The Remediation of the North Clooney Loop/I-10 Calcasieu River Bridge Area: Everything but the Kitchen Sink

Laura LeBouef, P.G.

LDEQ, Remediation Division

Disclaimer

- This is intended to tell a story rather than get into the specifics of each type of remedial system

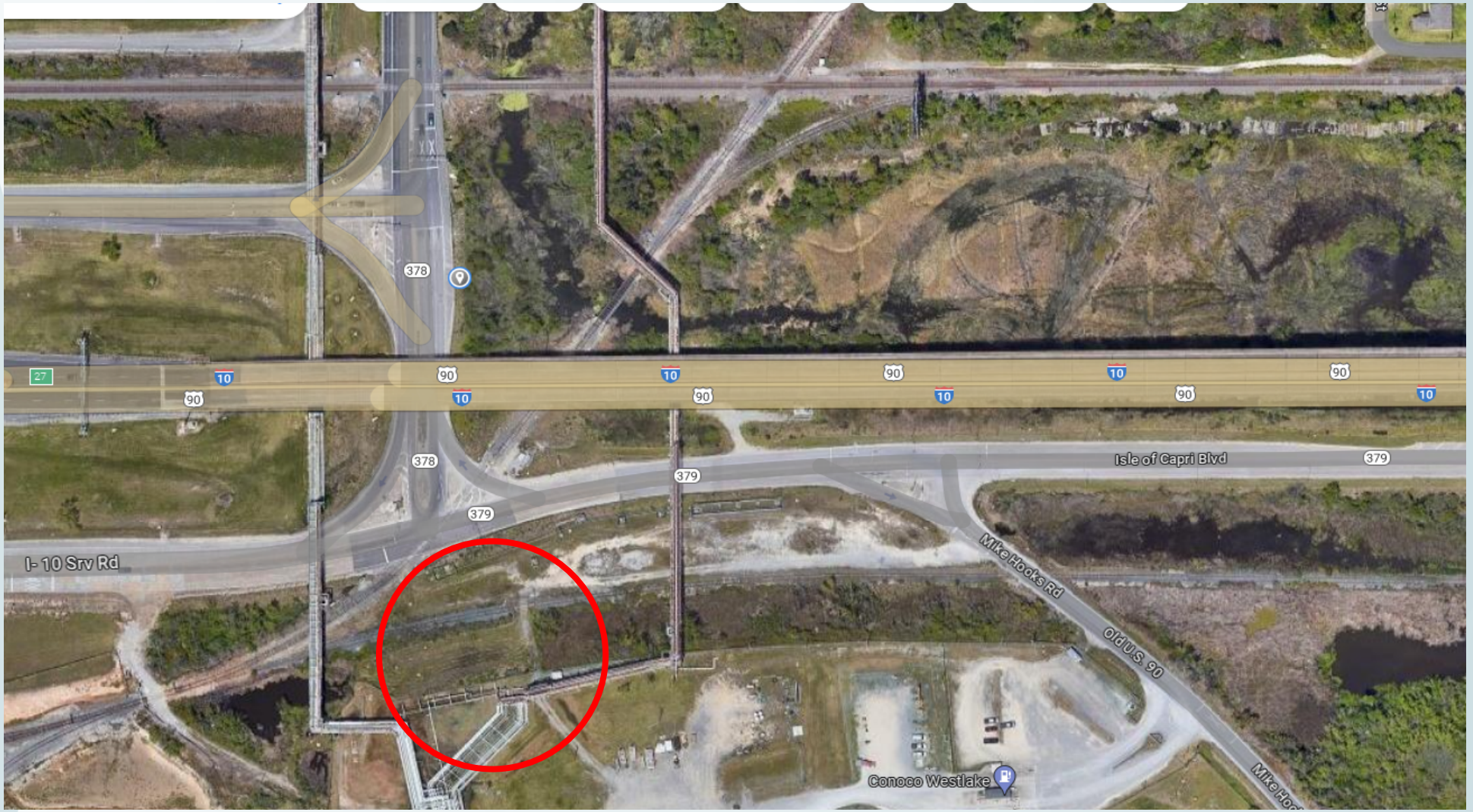
So why the I-10 Calcasieu River Bridge Site?

- This site is a great case study to show how different phases of remediation (including pilot testing) were implemented.
- Multiple zones were impacted and illustrate the differing behaviors of the contaminant in the subsurface and how different sediment types impacted remediation efforts.
- Illustrates the importance of good working relationships between parties.

Prologue…

- In 1994, a leak occurred in an underground pipeline underneath the ConocoPhillips (now Phillips 66) docks property, immediately south of the I-10 bridge in Westlake.
- It’s estimated that 150,000 and 170,000 gallons of 1,2-Dichloroethane (EDC) was spilled into the ground and stormwater ditches.

The Setting…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Isle of Capri Blvd
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I- 10 Srv Rd
Mike Hooks Rd
Old U.S. 90
Conoco Westlake

A Mess!

- This was a big spill.
- EPA took over the initial emergency response, and the US Coast Guard was involved as well as various state agencies. DEQ soon took over as lead agency directing cleanup.
- Emergency permits were requested and issued.

And so it begins…

- Initial emergency response activities included constructing earthen dams and ditches lined with Visqueen, collection of contaminated surface water, and excavation.
- Remediation Technique #1: Dig and Haul

How much digging?

- Just in the initial phase of remediation, over 6,200 tons of soil removed
- Thermal desorption unit placed to try to recover some EDC
- All contaminated excavated soils had to go to a Subtitle C landfill ($$)

Let’s fast-forward a bit…

- Following the initial emergency response, several rounds of investigations occurred to try to delineate the impacts.
- Monitoring and recovery wells were installed quickly and began operating (still operating)
- Remediation Technique #2: Pump and Treat

What's happening now with this?

- Multiple recovery wells have been operating since the 1990's, with an average pumping rate of 14.64 gpm (although that's variable depending on which well we're talking about)
- As of June 2023, over 161 million gallons of groundwater have been recovered, treated on site, and released

It’s time to go deeper… The permeable zones

- Organic Silt and Peat Zone (0-20’ bgs, non-continuous)
- 40’ Sand: semi-confined aquifer which thins to the north
- Interbedded Unit: interbedded sand, silt, and clays roughly 60-80’ bgs
- Upper Chicot Aquifer (a.k.a. 200’ Sand): roughly 120-150’ bgs in this area, overlain by over 25’ of “gumbo clay”

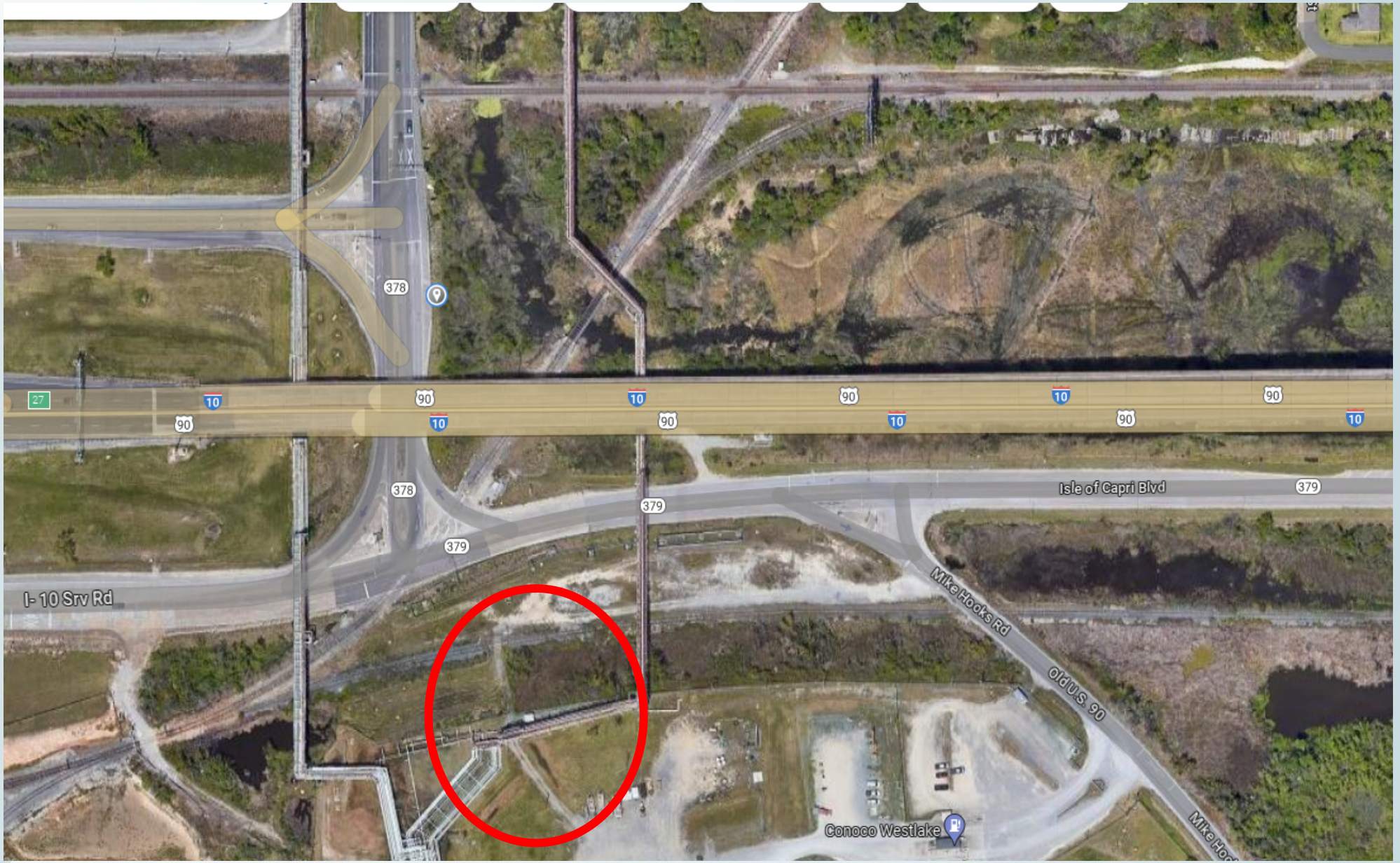
- What’s weird? All units have potentiometric flow directions roughly toward the south except for the IU. This will get interesting.

What does any of this have to do with a bridge?

- In early 2000s, LDOTD informed LDEQ that they needed to replace the I-10 Bridge over the Calcasieu River.
- Since this is so close to the EDC release area, both agencies agreed additional investigation was necessary
- Phillips 66's cooperation was requested in sampling the area north of Isle of Capri Blvd in preparation for construction

The Bridge

- Calcasieu River Bridge (a.k.a. LA Memorial World War II Bridge) opened in 1952. It turned 70 last year! (average bridge age in the US is 42 yo)
- Has been rated as Structurally Deficient by the National Bridge Inventory with a rating of 3 and a Sufficiency Rating of 9.9/100. Because of this, speed limit has been dropped to 50 mph, and truck traffic is contained to the right lane.
- Steep grade further slows trucks, backing up traffic regularly and adding to weight on the bridge.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Seek and ye shall find…

- 2 sets of borings were conducted in 2007 and a third in 2009
- It was discovered that the EDC contamination had migrated off-site into the area of proposed bridge construction
- An “area of thin separation” was found in the clay between the 40’ Sand and the Interbedded Unit. While the 40’ Sand does not occur in the marsh area, the unique flow pattern of the Interbedded Unit carried EDC to the northeast.

Some important stuff…

- This area is extremely challenging to work in!
- Is a marsh/wetland area, so CoE agreement was needed
- There are 2 different rail lines from 2 different RRs
- Buried utilities
- Pipe racks
- Right off the interstate
- Surface roads adjacent
- Political!

Nope. Not fun at all.

Meanwhile…

- As the investigation proceeded in the marsh area, pilot testing was occurring to the south near the source area.
- In 2008-2009, Phillips 66 submitted a pilot test plan for ERH (Electrical Resistance Heating or Remediation Technique #3), which was subsequently approved and implemented.
- Final report submitted 2/16/10

But what is it?

- ERH is an in-situ thermal treatment for soil and groundwater
- An electrical current is passed through the soil and groundwater, which boils a portion of soil moisture into steam. Steam is recovered and volatile organic compounds (VOCs – like EDC) are removed from the vapor stream
- Also tested different methods for VOC removal from steam

The system…

- 3 pairs of electrodes (consisting of 2 interlocked carbon steel sheet piles) energized by a power control unit
- Test area covered with synthetic liner underlain by slotted vacuum piping to control and collect vapors
- Vapor treatment equipment included condenser, various vapor-phase treatment technologies, and activated carbon
- Power was provided by dedicated power line (installed by Entergy) and connected to a step-down transformer
- Average temps were raised to 52 C or 125 F

What it looked like…

Did it work? Yes and no…

- Hurricane Ike damaged one thermocouples
- Both Hurricanes Gustav and Ike resulted in significant downtime during which higher temps were lost
- Different vapor treatment options had mixed results
- EDC mass removal was calculated to be 98%
- While only the 40’ Sand and Organic Silt and Peat Zones were tested, there was significant settling in the OS&P zone, unacceptable given all the infrastructure.
- So, no dice.

Now what?

- In 2009, Phillips initiated some bench studies to try different techniques to treat EDC concentrations. Selected to try were:
  - In-Situ Chemical Oxidation (ISCO, or Remediation Technique #4)
  - Enhanced In-Situ Bioremediation (EIB, or Remediation Technique #5)

ISCO First…

- ISCO is a remediation technology in which oxidants are introduced into the subsurface to react with the contaminants
- Phillips tried both Fenton's reagent and iron-activated persulfide to see how they would react to the lower EDC concentrations in the Interbedded Unit
  - Fenton's reagent is a combination of peroxide and dissolved iron

And?

- Bench-testing on ISCO found that it had the potential to reduce EDC concentrations if delivery and subsurface distribution were successful.
- Off-gassing was identified as a potential problem
- EIB was more successful during bench-testing

EIB for the win (for bench-testing, anyway)!

- EIB seeks to stimulate reductive dechlorination
- In “plain speak:” using, adding, or supplementing bugs (*Dehalococcoides sp*. and *Dehalobacter sp*.) to break down the EDC into less nasty stuff

Test goes live..

- Since bench-testing was successful, Phillips opted to launch pilot testing for the IU
- 12 injection points were selected at depths from 55-60’bgs
- A slurry of zero valent iron (ZVI), hydrolyzed kelp, yeast extract, EHC (a proprietary formula often used in EIB systems), and other nutrients were injected (roughly 1,800 gallons’ worth)
- Monitoring wells sampled before and after to see if injections worked

Did this work?

- Yep.
- It was found that EDC concentrations were substantially reduced in the test area within several months.
- Would require closely-spaced injections.
- Would be a technology “to be considered” moving forward
- So? Why aren’t we more excited?

Remember this?

Final thoughts on EIB (and ISCO)

- Given the challenges of working in the marsh (not to mention all the other infrastructure), would be a challenging technology to implement
- Be advised that both require injection permits by DNR
- Final report on the EIB submitted to LDEQ 10/10/14

Is there anything left to try? Yes!

Enter the LDA/SS…Or Remediation Technique #6 if you're counting

- In October 2013, Phillips 66 submitted a work plan to pilot test the Large Diameter Auger/Steam Stripper
- LDA/SS is a thermal remediation process that combines the mixing of deep soil, steam injection, and vapor extraction all in a single process

But what IS it?

- A large-diameter hollow auger (8’ diameter) which then injects hot compressed air and steam out of injection ports on the back side of the auger blade
- All the while, soil is also blended by the auger’s motion – three total passes per injection point
- At the surface, a 12’ diameter, 10 ton shroud is in place to intercept vapors
- Vapors sent to vapor conditioning system

Excitement!


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STOP

Details…

- The pilot test was broken into 2 areas, with some using ZVI as an amendment
- Also tested were different off-gas treatment units
- Soil and GW samples collected before and after

How did it go? Well….

- The OS&P zone caused some pretty major problems
- Material “flowed” out from under the shroud, resulting in numerous work stoppages
- Heavy rain also made matters worse

Results?

- Soil sampling indicated that LDA/SS treatment could reduce EDC concentrations up to 90% without ZVI and up to 98% with ZVI
- Groundwater was a bit different: Sampling showed a 90% reduction in the OS&P zone, but not in the 40’ Sand
- Ultimately, it was determined that this was not a good option for this area, predominantly due to soil stability. The resulting loss of soil strength would require soil stabilization if full-scale application was implemented.
- Final report submitted 4/13/15

Today…

- The North Clooney Loop Marsh Area has been exhaustively studied
- From 2009-2022, quarterly sampling was conducted (now semi-annual)
- Groundwater modeling has shown that natural attenuation is occurring, and that by 2033, all concentrations will be below the RECAP SS (That's the FINAL remediation technique: Monitored Natural Attenuation!)

MNA….

- This is not just a “watch and wait” approach
- Appropriate when concentrations are low
  - Must see the concentrations drop via consistent monitoring
  - Also look for daughter products if applicable

That’s all, folks

- All reports referenced can be found in LDEQ’s EDMS under AI #2538

Laura LeBouef

Laura.Lebouef@la.gov

225-219-3654

THANK YOU!