

Victor, Elizabeth A - DNR

From: Stanforth, Robert <RStanforth@trcsolutions.com>
Sent: Wednesday, December 13, 2017 3:43 PM
To: Zhang, Xiaochun - DNR; Victor, Elizabeth A - DNR
Cc: Bougie, Cheryl - DNR; Killian, James - DNR
Subject: RE: Kewaunee Marsh arsenic Project
Attachments: Stabilization Approaches Tested for Kewaunee Marsh Sediments.docx

Xiaochun

It was a pleasure to meet with you and Liz this morning and discuss the Kewaunee Marsh. Hopefully the discussion has been of some use to you.

I've listed the stabilization approaches that were tested during the various treatability studies in the attached memo. Also included are some ideas of what could be done at the site. These are just some thoughts intended simply to start a discussion.

One of the puzzles (for me anyway) at the site is how the arsenic gets to be so widespread laterally around the capped area, such as the 5 mg/L levels in the surface water south of the tracks that we discussed. DNR found 500 ug/L in a similar sample (Figure 2.4 of the Test Plots report – 2010), and there are some fairly high numbers in the ponds to the north of the site. Something to think about.

Bob

From: Zhang, Xiaochun - DNR [mailto:Xiaochun.Zhang@wisconsin.gov]
Sent: Tuesday, December 12, 2017 3:54 PM
To: Stanforth, Robert <RStanforth@trcsolutions.com>; Victor, Elizabeth A - DNR <Elizabeth.Victor@wisconsin.gov>
Cc: Bougie, Cheryl - DNR <Cheryl.Bougie@wisconsin.gov>; Killian, James - DNR <James.Killian@wisconsin.gov>
Subject: RE: Kewaunee Marsh arsenic Project

Hi Bob,

I started working on the project not long ago. I was thinking it will be beneficial to me if we could have a summary of remedial alternatives that TRC has evaluated for the site and the pros and cons of the alternatives. If it takes a long time to cover all alternatives you could select the ones that may be more feasible for the site.

Also I would like to let you know that I contacted Ted O'Connell earlier in an effort to understand field sampling protocols TRC used in the past (see attached message). The purpose was to make sure that similar sampling methods will be used for future assessment. I hope that either Ted or you could elaborate on some of your field experiences and recommendations for improvement if needed.

I am looking forward to meeting with you tomorrow.

Xiaochun

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Xiaochun Zhang
Phone: (608)264-8888
Xiaochun.zhang@wisconsin.gov

From: Stanforth, Robert [<mailto:RStanforth@trcsolutions.com>]
Sent: Monday, December 11, 2017 2:35 PM
To: Victor, Elizabeth A - DNR
Cc: Zhang, Xiaochun - DNR
Subject: RE: Kewaunee Marsh arsenic Project

The dark recesses get harder to reach the older I get.

I'll review the reports as well.

Bob

From: Victor, Elizabeth A - DNR [<mailto:Elizabeth.Victor@wisconsin.gov>]
Sent: Monday, December 11, 2017 2:33 PM
To: Stanforth, Robert <RStanforth@trcsolutions.com>
Cc: Zhang, Xiaochun - DNR <Xiaochun.Zhang@wisconsin.gov>
Subject: RE: Kewaunee Marsh arsenic Project

How good at you at reaching into the dark recesses of your brain?

I think focus on the work that you have done in trying to figure out where the arsenic is going – how is it leaving the site or where it might be concentrated. Take a look at the reports you prepared for us. I plan on looking through those reports again today or tomorrow. If I have specific questions, I will email these to you. How does that sound?

Liz

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Elizabeth A. Victor, P.G.
Phone: (920) 303-5424
elizabeth.victor@wisconsin.gov

From: Stanforth, Robert [<mailto:RStanforth@trcsolutions.com>]
Sent: Monday, December 11, 2017 2:27 PM
To: Victor, Elizabeth A - DNR <Elizabeth.Victor@wisconsin.gov>
Subject: RE: Kewaunee Marsh arsenic Project

Sounds good. See you then. Anything in particular you would like me to review?

From: Victor, Elizabeth A - DNR [<mailto:Elizabeth.Victor@wisconsin.gov>]
Sent: Monday, December 11, 2017 3:26 PM
To: Stanforth, Robert <RStanforth@trcsolutions.com>
Subject: RE: Kewaunee Marsh arsenic Project

Sure!

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Elizabeth A. Victor, P.G.

Phone: (920) 303-5424

elizabeth.victor@wisconsin.gov

From: Stanforth, Robert [<mailto:RStanforth@trcsolutions.com>]

Sent: Monday, December 11, 2017 2:25 PM

To: Victor, Elizabeth A - DNR <Elizabeth.Victor@wisconsin.gov>

Cc: Zhang, Xiaochun - DNR <Xiaochun.Zhang@wisconsin.gov>

Subject: RE: Kewaunee Marsh arsenic Project

Liz

Can we make it at 10 AM on Weds?

Bob

From: Victor, Elizabeth A - DNR [<mailto:Elizabeth.Victor@wisconsin.gov>]

Sent: Monday, December 11, 2017 3:20 PM

To: Stanforth, Robert <RStanforth@trcsolutions.com>

Cc: Zhang, Xiaochun - DNR <Xiaochun.Zhang@wisconsin.gov>

Subject: RE: Kewaunee Marsh arsenic Project

Hi Bob:

Can we meet in the morning around 9:30 am on Weds?

Also: can you resend the information from the Dec 8th email (below) separately? This way I can authorize the work by returning your email and don't have to worry about having a long email train associated with this. Thanks!

Liz

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Elizabeth A. Victor, P.G.

Phone: (920) 303-5424

elizabeth.victor@wisconsin.gov

From: Stanforth, Robert [<mailto:RStanforth@trcsolutions.com>]

Sent: Friday, December 08, 2017 4:18 PM

To: Victor, Elizabeth A - DNR <Elizabeth.Victor@wisconsin.gov>

Cc: Zhang, Xiaochun - DNR <Xiaochun.Zhang@wisconsin.gov>

Subject: RE: Kewaunee Marsh arsenic Project

Liz,

TRC will attend a meeting with the WDNR to discuss the work conducted by TRC at the Kewaunee Marsh site and to obtain a better understanding of the conclusions and recommendations contained

within the 2007 and 2015 Treatability Reports, the 2010 Bioreductant Test Plots Pilot Study Report, and the 2012 Remedial Report. The WDNR is also requesting a discussion on the previous sampling and analytical methodologies used at the site.

Please authorize up to 8 hours of my time at a billing rate of \$221/hr. The 8 hours will include the meeting preparation and a half day meeting (up to 4 hours). The tentative meeting date is Wednesday, December 13, 2017. TRC proposes to perform these services under TRC General Terms and Conditions.

Thank you
Bob

From: Victor, Elizabeth A - DNR [<mailto:Elizabeth.Victor@wisconsin.gov>]
Sent: Friday, December 8, 2017 3:35 PM
To: Stanforth, Robert <RStanforth@trcsolutions.com>
Cc: Zhang, Xiaochun - DNR <Xiaochun.Zhang@wisconsin.gov>
Subject: RE: Kewaunee Marsh arsenic Project

Hi Bob:

For projects under \$5,000 we should get a quote from you for the work, approve the quote verbally or by writing (I would email you approval), you do the work, send me the invoice, I approve the invoice and send it in for payment. We typically would not issue a P.O. for work under \$5K. If this works for you (No P.O.), that would be perfect!

So: send me an email similar to below. The purpose of the meeting is to discuss the work conducted by TRC at the Kewaunee Marsh site and to obtain a better understanding of the conclusions and recommendations contained within the 2007 and 2015 Treatability Reports, the 2010 Bioreductant Test Plots Pilot Study Report, and the 2012 Remedial Report. We would like to discuss the previous sampling and analytical methodologies used at the site.

I would like to authorize up to 8 hours at your billing rate. The 8 hours should cover meeting preparation and a half day meeting (up to 4 hours). Is this reasonable? We don't expect a "dog and pony show" from you. Just take some time to review the old reports to re-familiarize yourself with them, and then the meeting time to discuss.

Weds afternoon would work great for Xiaochun and I.

Thanks,

Liz

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Elizabeth A. Victor, P.G.
Phone: (920) 303-5424
elizabeth.victor@wisconsin.gov

From: Stanforth, Robert [<mailto:RStanforth@trcsolutions.com>]
Sent: Tuesday, February 28, 2017 3:31 PM
To: Victor, Elizabeth A - DNR <Elizabeth.Victor@wisconsin.gov>
Subject: RE: Kewaunee Marsh arsenic Project

Liz

Is it possible for you to cut a PO for up to eight hours of my time (at an hourly rate of \$221/hr)? The scope is simply to discuss the Kewaunee marsh site, with no written output.

By the way, I will be at a conference next week, and may have some time to go over the results if you can get them to me.

Bob

From: Victor, Elizabeth A - DNR [<mailto:Elizabeth.Victor@wisconsin.gov>]
Sent: Thursday, February 16, 2017 4:16 PM
To: Stanforth, Robert <RStanforth@trcsolutions.com>
Subject: RE: Kewaunee Marsh arsenic Project

Thanks for the poster, Bob!

I am looking forward to meeting with you, too.

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Elizabeth A. Victor, P.G.
Phone: (920) 303-5424
elizabeth.victor@wisconsin.gov

From: Stanforth, Robert [<mailto:RStanforth@trcsolutions.com>]
Sent: Thursday, February 16, 2017 4:07 PM
To: Victor, Elizabeth A - DNR
Subject: RE: Kewaunee Marsh arsenic Project

Liz

It was good talking to you today, and I'm looking forward to more detailed discussion. I'll get a proposal to you shortly. In the meantime, here's a copy of the poster that I will be presenting.

Bob

From: Victor, Elizabeth A - DNR [<mailto:Elizabeth.Victor@wisconsin.gov>]
Sent: Thursday, February 16, 2017 3:31 PM
To: Stanforth, Robert <RStanforth@trcsolutions.com>
Subject: RE: Kewaunee Marsh arsenic Project

Hi Bob:

I'm sorry I didn't get back to you on this. I don't have any problems with you presenting the data.

I would like to find a time to meet with you to discuss the project. I have been hesitant to go forward with your proposal for additional treatment because I wanted to get a handle on what has been done and then take a step back to look at the "big picture". I am thinking the arsenic in the marsh will need "management" well into the future even if we immobilize or remediate the bulk of it because it is such a dynamic environment. What will be the cost of that management and what is the long term goal for the property? What about the woodchip cap? Much of the marsh was flooded this summer. Standing water and stressed vegetation was observed on the cap. We are concerned the cap may be deteriorating so are having to do some investigation of it this spring. I am thinking we need to revisit the remedial actions options previously evaluated for this site with an eye on the long term costs, goals, and issues before moving forward. I would also like to go over the geochemistry to make sure I understand the science and the issues.

I can come to Madison - it isn't that far for me - I live in Fond du Lac. It would be nice to set aside a good chunk of time for your input to come up with some ideas. We would have to set up a PO for your time. What do you think? Middle to late March?

Give me call when you get a chance,

Liz

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Elizabeth A. Victor, P.G.

Phone: (920) 303-5424

elizabeth.victor@wisconsin.gov

From: Stanforth, Robert [<mailto:RStanforth@trcsolutions.com>]

Sent: Thursday, November 10, 2016 12:07 PM

To: Victor, Elizabeth A - DNR

Subject: RE: Kewaunee Marsh arsenic Project

Liz

I would like to present the results of the treatability study on the moderately contaminated Kewaunee sediments at the upcoming RemTec conference next year, and wanted to make sure that it is ok to talk about the site in a conference presentation.

Any action happening on the site?

Bob

From: Victor, Elizabeth A - DNR [<mailto:Elizabeth.Victor@wisconsin.gov>]

Sent: Wednesday, November 18, 2015 2:53 PM

To: Stanforth, Robert <RStanforth@trcsolutions.com>

Subject: Kewaunee Marsh arsenic Project

Hi Bob:

I have taken over the management of the Kewaunee Marsh Arsenic Spill Project from Tauren. I will be spending the next several months reviewing the project data and developing a long term plan and budget for the site. At some point in the future it would be nice to meet with you to discuss your injection proposal and where you see this project going. Please feel free to contact me anytime!

Liz

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Visit our survey at <http://dnr.wi.gov/customersurvey> to evaluate how I did.

Elizabeth A. Victor, P.G.

Hydrogeologist

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Stabilization Approaches Tested for Kewaunee Marsh Sediments
Bob Stanforth, December 2017

TRC (originally RMT) evaluated stabilization approaches for the arsenic in Kewaunee Marsh starting in 2005 and continuing through several phases of work for ten years. Several different approaches were tested and are listed (and briefly discussed) below. Note that dig and haul (or dig, treat, and haul) was not considered since the focus was on stabilization. After the initial testing, the testing was often conditioned by the approach suggested by DNR.

The arsenic stabilization approaches are generally based on the natural cycling on arsenic in the environment, as shown in Figure 4.1 of the 2010 Test Plots report.

Initial Testing (August 2007 report)

Process	Additive	Comment
Adsorption	Aluminum hydroxide	Not very effective
	Iron hydroxide	Moderately effective
	Foundry Waste Products	Moderately effective
Precipitation/adsorption	Aluminum sulfate w/wo pH control	Moderately effective
	Ferric sulfate w/wo pH control	Very effective with pH control
Reduction	Metallic iron	Very effective
	pyrite	Not effective
Solidification	cement	Very effective

During the testing, it was noted that the arsenic concentrations at the site seem to be going down over time. It was hypothesized that this could be due to arsenic loss as arsine due to the very reducing conditions in the marsh. The next testing was done to see if the arsine formation could be enhanced by adding bioreductants. The concept worked in the lab, but was less successful in field trials (probably due to the marsh surface becoming oxidized as the water level fell). It is more likely that the arsenic loss is due to vertical mobility to the surface, followed by surface runoff, but this is a hypothesis that needs to be tested.

Hot Spot remediation

During the stabilization investigations, areas of high arsenic contamination were found under and next to the railroad bed. We looked at several approaches for remediating this highly contaminated area, including groundwater extraction with off-site disposal or treatment and on-site treatment with either off-site disposal or replacement on site. The groundwater extraction would require that too much water be moved, so an in-situ treatment approach was developed including the following steps:

- Peroxide addition to convert arsenite to arsenate
- Ferric sulfate addition to precipitate arsenic as ferric arsenate
- Limestone addition for pH control (to neutralize the acid from the ferric iron)
- Bentonite to lower the permeability following treatment

The approach was implemented in 2011 and was generally successful at reducing dissolved arsenic to much lower levels than before treatment.

As a follow-up to the hot spot remediation, DNR requested that an injectable reagent be developed for the area immediately adjacent to the hot spot, with the idea being that the reagent could be introduced via Geoprobe and without disturbing the marsh. The approach developed utilizes a sodium lactate-ferrous sulfate reagent that stimulates the bacteria to generate very reducing conditions and immobilize arsenic as a sulfide compound (such as arsenicopyrite – FeAsS). The approach worked well in the lab, but has not been tested in the field. Note that the reduced arsenic will stay stable as long as the conditions are reducing (i.e. in the groundwater).

What are some approaches that could be used for larger scale remediation at the site?

Possibly

- Dig and haul with disposal as a hazardous waste
- Dig, treat to render nonhazardous, and haul
- Treat with ferric iron and place above ground
- Treat with ferrous iron/sulfide and place below the groundwater table
- Treat with cement and place anywhere (Could we use the cement to make a rest area by the trail, or place on the downgradient edge and use that as the nonpermeable barrier suggested below?)
- Replace the cap with a layer either of ferrous sulfide or metallic iron (below the groundwater table) or ferric or aluminum oxide (above the groundwater), or with a nonpermeable layer (e.g. bentonite) to trap contaminated groundwater below the cap. We need to do something to stop the vertical migration of arsenic.
- In conjunction with replacing the cap, install a nonpermeable barrier around the downgradient edge of the contaminated area (this is Ted O'Connell's idea).
- Some form of phytoremediation.