Wetland Design for the Prospector Outfall

Mark Fitch, Associate Professor,
University of Missouri-Rolla

Al Mattes & Bill Duncan, Nature Works Remediation Corp.

UMR UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

Agenda

- Credentials
- Problem
- Wetlands
- Design
- Review and questions

UMR UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

Credentials

Fitch
- PhD, University of Texas, 1996
- University professor 9 years
- Senior Environmental Engineer TI with Burns & McDonnell, but not a P.E.

Wetlands research
- Supported initially by Doe Run
- 4 years support from USEPA
- Collaboration also with Teck Cominco

UMR UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

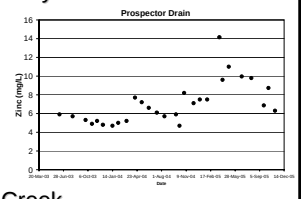
Credentials

Nature Works Remediation Corp.
- Designed & operate Teck Cominco wetland
  - 10 years, phased approach
  - 550 mg/L Zn, 100 mg/L As, 5 mg/L Cd,
  - ~98% removal

UMR UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

Problem

Prospector Drain Outfall
- ~ 119,000 gallons per day
- 5 – 15 mg/L Zinc



Utah DEQ (DWQ)
- TMDL
- Silver Creek health advisory
- Decrease the heavy metals load to Silver Creek

UMR UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

Alternatives

- Policy change
- Ignore the problem
- Change discharge to not Silver Creek
- Engineering solution
  - Intercept the water source
  - Constructed wetland
  - Ion exchange
  - Chemical precipitation
  - RO
  - Electrodialysis

UMR UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

Proposed Solution

- Phased wetlands
  - Wetland 1 at pipe (manhole intercept), full-scale demonstration
  - Wetland 2 (potential) across rail trail (take existing outlet across creek and under rail trail), open water pond at end?
  - Wetland 3 (potential) farther along creek

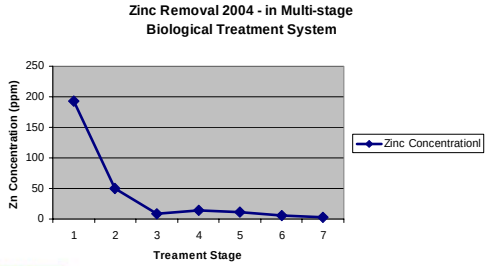
UMR UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

Wetlands

- Water-logged sediment
- Used for decades (1965) for wastewater treatment and AMD detoxification
- Only recent (~10 yrs) use for neutral metals
  - United Keno Hill Mines
  - 3 other mining ops
  - Upstate NY facility
  - Savannah River Labs

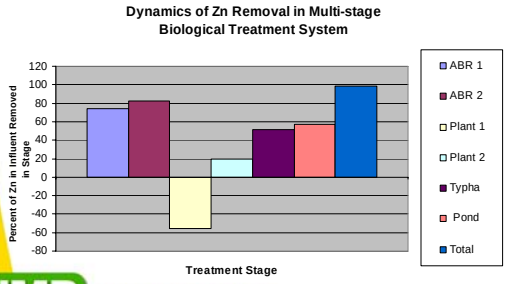
UMR UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

Teck Cominco results



UMR UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

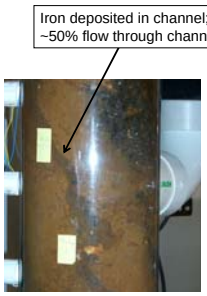
Teck Cominco results



UMR UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

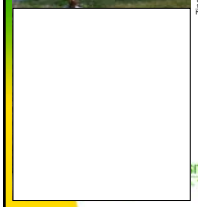
UMR lab-scale results

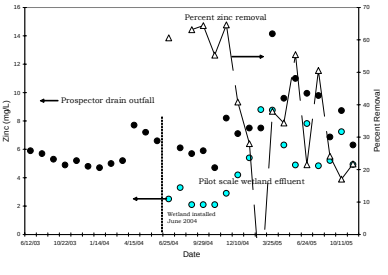
- 6 years, Pb mine effluent, 70-90% Pb, 48-70% Zn
- Push to failure:
  - Adsorptive (high flow)
  - Hydraulic
- Drying/disturbance
  - Brief pulse
  - Redistribution



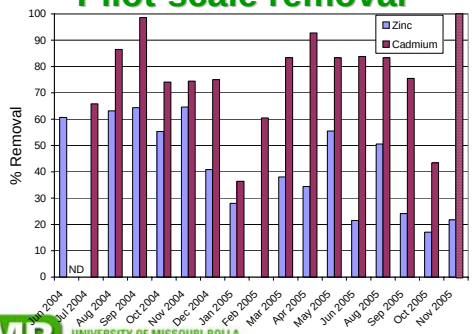
UMR UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

Prospector pilot-scale wetland





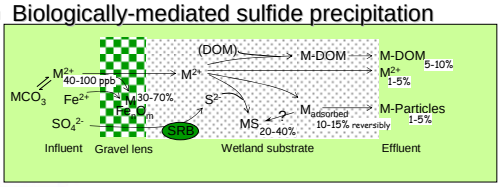
Pilot-scale removal



UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

Wetlands - mechanism

- Adsorption
- Oxidation (Fe & Mn, esp.)
- Fe co-precipitation
- Biologically-mediated sulfide precipitation



Values are % of Pb

UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

Wetland design

- Flow
  - Vertical – requires pipes
  - Horizontal – slower, thus larger
- Substrate (Sediment)
  - Inexpensive organic = wood chips
  - Inoculum = sewage sludge, manure
  - Hydraulic flow = sand, gravel

UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

Design

- Horizontal flow
- Phase 1 wetland at manhole
- Considerations
  - Substrate volume
  - Substrate composition
  - Hydraulic distribution
  - Winter

UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

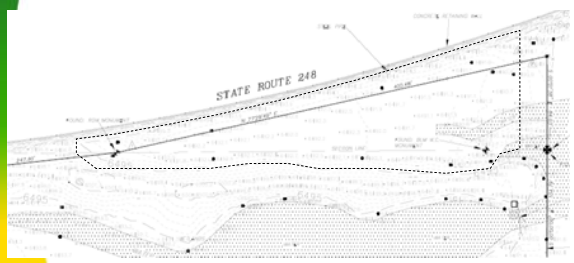
Area

UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

Area

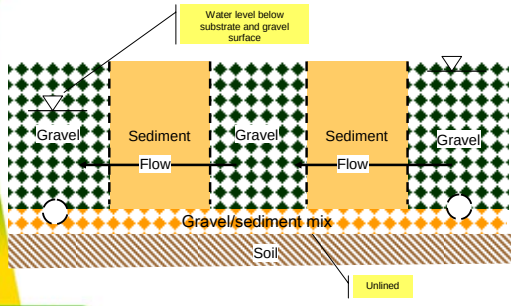
UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

Phase 1 Area



UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

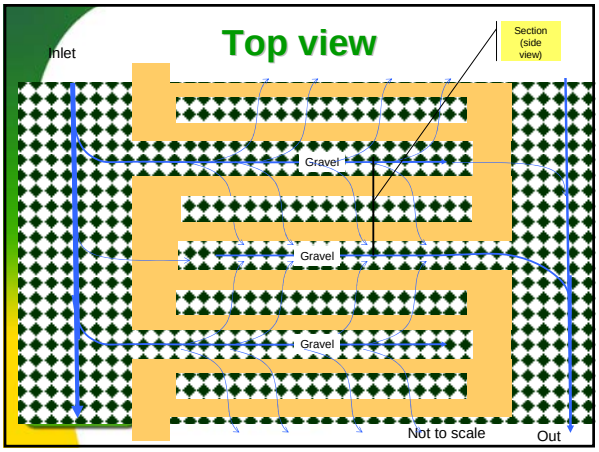
Side (cross section) view

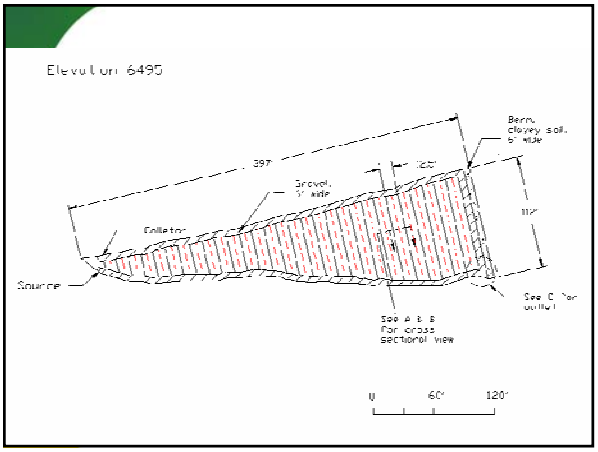


UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

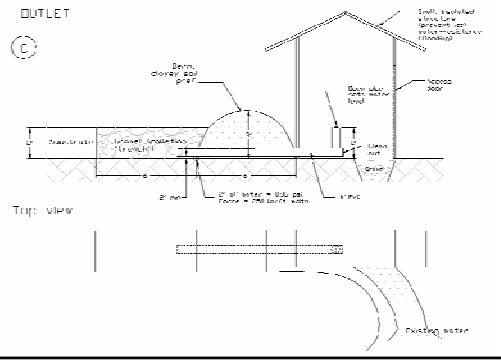
Not to scale

Top view





Outlet structure



Flow Rate

- Sufficient substrate for full flow
- Head loss issues
  - Flow path = 400 ft large channel, 60 ft distribution & collection arms, 3 ft substrate
  - 12" pipe in channel and 4" pipe in arms, head loss (ft of water):

	Flow (gal/day)		
	170,000	150,000	100,000
Channel	0.006	0.005	0.002
Arm	0.003	0.002	0.001
Substrate	0.85	0.75	0.49

UNIVERSITY OF MISSOURI-ROLLA
The Name. The Degree. The Difference.

Phase 1 Construction

- Construction, $99,300 estimate
  - 1020 yds gravel
  - 680 yds substrate (mixed)
  - Awkward placement: skid steer loader with manual dress up suggested, silt fence alternate
  - Berm at end (112 foot, 3 foot high)
  - Outlet structure
  - Plant (cattails…)

UMR UNIVERSITY OF MISSOURI-ROLLA The Name. The Degree. The Difference.

Operation

- Monitor flow, flow patterns (tracer tests), and treatment efficacy
- Fix any short circuiting spots by adding substrate and compressing
- Allow plants to grow
- Replace degraded substrate (decade or two, likely)

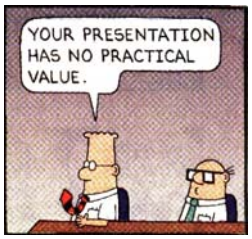
UMR UNIVERSITY OF MISSOURI-ROLLA The Name. The Degree. The Difference.

Next Step

1. Final design proposal with 3rd-party comments Wednesday
2. Stakeholder input and review, 1 Feb.
3. Construct, operate & monitor 1-2 years
4. Review concepts and costs for phase 2, phase 3

UMR UNIVERSITY OF MISSOURI-ROLLA The Name. The Degree. The Difference.

Questions



UMR UNIVERSITY OF MISSOURI-ROLLA The Name. The Degree. The Difference.