided.

Table 9. Frequency of Detection, Recommended Indoor Air Inhalation CV, and Exposure Point Concentrations for Indoor Air Contaminants, Building D (residential)*

For four indoor air contaminants found to be above air comparison values, the frequency of detection, recommended indoor air inhalation comparison value, exposure point concentration, and whether the contaminant is selected for further evaluation for those contaminants at Building D are provided.

Table 10. Frequency of Detection, Recommended Indoor Air Inhalation CV, and Exposure Point Concentrations for Indoor Air Contaminants, D&D Mountain Air Cleaners Facility*

For four indoor air contaminants found to be above air comparison values, the frequency of detection, recommended indoor air inhalation comparison value, exposure point concentration, and whether the contaminant is selected for further evaluation for those contaminants at the D&D Mountain Air Cleaners Facility are provided.

Table 13. Adjusted Exposure Point Concentrations and Noncancer Hazard Quotients, Building C (residential)

Acute, intermediate, and chronic hazard quotients and adjusted exposure point concentrations for Building C (residential).

Table 14. Adjusted Exposure Point Concentrations and Noncancer Hazard Quotients, Building D (residential)

Acute, intermediate, and chronic hazard quotients and adjusted exposure point concentrations for Building D (residential).

Table 16. Noncancer Hazard Quotients, D&D Mountain Air Cleaners Facility*

Acute, intermediate, and chronic hazard quotients for four indoor air contaminants at D&D Mountain Air Cleaners facility.

Table 17. Calculated Child and Adult Reasonable Maximum Exposure Lifetime Excess Cancer Risks from Long-Term Inhalation of Carcinogenic Contaminants in Indoor Air from Building C (residential)

Inhalation unit risk, adult and child resident reasonable maximum exposure estimated lifetime excess cancer risks, and total cancer risks are provided for two indoor air contaminants at Building C.

Table 18. Calculated Child and Adult Reasonable Maximum Exposure Lifetime Excess Cancer Risks from Long-Term Inhalation of Carcinogenic Contaminants in Indoor Air from Building D (residential)

Inhalation unit risk, adult and child resident reasonable maximum exposure estimated lifetime excess cancer risks, and total cancer risks are provided for two indoor air contaminants at Building D.

Table 19. Calculated Full-Time Employee Reasonable Maximum Exposure Lifetime Excess Cancer Risks from Long-Term Inhalation of Carcinogenic Contaminants in Indoor Air from the D&D Mountain Air Facility

Inhalation unit risk, full-time employee reasonable maximum exposure estimated lifetime excess cancer risks, and total cancer risks are provided for four indoor air contaminants at the D&D Mountain Air facility.

Table 20. Maximum Detected Indoor Air Concentrations of Tetrachloroethylene and Trichloroethylene at D&D Mountain Air Cleaners Facility along with Concentrations of Concurrent Subslab Soil Gas Samples and Calculated Subslab Soil Gas Attenuation Factors

For tetrachloroethylene and trichloroethylene, the maximum detected indoor air concentration, recommended indoor air inhalation comparison value, concurrent subslab soil gas concentration, recommended soil gas vapor intrusion comparison value, and subslab soil gas attenuation factor are provided.

Table 21. List of ATSDR Groundwater VICVs Used for Screening Groundwater Samples to Determine Additional Buildings NMED May Prioritize for Vapor Intrusion Sampling*

For seven contaminants, the groundwater vapor intrusion comparison value and vapor intrusion comparison value type are provided.

Table 22. List of ATSDR Soil Gas VICVs Used for Screening Exterior Soil Gas Samples to Determine Additional Buildings NMED May Prioritize for Vapor Intrusion Sampling*

For four contaminants, the soil gas vapor intrusion comparison value and vapor intrusion comparison value type are provided.

Equation 3. Equation for Deriving Full-Time Worker Chronic Exposure Factor

Chronic exposure factor equation equals 8.5 hours per day times 5 days per week times 50 weeks per year times 20 years, all divided by 24 hours per day times 7 days per week times 52.14 weeks per year times 20 years.

Equation 4. Equation for Deriving Full-Time Worker Intermediate Exposure Factor

Intermediate exposure factor equation equals 8.5 hours per day times 5 days per week times 50 weeks per year, all divided by 24 hours per day times 7 days per week times 50 weeks per year.

Equation 5. Equation for Deriving Full-Time Worker Acute Exposure Factor

Acute exposure factor equation equals 8.5 hours per day times 5 days per week, all divided by 24 hours per day times 5 days per week.