ATSDR Newsletter for Health Assessors
Including APPLETREE Partners

Guidance & Clearance News

July 2025

Welcome!

The purpose of this newsletter is to keep you informed about the guidance and resources that are available for use in your health evaluations.

What is in this Newsletter?

The following topics are included in this edition of the ATSDR Newsletter for Health Assessors. An index of all topics covered in previous newsletters has been added to the Public Health Assessment Guidance Manual (PHAGM) resource page under the heading of ATSDR Health Assessor Newsletter.

Background Indoor Air Concentrations

Determining the source of indoor air contaminants allows health assessors to issue appropriate recommendations, reduce exposure, and mitigate associated risk. Indoor air contaminants can come from vapor intrusion (VI), an indoor source, or an outdoor source. Comparing measured indoor air concentrations to background levels from the literature can help determine if your contaminant source is site-related. When indoor air concentrations are within normal background levels, it is likely that the source is everyday products and materials in the building.

Eliminating site-related sources in buildings that are within normal background levels often will not lower the indoor air concentrations. In these situations, advise building workers or residents on methods to reduce exposures from background sources, such as increasing ventilation and properly using and storing products and materials. Representative background study concentrations depend on the building type (residence, office, etc.) and are assumed to reflect contributions from typical indoor background sources in that building type (e.g., cleaning products, building materials).

How to Select Appropriate Background Studies

When identifying representative background study concentrations, health assessors should use data from studies that are as similar as possible to the site under investigation. Consider study characteristics, such as building type, construction, size, or location, when selecting background study data for comparison to site-related data. Health assessors should also note whether the type of background study level (e.g., mean, median, 95th percentile, max) is the same as the value being used for the site under evaluation. Background studies of different building types are described below. Other studies beyond those identified below may also be considered.

Office and School Indoor Air Study

Rago et al. [2021] measured volatile organic compounds (VOCs) in indoor air from 2013 to 2015. They collected 61 samples from 42 office buildings in 18 states and 25 samples from 21 schools in Connecticut and Massachusetts. The article provides summary statistics for schools and office buildings, including frequencies, Kaplan-Meier means, and percentiles of detected concentrations.

USEPA Residential Indoor Air Data Review

The US Environmental Protection Agency (USEPA) compiled summary statistics from 15 studies conducted between 1990 and 2005 that measured background indoor air VOC concentrations in thousands of North American residences [USEPA 2011]. The residences were not expected or known to be located over contaminated soil or groundwater or to have VI mitigation systems in place. Therefore, ATSDR considers USEPA's statistics to reflect typical background concentrations in U.S. residences.

Residential and Office Building Indoor Air Literature Review

Hodgson and Levin [2003] conducted a literature review on background indoor air VOC concentrations in residential and office buildings in North America. They considered only cross-sectional studies that investigated five or more buildings and excluded investigations of unusual environments or pollutant sources. Their review included data from 12 studies of existing residences, two studies with data for new residences, and three studies with results for office buildings. The article provided separate summary statistics for each building type and included central tendency and upper percentile measurements as available based on the source studies they reviewed.

Commercial Buildings Indoor Air Study

Wu et al. [2011] measured indoor air VOC concentrations in 37 commercial buildings in California. The study includes 24 small buildings (1,000–12,000 square feet [ft^2]), seven medium buildings (12,000–25,000 ft^2), and six medium/large buildings (25,000–50,000 ft^2). The study provides summary statistics for dental offices and healthcare facilities, convenience stores, groceries and restaurants, hair salons and gyms, offices, retail buildings, and other buildings.

ATSDR Toxicological Profiles

ATSDR maintains toxicological profiles on hazardous air pollutants (ATSDR, nd). Each peer-reviewed profile reflects a comprehensive and extensive evaluation, summary, and interpretation of toxicological and epidemiological information available in the literature. The profiles provide information on contaminants' relevance to public health, which includes background and environmental exposure levels in the United States.

Summary

A background study is most representative when the buildings in the study are similar to the building being evaluated. Indoor air background data from the studies summarized above are compiled in a spreadsheet titled "Background Indoor Air Reference Data" that is available on the Public Health Assessment Site Tool (PHAST) resources page. Other studies beyond those identified herein may also be considered.

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Update Your Public Health Documents with These New Minimal Risk Levels

In October 2024, ATSDR released 11 toxicological profiles.

- Benzene (71-43-2)
- Carbon disulfide (782-182-0)
- Chloroform (67-66-3)
- Cobalt (7440-48-4)
- Copper (7440-50-8)
- Cyanide (74-90-8)
- Mercury, elemental (7439-97-6)
- Mercury, inorganic (1600-27-7, 7487-94-7, 1344-48-5)
- Methylmercury (22967-92-6)
- Nickel (7440-02-0)
- Thallium (7440-28-0)
- 2,3,7,8-TCDD (1746-01-6)

The minimal risk levels (MRLs) for benzene, carbon disulfide, cyanide, and 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) are provisional because these profiles were released as draft for public comment. Provisional MRLs can be used in making public health decisions because they have gone through peer review at the agency. The other profiles in this list completed their public comment review and were released as final. The provisional and final MRLs were added to ATSDR's PHAST in November 2024 and should be used in your public health documents.

It's easy to identify newly released toxicological profiles and MRLs by periodically checking ATSDR's toxicological profiles website. You can receive email updates about MRLs and tox profiles by providing your email address to our tox profile group. Look for "Get Email Updates" on the bottom right of the toxicological profile website.

Update Your MRLs in Documents Being Developed

If you are currently working on a public health document with these chemicals, you should review your screening process to see if any environmental media evaluation guides (EMEGs) changed because the MRL changed.

Some MRLs are now lower, which results in lower EMEGs used to screen your data for noncancer endpoints. Examples include chronic, oral MRLs for benzene and 2,3,7,8-TCDD. In some cases, an MRL might have existed in the previous profile but an MRL was not developed in the newly released profile. This happened several times, including with the oral intermediate MRL for copper and 2,3,7,8-TCDD.

If you had previously selected a chemical as a potential contaminant of concern (COC) and the MRL changed, you'll need to update your toxicological evaluation using the new MRL. Table 1 shows the MRLs that were released in October 2024 and whether the MRL changed or is new.

Table 1. Summary of the MRLs released in October 2024 compared to the previous MRL

Chemical	Route, Duration	Previous MRL	Current MRL	Current MRL Is Different
Benzene	Oral, chronic	0.0005 mkd	0.0003 mkd	**Yes**
Benzene	Oral, intermediate	None	0.0009 mkd	*New*
Benzene	Oral, acute	None	0.0009 mkd	*New*
Benzene	Inhalation, chronic	3 ppb	3 ppb	No
Benzene	Inhalation, intermediate	6 ppb	7 ppb	**Yes**
Benzene	Inhalation, acute	9 ppb	9 ppb	No
Carbon Disulfide	Oral, acute	0.01 mkd	0.03 mkd	**Yes**
Carbon Disulfide	Inhalation, chronic	0.3 ppm	0.1 ppm	**Yes**
Carbon Disulfide	Inhalation, acute	None	0.2 ppm	*New*
Chloroform	Oral, chronic	0.02 mkd	0.02 mkd	No
Chloroform	Oral, intermediate	0.1 mkd	0.1 mkd	No
Chloroform	Oral, acute	0.3 mkd	0.3 mkd	No
Chloroform	Inhalation, chronic	0.4 ppb	0.4 ppb	No
Chloroform	Inhalation, intermediate	0.8 ppb	0.8 ppb	No
Chloroform	Inhalation, acute	1 ppb	1 ppb	No
Cobalt	Oral, intermediate	0.03 mkd	0.02 mkd	**Yes**
Cobalt	Oral, acute	0.03 mkd	0.03 mkd	No
Cobalt	Inhalation, chronic	0.0001 mg/m^3	0.0001 mg/m^3	No
Cobalt	Inhalation, acute	None	0.0003 mg/m^3	*New*
Copper	Oral, intermediate	0.02 mkd	None	**Yes**
Copper	Oral, acute	0.02 mkd	0.02 mkd	No
Cyanide	Oral, intermediate	None	0.04 mkd	*New*
Mercury, elemental	Inhalation, chronic	0.0003 mg/m^3	0.0003 mg/m^3	No
Mercury, inorganic	Oral, intermediate	1E-5 mkd	1E-5 mkd	No
Mercury, inorganic	Oral, acute	0.002 mkd	0.002 mkd	No
Methylmercury	Oral, chronic	0.0001 mkd	0.0001 mkd	No
Nickel	Inhalation, chronic	0.00001 mg/m^3	None	**Yes**
Nickel	Inhalation, intermediate	3E-5 mg/m^3	3E-6 mg/m^3	**Yes**
Nickel	Inhalation, acute	None	0.0001 mg/m^3	*New*
2,3,7,8-TCDD	Oral, chronic	1E-6 mkd	4E-7 mkd	**Yes**
2,3,7,8-TCDD	Oral, intermediate	2E-5 mkd	None	**Yes**
2,3,7,8-TCDD	Oral, acute	2E-4 mkd	2E-4 mkd	No

ppm = part per million; ppb = parts per billion; mkd = mg/kg/day

Checking for MRL Updates

The PHAST team plans to email health assessors when there are changes to PHAST. Another way to check for changes in MRLs is to click "Contaminant Updates" on the PHAST homepage. . You can then open an Excel file that will show recent updates to the PHAST database, including changes to MRLs. The file will show the old and new MRLs and provide information about other changes to PHAST. If MRLs change while your document is being developed or during clearance, you will need to update your document to the new MRL, even if it's in eClearance. If you have questions, talk to your Associate Director for Science (ADS) office or technical project officer (TPO).

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Protecting Privacy of Spatially Linked Data Using Geomasking

To understand the extent of environmental contamination and who could be at risk for health effects, it is useful and often necessary to map the location and results of environmental sampling. However, health assessors might encounter situations where it is inappropriate to display individual sampling results because of personally identifiable information and other concerns. Examples include when an environmental agency may not want to release the exact location of sampling equipment to prevent theft, or when environmental data are collected on private property under the condition that the location not be made public. ATSDR's Geospatial Research, Analysis, and Services Program (GRASP) can assist health assessors who don't want to reveal the exact location of geospatial data. Below are a few examples of **geomasking**, the process of obscuring specific locations on a map.

Aggregation

If the study area of interest is large enough, health assessors might consider displaying the average sampling result of a geographic unit. This method is commonly used for demographic information, such as data from the U.S. Census, in which a statistic (e.g., income, age, family size) is collected at the household level and aggregated to a census block or tract. When aggregating spatial data, the choice of geographic unit is important. Aggregating to a large geographic unit may hide important local variation, while a very small geographic unit may not sufficiently mask point locations. GRASP analysts can help health assessors decide when and how to best aggregate location data.

Geographic units that are used to aggregate data for spatial privacy may not be the same as the exposure units, or points of human contact with contamination. You should consider exposure units, not geographic units, when aggregating data for screening and calculating exposure point concentrations (EPCs). More information about exposure units and EPCs is available on the resource page to the public health assessment guidance manual (PHAGM) (ATSDR 2020, 2023).

Interpolation and Prediction Surfaces

GRASP can use an interpolation process called **kriging** to create an image of estimated contaminant concentrations based on point sampling data. Kriging starts with measured values at point locations and applies a geostatistical model to predict the values between those points. This method generates a continuous "prediction surface" (a visual representation of the predicted values), as well as error or uncertainty surfaces, which help an analyst understand how good the predictions are. Kriging is not the best

choice for all datasets, though. Ask the OCHHA or OCDAPS ADS office if it is appropriate for your contaminants and environmental media of interest.

We can visualize the prediction surface in different ways. Health assessors can use one color to shade only the areas above a certain concentration on the prediction surface to illustrate the extent of contamination. Prediction surfaces can also use gradient shading to show areas of higher and lower concentrations.

Figure 1 shows an example using zinc concentrations from the "Meuse River" dataset, a free example available in the R programming language. These zinc concentrations were measured in the topsoil of the floodplain of the Meuse River near the village of Stein in the Netherlands (Rikken and Van Rijn, 1993). In the left image, zinc concentrations are mapped at the point where the sample was collected within the floodplain. The right image shows a prediction surface of zinc concentrations across the floodplain, generated from the individual sample points by kriging. Note that concentration values in the right image are log-transformed. Log transformation is not always necessary, but in this case, it helped satisfy the assumptions of ordinary kriging. GRASP analysts can customize kriging maps with additional contextual information, such as points of interest, population data, or street basemaps.

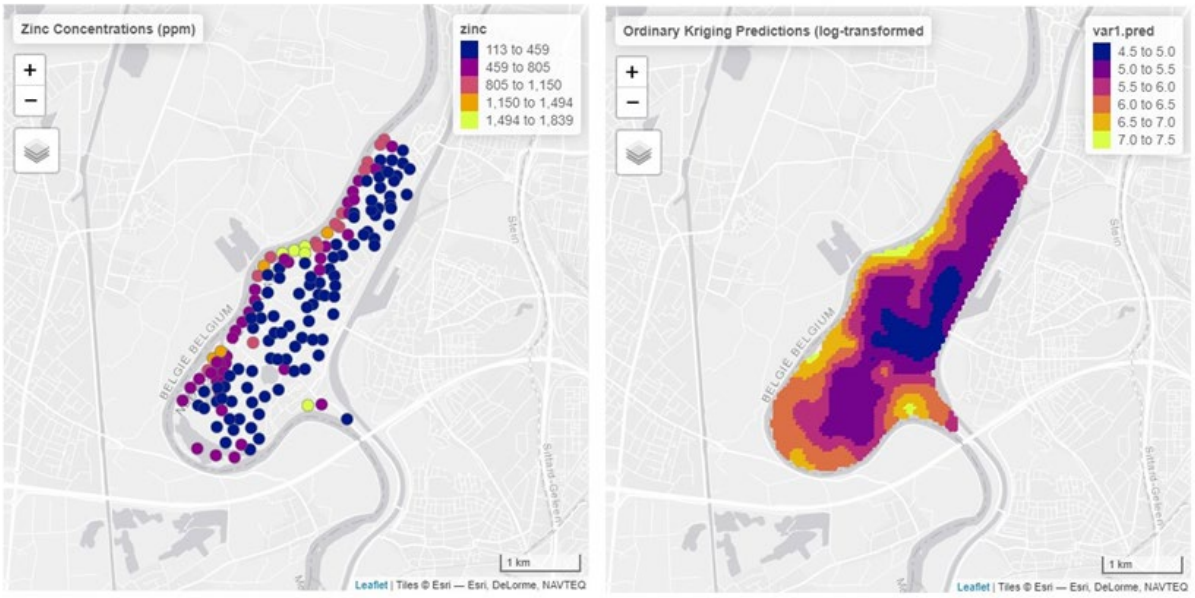

Figure 1. Individual soil zinc concentrations measured in the Meuse River floodplain (left) are turned into a continuous surface with gradient shading by concentration using kriging (right) (Rikken and Van Rijn, 1993).

The "Donut" Technique

Using this technique, GRASP analysts can move a point to a random location between a set minimum and maximum distance from the true sampling location. The points will no longer show the true sampling location. Figure 2 illustrates a simple example of this approach to geomasking:

- In image A, a selection of points is placed on a map, representing sampling locations.
- In image B, a smaller circular buffer and a larger buffer are drawn around each location, indicating the minimum and maximum adjustment.
- In image C, each sampling location is shifted to a new point within the "donut."
- Image D shows the final result.

In a real situation, the minimum and maximum distance—the size of the donut—would be adjusted to provide the appropriate level of masking.

These techniques could potentially apply to any spatially linked data for any environmental media, but it depends on the specific privacy concern, media-specific considerations, or your exposure units. Consult with an ADS or your technical project officer (TPO) if you have questions.

Geo-privacy is a rapidly evolving field, and more specialized geomasking methods may be appropriate, depending on the dataset. GRASP can help you decide on the best approach and then implement it. ATSDR staff can use the GRASP Service Request Form, and APPLETREE staff can make a request through their TPO.

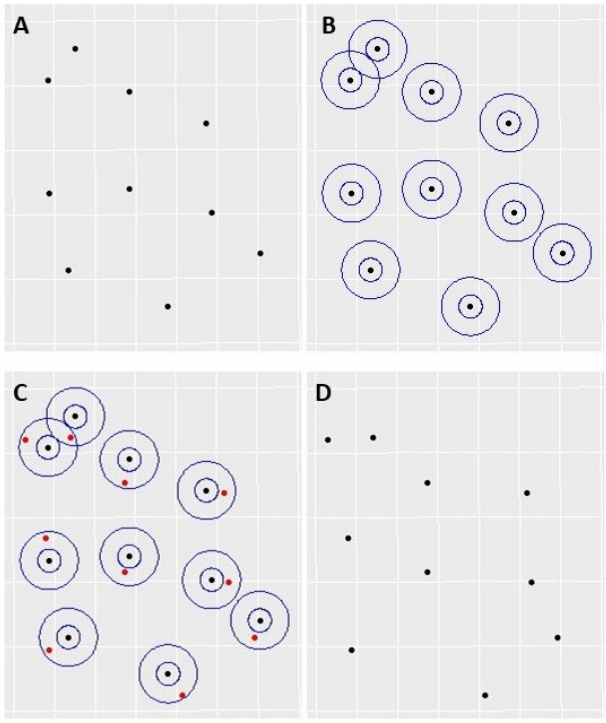

Figure 2. Four images (A through D) show an example of "donut" geomasking in which points are randomly shifted within a certain distance

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Looking Back at Health Assessor Newsletters

Did you know that we sent the first health assessor newsletter in January 2020? With typically three newsletters each year, we now have 13 newsletters packed with information about the public health assessment process that you can use to make your documents better. These newsletters, along with an index document, are available on the resource page to the Public Health Assessment Guidance Manual (PHAGM) under ADS newsletters. The list below contains an index to all the newsletters along with links to a pdf file of each newsletter.

Newsletter Index	January 2020	April 2020	September 2020	February 2021
June 2021	October 2021	January 2022	May 2022	December 2022
April 2023	December 2023	June 2024		

If you want to find out what articles have been written about cancer over the years, open the index and search for "cancer." Here are a few of the eight articles:

- Describing Cancer Classification in Public Health Documents
- Evaluating Noncancer and Cancer Multi-Routes Exposures from The SHOWER Model
- Describing Cancer Risk in Public Health Assessment Documents
- How To Present Doses, Hazard Quotients, and Cancer Risk in Health Assessments

Newsletter articles cover a wide range of topics. We encourage you to review some of these articles:

- Tonia Burk and Sandy Miller have written six articles about vapor intrusion.
- Michelle Natale and John Truhe have written four articles with 508 tips and tricks.
- Sandra Lopez has written numerous articles about the Lectora-based public health assessment (PHA) modules and staff-led webinars, all designed to introduce new health assessors to the PHA process.
- Carole Hossom wrote a four-part series on lead exposure.
- Lydia Hoadley introduced us to ways to incorporate geospatial information into our public health documents.
- Lee Moores wrote articles on summing cancer risk for Aroclors and evaluating nitrogenous chemicals.
- David Mellard has kept us up to date on changes in health guidelines and using tools like the SHOWER model, the exposure point concentration tool, and the public health assessment site tool (PHAST).

The newsletter team welcomes other authors from ATSDR and our state partners who want to write about their expertise or site work. You can contact the ADS office in either OCHHA or OCDAPS.

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508 Tips and Tricks: Using Headings in Word Documents

It is important to use headings for the titles, sections, and subsections of your Word documents. Headings establish the document's structure and help readers navigate through it. They especially help readers with visual impairments who use screen readers: When a Word document has appropriate headings, the screen reader scrolls through the content.

Including a table of contents (TOC) in your document further helps readers navigate it. TOCs help screen readers announce heading levels.

How to create headings

1. Select the text that will serve as a heading in your document.
2. Go to the Styles menu in the Home tab and select a heading level for the selected text.
3. Organize the headings in order of importance. In a document with five headings, Heading 1 (H1) will represent the most important content, and H5 will include the least important information.
4. Always use H1 for the title of the document. **Use only one H1 per document**. Use H2 for the main sections of the document. Finally, employ H3, H4, etc., for subsections. Maintain a logical hierarchy and don't skip heading levels. For example, don't use an H4 after an H2 without an H3 in between.
5. Avoid the use of all caps, italics, and underline in headings.
6. Make sure that the order of headings matches their arrangement within the document. Go to the View menu and show the navigation pane (Figure 3). The red circle in the example highlights the H1 for the title of the article and the H2s for the titles of the sections. It also shows the correct order of the headings.

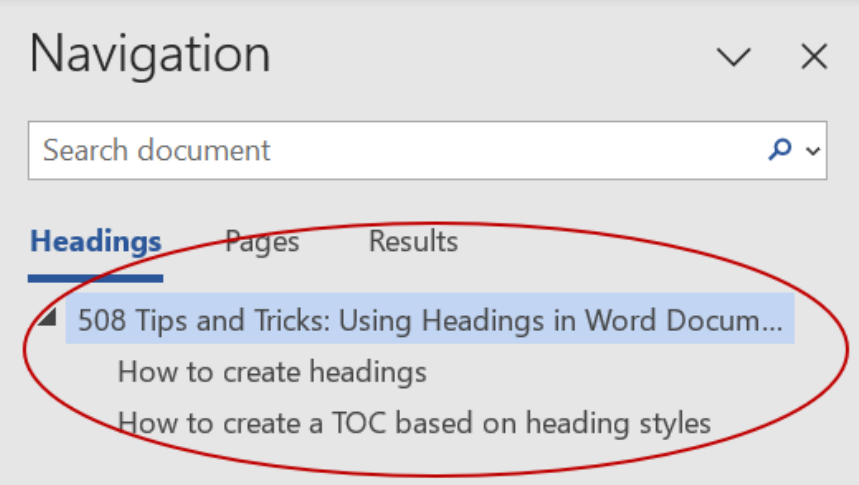

Figure 3. Snapshot of the navigation pane showing the H1 and H2 headings in this article

Remember to use H1 only once, for the document title. Browsers do not support documents with multiple H1s.

How to create a TOC based on heading styles

Now that you have created a headings structure, you can easily develop a TOC.

1. On the References tab, click "Table of Contents" on the far left of the screen and then click on "Custom Table of Contents" at the bottom of the popup.
2. Next, click on "Options" in the lower right of the dialog box.
3. This will open the TOC Options dialog box. Make sure that the "Styles" checkbox is checked (it should be selected by default). See Figure 4 for a screen shot of this dialog box with a red arrow pointing at the "Styles" checkbox.

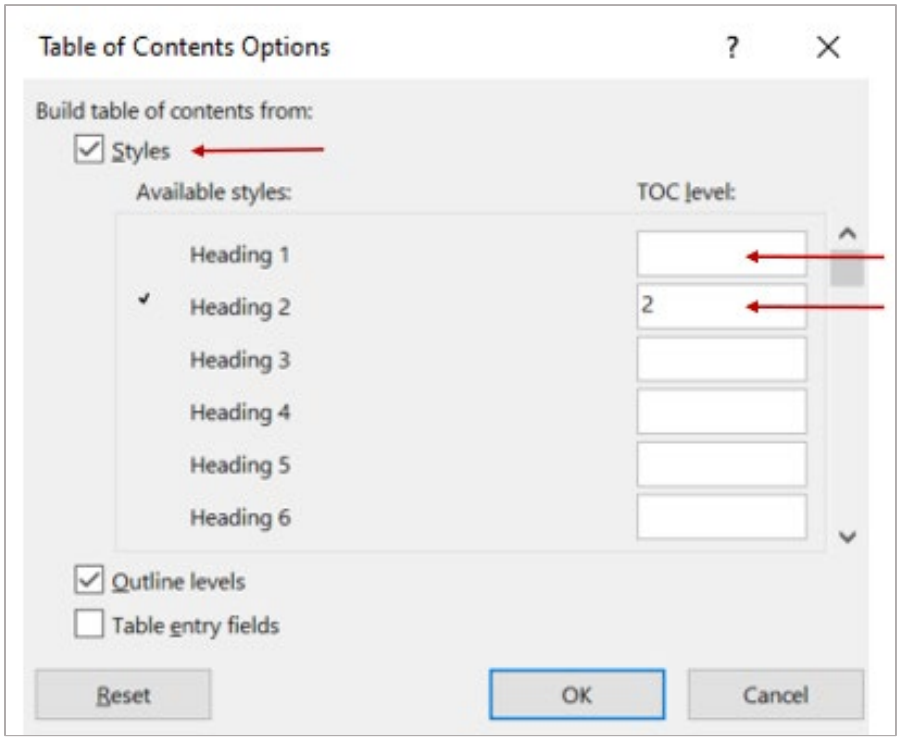

Figure 4. Snapshot of Table of Contents Options dialog box

From here, you can change the TOC levels to include only the ones you want shown in the TOC, with the exception of H1. Remember that H1 should be assigned only to the title of the document, so make sure the H1 box is blank. If it has a number, delete it. Likewise, make sure that all the heading levels in your document are included here. If you don't want to show a certain subsection in the TOC, leave that level blank.

In Figure 4 you can see that H2 has a TOC level of 2. H3, H4, etc. are blank because we don't have those headings in the article.

4. Finally, click OK twice to insert the TOC in your document. We suggest inserting it after the title of the document. For this article, this is how the TOC would look:

Table of Contents

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508 Tips and Tricks: Links and Screen Tips

ATSDR documents that are posted online need to be 508-compliant. This newsletter features a series of articles about common issues in making your public health documents 508-compliant. For this edition of 508 Tips and Tricks, we are discussing the use of links and ScreenTips in documents.

Links

When you put a link or hyperlink in a document, it most often looks like https://www.atsdr.cdc.gov/ or ATSDR. For 508 compliance, links are required to be underlined and in a different color from the rest of the text. But if you add a bookmark or cross-reference link, for example, Word won't automatically underline and change the color.

Here's how to fix that. Highlight the link text. On the Home tab in the Font group section, you will see the underline text symbol (Figure 5A). This will underline your text to enable readers to see it is a hyperlink. You can also press Ctrl+U to underline the text.

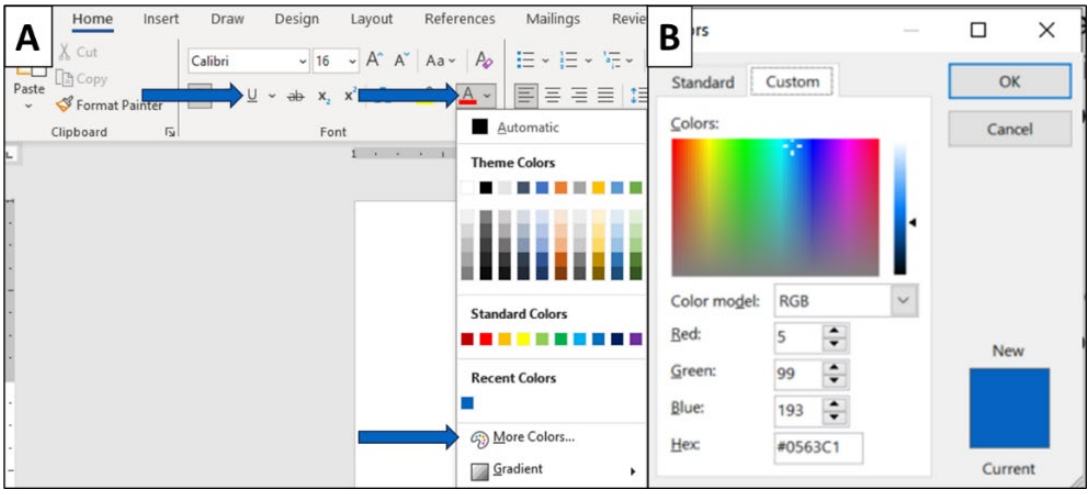

Figure 5. Screenshots showing the steps to underline and change the color of text

To change the color of the text, select the dropdown for font color and select “More Colors” (Figure 5A). This will open a new window, shown in Figure 5B. The traditional hyperlink color is not the standard blue text in MS Office. Select the “Custom” tab to enter the Hex Code #0563C1, or set the Red value to 5, the Green value to 99, and Blue to 193.

There is one thing to keep in mind: If the color of your background blends into the color of your link, select another color that contrasts with the background color.

ScreenTips

Including descriptive links in your Word documents can increase their accessibility. This is particularly beneficial for learners with visual impairments who rely on screen readers, as they can navigate through the document by jumping from one link to another using the tab function. To ensure optimal accessibility, consider the following guidelines:

- Use phrases or sentences for your links instead of URLs. If you need to use URLs, avoid using lengthy ones. For example, it is easier to understand “Toxicological Resources” than “https://wwwn.cdc.gov/TSP/substances/SubstanceResources.aspx.”
- Develop concise links that clearly convey their intended destination
- Ensure that the link remains meaningful even when read independently.
    - Avoid vague phrases like "Click here" or "Read more." Instead, use specific statements such as "ATSDR Public Health Assessments and Health Consultations."

To further enhance usability, you may want to create ScreenTips for your links. A ScreenTip is a pop-up that appears when you hover over a link, providing a brief description of its content. This feature facilitates document navigation. Note that you can change the default settings of your screen reader to read these screen tips aloud.

To add a ScreenTip to your link, see Figure 6 and follow these instructions:

1. Highlight the text that you want to hyperlink. In this example, we are highlighting “Public Health Assessment Training.”
2. Go to Insert and select Link.
3. In the Insert Hyperlink dialog box, click on the ScreenTip button in the top-right corner.

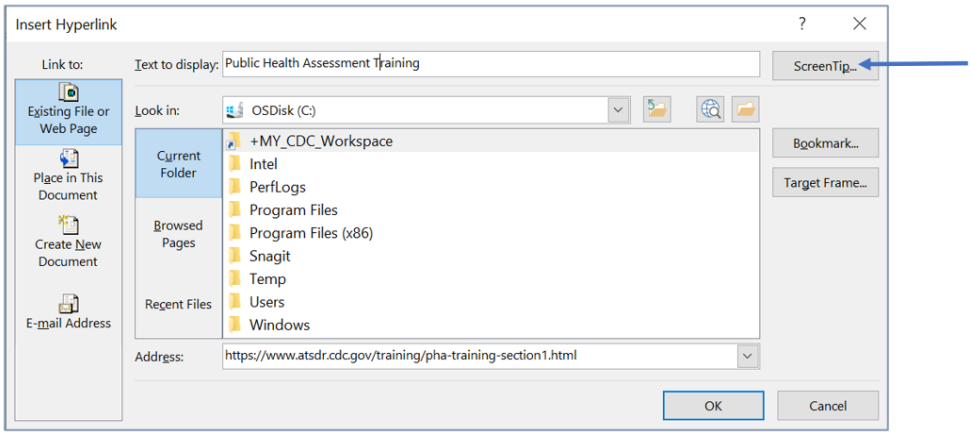

Figure 6. Snapshot of ScreenTip in Insert Hyperlink Box

4. Type the ScreenTip text with a description of the link. In this case, we are typing “Online Public Health Assessment Training Modules.”
5. After these steps, you will be able to hover over the “Public Health Assessment Training” link in your document and read its ScreenTip language. See Figure 7 for a snapshot of how the ScreenTip language will look upon hovering over the link.

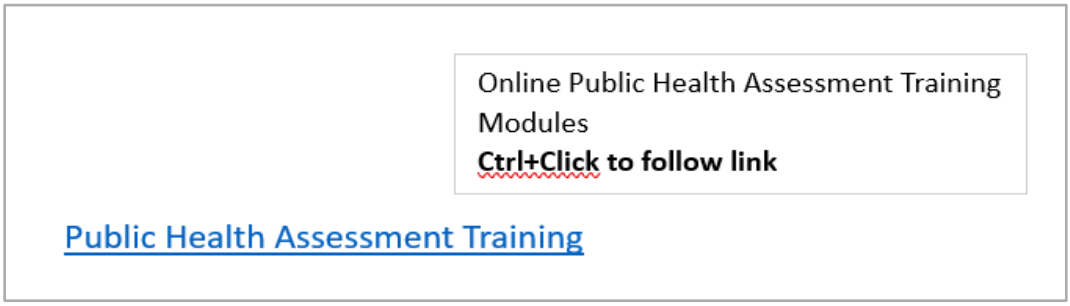

Figure 7. Snapshot of ScreenTip language upon hovering over a link

By following these recommendations, you can develop descriptive links for an enhanced learning experience.

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References

[ATSDR] Agency for Toxic Substances and Disease Registry. No Date [ND]. Toxicological profiles. Atlanta, GA: U.S. Department of Health and Human Services, U.S. Public Health Service. https://www.atsdr.cdc.gov/toxicological-profiles/about/index.html

[ATSDR] Agency for Toxic Substances and Disease Registry. 2023. Exposure Point Concentration Guidance for Discrete Sampling. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2020. Identifying Exposure Units for the Public Health Assessment Process. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, September 19.

Hodgson A, Levin H. 2003. Volatile organic compounds in indoor air: A review of concentrations measured in North America since 1990. Lawrence Berkeley National Laboratory. LBNL Report #: LBNL-51715. https://doi.org/10.2172/877673

Rago R, Rezendes A, Peters J, Chatterton K, Kammari A. 2021. Indoor air background levels of volatile organic compounds and air-phase petroleum hydrocarbons in office buildings and schools. Groundwater Monitoring & Remediation. 41(2): 27-47. https://doi.org/10.1111/gwmr.12433

Rikken, MGJ and Van Rijn, RPG. 1993. Soil pollution with heavy metals - an inquiry into spatial variation, cost of mapping and the risk evaluation of copper, cadmium, lead and zinc in the floodplains of the Meuse west of Stein, the Netherlands. Doctoraalveldwerkverslag, Dept. of Physical Geography, Utrecht University.

[USEPA] U.S. Environmental Protection Agency. 2011. Background indoor air concentrations of volatile organic compounds in North American residences (1990 – 2005): A compilation of statistics for assessing vapor intrusion. https://www.epa.gov/sites/default/files/2015-09/documents/oswer-vapor-intrusion-background-report-062411.pdf

Wu XM, Apte MG, Maddalena R, Bennett DH. 2011. Volatile organic compounds in small- and medium-sized commercial buildings in California. Environmental Science & Technology. 45(20): 9075–9083. https://doi.org/10.1021/es202132u

Disclaimer: The findings and conclusions in this newsletter have not been formally disseminated by the Agency for Toxic Substances and Disease Registry and should not be construed to represent any agency determination or policy.

Addendum for alt text > 120 characters

Figure 1: alt text

The left image shows points on a white background shaded on a gradient from deep purple, representing low zinc concentrations, to light yellow representing high zinc concentrations up to 1800 ppm. The right image shows a continuous surface with gradient shading from dark purple to light yellow representing zinc concentrations on a log scale.

Figure 2: alt text

Figure 2A in the top left of a four-figure panel shows ten original points in black on a gray background. In Figure 2B on the top right, a smaller circular buffer and a larger circular buffer, both in blue, are drawn around each point. In Figure 2C on the bottom left, a red dot representing the shifted location is added somewhere between the two circular buffers. Figure 2D on the bottom right shows each of the resulting 10 shifted points in black without the original point or the circular buffers.