Technical Review Workgroup for Metals and Asbestos
Bioavailability Committee Annual Report:
Accomplishments and Activities for Calendar Year 2018

Members

Region 1
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Region 2
Mark Maddaloni (retired – August, 2018)
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TRW Bioavailability Committee Accomplishments of 2018

Reports and Guidance on the Bioavailability of Metals in Soil

1. **Drafted Report on a Round Robin Study to Support the Lead and Arsenic and In Vitro Bioaccessibility (IVBA) Assay for the Flat Creek Reference Material (FCRM)**
   Drafted the report on a multi-laboratory round-robin study to establish consensus values for lead and arsenic IVBA (Standard Operating Procedure for an In Vitro Bioaccessibility Assay for Lead and Arsenic in Soil, update to Method 1340) and total lead and arsenic values for the following reference materials: National Institute of Standards and Technology (NIST) 2710a, FCRM (<250 µm), and FCRM (<74 µm). This study also established lead IVBA (Method 1340) and total lead values for the FCRM (<74 µm).

2. **Drafted Report on a Round Robin Study to Support the Lead IVBA** Assay for the New Standard Reference Materials
   Drafted the report on a multi-laboratory round-robin study to establish consensus values for lead IVBA (Method 1340) and total lead and arsenic (Method 3051A) the FCRM (<250 µm).

3. **Continued Development of the Flat Creek Reference Soil Material (FCRM) for Lead and Arsenic**
   In collaboration with U.S. Geological Survey (USGS), the TRW Bioavailability Committee continued development of a new soil Reference Material for lead and arsenic, using material collected from a Superfund site in Region 8. The new Reference Material is intended to replace the depleted National Institute of Standards and Technology (NIST) Soil Reference Materials (SRMs), and to be used as Quality Control standards in analyses of arsenic and lead levels in soil IVBA assays (Method 1340).

4. **Continued Development of a Memorandum on the Mouse Model for Arsenic Relative Bioavailability (RBA)**
   The TRW Bioavailability Committee is developing a memorandum to inform the EPA Regional offices about the development of an *in vivo* mouse model to measure arsenic RBA in soil.

5. **Initiated Revision of the Sampling Guidance for Relative Bioavailability (RBA) for Lead and Arsenic**
   Initiated revision of the IVBA Sampling Guidance to assist regional staff in developing sampling plans for site soil RBA assessments. Update will cover data quality objectives, sample planning, prospective and retrospective analyses, frequently asked questions, and case studies.

6. **Continued Development of Fact Sheets on Methods to Assess Lead Arsenic Bioavailability**
   Continued development of Fact Sheets to provide EPA risk assessors and other technical staff an overview of available methods to assess lead and arsenic relative bioavailability.

7. **Continued Research on the effect of particle size (150 vs. 250 µm) on lead and arsenic In Vitro Bioaccessibility (IVBA) and Relative Bioavailability (RBA)** Method 1340 was developed and validated using soils that were sieved to 250 µm, which was the sieve size the TRW Lead Committee recommended for assessments of the ingestion exposure pathway for arsenic and lead. The TRW Lead Committee changed this recommendation to sieve to 150 µm based on recent studies of incidental ingestion and soil particle size. The TRW Bioavailability Committee agreed and recommended the use of the same sieve size for Method 1340. The TRW Bioavailability Committee believes it is most appropriate to assess the bioavailability on the same size fraction being used to assess exposure. However, the change of sieve size introduces uncertainty into the Method 1340. This research will verify whether the smaller soil particle size changes the Method 1340 results, the mouse model RBA assay results, or the relationship between the two methods.

Communication, Training, and Outreach

1. ***Hotline.*** The TRW Bioavailability Committee responds to questions from inquiries made either by telephone to the TRW Bioavailability Committee hotline (toll-free 1-866-282-8622) or via bahelp@epa.gov. The TRW Bioavailability Committee responded to four requests for assistance in 2018: one from an EPA Regional office; one from a government agency; and two from consulting firms. Requests were for the following information:
    a. Soil reference materials that can be used to conduct EPA method 1340 (IVBA analysis);
    b. Basis for the 30% default value for RBA in the IEUBK model;
    c. Question on whether the national default RBA value of 60% for arsenic applies to arsenic only, if it can be applied to lead and PAHs, and
    d. Definition of RBA and information on RBA of total petroleum hydrocarbons.

2. **Acknowledgement of the Important Role of Bioavailability in EPA's 2018 "Protecting Children from Lead Exposures.**

New Testing Method for Lead in Contaminated Soil Protects Public Health and Saves Money

EPA scientists have been working on a bioavailability method that simulates how the human digestive system absorbs lead and arsenic in soil. "Bioavailability" refers to the amount of a substance that is absorbed by the body's gastrointestinal system following exposure. In May 2017, EPA validated the method after it was shown to meet rigorous regulatory acceptance criteria. This means that states and public health risk assessors can use the method during cleanups at EPA Superfund sites and other locations with lead and arsenic contamination issues. In addition to protecting public health, the bioavailability method improves the accuracy of human health risk assessments. Scientists and public health officials can now use the artificial stomach method to determine if arsenic and lead in contaminated soils are bioavailable and, if they are, can then remove those specific sections of soil.

EPA researcher Karen Bradham uses a "virtual stomach" that mimics human digestion to determine if lead and arsenic in contaminated soils are bioavailable.

Learn more at: https://www.epa.gov/sciencematters/new-testing-method-lead-and-arsenic-contaminated-soil-saves-money-and-protects-public.

3. **Recruitment of New TRW Bioavailability Committee Members**. The TRW Bioavailability Committee successfully recruited risk assessors from EPA Regions 1, 5, and 6 to become members of the Committee.

4. ***Publications and Presentations:***
    a. Bradham, K.D., G.L. Diamond, M. Burgess, A. Juhasz, J.M. Klotzbach, M. Maddaloni, C. Nelson, K.G. Scheckel, S.M. Serda, M. Stifelman, D.J. Thomas. 2018. In vivo and in vitro methods for evaluating soil arsenic bioavailability: relevant to human health risk assessment. J. Toxic. Environ. Health Part B. 21(2): 83-114.
    b. Bradham, K.D., G.L. Diamond, C.M. Nelson, M. Noerpel, K.G. Scheckel, B. Elek, R.L. Chaney, Q. Ma, and D.J. Thomas. 2018. Long term in situ reduction in soil lead bioavailability measured in a mouse model. Environmental Science and Technology, DOI: 10.1021/acs.est.8b04684.
    c. Henson, T.E., J. Navratilova, A.H. Tennant, K.D. Bradham, K.R. Rogers, and M.F. Hughes. 2018. In vitro intestinal toxicity of copper nanoparticles in rat and human cell models. Accepted for publication in Nanotoxicology.
    d. Hsi, H-C., C-Y. Hu, M-C. Tsou, H-J. Hu, H. Özkaynak, K. Bradham, Z-Y. Hseu, W. Dang, L-C. Chien. 2018. Determination of Hand Soil Loading, Soil Transfer, and Particle Size Variations after Hand Press and Hand-Mouthing Activities. Science of the Total Environment 627, 844-851. STICS ORD-021378
    e. Stevens, B., A. Betts, B. Miller, K. Scheckel, R. Anderson, K. Bradham, S. Casteel, D. Thomas, and N. Basta. 2018. Arsenic Speciation of Contaminated Soils / Solid Wastes and Relative Oral Bioavailability in Swine and Mice. Soil Systems, 2, 27.
    f. Rogers, K., J. Navratilova, A. Stefaniak, L. Bowers, A. Knepp, S. Al-Abed, P. Potter, A. Gitipour, I. Radwan, C. Nelson, and K. Bradham. 2018. Characterization of Spray Disinfectant Products Advertised to Contain Colloidal Silver. Science of the Total Environment 619-620, 1375-1384.

g. Bradham, K., G. Diamond, A. Juhasz, C. Nelson, and D. Thomas. 2018. Comparison of Mouse and Swine Bioassays for Determination of Soil Arsenic Relative Bioavailability. Applied Geochemistry 88, 221-225.
h. Nelson, C., K. Li, D.R. Obenour, J.C. Misenheimer, K. Scheckel, A. Betts, A. Juhasz, D.J. Thomas, J. Griggs, and K.D. Bradham. 2018. Hierarchical Modeling of Soil Geochemical Properties to Estimate Arsenic Bioaccessibility. Journal of Environmental Toxicology and Health, Part A. https://doi.org/10.1080/15287394.2018.1423798
i. Tsou, M-C., C-Y. Hu, H-C. Hsi, H-J. Hu, H. Özkaynak, Z-Y. Hseu, W. Dang, K.D. Bradham, and L-C. Chien. 2018. Soil-to-skin adherence during different activities for children in Taiwan. Environmental Research 167, 240-247.
j. Misenheimer, J., C. Nelson, E. Huertas, M. Medina-Vera, and K. Bradham. 2018. Analysis of arsenic and lead bioaccessibility and plant bioconcentration factors from three Puerto Rican urban community gardens. Geosciences, 8(2), 43. http://dx.doi.org/10.3390/geosciences8020043
k. Navratilova, J., K. Rogers, K. Bradham, and C. Nelson. Characterization of silver nanoparticles spray disinfectant products using asymmetrical flow field flow fractionation. 19th International Symposium on Field- and Flow-based Separations. May 2018.
l. Henson, T., J. Navratilova, K. Bradham, K. Rogers, and M. Hughes. Cytotoxicity of copper (II) oxide nanoparticles in rat intestinal cells: effect of simulated gastrointestinal fluids and generation of oxidative stress. 2018 Society of Toxicology presentation, San Antonio, TX.
m. Bradham, K., Nelson, C., Kelly J., Pomales A., and Thomas, D. Relationship between total and bioaccessible lead on children's blood lead levels in urban residential Philadelphia soils. Oral presentation in Workshop: Get the Lead Out: The Persistent Problem of Lead Exposure from Soil, Dust and Water. 2018 Society of Toxicology Conference, San Antonio, TX.
n. Nachman, K., T. Punshon, L. Rardin, A. Signes-Pastor, C. Murray, B. Jackson, M. Guerinot, T. Burke, C. Chen, H. Ahsan, M. Argos, K. Cottingham, F. Cubadda, G. Ginsberg, B. Goodale, M. Kurzius-Spencer, A. Meharg, M. Miller, A. Nigra, C. Pendergrast, A. Raab, K.G. Scheckel, T. Schwerdtle, V. Taylor, E. Tokar, T. Warczak, and M. Karagas. 2018. Opportunities and challenges for dietary arsenic intervention. Environ. Health Perspec. 126(8) 084503.
o. Morris, J.W., K.G. Scheckel, and D.H. McNear. Biogeochemistry of Nickel in Soils, Plants, and the Rhizosphere. 2018. In "Nickel in Soils and Plants". Tsadilas, C.D., Rinklebe, J., and Selim, H.M. (eds). CRC Press/Taylor & Francis Group. 51-86.
p. Tu, C., F. Guan, Y. Sun, P. Guo, Y. Li, L. Li, K.G. Scheckel, and Y. Luo. 2018. Stabilizing Effects on a Cd Polluted Coastal Wetland Soil using Calcium Polysulphide. Geoderma. 332: 190-197.
q. Kastury, F., E. Smith, R.R. Karna, K.G. Scheckel, and A.L. Juhasz. 2018. Methodological Factors Influencing Inhalation Bioaccessibility of Metal(loid)s in PM2.5 using Simulated Lung Fluid. Environ. Pollut. 241: 930-937.

r. Kastury, F., E. Smith, R.R. Karna, K.G. Scheckel, and A.L. Juhasz. 2018. An inhalation-ingestion bioaccessibility assay (IIBA) for the assessment of exposure to metal(loid)s in PM10. Sci. Total Environ. 631: 92-104.
s. Stevens, B.N., A.R. Betts, B.W. Miller, K.G. Scheckel, R.H. Anderson, K.D. Bradham, S.W. Casteel, D.J. Thomas, and N.T. Basta. 2018. Arsenic Speciation of Contaminated Soils / Solid Wastes and Relative Oral Bioavailability in Swine and Mice. Soil Systems. 2(2): 27.
t. Karna, R.R., M. Noerpel, T.P. Luxton, and K.G. Scheckel. 2018. Point of Zero Charge: Role in Pyromorphite Formation and Bioaccessibility of Lead and Arsenic in Phosphate Amended Soils. Soil Systems. 2(2): 22.
u. Elgazali, A.A.S., Z. Gajdosechova, Z. Abbas, E. Lombi, K.G. Scheckel, E. Donner, J. Feldman, and E.M. Krupp. 2018. Reactive Gaseous Mercury is Generated from Chloralkali Factories instead of Elemental Mercury Resulting in Extreme Concentrations of Mercury in Hair of Workers. Scientific Reports. 8: 3675.
v. Nelson, C.M., K. Li, D.R. Obenour, J.C. Misenheimer, K.G. Scheckel, A. Betts, A. Juhasz, D.J. Thomas, and K.D. Bradham. 2018. Relating Soil Geochemical Properties to Arsenic Bioaccessibility Through Hierarchical Modeling. J. Toxicol Environ. Health, Pt A. 81(6): 160-172.
w. Li, D., S. Egodawatte, D.I. Kaplan, S.C. Larsen, S.M. Serkiz, J.C. Seaman, K.G. Scheckel, J. Lin, and Y. Pan. 2017. Sequestration of U (VI) from Acidic, Alkaline and High Ion-Strength Aqueous Media by Functionalized Magnetic Mesoporous Silica Nanoparticles: Capacity and Binding Mechanisms. Environ. Sci. Technol. 51: 14330-14341.
x. Boyes, W.K., B.L. Thornton, S.R. Al-Abed, C.P. Andersen, D.C. Bouchard, R.M. Burgess, E. Cohen–Hubal, K.T. Ho, M.F. Hughes, K.T. Kitchin, J.R. Reichman, K.R. Rogers, J.A. Ross, P.T. Rygiewicz, K.G. Scheckel, S-F. Thai, R.G. Zepp, and R.M. Zucker. 2017. A comprehensive framework for evaluating the environmental health and safety implications of engineered nanomaterials. Crit. Reviews Toxicol. 47(9): 767-810.
y. Scheckel, K.G., and M. Noerpel. Analysis of Soil and Sediment in the Big River Watershed Utilizing Pb Isotopes for Source Attribution, Synchrotron Speciation for Phase Identification, and In-Vitro Bioaccessibility for Risk Assessment. U.S. Environmental Protection Agency, Washington, DC. (EPA/600/X-17/303).
z. Scheckel, K., E. Donner, R. Sekine, G. Brunetti, and E. Lombi. Environmental Transformations of Silver and Zinc Oxide Nanoparticles Drive Risk Assessment Understanding. 55th Annual Meeting of the Clay Minerals Society, Urbanna, IL, 2018.
aa. Scheckel, K., R. Karna, M. Noerpel, K. Bradham, C. Nelson, B. Elek, R. Chaney, and D. Thomas. In-situ Soil Amendments Alter Contaminant Speciation and Reduce Bioavailability. International Conference on Heavy Metals in the Environment, Athens, GA, 2018.
bb. Scheckel, K.G. Translating Synchrotron Data into Guidance and Policy for Risk Assessment. Synchrotron Environmental Science, Brookhaven National Lab, NY, 2017.

cc. Scheckel, K.G. Considerations in Remediating Urban Soil Pb. Annual Meeting of the Soil Science Society of America, Tampa, FL, 2017.
dd. Noerpel, M., T. Luxton, B. Ravel, A.J. Kropf, R. Karna, D. Peloquin, and K. Scheckel. Application of high energy resolution X-ray fluorescence detection spectroscopy on environmental samples. 254th American Chemical Society National Meeting, Washington, DC, 2017.
ee. Matt Lambert presented an update on the EPA In Vitro Bioaccessibility Method for Lead and Arsenic in Soils and Soil-like Material (EPA Method 1340) to the State Risk Assessors Forum on July 17th.
ff. Matt Lambert presented an update on the EPA In Vitro Bioaccessibility Method for Lead and Arsenic in Soils and Soil-like Material (EPA Method 1340) to the EPA Removal and Special Teams Managers on July 31st.
gg. Charles Partridge presented "Human Health Risk Assessment: The Basics, Lead Bioavailability and PCBs in Fish" at NARPM 2018:
hh. Charles Partridge presented "Challenging Contaminants in Superfund" at NARPM 2018.

Coordination/Support with States, Regions, EPA Program Offices, and Other Federal Agencies

1. **USGS:** Continued collaboration for the development and analysis of a new lead and arsenic soil Reference Material.

2. **EPA Region 1:** Provided assistance to Region 1 regarding application of arsenic bioavailability assessments for the Ash Street Tannery site.

3. **EPA Region 3**: Provided review and consultation regarding a remedial investigation/feasibility study of the Jackson Ceramix Superfund site.

4. **EPA Region 10:** Provided review and feedback regarding the bioavailability of mercury from ingested cinnabar.

5. **California Department of Toxic Substances Control, EPA Brownfields Training, Research and Technical Assistance Grant (TR-83415101):** The TRW Bioavailability Committee developed the final draft memorandum on the final technical report on "Arsenic Characterization/Bioavailability on Mine-Scarred Lands (Study)" for the Brownfields Training, Research and Technical Assistance Grant (TR-83415101) awarded to the California Department of Toxic Substances Control (DTSC).

TRW Bioavailability Committee Plans for 2019

1. **Arsenic and Lead RBA/IVBA Technical Fact Sheets.** Finalize technical Fact Sheets describing RBA and IVBA methods to assess arsenic and lead, including information about the *in vivo* mouse model to measure arsenic relative bioavailability (RBA) in soil. The target audience for these fact sheets is EPA risk assessors, remedial project managers, On-scene Coordinators, and technical staff. (Task #6 in 2018

Accomplishments above.)

2. **Arsenic and Lead RBA/IVBA General Fact Sheets.** Develop general Fact Sheets describing RBA and IVBA methods to assess arsenic and lead. The target audience for these fact sheets is EPA Community Involvement Coordinators and Public Affairs Officers.

3. **Lead and Arsenic IVBA**
    a. **Revise Arsenic and Lead IVBA SOP**. Revise the arsenic and lead IVBA SOP to include consensus values for the Flat Creek Reference Material.
    b. **Revise Sampling Guidance for Relative Bioavailability for Lead and Arsenic.** Continue revision of a sampling guidance document to assist risk assessors in developing sampling plans for site soil RBA assessments and provide guidance on application of RBA for arsenic and lead to site risk assessment.

4. **New Flat Creek Reference Material for Lead and Arsenic.**
    a. **Product Specification Sheet.** Complete Product Specification Sheet for the Flat Creek Reference Material.
    b. **Manuscript Development.** Develop publication on the new reference material development, including analyses by lead IVBA, EPA Method 3051A, and *in vivo* RBA assays.

5. **Evaluate IVBA-RBA Prediction Model for Lead and Arsenic for Soils Sieved to <150 µm.** Conduct grain size analysis archived soils to determine if grain size distribution affects the IVBA-RBA relationship.

6. **Continue Development of Mouse Assay for Lead Bioavailability.** Evaluate contaminated and amended soils in mouse model assay for continued development of mouse assay for use in assessing in situ lead amended soils.

7. **Review Bioavailability of Metals**. Review existing data on the RBA and IVBA of other metals. Develop scoping reports/fact sheets on the bioavailability of other metals to assist Regions on assessments of bioavailability.

8. **Community Outreach.** In conjunction with regional staff, continue community outreach and development of educational materials regarding arsenic bioavailability.

9. **Training Opportunities for 2019.** Identify training opportunities to support and update Regions on recent developments regarding application of bioavailability to site characterization and risk assessment.

10. **Archive of Site-Specific Bioavailability Assessments for Metals.** Develop an information archive of site-specific bioavailability assessments for metals that have been conducted in support of remedial investigations and human health risk assessments.

11. **TRW Bioavailability Committee Literature Archive.** Update archive of literature on

bioavailability of lead and arsenic. The TRW Bioavailability Committee will review lists of new literature available in the archive.

12. **TRW Bioavailability Committee Business**
    a. **Biennial Meeting.** Plan Annual Meeting for October/November 2019.
    b. **Annual Report.** Develop the 2019 Bioavailability Committee Annual Report.