

Biochemical Reactors for Treating Mining- influenced Water



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Advancing Environmental Solutions



National Conference on Mining- Influenced Water

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&

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Biochemical Reactors Team

Albuquerque, New Mexico

August 13, 2014



Today's Objective

- Brief ITRC and Team introduction
- Problem introduction & Explanation of a BCRs usefulness
- Guidance Introduction
- Discussion of Implementation Targets

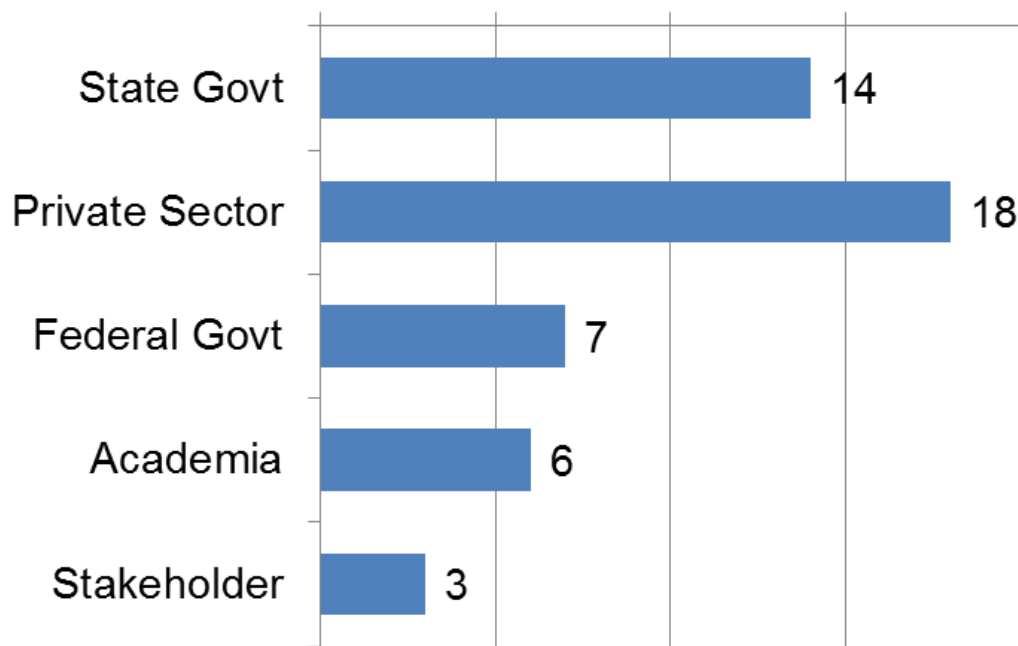
We need your help to identify example targets!





ITRC & The BCR Team

- ITRC is a state-led coalition which works to achieve regulatory acceptance of environmental technologies and innovative approaches.
- ITRC Team on Biochemical Reactors for Treating Mining Influenced Water





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What is the problem we face?

- There are over 500,000 abandoned mine sites in the U.S.
- MIW impacts state lands, federal lands, public land, private lands
- Many sites are in remote areas with extreme climates
- Negative environmental impacts extend miles downstream
- Liability lingers for years



Unnamed creek channel, PA
Note the color changes.



One Possible Solution. . .

- Biochemical Reactor (BCR)



Penn Hill #2 BCR, PA



What is a Biochemical Reactor (BCR)?

- ***...engineered treatment system that uses an organic substrate to drive microbial and chemical reactions to reduce concentration of metals, acidity, and sulfate in MIW.***



Golinsky Mine, Shasta County, CA

Biochemical Reactor



Advantages

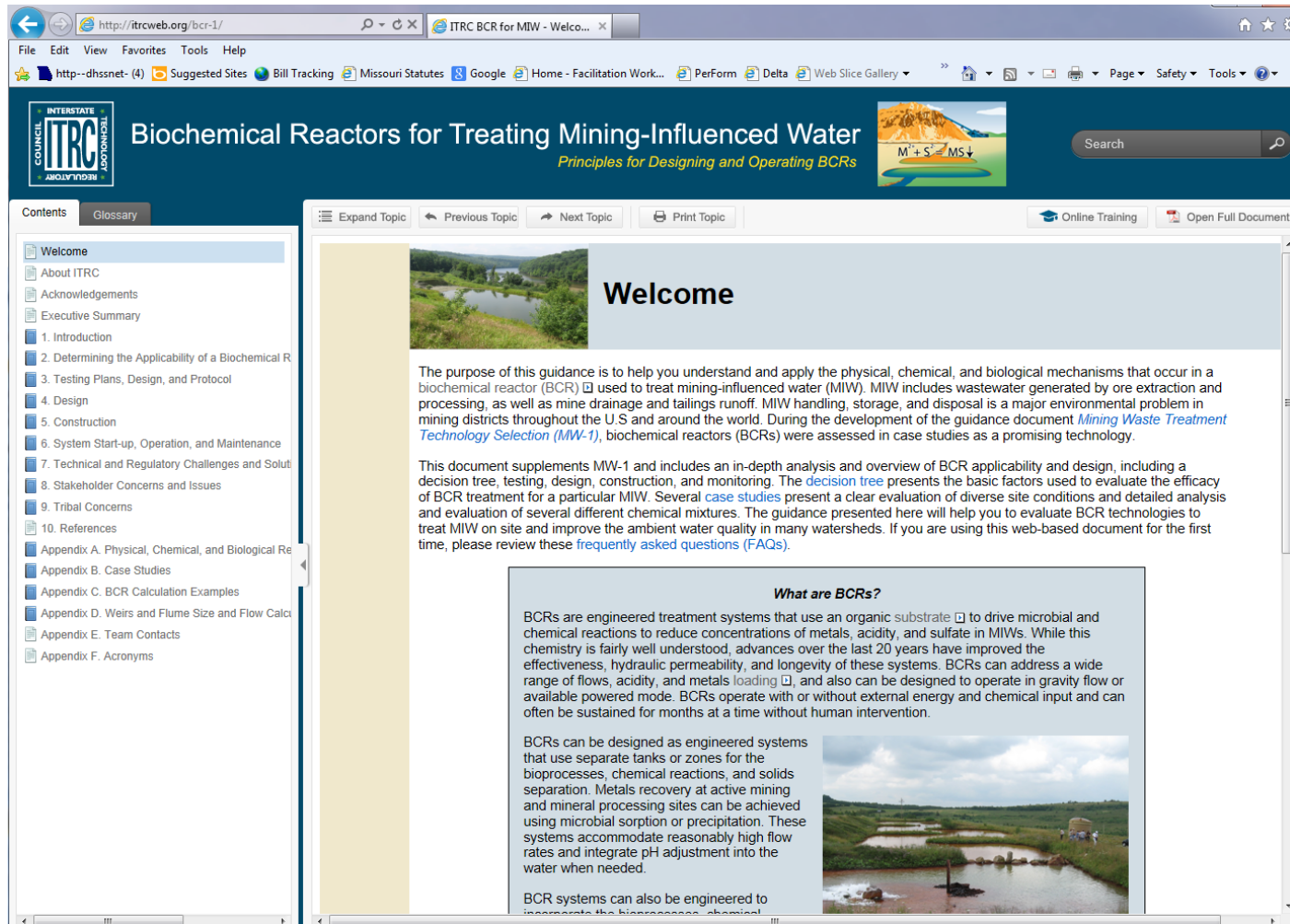
- Low energy requirements
- May be low maintenance if designed properly
- Can be used in remote situations
- Removes metals
- Flexible and versatile
- Treats wide variety of MIW
- Will improve ecological function of receiving stream

Cautions

- BCRs may not consistently meet strict water quality standards
- BCRs are not *walk away* systems
- Monitoring is required
- Maintenance may be needed periodically



Biochemical Reactors for Mining Influenced Water



http://itrcweb.org/bcr-1/ ITRC BCR for MIW - Welco...

File Edit View Favorites Tools Help

http--dhsnet- (4) Suggested Sites Bill Tracking Missouri Statutes Google Home - Facilitation Work... PerForm Delta Web Slice Gallery Page Safety Tools

INTERSTATE COUNCIL OF TRIBES ASSOCIATION ITRC

Biochemical Reactors for Treating Mining-Influenced Water

Principles for Designing and Operating BCRs

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Welcome

The purpose of this guidance is to help you understand and apply the physical, chemical, and biological mechanisms that occur in a biochemical reactor (BCR) used to treat mining-influenced water (MIW). MIW includes wastewater generated by ore extraction and processing, as well as mine drainage and tailings runoff. MIW handling, storage, and disposal is a major environmental problem in mining districts throughout the U.S. and around the world. During the development of the guidance document *Mining Waste Treatment Technology Selection (MW-1)*, biochemical reactors (BCRs) were assessed in case studies as a promising technology.

This document supplements MW-1 and includes an in-depth analysis and overview of BCR applicability and design, including a decision tree, testing, design, construction, and monitoring. The [decision tree](#) presents the basic factors used to evaluate the efficacy of BCR treatment for a particular MIW. Several [case studies](#) present a clear evaluation of diverse site conditions and detailed analysis and evaluation of several different chemical mixtures. The guidance presented here will help you to evaluate BCR technologies to treat MIW on site and improve the ambient water quality in many watersheds. If you are using this web-based document for the first time, please review these [frequently asked questions \(FAQs\)](#).

What are BCRs?

BCRs are engineered treatment systems that use an organic substrate to drive microbial and chemical reactions to reduce concentrations of metals, acidity, and sulfate in MIWs. While this chemistry is fairly well understood, advances over the last 20 years have improved the effectiveness, hydraulic permeability, and longevity of these systems. BCRs can address a wide range of flows, acidity, and metals loading, and also can be designed to operate in gravity flow or available powered mode. BCRs operate with or without external energy and chemical input and can often be sustained for months at a time without human intervention.

BCRs can be designed as engineered systems that use separate tanks or zones for the bioprocesses, chemical reactions, and solids separation. Metals recovery at active mining and mineral processing sites can be achieved using microbial sorption or precipitation. These systems accommodate reasonably high flow rates and integrate pH adjustment into the water when needed.

BCR systems can also be engineered to incorporate the bioprocesses, chemical



What This Guidance Can Do for YOU!

- Assess the suitability of using a BCR
- Support
 - ◆ Planning
 - ◆ Testing
 - ◆ Monitoring
 - ◆ Operating
 - ◆ Maintaining
- Provides examples of real world application of BCRs



I WANT YOU
TO REFERENCE THIS GUIDANCE

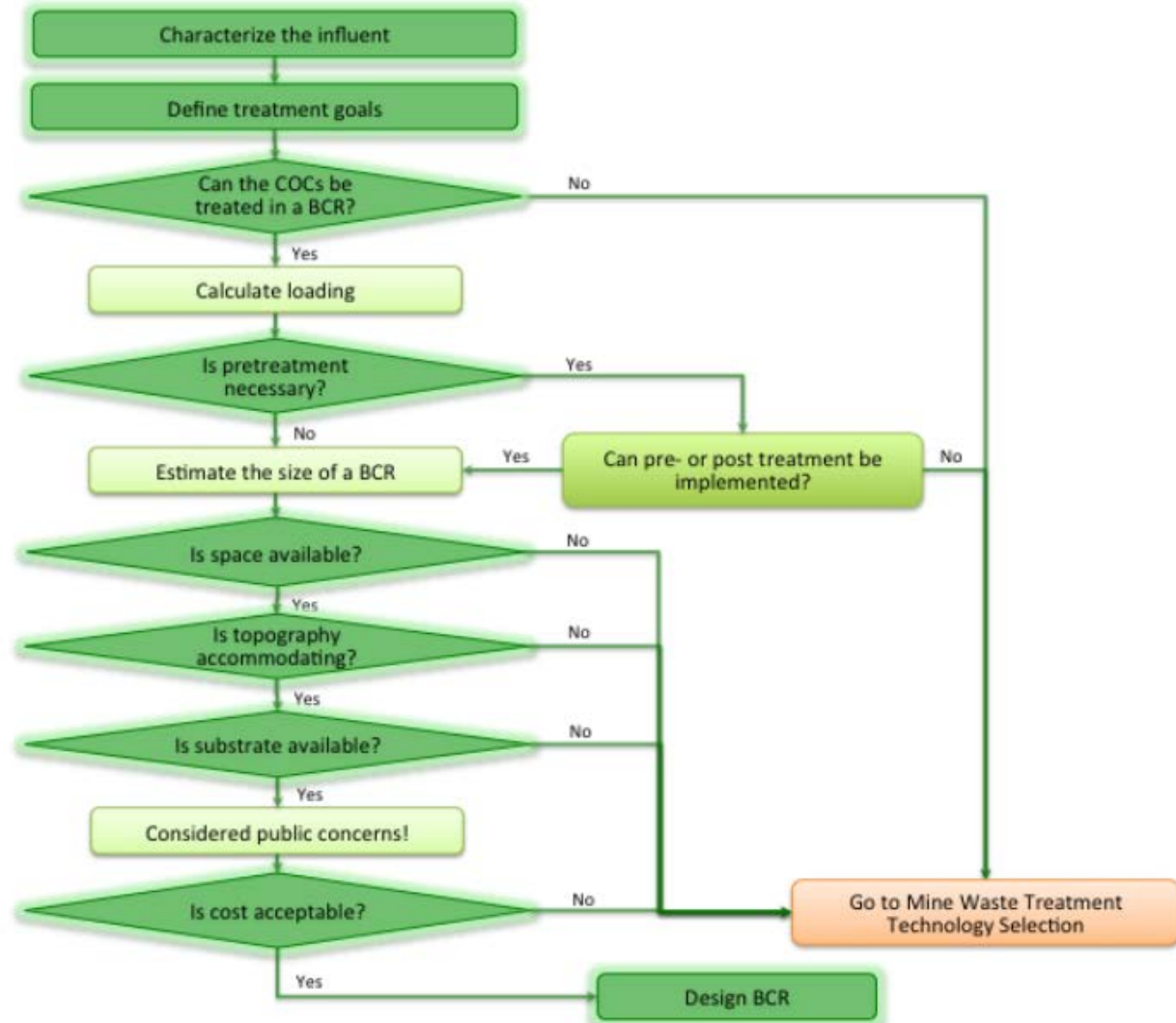


Topics Covered by the Guidance

- Applicability
- Testing
- Design
- Construction and startup
- Monitoring, operation and maintenance
- Challenges



Applicability





Is My Water BCR-Worthy

Periodic Table of Treatable Elements

Elements in Blue can be treated in a BCR

1 H	2 He											13 B	14 C	15 N	16 O	17 F	18 Ne
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	3	4	5	6	7	8	9	10	11	12	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac~	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 ---	111 ---	112 ---	114 ---	116 ---	118 ---	119 ---	120 ---	

Figure courtesy of Jim J. Gusek, 2009

Actinide Series

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Treatability Testing

- Proof of Principle
- Bench Testing
- Pilot Testing

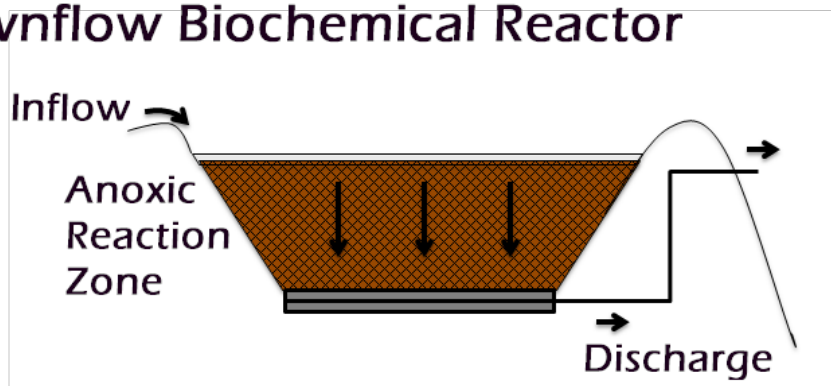


- Solid Substrate
- Liquid Substrate

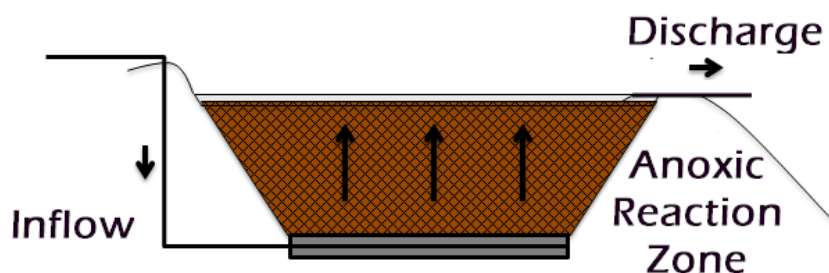


Design

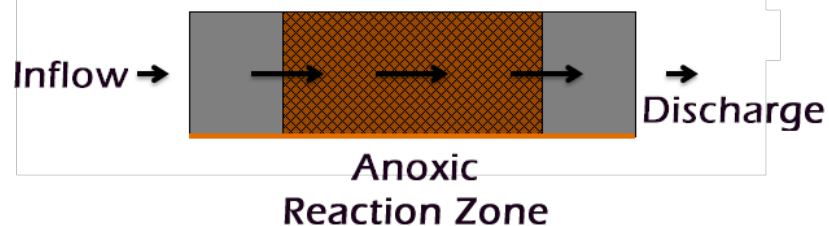
Downflow Biochemical Reactor



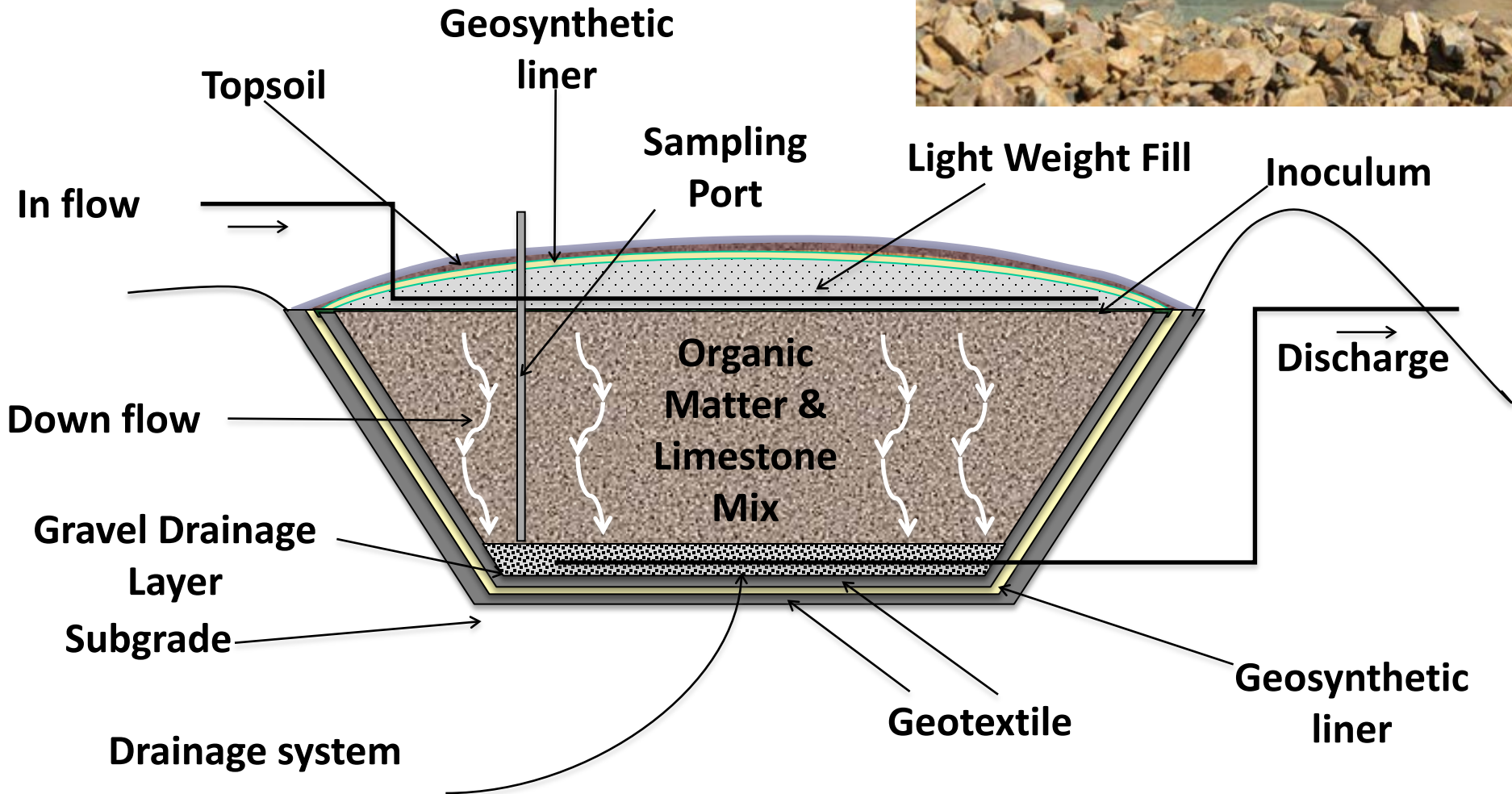
Upflow Biochemical Reactor



Horizontal Flow Biochemical Reactor



Construction





Operation & Monitoring of BCRs

- BCRs designed:
 - ◆ To run on their own with periodic oversight,
 - ◆ To be low maintenance
 - ◆ To be Low energy/passively driven systems

- Conduct monitoring for,
 - ◆ Physical conditions
 - ◆ Performance evaluations
 - ◆ Compliance requirements

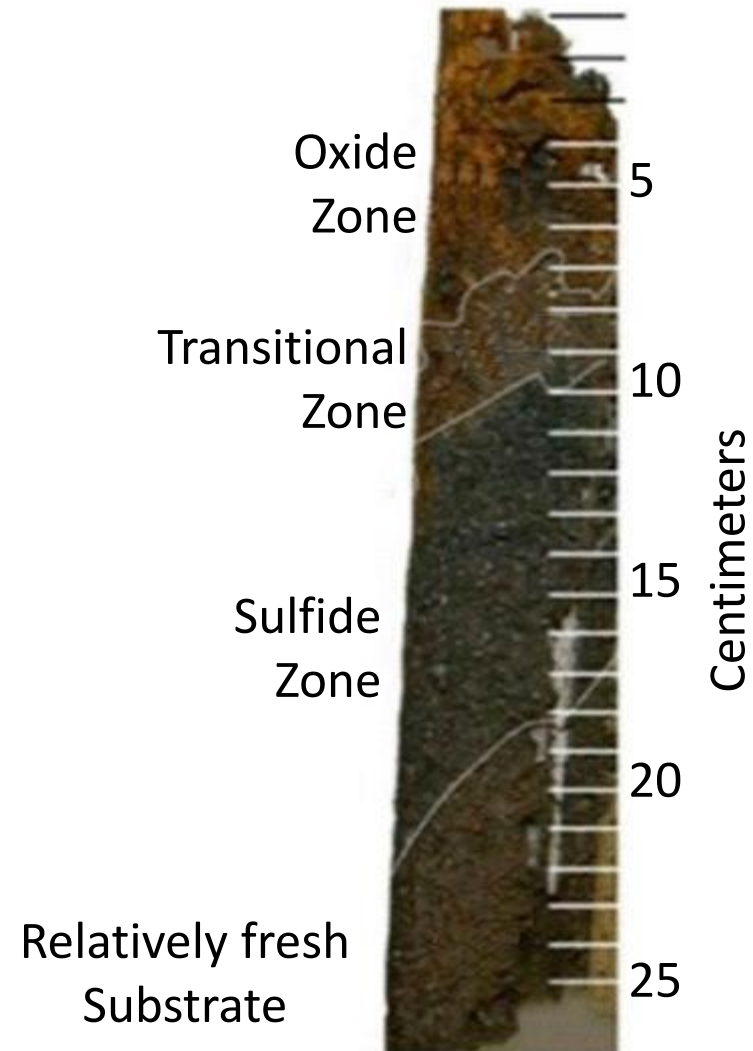


Penn Hills BCR Inflow Monitoring



Substrate Monitoring

- Chemistry (compare to design conditions)
- Substrate testing – ORP & Physical collection
- Substrate test for disposal
- Substrate replacement or additional amendment





Troubleshooting

- Chemical trends
- Physical Trends



Adjustable Elevation Head
Weir for BCR Effluent



Challenges

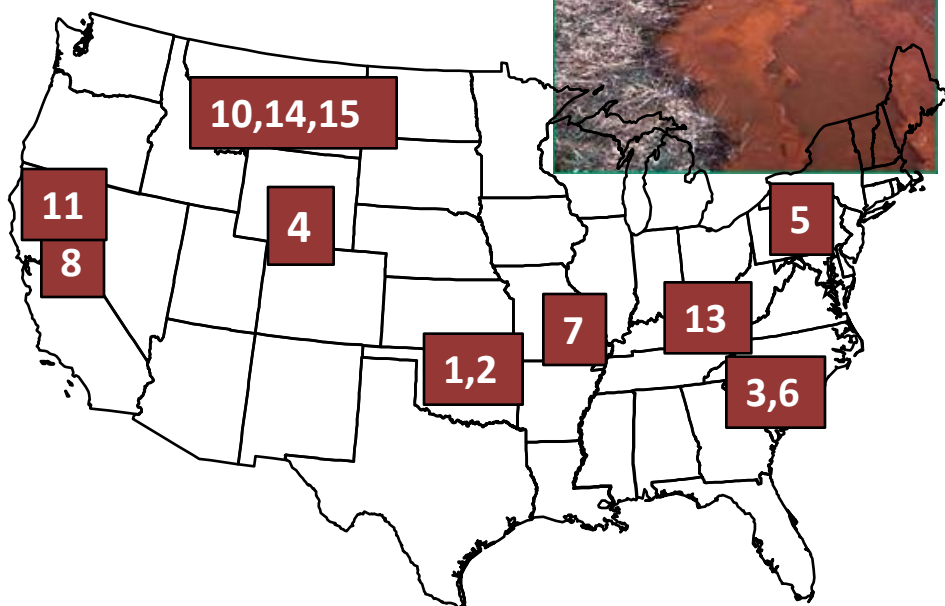
- There are technical, regulatory and stakeholder challenges, including:
 - ◆ Permitting and ability to attain strict water quality standards
 - ◆ Noise, attractive nuisance/safety, hydrogen sulfide odor
 - ◆ Long term liability concerns / Good Samaritan legislation
 - ◆ Reuse



Golinsky Biochemical Reactor, Lake Shasta, CA
Photo courtesy of Bruce Marvin



Example Implementation Targets





Key Message

1. BCRs are *viable alternatives* for treating MIW, even in remote areas
2. BCRs are *site-specific*
3. BCRs are not *walk away* systems
4. The guidance is a convenient *resource* when considering a BCR