



ENVIRO.wiki

Tech Transfer in the 21st Century

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Battelle 2024 Chlorinated Conference
Denver, CO
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SUPPORTING

[DOING]

LEADING

Problem

- Extensive research that is not easily accessible.
- Internet makes it easy to find LOTS of information
 - Massive volume of information
 - Lots of outdated information
 - Limited Integration
 - It just takes too much time!



Search Engines

- Priority given to # links and # “clicks”
- No quality assurance / peer review
- Time consuming to find most recent/relevant work



Brossard, D. & D. A. Scheufele, 2013. Science, New Media, and the Public. Science Magazine.

Science and Engineering Indicators, 2012. National Science Board

Wikipedia

■ Fantastic Resource

- Well written, concise articles
- More than 63,000,000 articles in 329 languages
- Approximately 10 billion global page views monthly
- Continually updated and improved

■ Limitations

- Susceptible to systemic bias
- Does not require any credentials for editing
- Limited information on many current technologies



Our Solution – ENVIRO Wiki



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WIKI

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Topic Categories

Transport & Attenuation Processes

Characterization, Assessment & Monitoring

Climate Change

Coastal and Estuarine Ecology

Contaminated Sediments

Light Non-Aqueous Phase Liquids (LNAPLs)

Munitions Constituents

Monitored Natural Attenuation (MNA)

Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS)

Regulatory Issues and Site Management

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Welcome to ENVIRO Wiki

Peer Reviewed. Accessible. Written By Experts

The goal of ENVIRO Wiki is to make scientific and engineering research results more accessible to environmental professionals, facilitating the permitting, design and implementation of environmental projects. Articles are written and edited by invited experts (see [Contributors](#)) to summarize current knowledge for the target audience on an array of topics, with cross-linked references to reports and technical literature.

Featured article: Restoration of Ecological Function in Terrestrial Systems Impacted by Invasive Species

```
graph LR
    Past[Past] --> Present[Present] --> Future[Future]
    Past --> StablePast[Stable novel ecosystem]
    Invasive[Invasive species] --> UnstablePresent[Unstable novel ecosystem]
    UnstablePresent --> StableFuture[Stable novel ecosystem]
    Intervention[Intervention ecology] --> StableFuture
    NoEffect[No effect on ecological process] --> StableFuture
    Loss[Loss of important ecological processes] --> UnstablePresent
    Eradication[Eradiation/Restoration] --> Past
```

Because of the increased ease and frequency of transportation of people and goods across the globe, almost all ecosystems have species introduced by humans that do not share an evolutionary history with the native members of the ecosystem. Only some of these species survive to reproduce, and even fewer cause harm. It is this subset of species that have been deemed “invasive”. Invasive species can be one of the greatest threats to ecological and economic well-being of the planet. Efforts focused on early detection and rapid response are preferable to trying to control a species once it has established. However, in many cases, it can be difficult to identify potential

invasive species until they have started causing obvious detrimental effects. A well-known example of an invasive species that caused detrimental effects to an entire ecosystem, where the intervention ecology approach is now being applied, is the [brown treesnake](#) (*Boiga irregularis*) on the island of Guam. The snake was introduced to the island at the end of WWII, likely a stowaway aboard U.S. military cargo ships. Within approximately 40 years the snake had spread throughout the entire island and eliminated 9 of the 11 species of native forest birds. Invasive species may cause the decline or extirpation of native species that provide essential ecological functions in the ecosystem. For example, the [Hemlock Woolly Adelgid](#) (*Adelges tsugae*), an invasive insect from Asia, has led to the destruction of up to 80% of the hemlock trees in the Eastern United States, which then impacted overall forest composition. Invasive species also cause problems for human health and economies. [\(Full article...\)](#)

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Enviro Wiki Highlights

BIOREMEDIATION – ANAEROBIC DESIGN CONSIDERATIONS

Amendment addition for biobarrier

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Attenuation & Transport Processes

- Biodegradation - 1,4-Dioxane
- Biodegradation - Cometabolic

Contaminated Sediments

- Contaminated Sediment Risk Assessment
- In Situ Treatment of Contaminated Sediments with Activated Carbon

Remediation Technologies

- Amendment Distribution in Low Conductivity Materials
- Anaerobic Bioremediation

ENVIRO Wiki (<http://www.ENVIRO.wiki>)



- Short 'encyclopedia' articles on environmental topics
 - Familiar Wikipedia format
 - Readily Accessible
 - Written by recognized experts from academia and industry
 - Compilation of relevant research
 - Summaries of Current Knowledge
 - Extensive Peer Review
 - Library of original documents
 - Lots of links for more detailed info.

Major Sections

- Attenuation & Transport Processes
- Characterization, Assessment & Monitoring
- Climate Change
- Coastal and Estuarine Ecology
- Contaminated Sediment
- LNAPLs
- Munitions Constituents
- MNA
- PFAS
- Regulatory Issues & Site Management
- Remediation Technologies
- Soil & Groundwater Contaminants

Example Articles

- 1,2,3-Trichloropropane
- Anaerobic Bioremediation
- Climate Change Effects on Wildlife
- Contaminated Sediment Risk Assessment
- Energetics Deposition
- Groundwater Flow and Solute Transport
- LNAPL Conceptual Site Models
- Molecular Biological Tools
- Natural Source Zone Depletion
- PFAS Transport and Fate
- Phytoplankton (Algae) Blooms
- Source Zone Modelling

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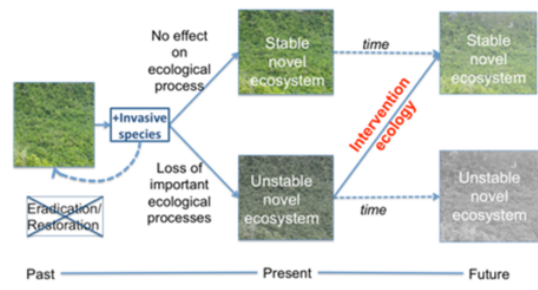
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Featured article: Restoration of Ecological Function in Terrestrial Systems Impacted by Invasive Species



Because of the increased ease and frequency of transportation of people and goods across the globe, almost all ecosystems have species introduced by humans that do not share an evolutionary history with the native members of the ecosystem. Only some of these species survive to reproduce, and even fewer cause harm. It is this subset of species that have been deemed "invasive". Invasive species can be one of the greatest threats to ecological and economic well-being of the planet. Efforts focused on early detection and rapid response are preferable to trying to control a species once it has established. However, in many cases, it can be difficult to identify potential

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Enviro Wiki Highlights

BIOREMEDIATION – ANAEROBIC DESIGN CONSIDERATIONS



Amendment addition for biobarrier

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- Mobility of Metals and Metalloids
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 - Vapor Intrusion - Separation Distances from Petroleum Sources
 - Vapor Intrusion - Sewers and Utility Tunnels as Preferential Pathways

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- Direct Push (DP) Technology
 - Direct Push Logging
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 - Case Studies
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- Long-Term Monitoring (LTM)
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 - LTM Data Variability
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 - Proteomics and Proteogenomics
 - Quantitative Polymerase Chain Reaction (qPCR)
 - Stable Isotope Probing (SIP)
- Natural Attenuation in Source Zone and Groundwater Plume - Bemidji Crude Oil Spill

Climate Change

- Climate Change Effects on Wildlife
- Downscaled High Resolution Datasets for Climate Change Projections
- Infrastructure Resilience
- Predicting Species Responses to Climate Change with Population Models
- Restoration of Ecological Function in Terrestrial Systems Impacted by Invasive Species

Coastal and Estuarine Ecology

- Phytoplankton (Algae) Blooms

Contaminated Sediments

- Contaminated Sediment Risk Assessment
- In Situ Treatment of Contaminated Sediments with Activated Carbon
- Mercury in Sediments
- Passive Sampling of Sediments
- Sediment Capping

Light Non-Aqueous Phase Liquids (LNAPLs)

- LNAPL Conceptual Site Models
- LNAPL Remediation Technologies
- NAPL Mobility

Munitions Constituents

- Abiotic Reduction
- Alkaline Degradation
- Composting
- Deposition
- Dissolution
- Metal(loid)s - Small Arms Ranges
- Passive Sampling
- Photolysis
- Soil Sampling
- Sorption
- Toxicology
- TREECS™

Monitored Natural Attenuation (MNA)

- MNA of Chlorinated Solvents
- MNA of Fuels
- MNA of Metals and Metalloids
- Natural Source Zone Depletion (NSZD)
- Transitioning from Active Remedies

Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS)

- PFAS Ex Situ Water Treatment
- PFAS Soil Remediation Technologies
- PFAS Sources
- PFAS Transport and Fate
- PFAS Treatment by Electrical Discharge Plasma
- Photoactivated Reductive Defluorination

Regulatory Issues and Site Management

- Alternative Endpoints
- Mass Flux and Mass Discharge
- Plume Response Modeling
- REMChlor-MD
- Source Zone Modeling
- Sustainable Remediation

Remediation Technologies

- Amendment Distribution in Low Conductivity Materials
- Anaerobic Bioremediation
 - Design Considerations
 - Design Tool - Base Addition for ERD

• In Situ Chemical Oxidation (ISCO)

• Design Considerations

• Oxidant Selection

- ~~Electron Transfer Capacity (ETC) Estimation~~
- In Situ Groundwater Treatment with Activated Carbon
- Injection Techniques for Liquid Amendments
- Injection Techniques - Viscosity Modification
- Landfarming
- Remediation of Metals and Metalloids
- Remediation Performance Assessment at Chlorinated Solvent Sites
- Soil Vapor Extraction (SVE)
- Stream Restoration
- Subgrade Biogeochemical Reactor (SBGR)
- Supercritical Water Oxidation (SCWO)
- Thermal Remediation
 - Combined Remedies
 - Electrical Resistance Heating (ERH)
 - Smoldering
 - Steam Enhanced Extraction (SEE)
 - Thermal Conduction Heating (TCH)

Soil & Groundwater Contaminants

- 1,2,3-Trichloropropane
- 1,4-Dioxane
- Chlorinated Solvents
- Metals and Metalloids
- N-nitrosodimethylamine (NDMA)
- Perchlorate
- Petroleum Hydrocarbons (PHCs)
- Polycyclic Aromatic Hydrocarbons (PAHs)

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Topic Categories

- Characterization & Monitoring
- Contaminants
- Energetics
- Management
- Remediation
- Transport & Attenuation

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In Situ Chemical Oxidation - ISCO

Chemical Oxidation is an [in situ](#) remediation technology that can be applied to groundwater or soils and many different contaminants. It is a chemical technology where strong oxidants are injected or mechanically mixed into the treatment zone to promote destructive abiotic degradation reactions. It is commonly used, applicable to many hydrogeologic settings, and relies on well-known technologies such as [injection](#) and mixing. Because of stoichiometry and mass balance limitations, it may be inefficient when applied to treat free-phase (i.e., free-product or non-aqueous phase liquid (NAPL)) zones.

Related Article(s):

- [Oxidant Selection for ISCO](#)
- [ISCO Design Considerations](#)
- [Injection and Distribution of Liquid Amendments in Groundwater](#)
- [Monitored Natural Attenuation \(MNA\)](#)

CONTRIBUTOR(S): [Dr. Michelle Crimi](#)

Key Resource(s):

- [In Situ Chemical Oxidation for Groundwater Remediation Protocol \(ESTCP ER-200623\)](#) ^[1]

Introduction

[In situ](#) chemical oxidation (ISCO) is a mature technology for remediation of contaminated groundwater, including both source zones and contaminant plumes. ISCO involves the introduction of chemical oxidants into the subsurface to react with contaminants to convert them into less harmful products. Commonly used oxidants include [Fenton's reagent](#), [ozone](#), [potassium permanganate](#), and [sodium persulfate](#).

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- [6 Summary](#)
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■ Extensive Links, Online Referencing & “See Also”

References

1. ^ 1.0 1.1 Siegrist, R.L., 2010. In situ chemical oxidation for groundwater remediation - technology practices manual. ESTCP Project ER-0623. [ER-200623](#)
2. ^ Siegrist, R. L. Urynowicz, M.A., West, O.R., Crimi, M.L. and Lowe, K.S., 2001. Principles and practices of in situ chemical oxidation using permanganate. Columbus, OH: Battelle Press. ISBN-10: 1574771027. doi: [10.1016/S0304-3894\(01\)00355-7](#)
3. ^ ITRC, 2005. Technical and Regulatory Guidance for In Situ Chemical Oxidation of Contaminated Soil and Groundwater. Council TITaR, editor. [Report pdf](#)
4. ^ Huling, S. G., and Pivetz, B. E., 2006. In-situ chemical oxidation (No. EPA/600/R-06/072). Environmental Protection Agency, Washington, DC. Office of Water. [Report pdf](#)
5. ^ Krembs, F.J., Siegrist, R.L., Crimi, M.L., Furrer, R.F. and Petri, B.G., 2010. ISCO for groundwater remediation: analysis of field applications and performance. Groundwater Monitoring & Remediation, 30(4), 42-53. doi: [10.1111/j.1745-6592.2010.01312.x](#)
6. ^ 6.0 6.1 6.2 6.3 6.4 Siegrist, R.L., Crimi, M. and Simpkin, T.J. eds., 2011. In situ chemical oxidation for groundwater remediation (Vol. 3). Springer Science & Business Media. 678 pgs. ISBN: 978-1-4419-7825-7. doi: [10.1007/978-1-4419-7826-4](#)
7. ^ 7.0 7.1 McGuire, T., 2016. Development of an Expanded, High-Reliability Cost and Performance Database for In-Situ Remediation Technologies. ESTCP Project ER-201120. [ER-201120](#)
8. ^ ESTCP, 2009. Database for ISCO (DISCO). ER-0623. [ER-0623](#)
9. ^ Borden, R., Cha, K.Y., Simpkin, T. and Lieberman, M.T, 2010. Development of Design Tools for Planning Aqueous Amendment Injection Systems. Permanganate Design Tool. ESTCP Project ER-200626. [ER-200626](#)

See Also

- [Improved Understanding of Fenton-Like Reactions for In Situ Remediation of Contaminated Groundwater Including Treatment of Sorbed Contaminants and Destruction of DNAPLs](#)
- [Improved Understanding of In Situ Chemical Oxidation \(ISCO\)](#)
- [Reaction and Transport Processes Controlling In Situ Chemical Oxidation of DNAPLs](#)
- [Control of Manganese Dioxide Particles Resulting from In Situ Chemical Oxidation Using Permanganate](#)
- [Enhanced Reactant-Contaminant Contact Through the Use of Persulfate In Situ Chemical Oxidation \(ISCO\)](#)
- [Semi-Passive Oxidation-Based Approaches for Control of Large, Dilute Groundwater Plumes of Chlorinated Ethylenes](#)
- [Impacts on Groundwater Quality Following the Application of ISCO: Understanding the Cause of and Designing Mitigation for Metals Mobilization](#)
- [CleanOX® In Situ Chemical Oxidation of Groundwater](#)

Enviro Wiki - Videos

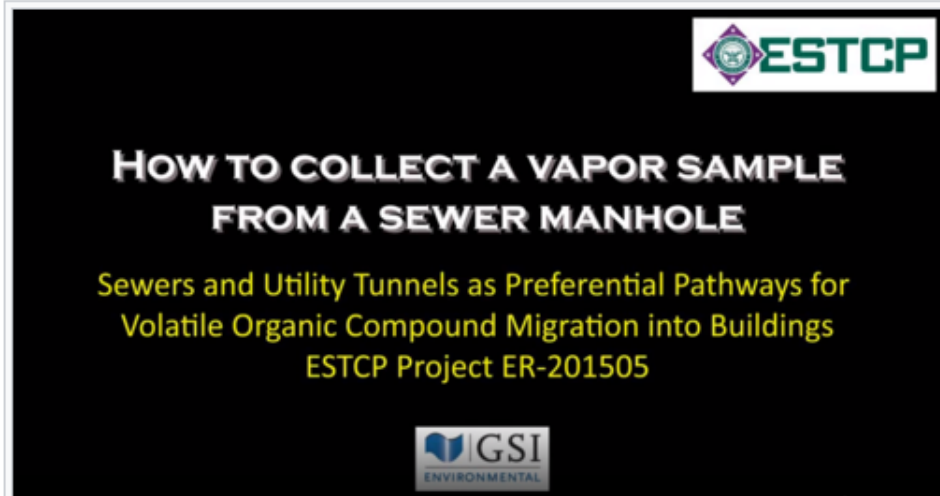


Figure 3. Sewer Vapor Sample Collection Video

Figure 3. Webcam video of a self-sustaining smoldering reaction traveling upwards in a 30 cm tall transparent quartz column containing coal tar contaminated soil (accelerated 50 times).



Figure 1. Remediation performance at 235 chlorinated solvent sites.

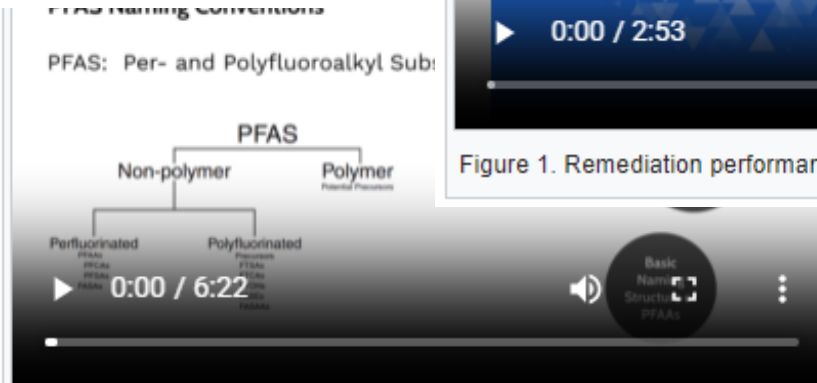


Figure 3. PFAS naming conventions explained.

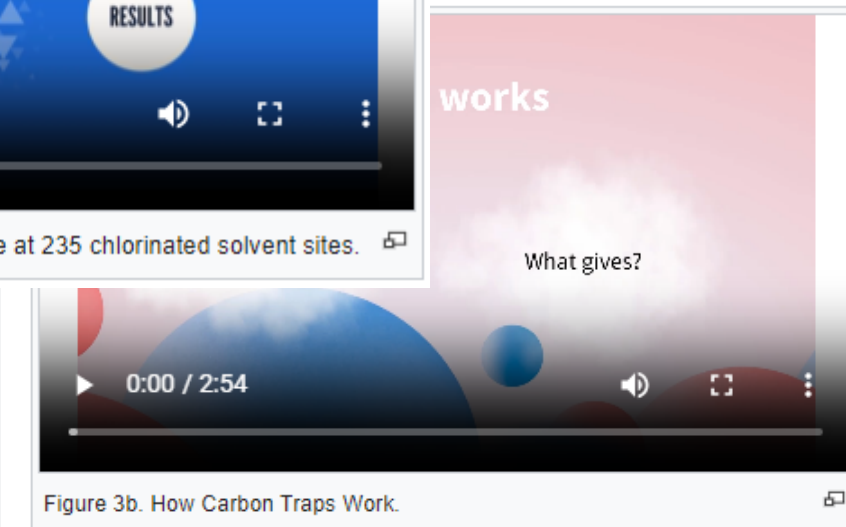
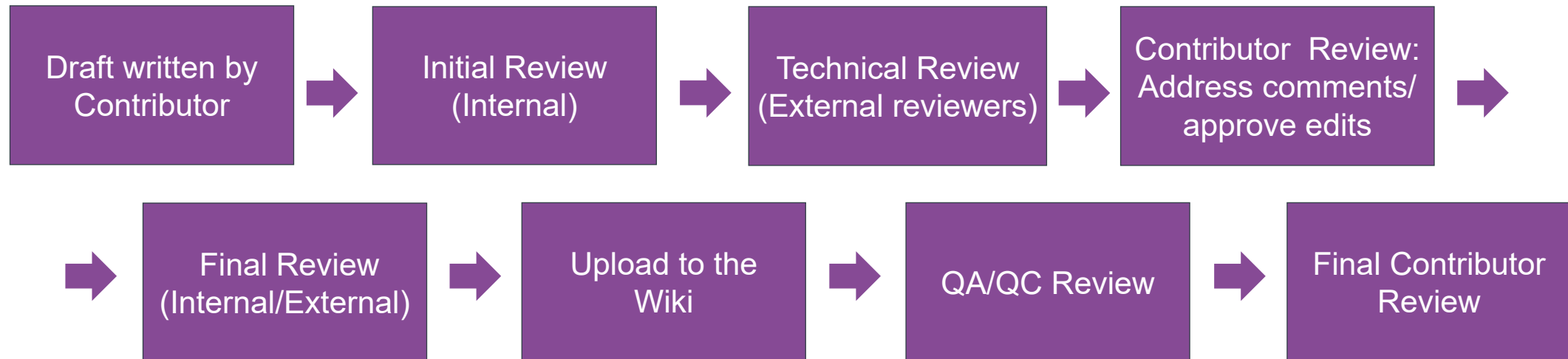


Figure 3b. How Carbon Traps Work.

Development

- Prepared by internationally recognized experts
- Extensive peer review

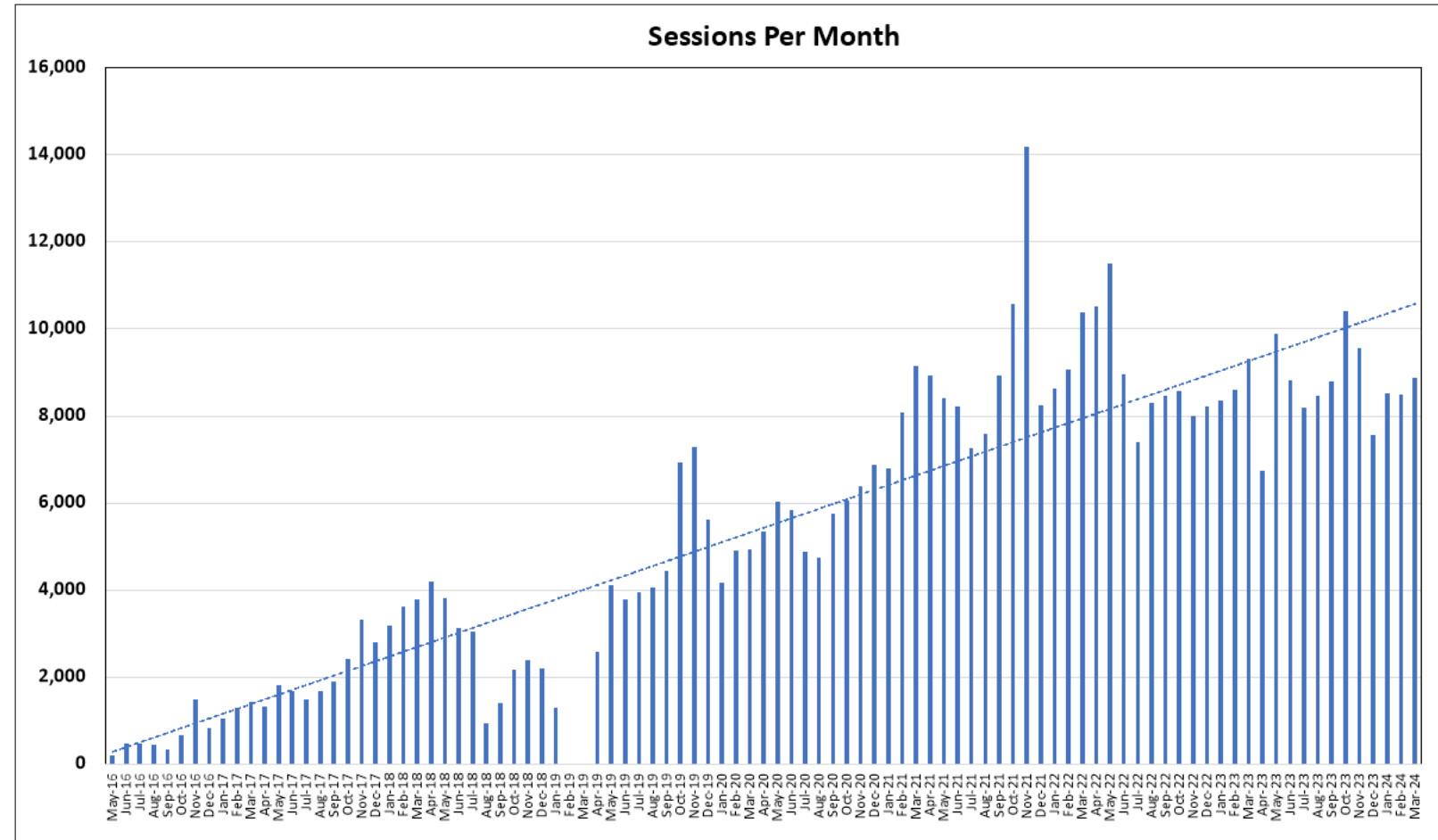


Outreach



Google analytics

- Totals since May 2016
 - > 813,000 page views
 - > 543,000 sessions
 - > 256,000 page views (31%) with durations lasting >10min
 - Avg. 5 min per session for returning users



- 116 Articles
- 313 pages (articles + miscellaneous pages)
- References
 - >1,600 external links
 - 874 internal documents/pdfs

Expansion, Improvement & Maintenance

- Continuous Improvement
 - Focused on mainly PFAS articles
 - Edit / update existing articles
 - Highlight recent research
 - Provide alternative points of view
 - Broken links/missing references
- Graphics & videos
 - Adding more visuals (i.e., short (2-3 min) videos, illustrative graphics
- Difficult to find authors for
 - 'Older' topics (e.g. pump and treat)



Public Involvement



We need YOUR help!

Please go to the Enviro Wiki, review the content, and provide us with your input.

- Feedback form on the website
- Suggestions for new topics, website improvements and general impressions are all welcome
- Additional 'hard to find' documents



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