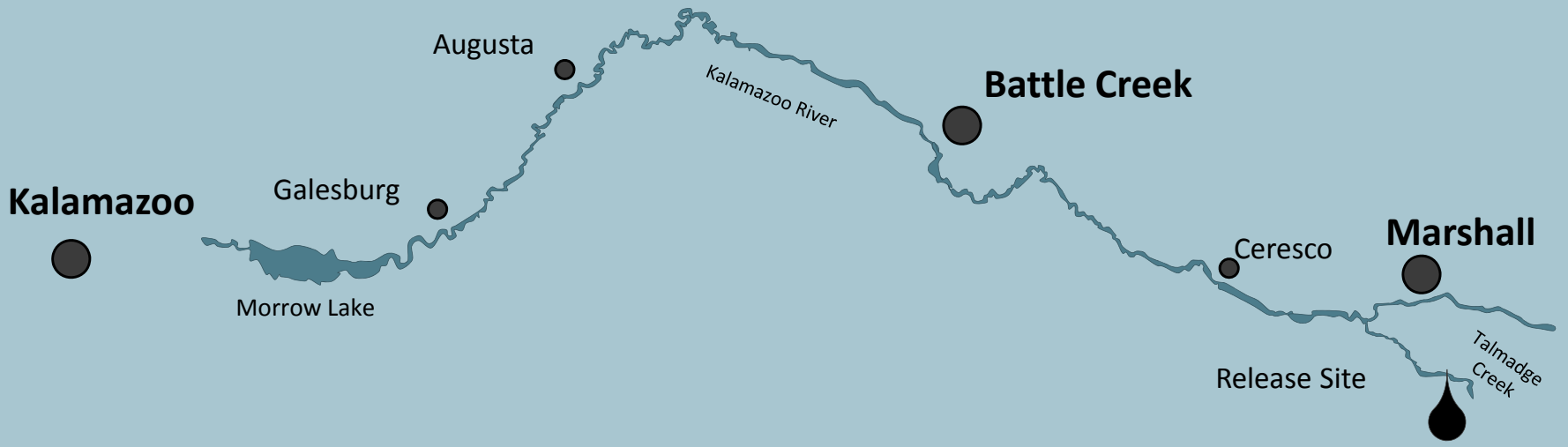
Briefing – Enbridge Oil Spill
September 2012



Briefing Topics

Project Status Update

- Chronological Work Summary
- 2012 Spring Submerged Oil Reassessment Summary
- 2012 River Opening Summary
- Current & Projected Sediment Trap Locations
- Sheen Management

Submerged Oil Quantification

Net Environmental Benefit Analysis

Endpoint Framework

Transition to MDEQ

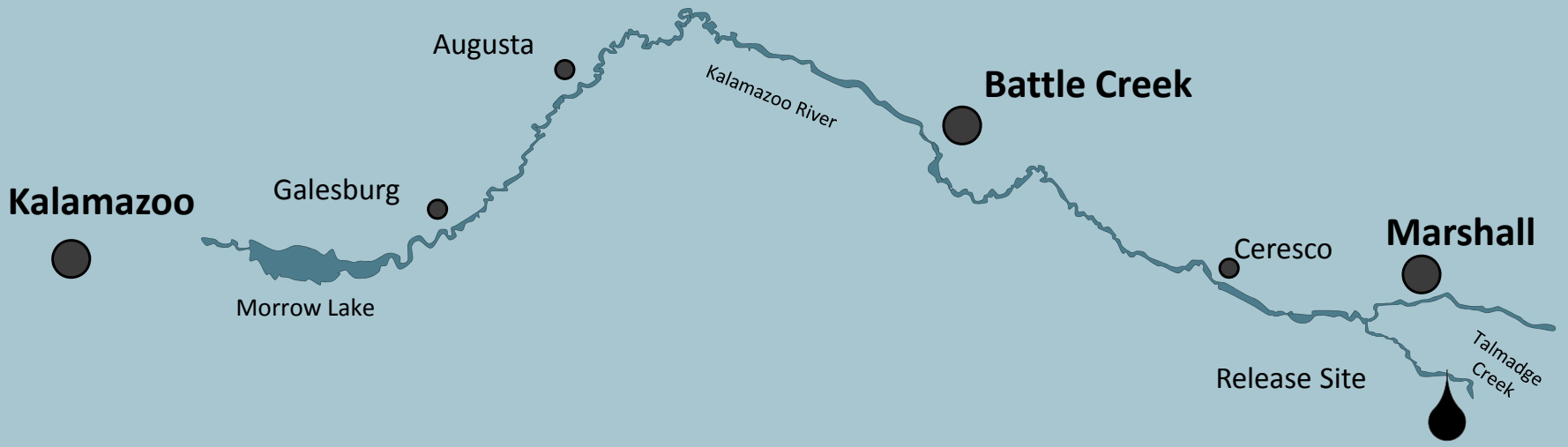
U.S. EPA Regulatory Background

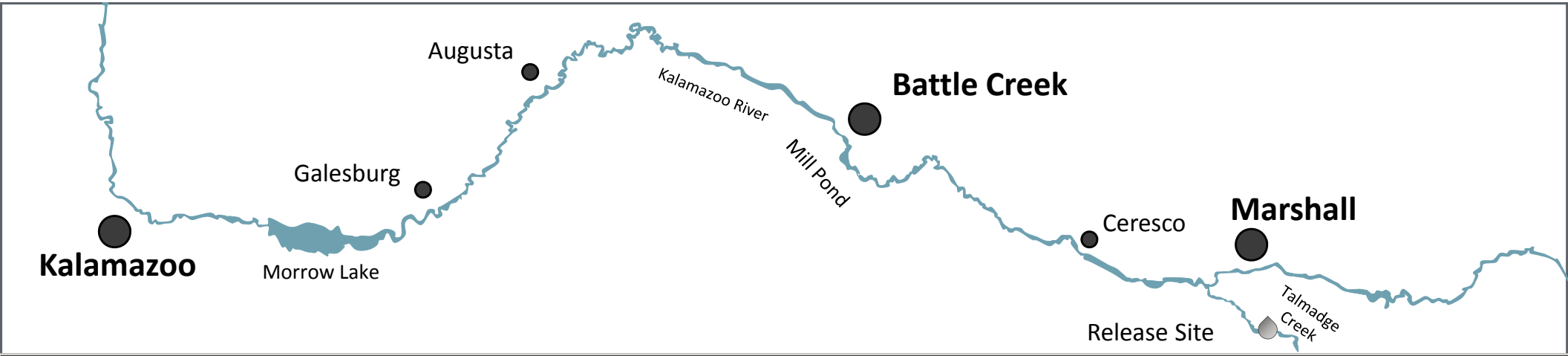
Ceresco Dam Conditions

Mill Ponds Conditions

Morrow Lake Delta Conditions

Project Status Update





Chronological Work Summary

Jan. 2012

April 2012

June 2012

Sept. 2012

Winter

Spring

Summer

System Wide Agitation Recovery

2012 Spring Reassessment

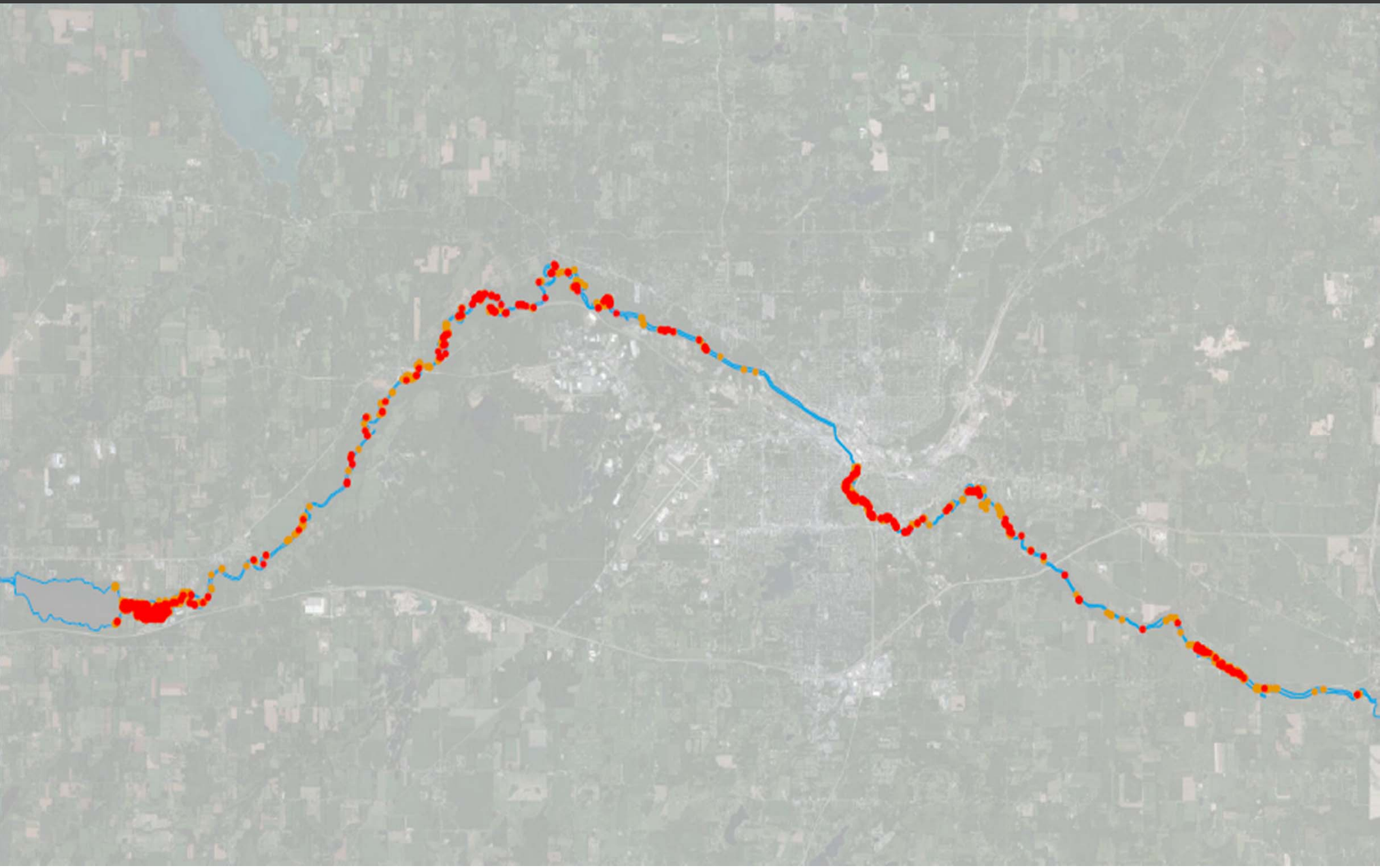
Sediment Trap Installation / Targeted Residual Recovery

Incremental River Opening With Buoy Permit

Transition to MDEQ

Ongoing Scientific Work

2012 Spring Submerged Oil Reassessment Heavy & Moderate Poling along entire Kalamazoo River System



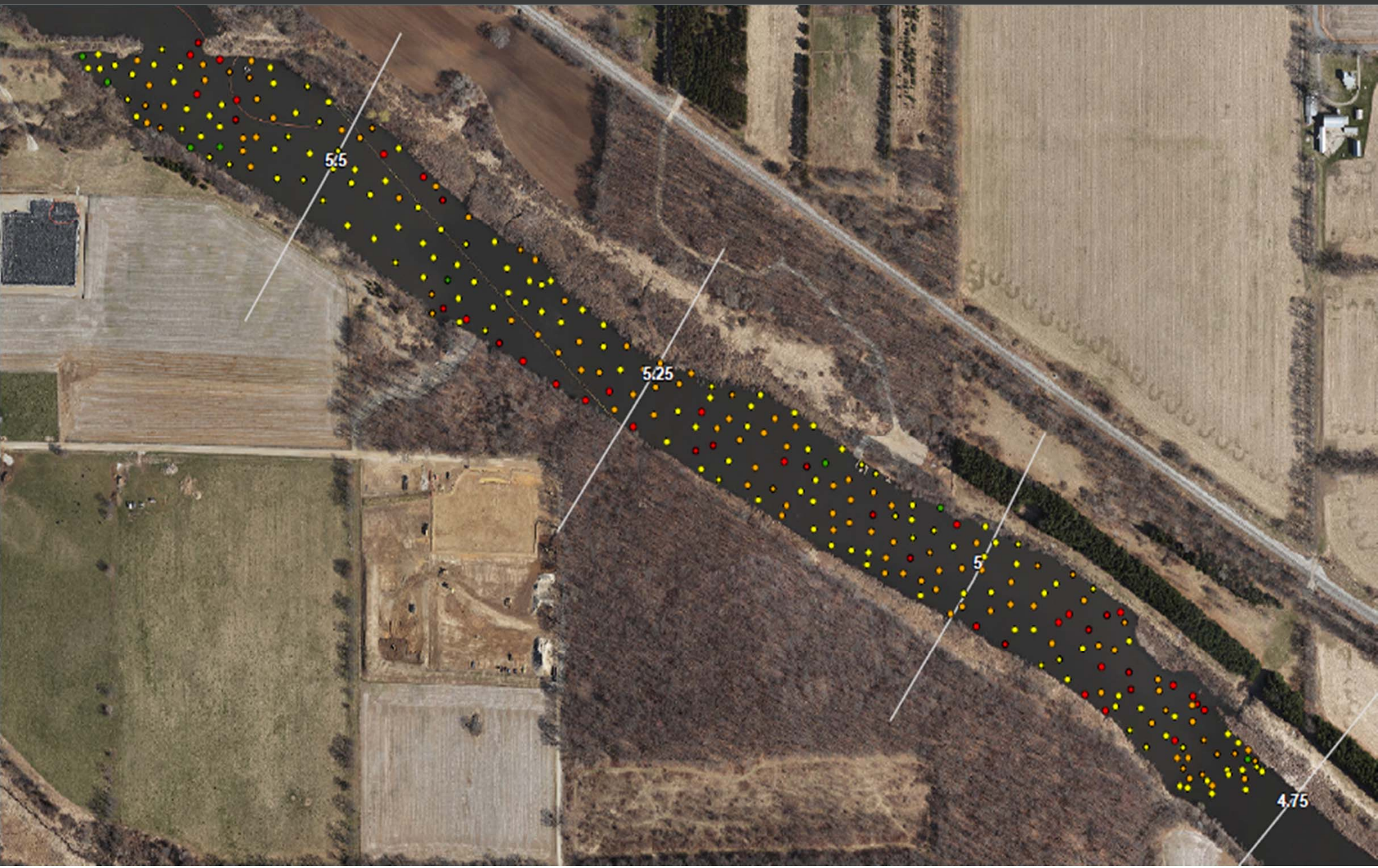
2012 Spring Submerged Oil Reassessment Heavy & Moderate Poling Delineation at Ceresco Dam



2012 Spring Submerged Oil Reassessment Poling at Ceresco Dam – MP4.75 to MP MP5.63



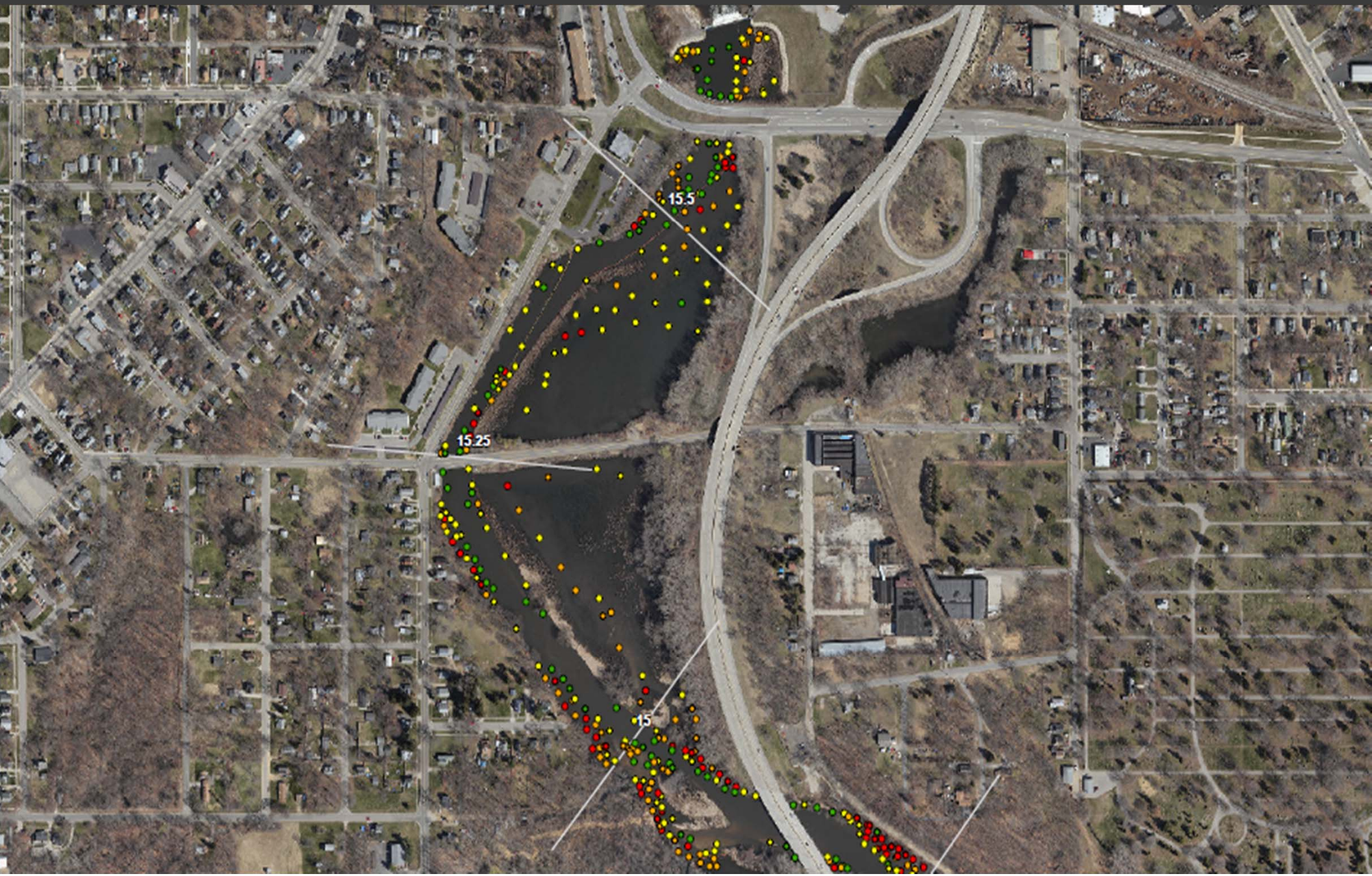
2012 Late Summer Submerged Oil Reassessment Poling at Ceresco Dam – MP4.75 to MP MP5.63



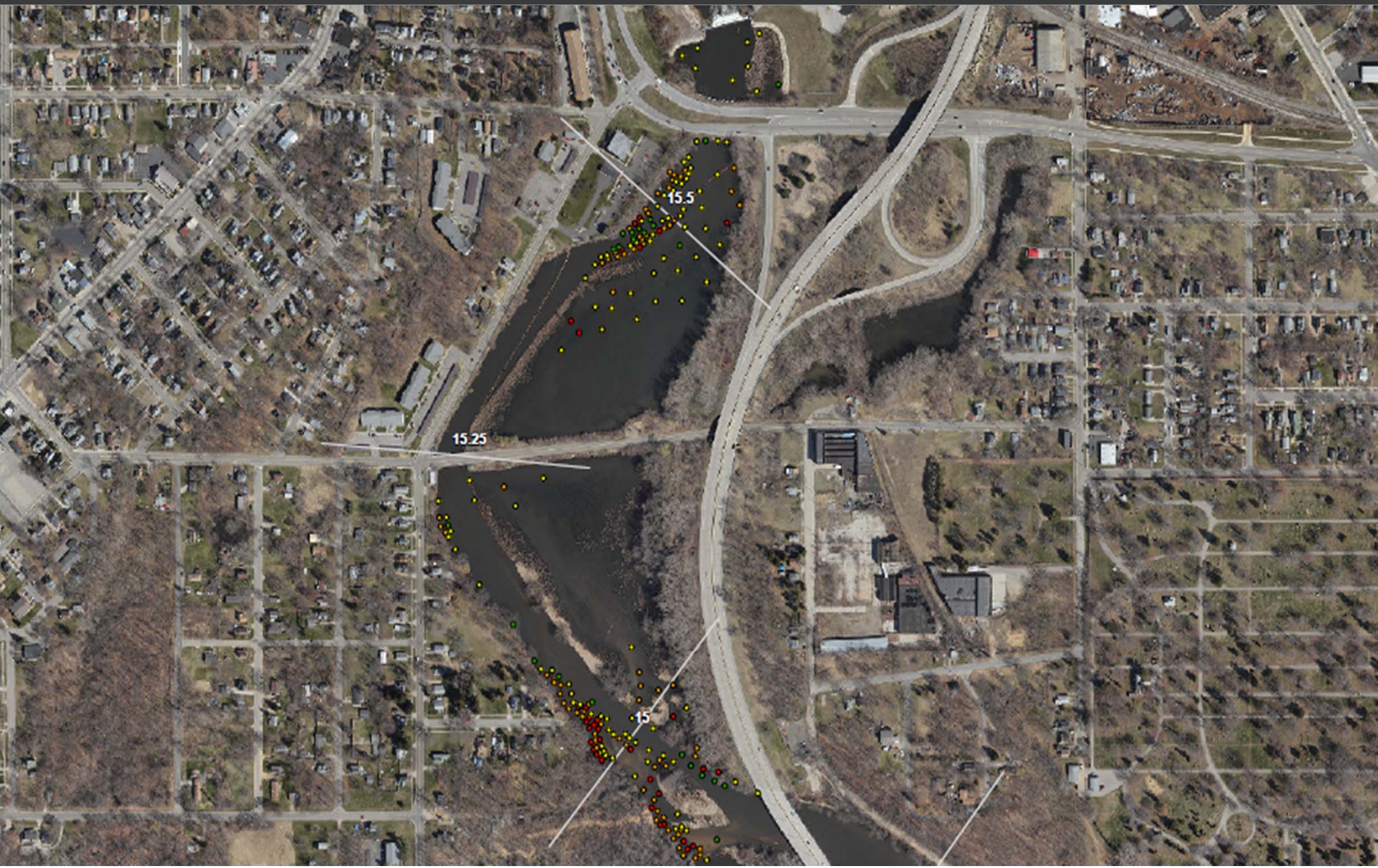
2012 Spring Submerged Oil Reassessment Heavy & Moderate Poling Delineation at Mill Ponds



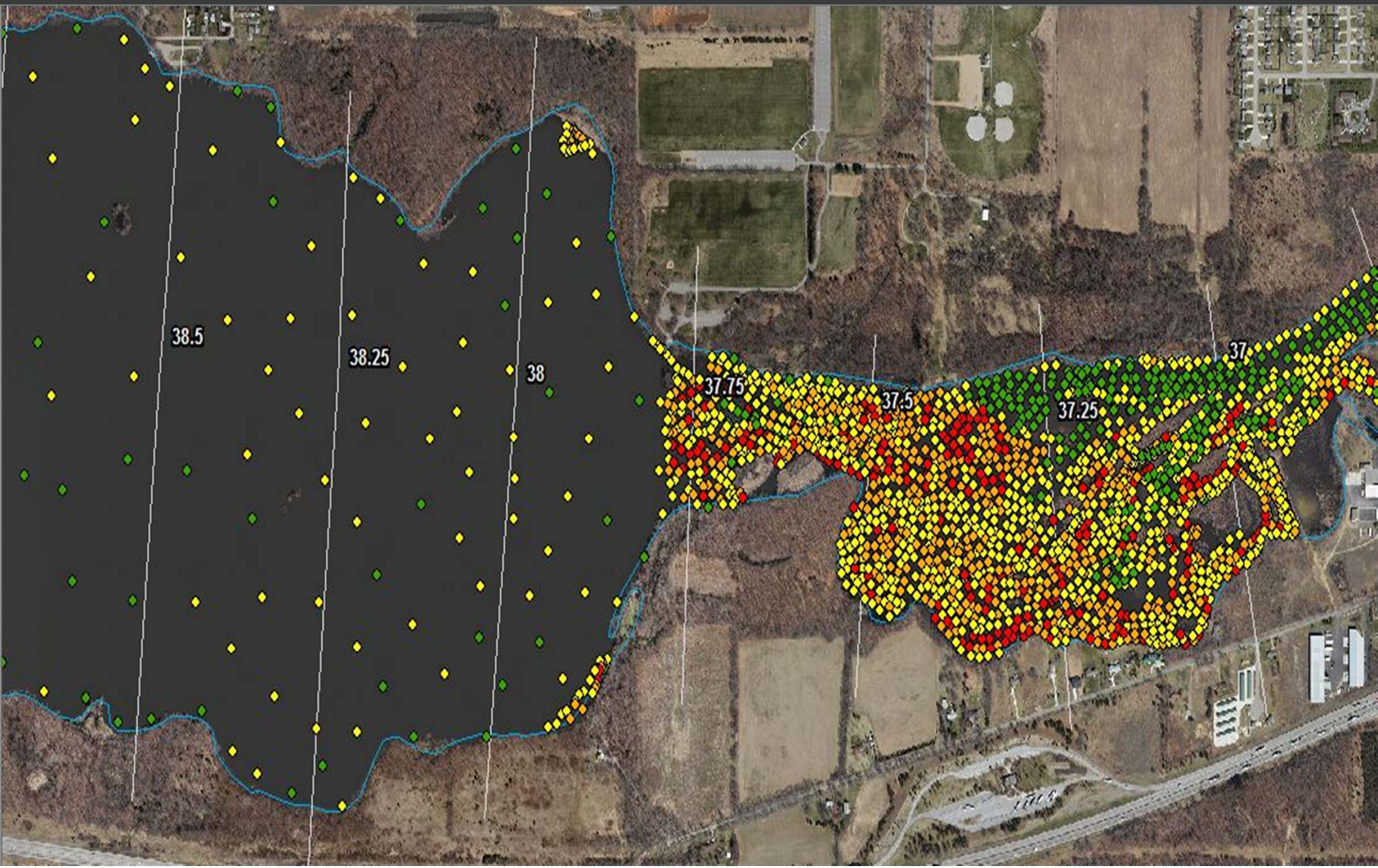
2012 Spring Submerged Oil Reassessment Poling at Mill Ponds



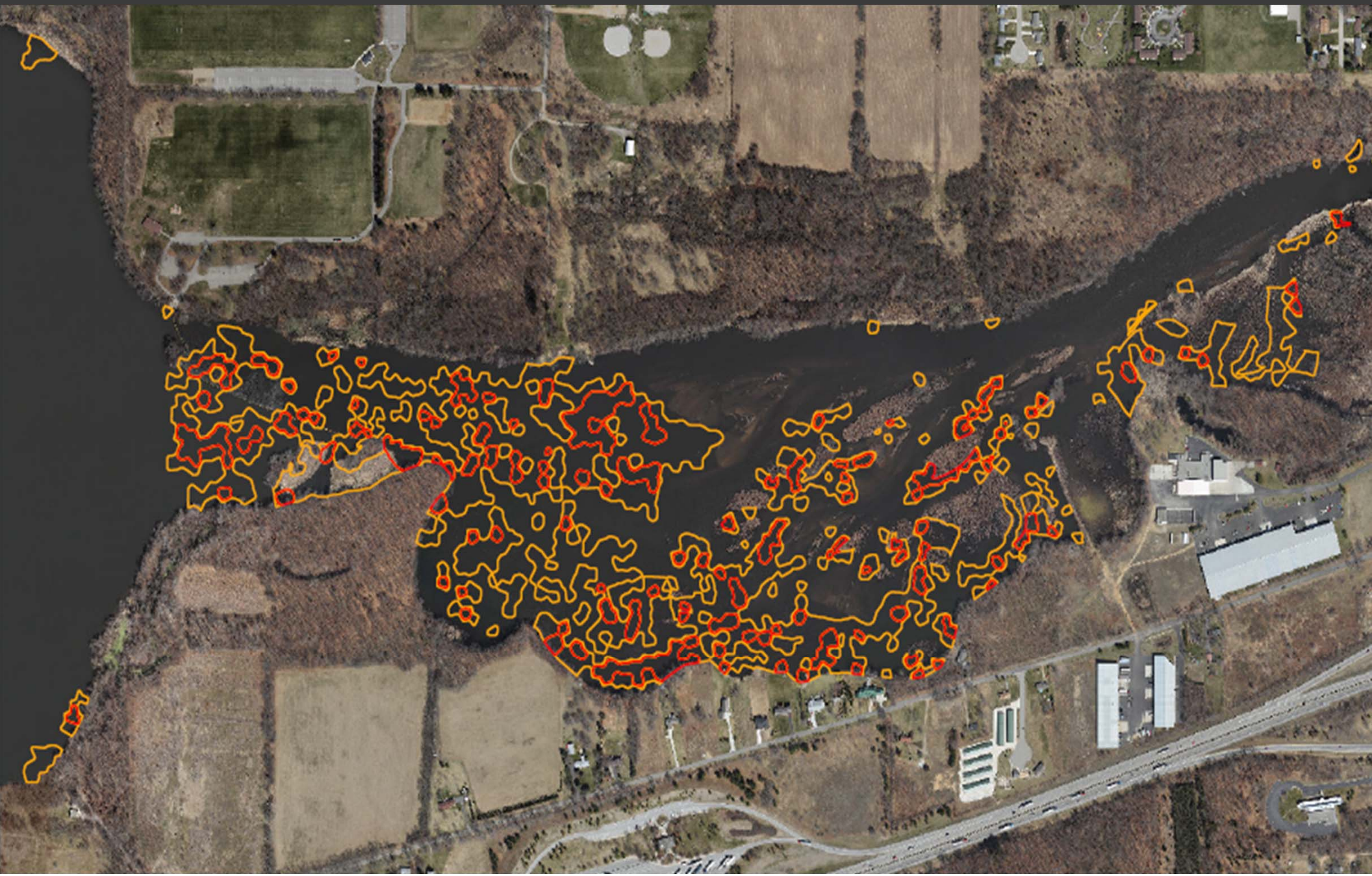
2012 Late Summer Submerged Oil Reassessment Poling at Mill Ponds



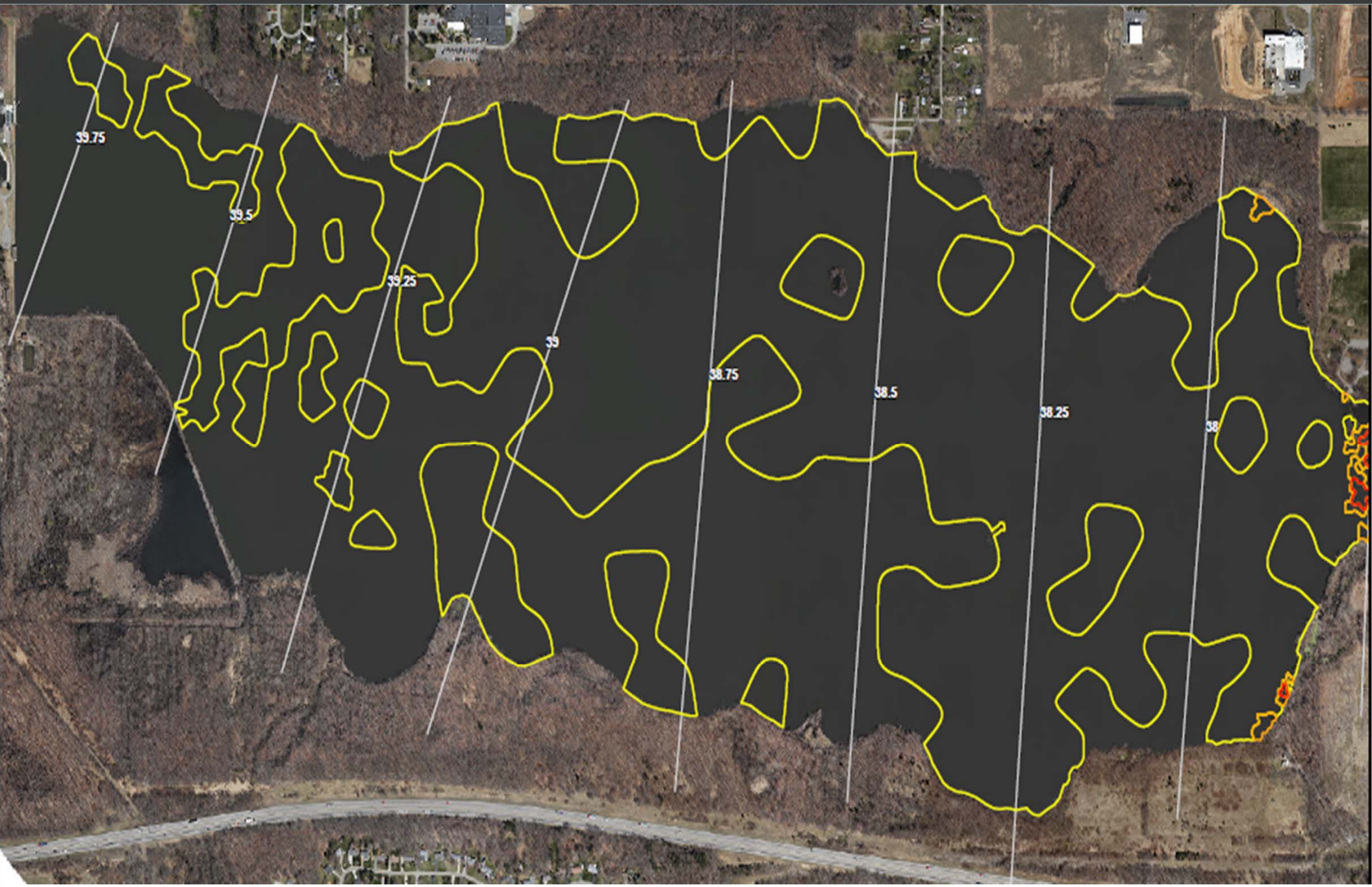
2012 Spring Submerged Oil Reassessment Heavy & Moderate Poling at Morrow Lake Delta and Morrow Lake



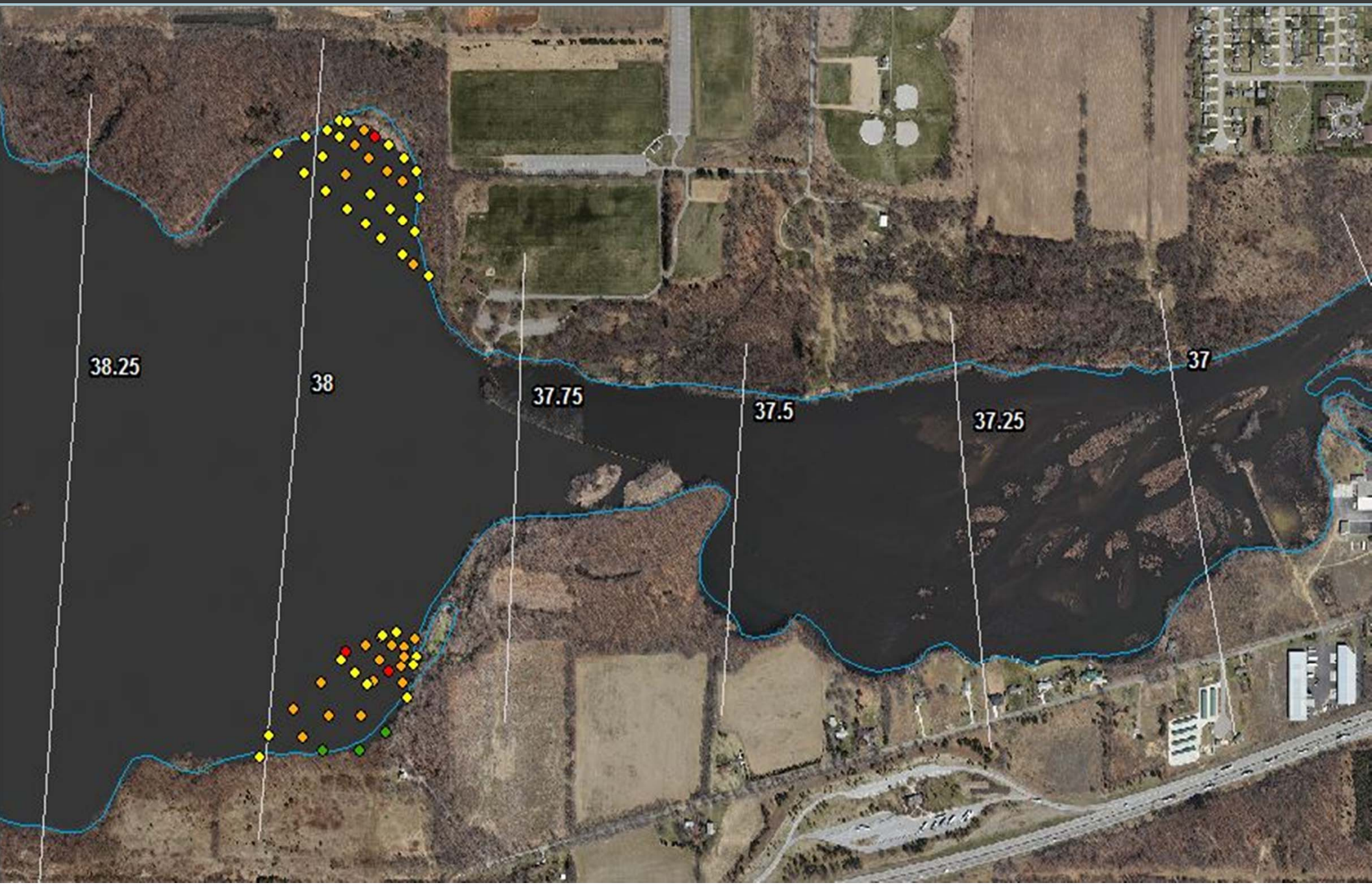
2012 Spring Submerged Oil Reassessment Heavy & Moderate Poling Delineation at Morrow Lake Delta



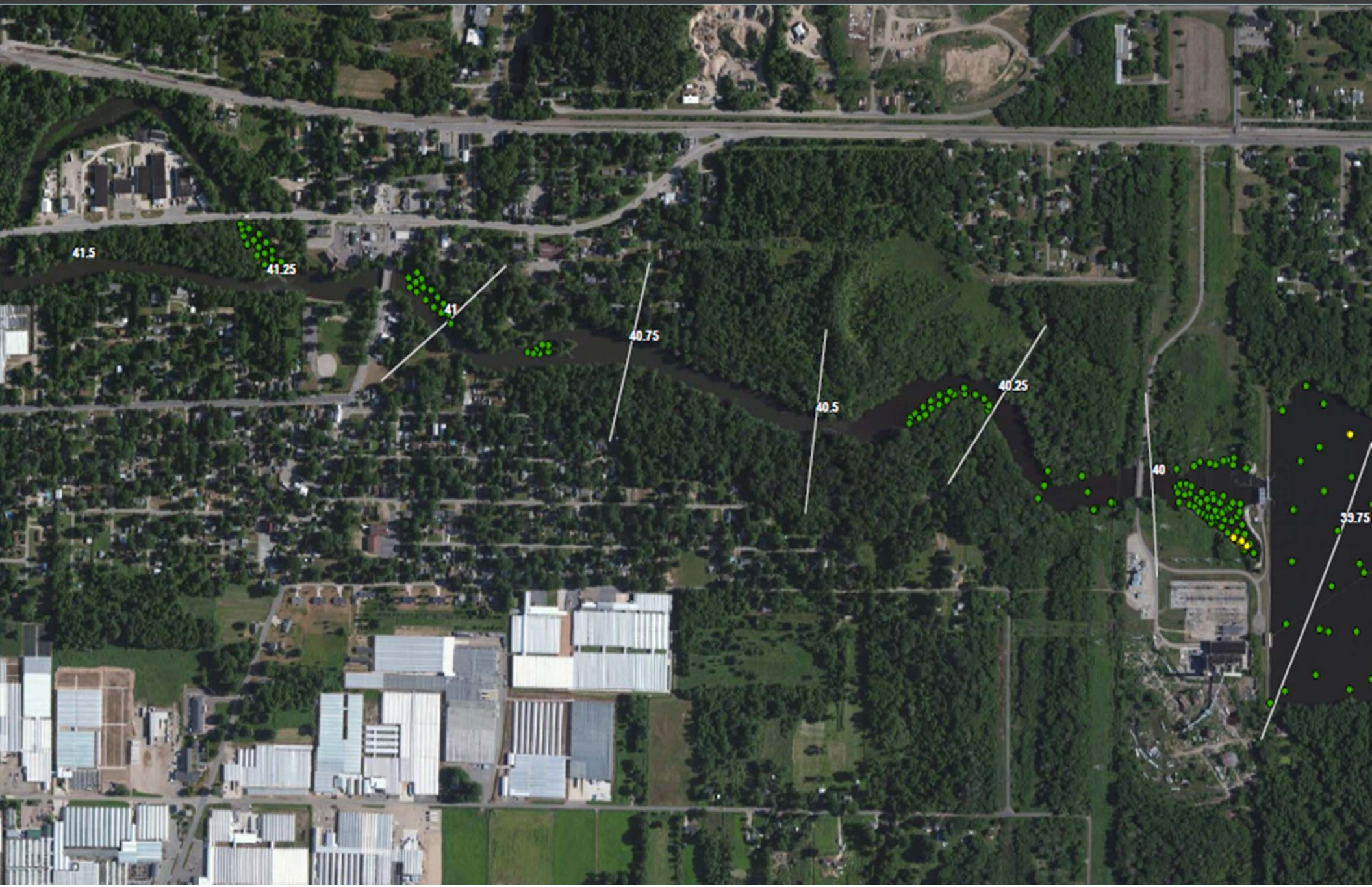
2012 Spring Reassessment Heavy, Moderate, & Light Poling Delineation at Morrow Lake

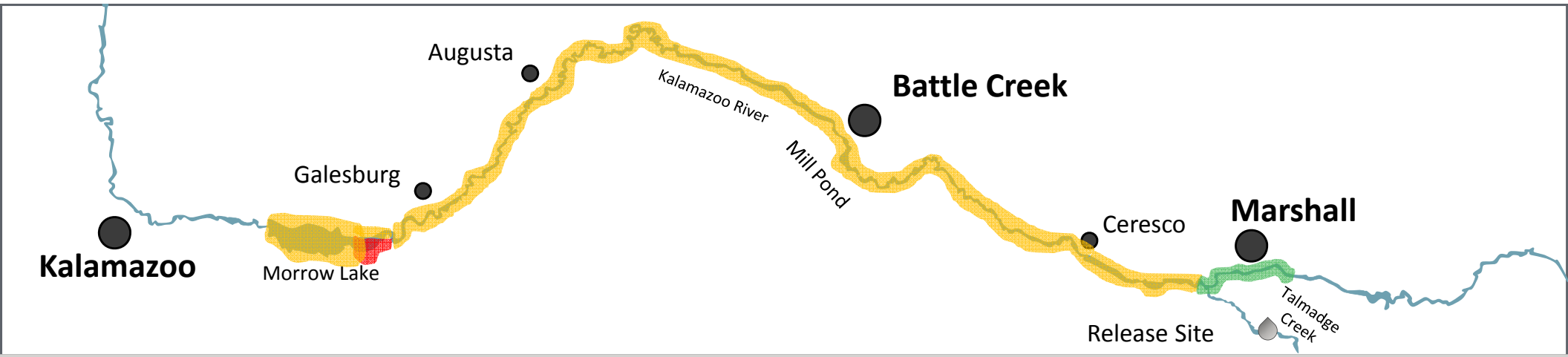


2012 Late Summer Reassessment Heavy, Moderate, & Light Poling at Morrow Lake



2012 Spring Submerged Oil Reassessment
Downstream of Morrow Lake Dam

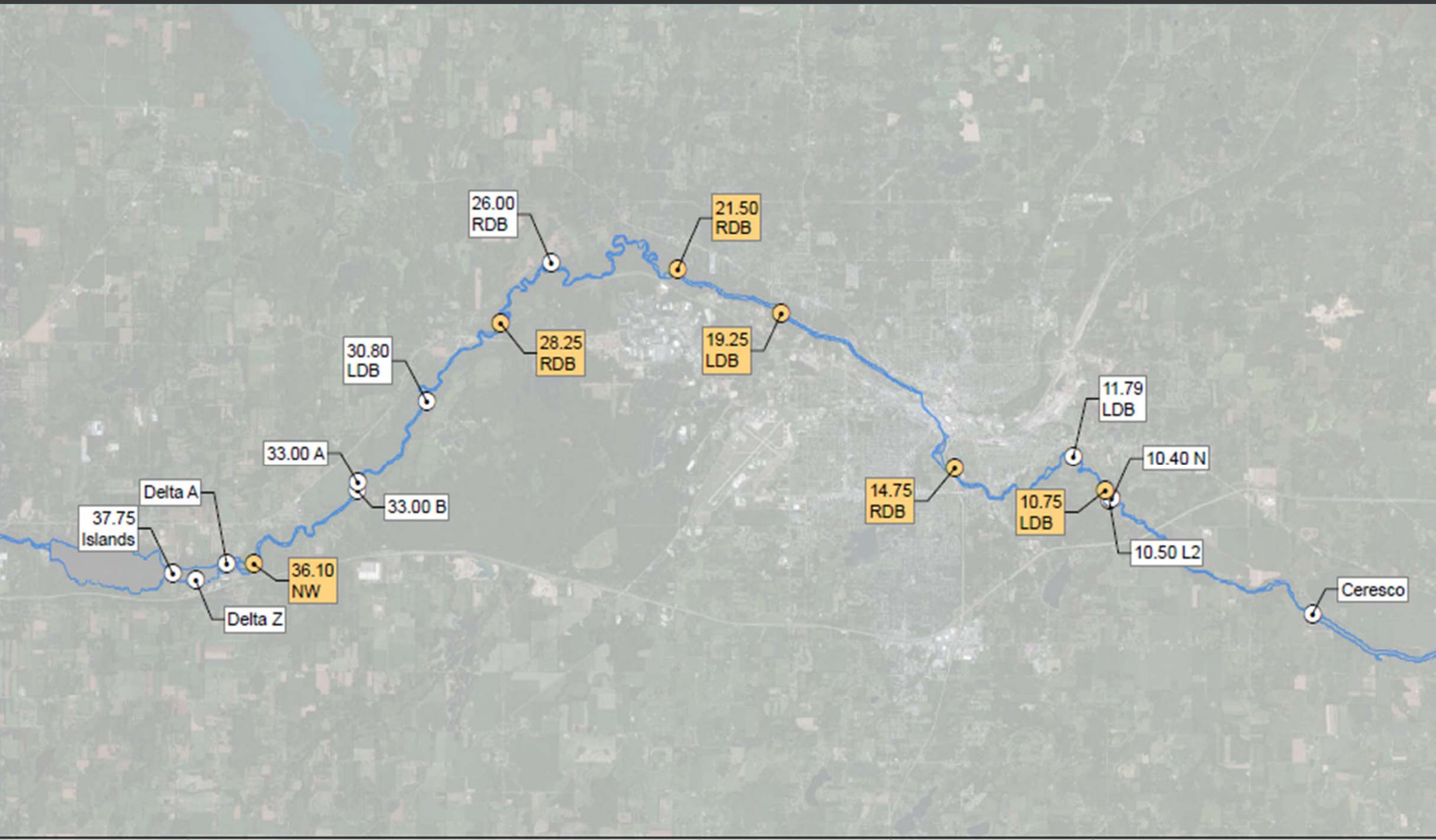




2012 River Opening Summary

- Phase I - Opened on April 18, 2012
- Phase II - Opened June 22, 2012
- Morrow Lake Delta: Remains Closed except River Channel

Current & Projected Sediment Trap Locations



FOR OFFICIAL USE ONLY

Legend

- Phase 1 Sediment Traps
- Phase 2 Sediment Traps

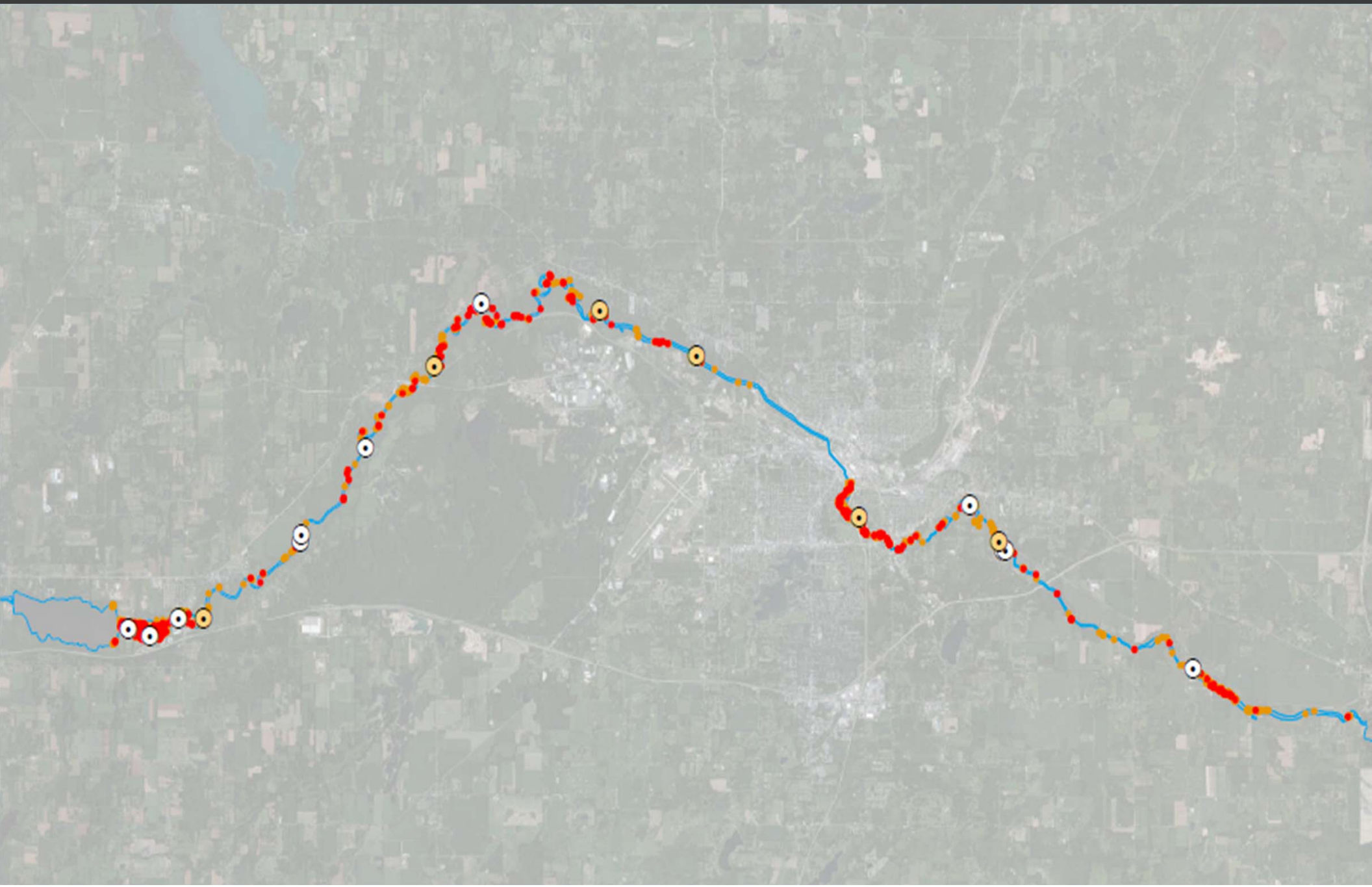
0 0.5 1 2 Miles

Prepared for:
U.S. EPA REGION V
Contract No.: EP-S5-06-04
TDD: S05-0006-1007-030
DCN: 1154-4D-AHMS

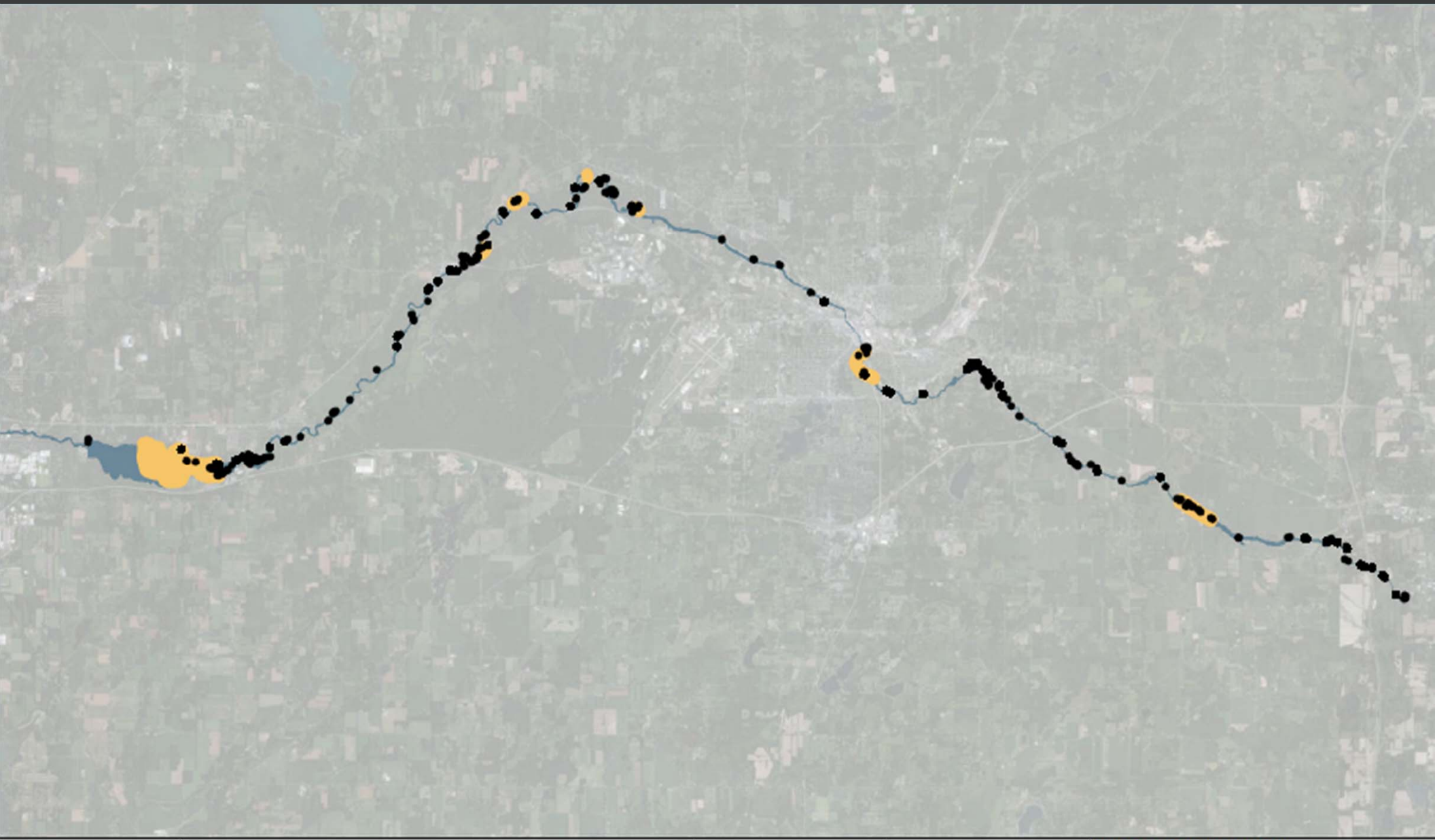
Prepared by:
WESTON SOLUTIONS, INC.
2501 Jolly Road, Suite 100
Okemos, MI

SEDIMENT TRAP OVERVIEW MAP
08/24/12
MARSHALL OIL ER
MARSHALL, KALAMAZOO AND CALHOUN COUNTIES, MICHIGAN
CREATED: AUGUST 2012

Current & Projected Sediment Trap Locations



2012 Sheen Management at Submerged Oil Locations



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Sheen Observed

Daily Sweep Areas

Kalamazoo Waterway

0 0.45 0.9 1.8 Miles

Prepared for:
U.S. EPA REGION V
Contract No.: EP-S5-08-04
TDO: S05-0006-1007-030
DCN: 1154-4D-AHM3

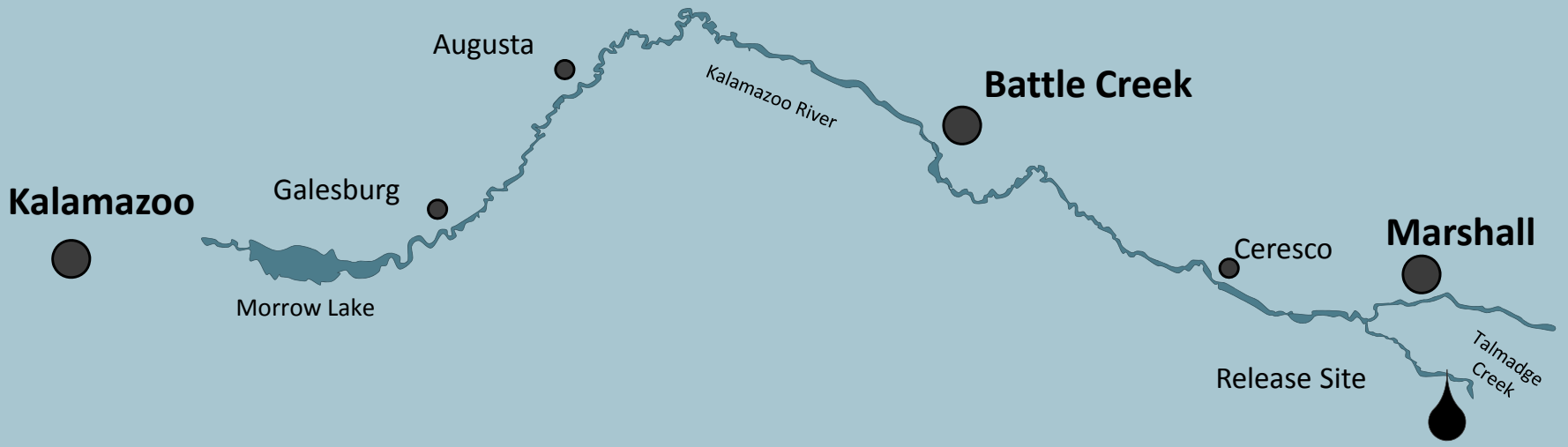
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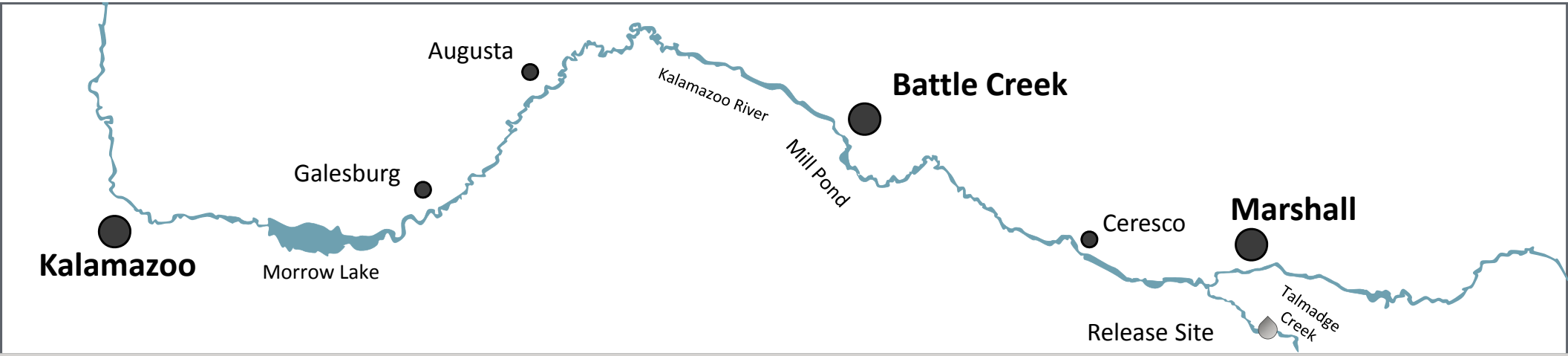
OVERALL SHEEN SYSTEM
07/10/2012
MARSHALL, MI PIPELINE RELEASE
KALAMAZOO RIVER, MI
CREATED: AUGUST 2012

2012 Sheen Management at Ceresco Dam Impoundment



Submerged Oil Quantification





Submerged Oil Quantification

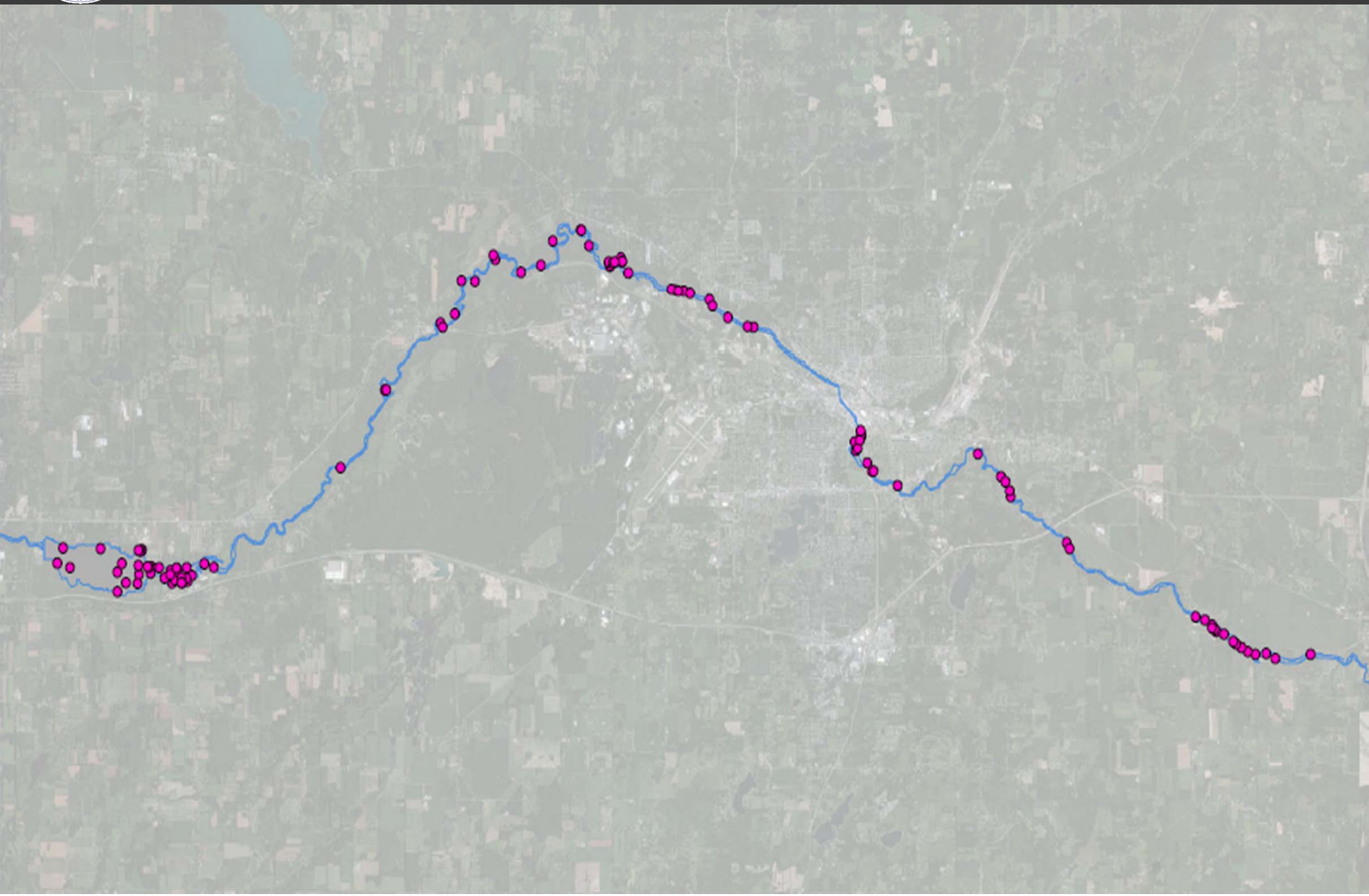
Stratified Sediment Sampling

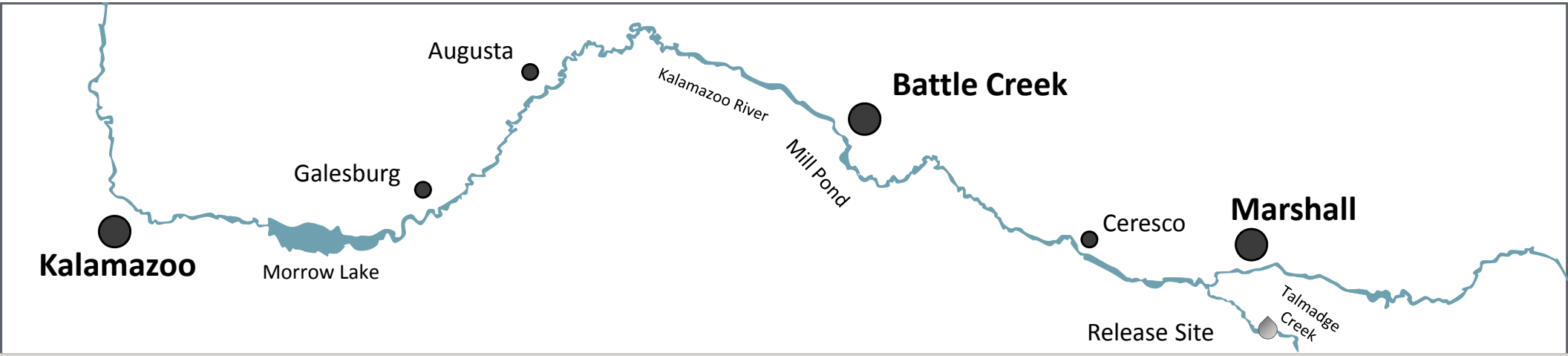
Generalized Random Tessellation Survey (GRTS)

Coring locations were selected using a GRTS model.

- The coring locations were randomly selected from heavy/moderate and light/none polygons within the 10 different stratified geomorphic units (i.e. Impounded waters, depositional backwaters, oxbows, etc.)
- Stratified – likely to reduce variance of the oil estimate.
- Spatially balanced – across the entire site.

Submerged Oil Coring Locations for Volume Calculations





Preliminary Findings of Submerged Oil Coring Program

There appears to be much less submerged oil in 2012 as compared to 2011. Likely explanations include:

a) 2011 oil recovery efforts may have been very successful, or

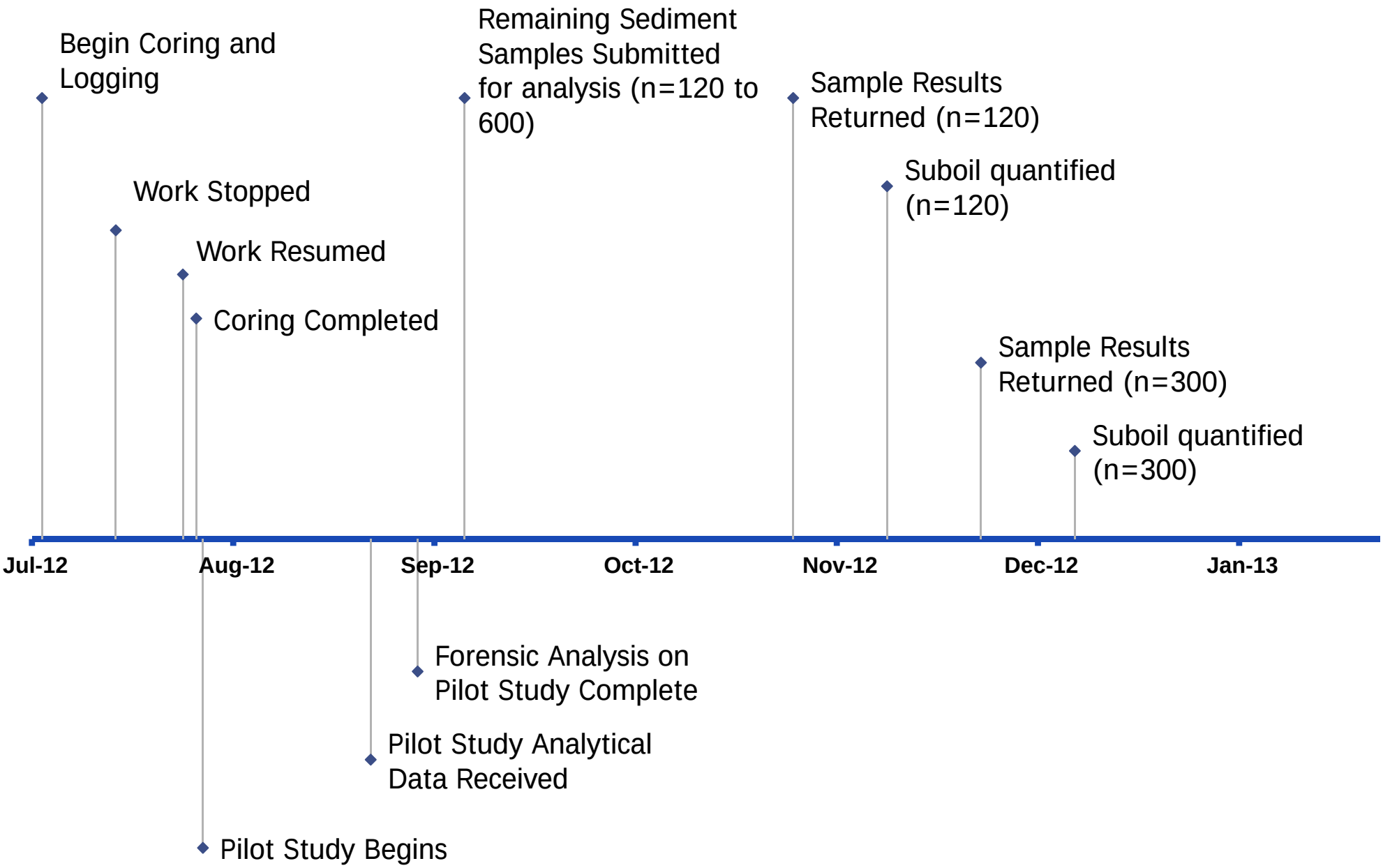
b) The ability to see the oil in the cores (using both visible and UV illumination) has decreased significantly.

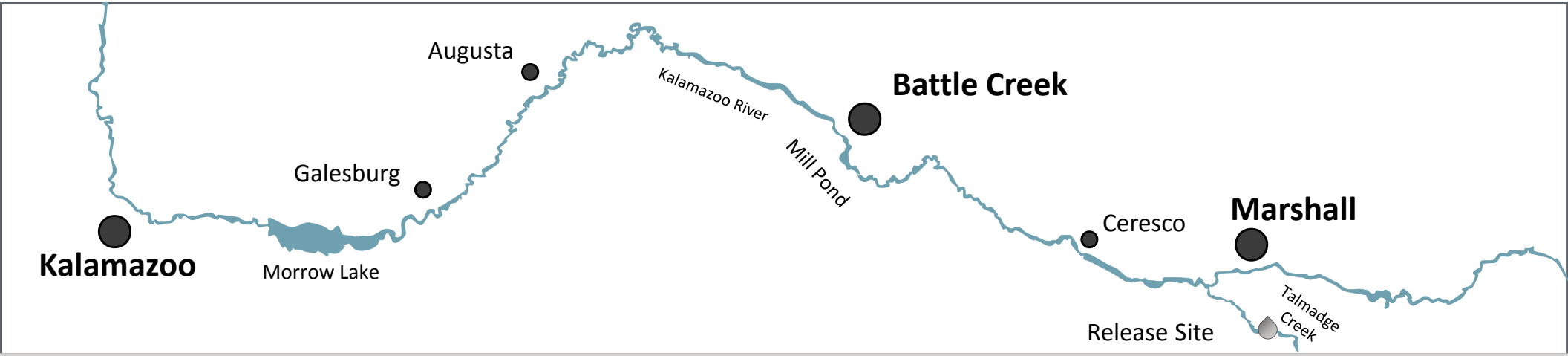
In order to distinguish between these alternatives, a **Pilot Study** was initiated to quickly assess the ability to see oil in the cores. This is very important because the Submerged Oil Quantification task is based upon selecting core intervals for forensic oil fingerprinting using visual observations.

The Pilot Study consists of two components:

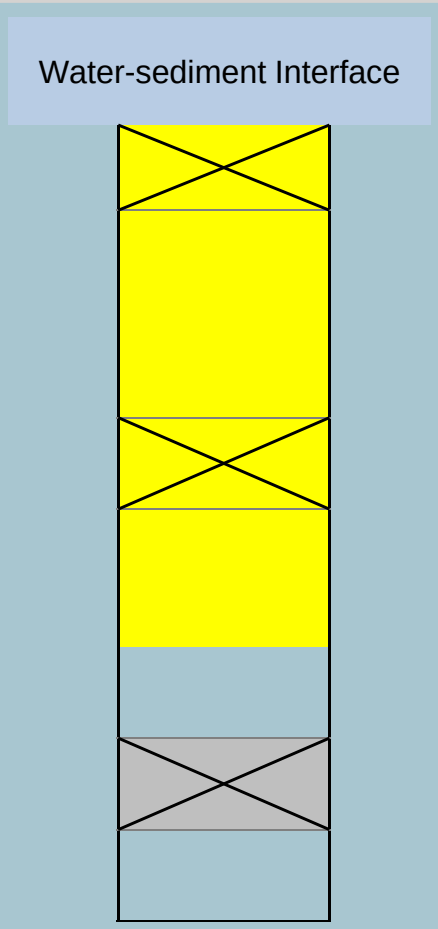
1. Increased level of sampling and oil fingerprinting on 12 sediment cores covering a range of oiling levels.
2. Investigation of UV fluorescence behavior of Line 6B oil and interactions with Kalamazoo River sediment (Dr. Ken Lee).

Projected Timeline for Submerged Oil Quantification



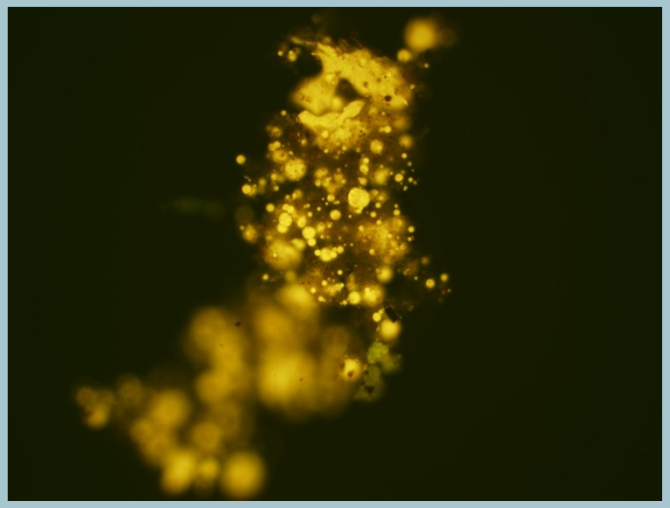


Sediment Core Sampling Scheme is Based Upon "Seeing" Oil

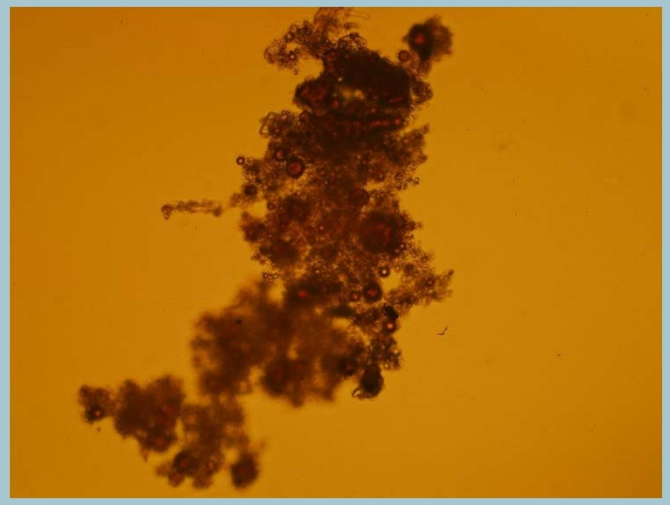


- Top 1-inch of the core is always analyzed
- Zone of greatest oiling below 1-inch is analyzed
- Sample below oiled zone is archived for possible future analysis

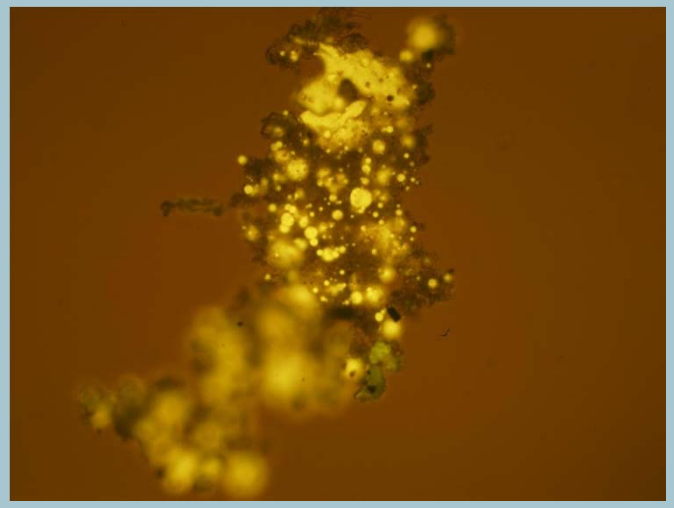
Photomicrographs of Line 6B Oil-Mineral Aggregates (OMA)



UV epifluorescence



Bright field transmitted light

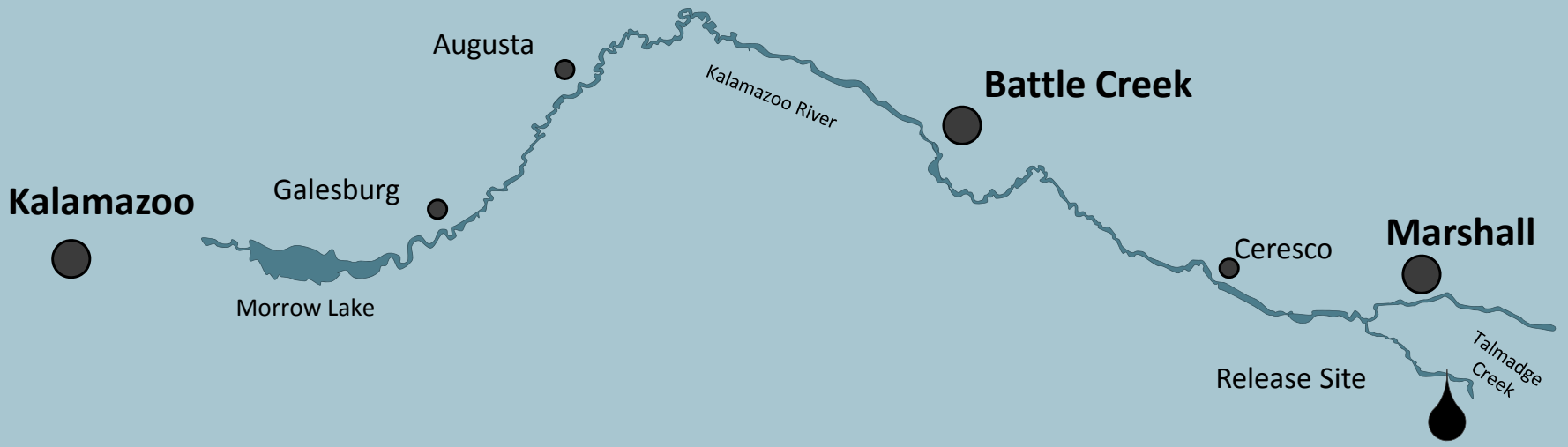


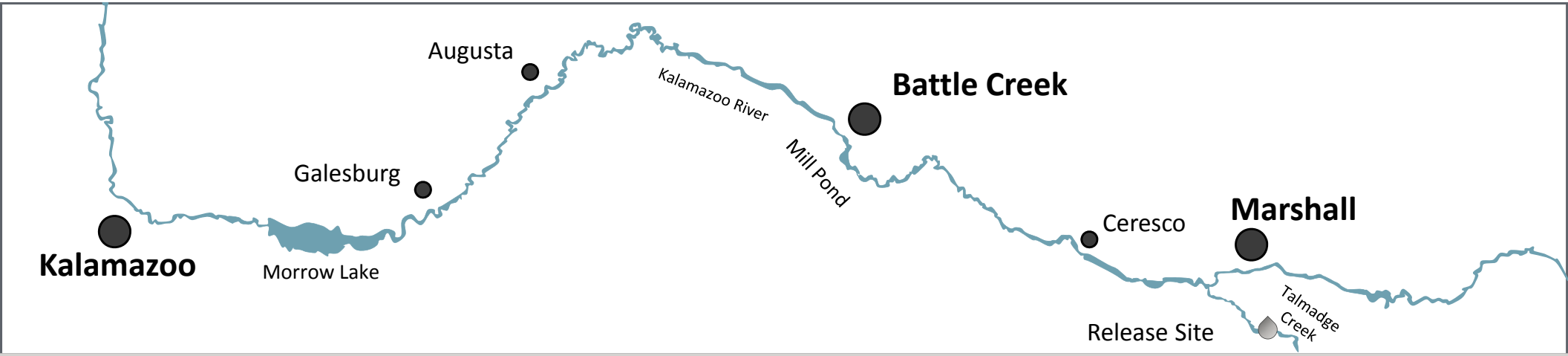
Combined illumination

Oil-mineral aggregates are oil droplets stabilized by fine mineral particles.

Dr. Ken Lee (Fisheries and Oceans Canada) prepared this OMA in his laboratory using Line 6B oil and Kalamazoo River sediments.

Net Environmental Benefit Analysis





Net Environmental Benefit Analysis

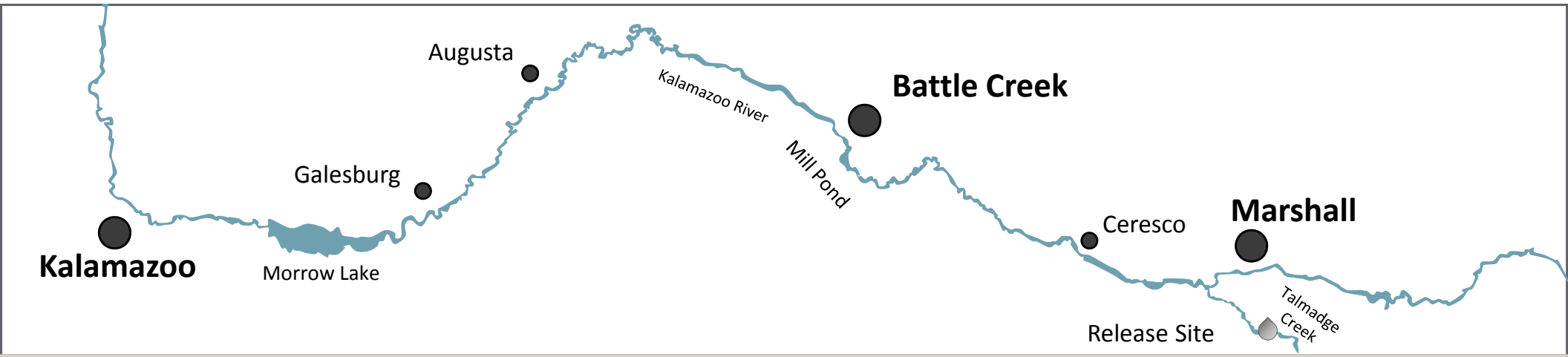
NEBA

- Weighs the environmental risks associated with leaving residual submerged oil in place as compared to ecological impacts resulting from additional oil recovery actions.

- Addresses only potential ecological effects. Does not address human health impacts or other designated uses of a water body.

- Addresses habitats and considers resource impact on most sensitive species affected by oil and;

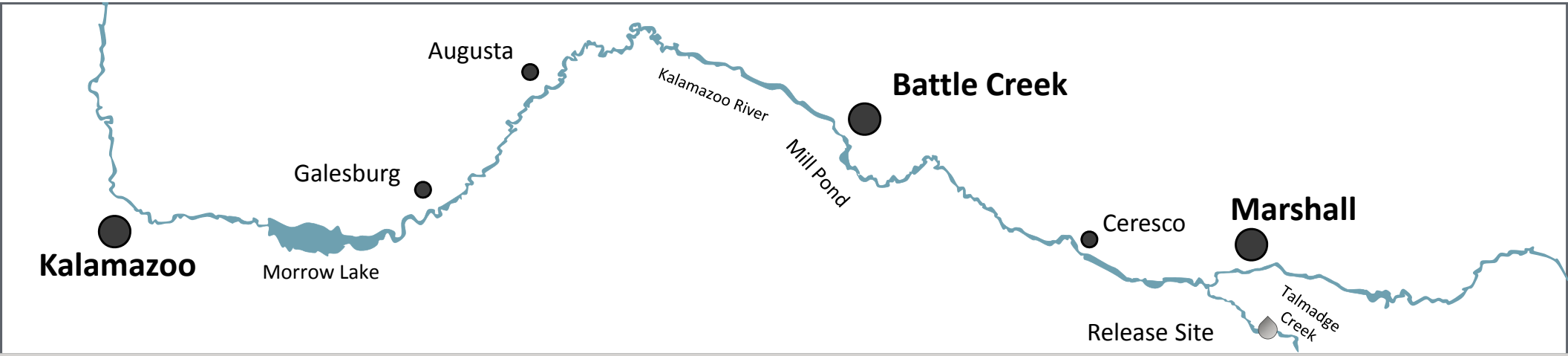
- Evaluates potential impacts from specific submerged oil recovery actions.



Net Environmental Benefit Analysis

Summary NEBA Relative Risk Matrix

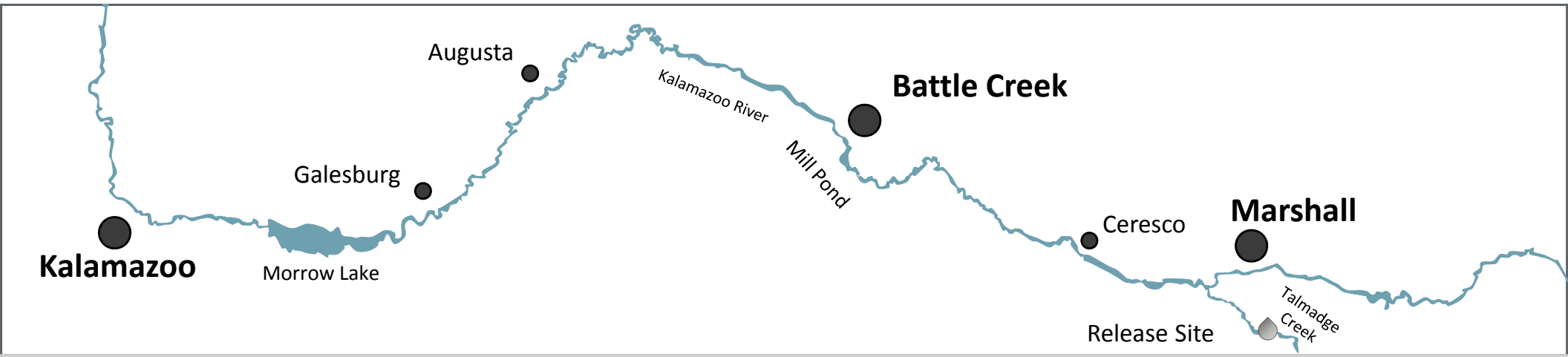
Habitats	Resource Category	Recovery Actions: Monitored Natural Attenuation	Enhanced Deposition	Agitation Toolbox	Dredging/ Vacuum Truck	Dewater/ Excavate	Sweep/Push	Scraping	Sheen Collection
Impounded waters and associated deltas	Plants	4D	3B	3B	3B	NA	3B	4C	4D
	Mammals	4D	4D	4D	4D	NA	4D	4D	4D
	Birds	4D	4D	4D	4D	NA	4D	4D	4D
	Amphibians/reptiles	3C	2B	2B	2B	NA	2B	4C	4D
	Fish	3C	2B	2B	2B	NA	2B	4D	4D
	Invertebrates	3C	2B	2B	2B	NA	2B	4C	4D
Flowing channels	Plants	4D	NA	4D	NA	NA	4D	NA	4D
	Mammals	4D	NA	4D	NA	NA	4D	NA	4D
	Birds	4D	NA	4D	NA	NA	4D	NA	4D
	Amphibians/reptiles	4D	NA	4D	NA	NA	3D	NA	4D
	Fish	4D	NA	3D	NA	NA	3D	NA	4D
	Invertebrates	4D	NA	3D	NA	NA	2C	NA	4D



Net Environmental Benefit Analysis

Major Habitat Types Evaluated

- Impounded waters and associated deltas
- Flowing channels
- Depositional backwaters, pools, and side channels
- Bars
- Emergent wetlands
- Islands
- Oxbows, meander cutoffs, ponds
- Forested scrub-shrub wetlands

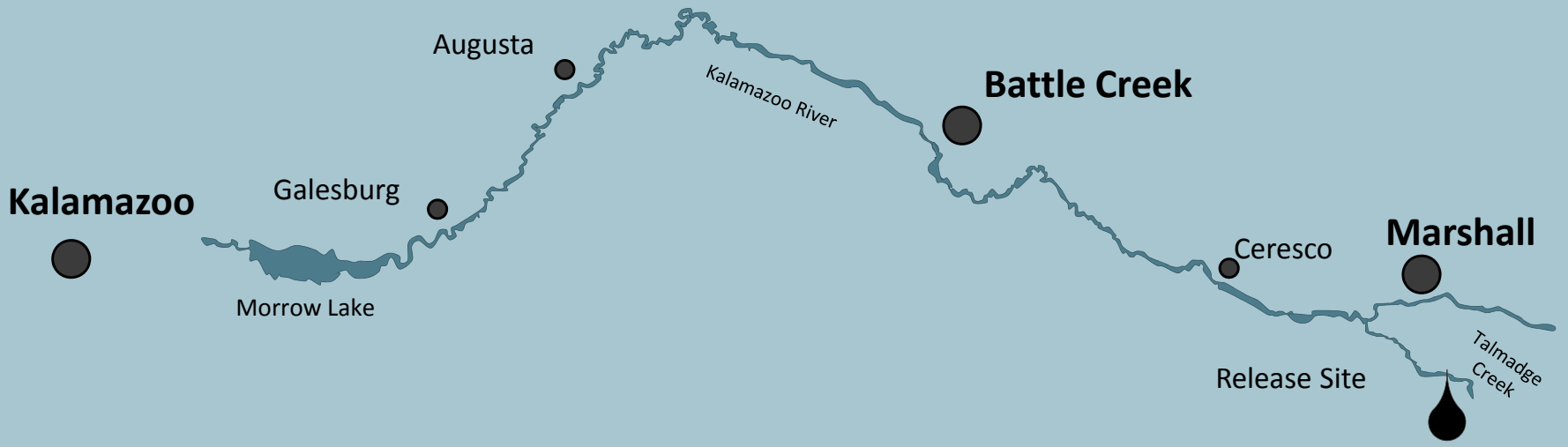


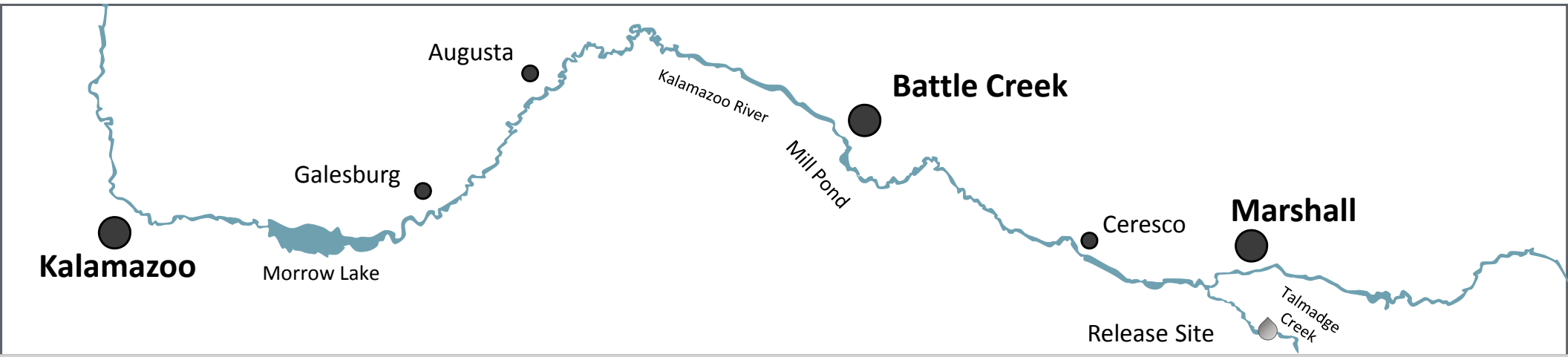
Net Environmental Benefit Analysis

Submerged Oil Recovery Actions Considered

- Monitored natural attenuation
- Enhanced deposition and recovery
- Agitation toolbox
- Dredging/vacuum truck
- Dewater/excavate
- Sweep/push
- Scraping
- Sheen collection

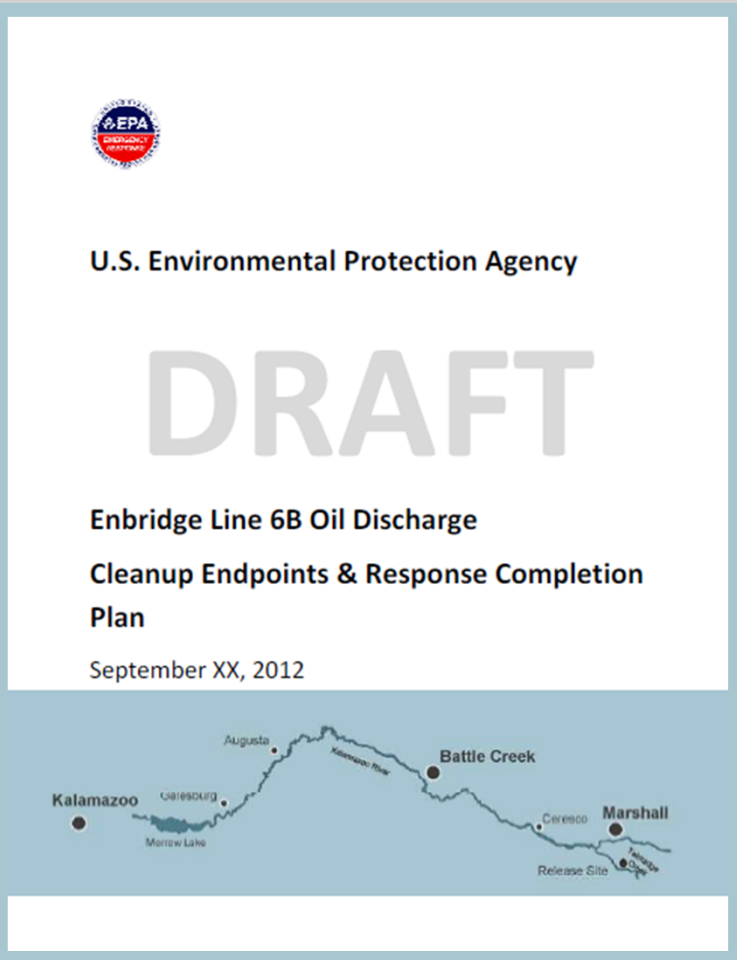
Endpoint Framework





Endpoint Framework





5. Shoreline Clean-up Endpoints

The following tables identify the Eastern States Shoreline Clean-up Endpoints. Shoreline type is as defined in the relevant STR.

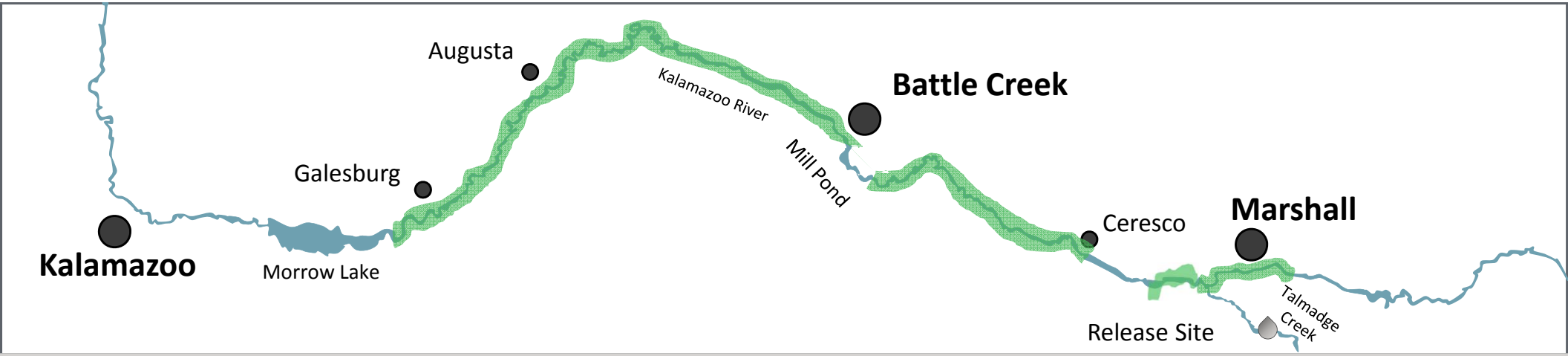
Shoreline Type	Surface Oil	Subsurface Oil
Residential and Amenity Sand Beaches	No visible MC-252 oil, *or* as low as reasonably practicable, considering the allowed treatment methods and net environmental benefit	No visible MC-252 oil, *or* as low as reasonably practicable considering the allowed treatment methods and net environmental benefit
Non-Residential or Non-Amenity Sand Beaches	< 1% visible surface oil and oiled debris, and no SRBs > 5 cm (~2 inches) *or* as low as reasonably practicable, considering the allowed treatment methods and net environmental benefit	No subsurface oil exceeding 3 cm (~1¼ inch) in thickness and patchy (<50%) distribution that is greater than Oil Residue, *or* as low as reasonably practicable considering the allowed treatment methods and net environmental benefit
Beaches in Special Management Areas (state and federal wildlife refuges, parks, wilderness areas)	Subject to direction of Special Area Managers: < 1% surface oil and oiled debris, and no SRBs > 2.5 cm (~1 inch) *or* as low as reasonably practicable considering the allowed treatment methods and net environmental benefit	Subject to direction of Special Area Managers: No subsurface oil exceeding 3 cm (~1¼ inch) in thickness and patchy (<50%) distribution that is greater than Oil Residue, *or* as low as reasonably practicable considering the allowed treatment methods and net environmental benefit
USFWS Breton National Wildlife Refuge (Chandeleur Islands)	< 1% surface oil and oiled debris, *or* as low as reasonably practicable considering the allowed treatment methods and net environmental benefit	No removal of subsurface oil

Table 1 - Shoreline Clean-up Endpoints Eastern States

X. Clean-up Endpoints

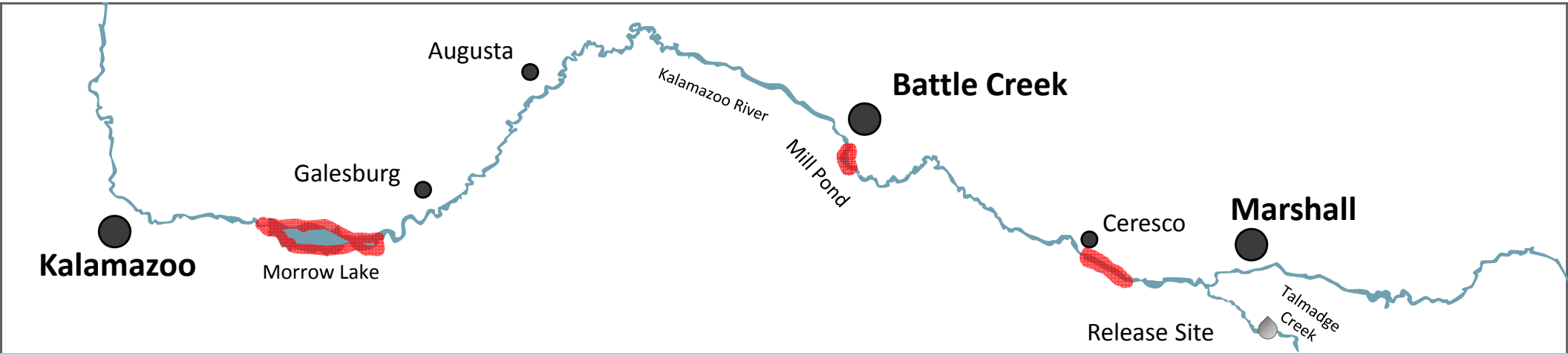
The following table identifies Line 6B Oil Spill Clean-up Endpoints under U.S. EPA's Order(s).

River Corridor	Overbank Oil Endpoints	Submerged Oil Endpoints
General	1. No Line 6B oil on surfaces that rubs off on contact; **and** 2. No oil and/or sheen from Line 6B that affects navigable waterways and/or poses the threat of release of a visible oil and/or sheen to navigable waterways.	1. No Line 6B oil and/or oil-contaminated sediments at levels represented by heavy or moderate poling response using U.S. EPA-approved poling methods; **and** 2. No Line 6B oil and/or oil-contaminated sediments that has the potential to migrate downstream of Morrow Dam.
	or As little oil and/or sheen from Line 6B as practicable considering the treatment methods allowed and net environmental benefit.	**or** As little oil and/or oil-contaminated sediment from Line 6B as practicable considering the treatment methods allowed and net environmental benefit.
Sediment Traps	Not applicable.	Allow Line 6B oil and/or oil-contaminated sediments to accumulate at specific sediment traps along the river. Recover oil periodically, in accordance with U.S. EPA-approved Operations & Maintenance Plan.
Sensitive Habitat Areas MP 8.5 LDB OB 11.79 LDB OB 26.23 RDB	As little oil and/or sheen from Line 6B as practicable considering the treatment methods allowed and net environmental benefit.	No removal of submerged oil.
High Recreational Use *(under consideration for implementation at public access points)* Saylors Landing Ceresco Dam Fisherman Landing Historical Bridge Park Paddlers Cove C-5 Boat Launch Jackson Linear Park Custer Road Fort Custer Galesburg Park River Oaks Park Canoe Launch River Oaks Park	1. No Line 6B oil on surfaces that rubs off on contact; **and** **2.** No oil and/or sheen from Line 6B that affects navigable waterways and/or poses the threat of release of a visible oil and/or sheen to navigable waterways.	No Line 6B oil and/or oil-contaminated sediments at levels represented by heavy or moderate poling response using U.S. EPA-approved poling methods, and located within XXX feet of a public access point.



Sites That Likely Meet U.S. EPA Endpoints

Approximately 34 of 40 River Miles Meet the U.S. EPA Endpoints



Sites That Currently Do Not Meet U.S. EPA Endpoints

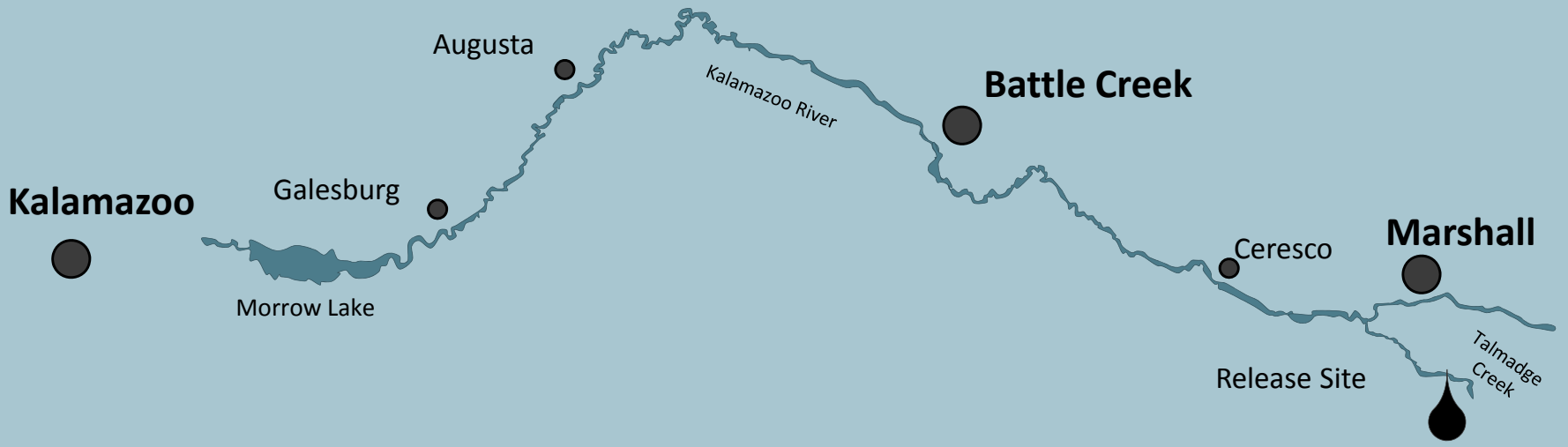
Approximately 6 of 40 River Miles do not Meet U.S. EPA Endpoints

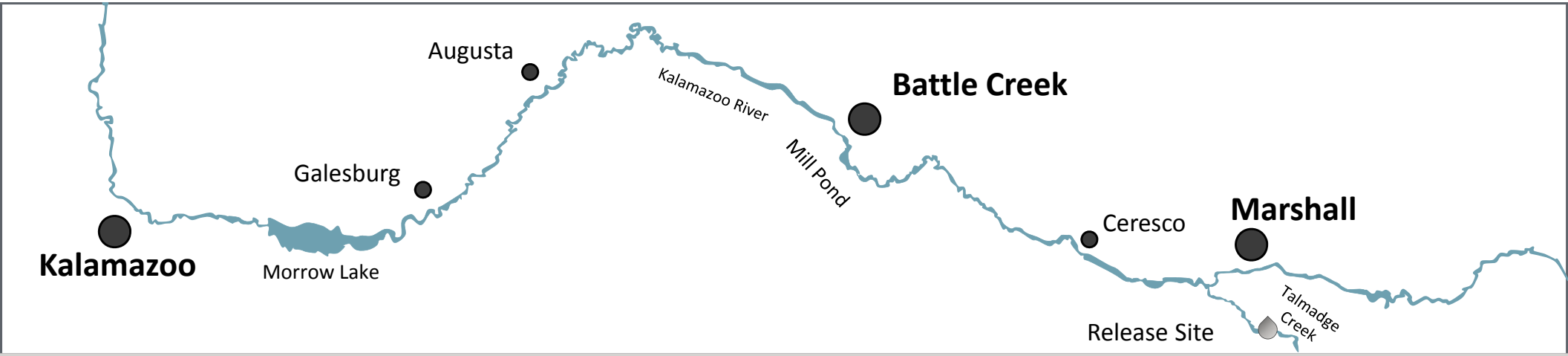
Ceresco (MP 4.75 to 5.85)
Mill Ponds (MP 13.9 to 15.7)
Morrow Lake and Delta (MP 36.25 to 39.85)

SO 13.48
SO 20.23
SO 26.30
SO 27.94
SO 36.27

Currently being monitored with updated poling – endpoint status will be re-evaluated after monitoring

Transition to MDEQ





Transition to MDEQ

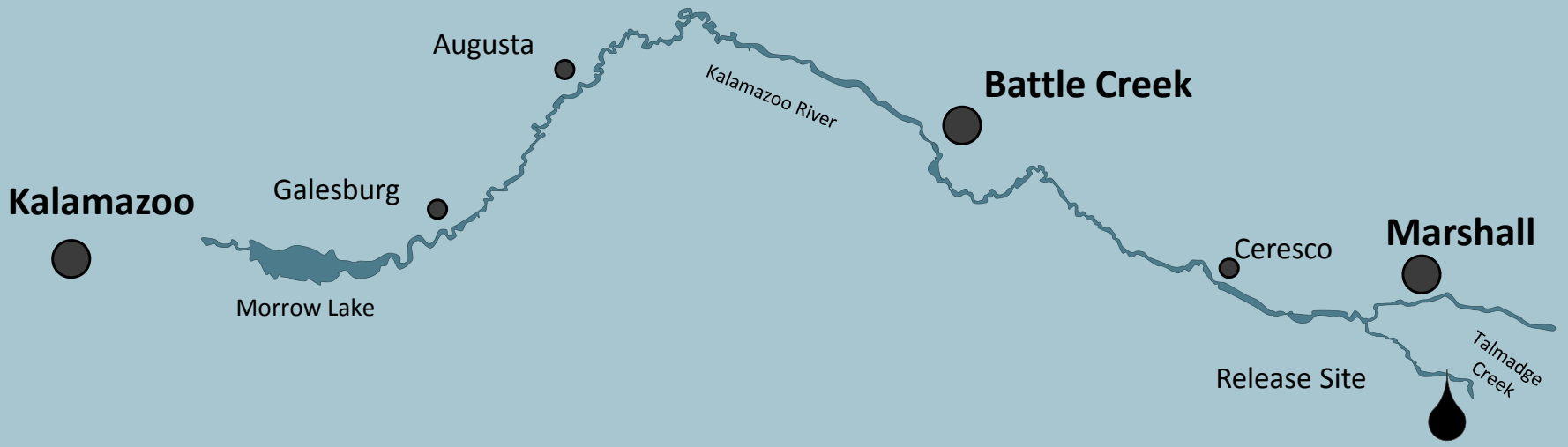
1. Submerged Oil Sites delineated by **poling** as light oil shall be transferred to the MDEQ

2. Submerged Oil Sites identified by the **NEBA** evaluation requiring monitoring or no action with heavy, moderate, or light delineation to be transferred to MDEQ

3. Long Term Sediment Trap Monitoring & Maintenance be transferred to the MDEQ

4. Recovery completion at remaining sites (Ceresco, Mill Ponds, ML Delta) to EPA framework endpoints, sites to be transferred to MDEQ

U.S. EPA Regulatory Background



U.S. EPA REGULATORY BACKGROUND

OPA Endpoint Criterion Requirement

OPA of 1990, Subtitle B

"(1) GENERAL REMOVAL REQUIREMENT. (A) The President shall, in Accordance with the National Contingency Plan and any appropriate Area Contingency Plan, ensure effective and immediate ***removal of a discharge***, ***and mitigation or prevention of a substantial threat of a discharge***, of oil or a hazardous substance

(i) into or on the navigable waters;

(ii) on the adjoining shorelines to the navigable waters..."

U.S. EPA REGULATORY BACKGROUND
40 CFR Ch. 1 Part 110 Discharge of Oil

reational or other purposes;

(2) From which fish or shellfish are or could be taken and sold in interstate or foreign commerce;

(3) That are used or could be used for industrial purposes by industries in interstate commerce;

(d) All impoundments of waters otherwise defined as navigable waters under this section;

(e) Tributaries of waters identified in paragraphs (a) through (d) of this section, including adjacent wetlands; and

(f) Wetlands adjacent to waters identified in paragraphs (a) through (e) of this section: Provided, That waste treatment systems (other than cooling ponds meeting the criteria of this paragraph) are not waters of the United States;

Navigable waters do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other federal agency, for the purposes of the Clean Water Act, the final authority regarding Clean Water Act jurisdiction remains with EPA.

NPDES means National Pollutant Discharge Elimination System;

Sheen means an iridescent appearance on the surface of water;

Sludge means an aggregate of oil or oil and other matter of any kind in any form other than dredged spoil having a combined specific gravity equivalent to or greater than water;

§ 110.2 Applicability.

The regulations of this part apply to the discharge of oil prohibited by section 311(b)(3) of the Act.

[61 FR 7421, Feb. 28, 1996]

§ 110.3 Discharge of oil in such quantities as "may be harmful" pursuant to section 311(b)(4) of the Act.

For purposes of section 311(b)(4) of the Act, discharges of oil in such quantities that the Administrator has determined may be harmful to the public health or welfare or the environment of the United States include discharges of oil that:

(a) Violate applicable water quality standards; or

(b) Cause a film or sheen upon or discoloration of the surface of the water or adjoining shorelines or cause a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines.

[61 FR 7421, Feb. 28, 1996]

§ 110.4 Dispersants.

Addition of dispersants or emulsifiers to oil to be discharged that would circumvent the provisions of this part is prohibited.

[52 FR 10719, Apr. 2, 1987. Redesignated at 61 FR 7421, Feb. 28, 1996]

§ 110.5 Discharges of oil not determined "as may be harmful" pursuant to Section 311(b)(3) of the Act.

U.S. EPA REGULATORY BACKGROUND
Federal Water Pollution Control Act

(4) The President shall by regulation determine for the purposes of this section those quantities of oil and any hazardous substances the discharge of which may be harmful to the public health or welfare or the environment of the United States, including but not limited to fish, shellfish, wildlife, and public and private property, shorelines, and beaches.

U.S.EPA REGULATORY BACKGROUND

U.S. EPA Notice of Directive for Fall 2011 into Summer 2012 Response Activities issued on September 30, 2011

"Enbridge shall conduct response actions, as approved and/or modified by the U.S. EPA, at all heavy, moderate and light submerged oil locations identified by the Spring 2011 Reassessment, the late Summer 2011 Reassessment, and the above –referenced, Spring 2012 Reassessment. Response actions shall proceed in a strict upstream to downstream sequence in the 3 major segments identified herein.."

"U.S. EPA will consider allowing termination of the iterative assessment/ recovery response action requirement for submerged oil areas when Enbridge can demonstrate, to U.S. EPA's satisfaction and through appropriate poling techniques conducted during optimum seasonal conditions (described below), that the areas consistently show no heavy or moderate submerged oil."

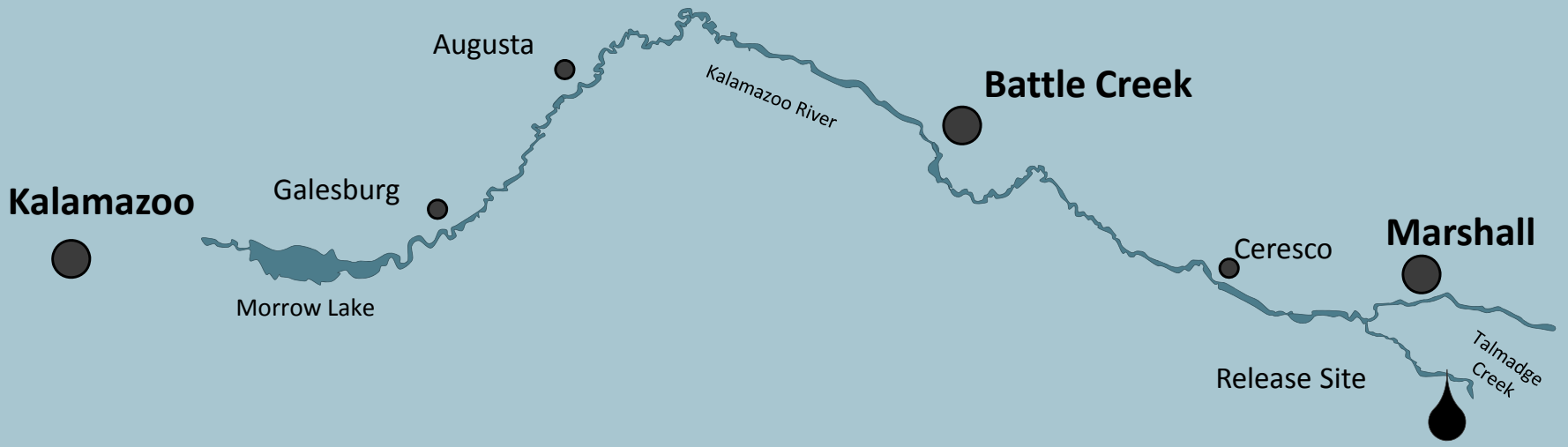
U.S. EPA REGULATORY BACKGROUND

2012 Consolidated Work Plan (2012 CWP) approved on December 21, 2011

"Submerged oil recovery shall be addressed in a top down approach working upstream to downstream within each of the three defined sections of the river. The first section shall consist of a portion of the river starting at the confluence of the Talmadge Creek and the Kalamazoo River and ending at the Ceresco Dam"

"The need for further active oil recovery shall include an evaluation of the ecological considerations, as well as an evaluation of the potential benefits and consequences of active oil recovery, or the lack thereof. This evaluation and decision of adverse ecological risk shall be made solely by the U.S. EPA FOSC following consultation with the SSC Group."

Ceresco Dam Conditions



2010 Ceresco Dam during early response activities



08.11.2010

Oil flowing over Ceresco Dam 2010

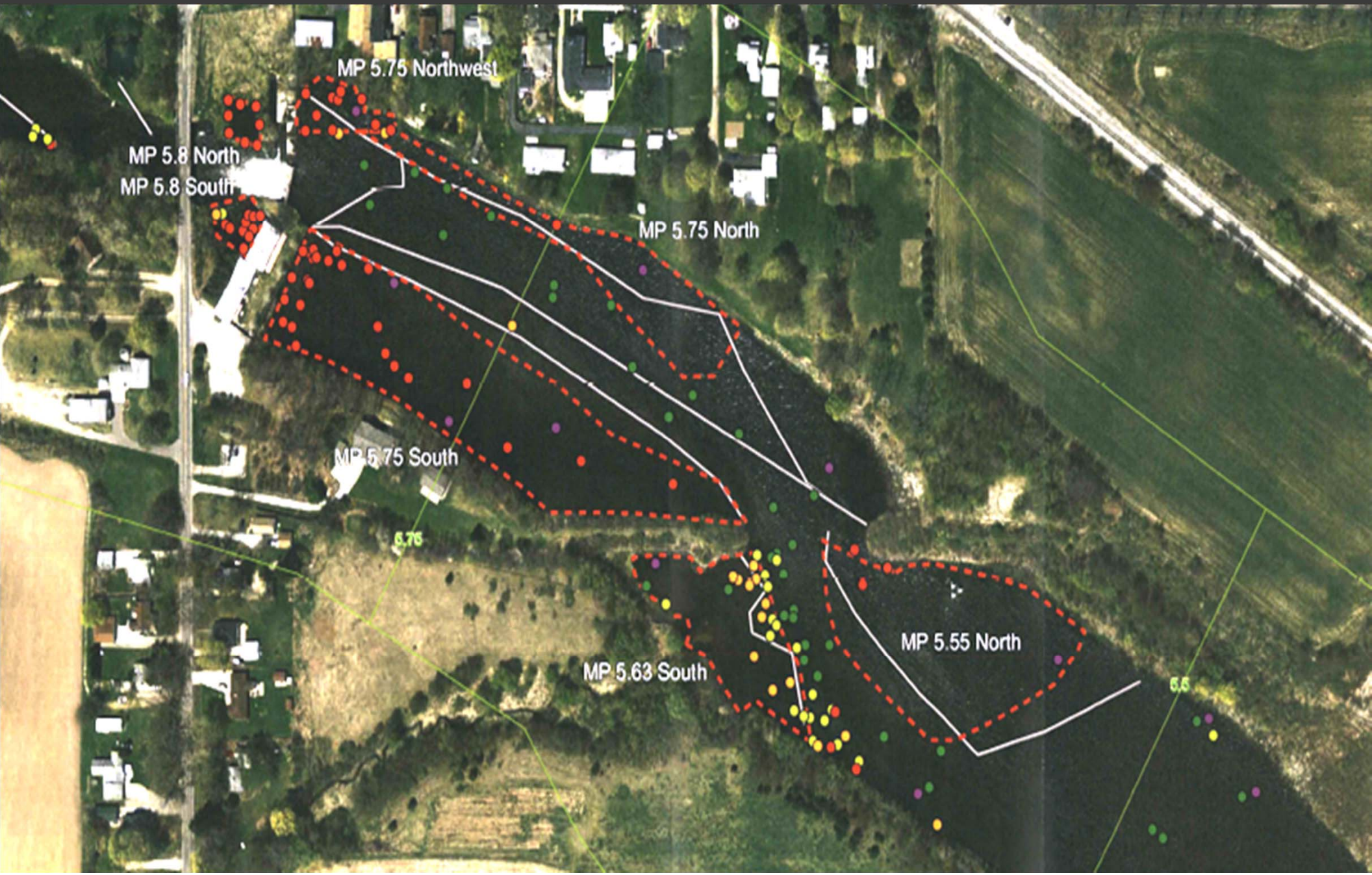




Oil pooled downstream of Ceresco Dam 2010



Ceresco Dam Conditions Prior to Fall 2010 Dredging



2010 Dredging Activities at Ceresco Dam



2010 Amphibex Dredge during Ceresco Dredging 2010



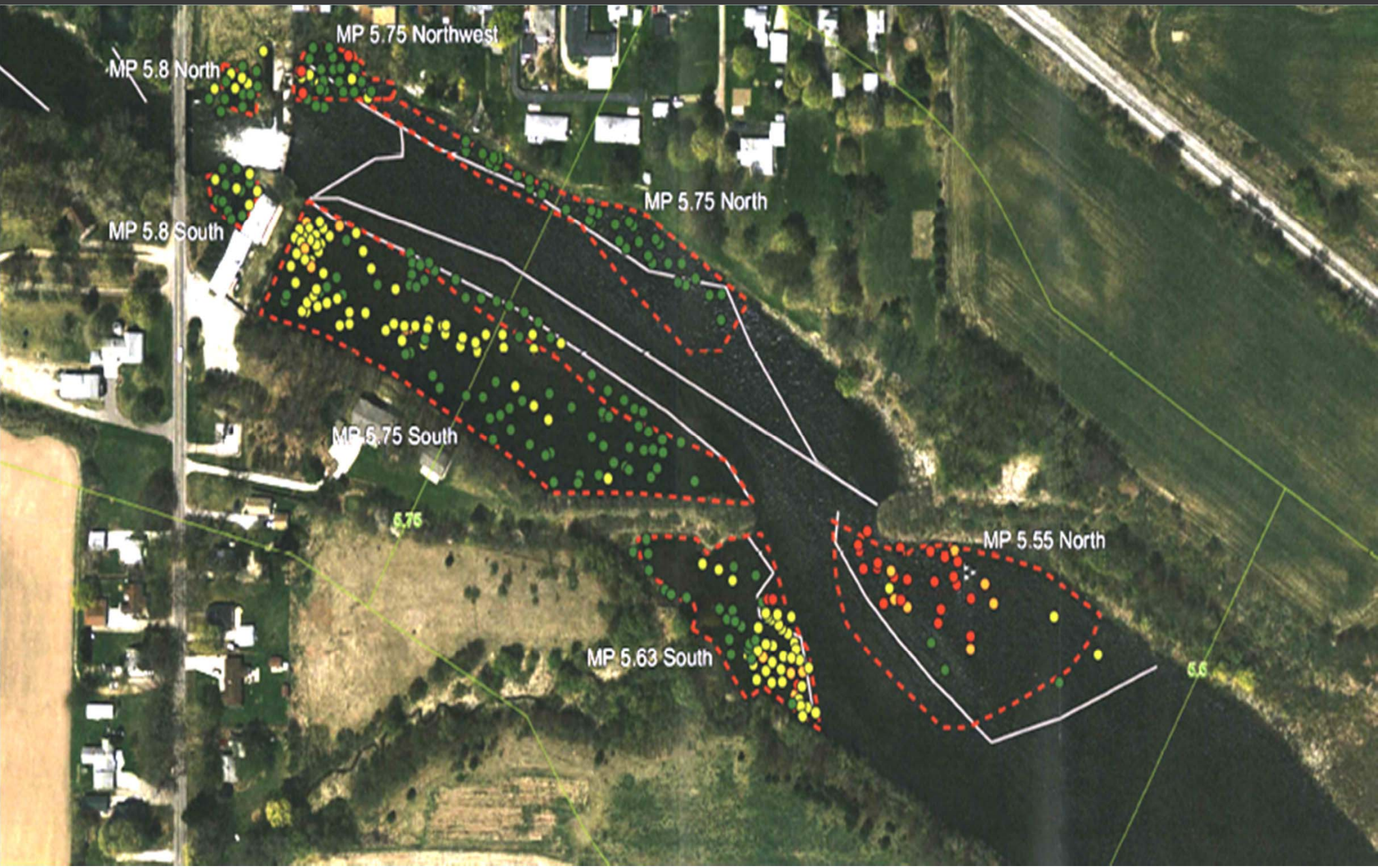
Geotube used for Sediment Dewatering during Ceresco Dam Dredging 2010



GAC water treatment used during Ceresco Dam Dredging 2010



Ceresco Dam Conditions after Fall 2010 Dredging



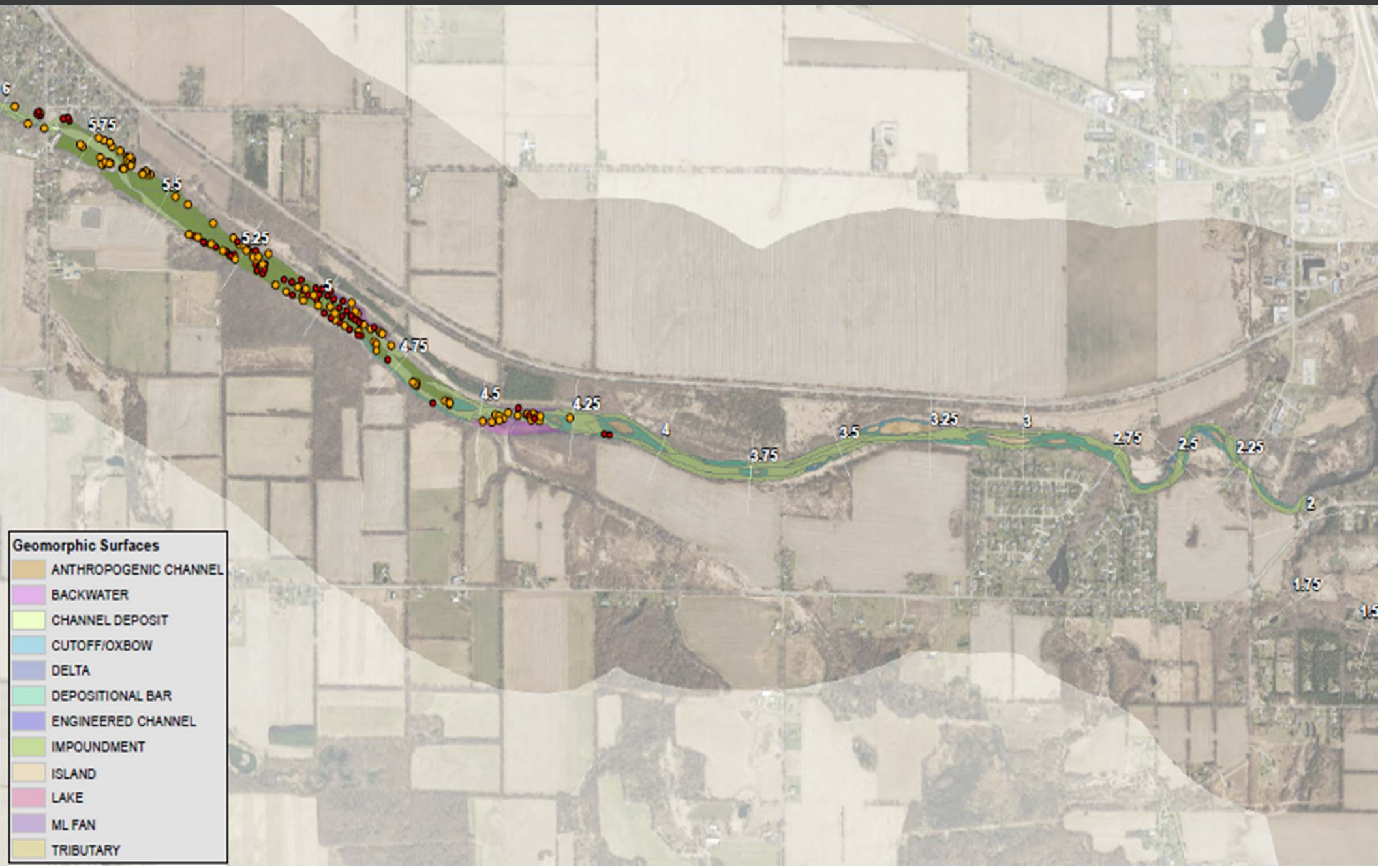
Ceresco Dam Conditions during July 2011 Agitation



Ceresco Dam Conditions during July 2011 Agitation



Ceresco Dam Late Summer Reassessment 2011



Ceresco Dam Spring Submerged Oil Reassessment 2012



Ceresco Sub Oil LSR 2012: MP-4.5 to MP-5.83
Spring 2012 Sub Oil: Confluence to MP-4.5



Ceresco Dam Submerged Oil Late Summer Reassessment 2012: MP-4.5 to MP 5.83



Ceresco Dam Submerged Oil Late Summer Reassessment 2012: MP-5.6 to MP 5.83

Heavy, Moderate, Light, & None Poling Results

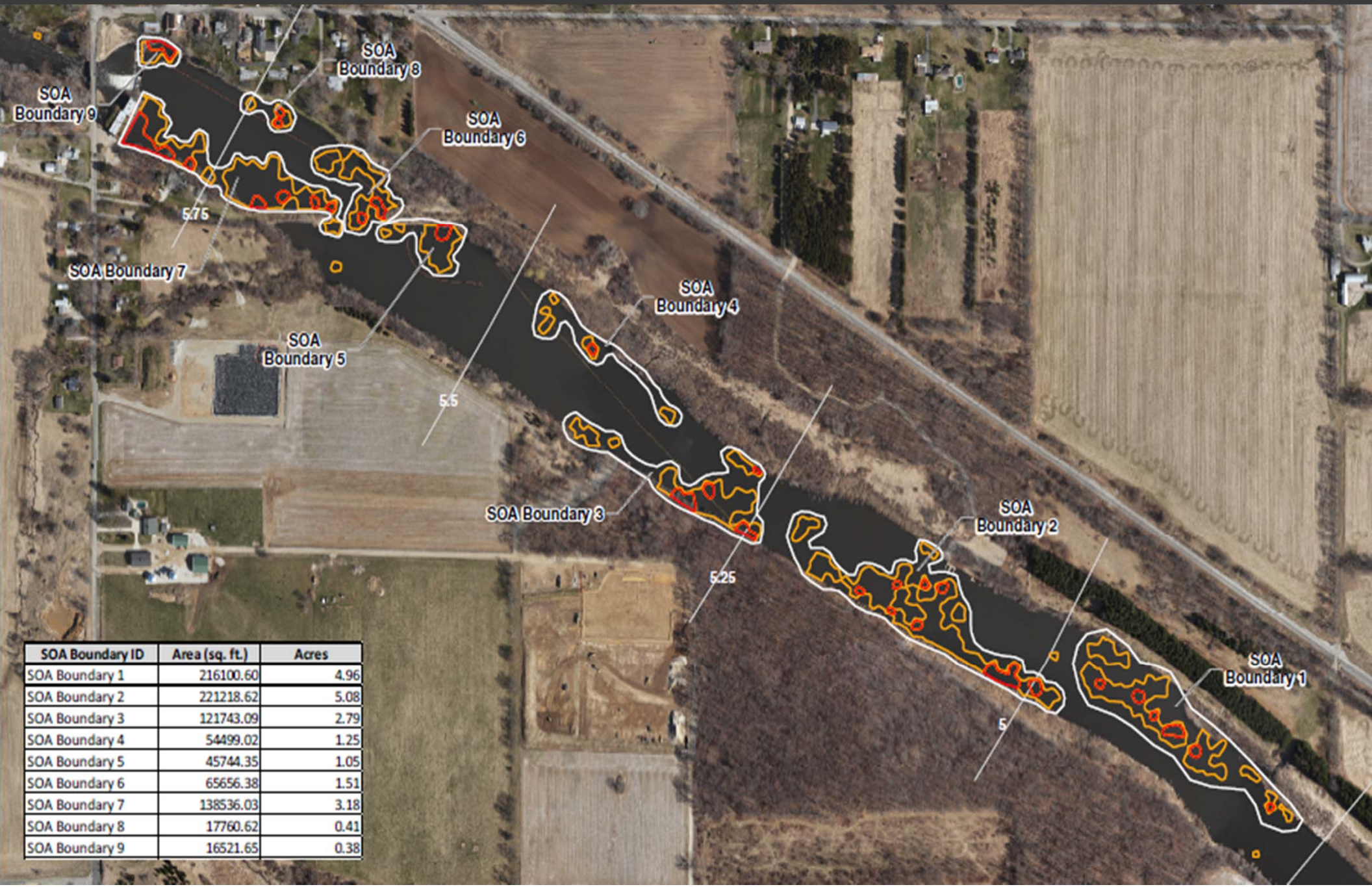


Ceresco Dam Submerged Oil Late Summer Reassessment 2012: MP-5.6 to MP 5.83

Heavy & Moderate Poling Results

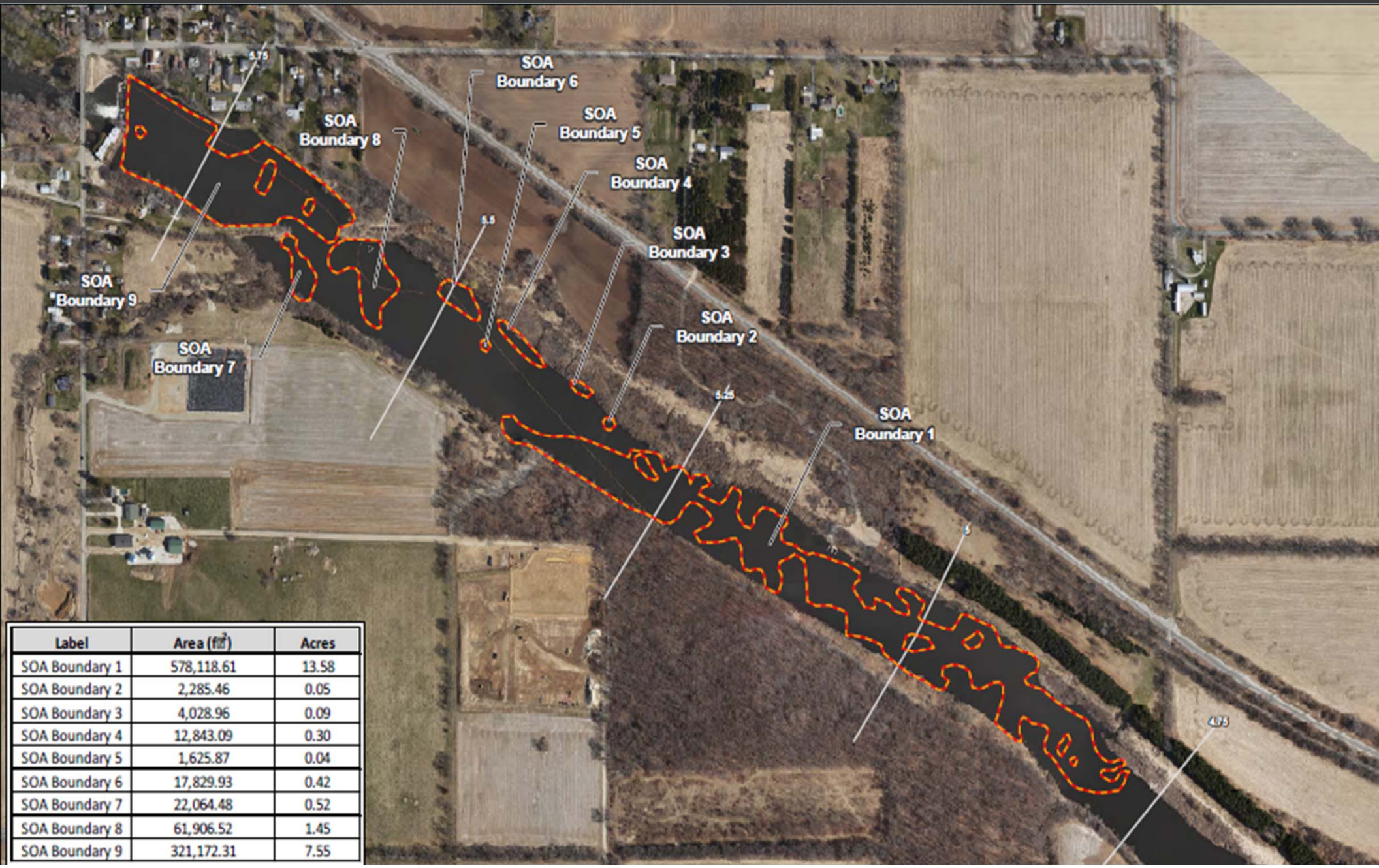


Moderate and Heavy Submerged Oil Delineations Spring 2012



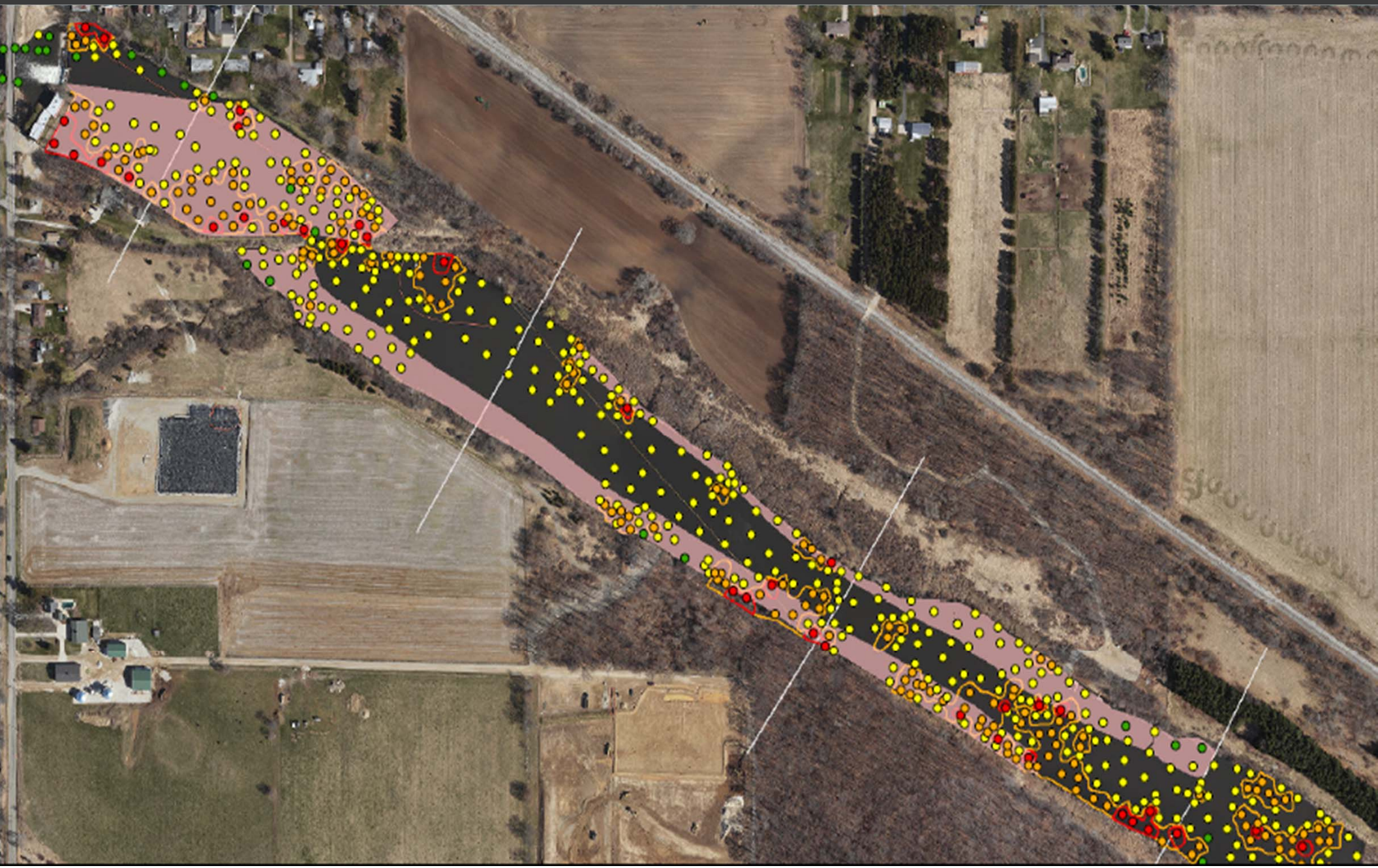
SOA Boundary ID	Area (sq. ft.)	Acres
SOA Boundary 1	216100.60	4.96
SOA Boundary 2	221218.62	5.08
SOA Boundary 3	121743.09	2.79
SOA Boundary 4	54499.02	1.25
SOA Boundary 5	45744.35	1.05
SOA Boundary 6	65656.38	1.51
SOA Boundary 7	138536.03	3.18
SOA Boundary 8	17760.62	0.41
SOA Boundary 9	16521.65	0.38

Moderate and Heavy Submerged Oil Delineations Later Summer Reassessment 2012

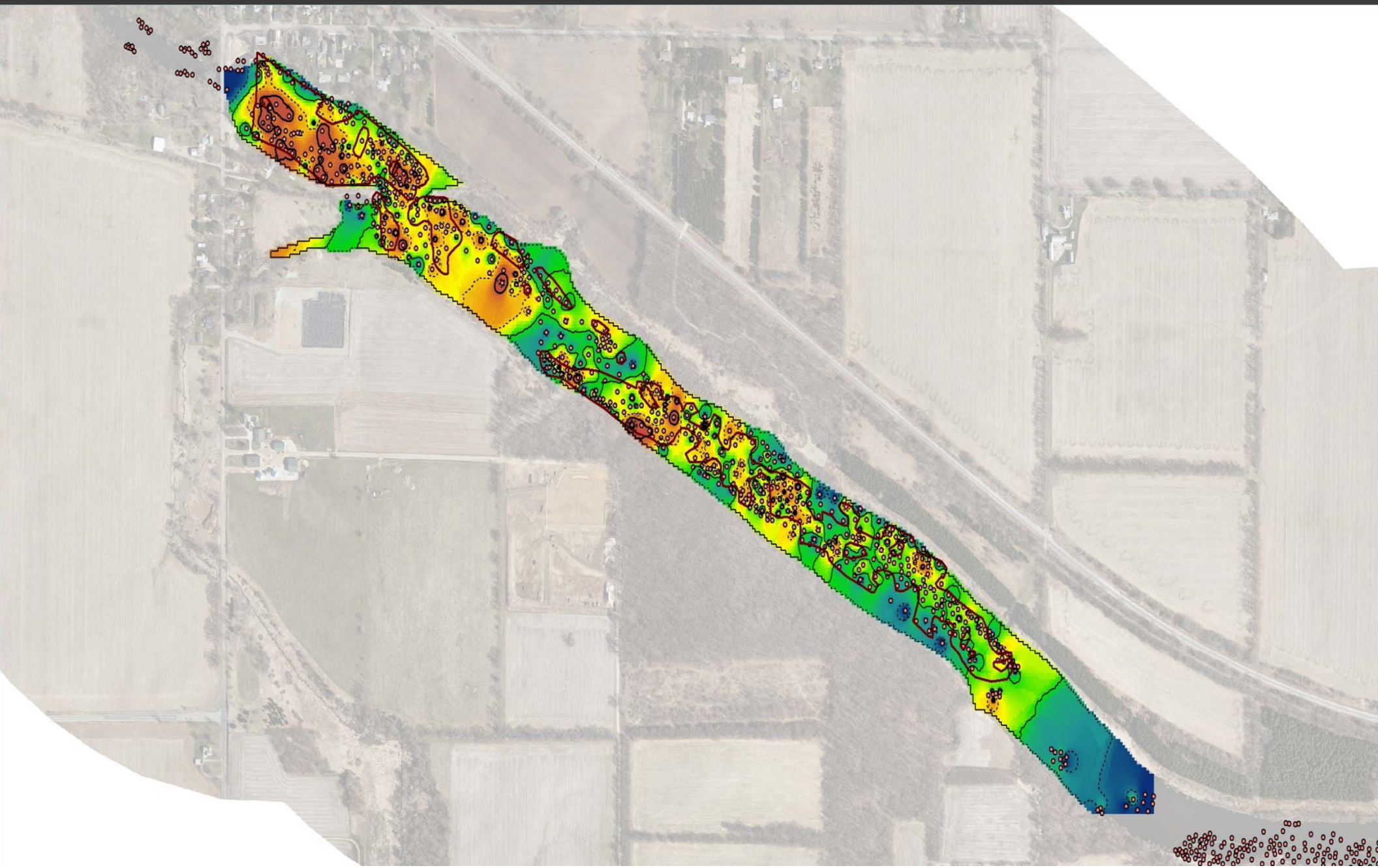


Label	Area (ft²)	Acres
SOA Boundary 1	578,118.61	13.58
SOA Boundary 2	2,285.46	0.05
SOA Boundary 3	4,028.96	0.09
SOA Boundary 4	12,843.09	0.30
SOA Boundary 5	1,625.87	0.04
SOA Boundary 6	17,829.93	0.42
SOA Boundary 7	22,064.48	0.52
SOA Boundary 8	61,906.52	1.45
SOA Boundary 9	321,172.31	7.55

Emerging oil/sheen and globule observations June 1 through August 14, 2012



Ceresco Dam Impoundment – Soft Sediment Thickness One Push



Ceresco Dam Impoundment NEBA Analysis

NEBA

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- **MP-4.5. to MP-5.6:** Sheen collection, increase monitoring frequency, continue to evaluate for possible recovery

- **MP-5.6 to MP-5.83:** Follow sediment trap monitoring/maintenance plan, consider recovery (dredging)”

Ceresco Dam Heavy & Moderate Impact Areas
MP-4.5 to MP-5.84

Impacted Area & Volume

.

- Area of impacted sediment defined by heavy and moderate poling results based on the 2012 Late Summer Reassessment results. Area = 34 Acres

- Volume of impacted sediment defined by Area and dredging depth of 12 inches. Volume = 55,000 CY

March 20, 2012
Sheen observed flowing over Ceresco Dam



Water Temperature: 63.3 °F
Sediment Temperature: 53.8 °F

March 22, 2012
Chevron boom configuration was deployed above Ceresco Dam



Water Temperature: 68.0 °F
Sediment Temperature: 58.9 °F

March 22, 2012
Chevron boom configuration was deployed above Ceresco Dam



Water Temperature: 68.0 °F
Sediment Temperature: 58.9 °F

April 5, 2012 Tar globs and sheen observed at Ceresco Dam



Water Temperature: 56.2 °F
Sediment Temperature: 54.7 °F

April 10, 2012 Boom was reconfigured to bank to bank above Ceresco Dam



Water Temperature: 49.6 °F
Sediment Temperature: 52.0 °F

April 26, 2012
Boom was reconfigured above Ceresco Dam



Water Temperature: 57.0 °F
Sediment Temperature: 56.3 °F

May 9, 2012 Tar globs and sheen observed at Ceresco Dam



Water Temperature: 64.3 °F
Sediment Temperature: 62.2 °F

May 31, 2012 Tar globs and sheen observed at Ceresco Dam



Water Temperature: 63.2 °F
Sediment Temperature: 63.1 °F

June 6, 2012 Tar globs and sheen observed at MP5.63 LDB



Water Temperature: 64.3 °F
Sediment Temperature: 64.3 °F

June 7, 2012 Tar globs and sheen observed at Ceresco Dam



Water Temperature: 67.6 °F
Sediment Temperature: 66.9 °F

June 19, 2012
Boom was removed from Ceresco Dam



Water Temperature: 74.4 °F
Sediment Temperature: 73.1 °F

June 19, 2012 Tar globs and sheen observed at Ceresco Dam



Water Temperature: 74.4 °F
Sediment Temperature: 73.1 °F

V

June 19, 2012 Tar globs and sheen observed at Ceresco Dam



Water Temperature: 74.4 °F
Sediment Temperature: 73.1 °F

V

June 19, 2012 Tar globs and sheen observed at Ceresco Dam



Water Temperature: 74.4 °F
Sediment Temperature: 73.1 °F

June 20, 2012 Tar globs and sheen observed flowing over Ceresco Dam



Water Temperature: 82.1 °F
Sediment Temperature: 77.9 °F

June 20, 2012 Tar globs and sheen observed during the portage work above Ceresco Dam



Water Temperature: 82.1 °F
Sediment Temperature: 77.9 °F

June 25, 2012 Tar globs and sheen observed flowing over Ceresco Dam



Water Temperature: 79.7 °F
Sediment Temperature: 69.0 °F

June 27, 2012
Sheen observed at
Ceresco Dam



Water Temperature: 68.6 °F
Sediment Temperature: 69.6 °F

June 29, 2012 Tar globs and sheen observed flowing over Ceresco Dam



Water Temperature: 75.5 °F
Sediment Temperature: 74.9 °F

July 2, 2012 Sheen observed above Ceresco Dam



Water Temperature: 74.1 °F
Sediment Temperature: 73.1 °F

July 3, 2012 Tar globs and sheen observed flowing over Ceresco Dam



Water Temperature: 79.4 °F
Sediment Temperature: 78.2 °F

July 5, 2012 Sheen observed flowing over Ceresco Dam



Water Temperature: 89.4°F (MP18.25)
Sediment Temperature: 84.1°F (MP18.25)

July 7, 2012 Sheen generated during boom reinstallation above Ceresco Dam



Water Temperature: 91.9 °F (July 6)
Sediment Temperature: 85.8 °F (July 6)

July 7, 2012 Sheen observed above Ceresco Dam



Water Temperature: 91.9 °F (July 6)
Sediment Temperature: 85.8 °F (July 6)

July 7, 2012 Sheen observed above Ceresco Dam



Water Temperature: 91.9 °F (July 6)
Sediment Temperature: 85.8 °F (July 6)

July 7, 2012 Boom reinstalled at Ceresco Dam



Water Temperature: 91.9 °F (July 6)
Sediment Temperature: 85.8 °F (July 6)

July 7, 2012 Sheen generated during boom reinstallation above Ceresco Dam



Water Temperature: 91.9 °F (July 6)
Sediment Temperature: 85.8 °F (July 6)

July 7, 2012 Boom reinstallation above Ceresco Dam



Water Temperature: 91.9 °F (July 6)
Sediment Temperature: 85.8 °F (July 6)

V

July 7, 2012 Sheen flowing over Ceresco Dam during boom reinstallation



Water Temperature: 91.9 °F (July 6)
Sediment Temperature: 85.8 °F (July 6)

July 16, 2012
Sheen observed above Ceresco Dam



Water Temperature: 86.1 °F
Sediment Temperature: 80.8 °F

July 17, 2012
Sheen observed above Ceresco Dam



Water Temperature: 89.0 °F
Sediment Temperature: 81.7 °F

July 17, 2012
Sheen observed above Ceresco Dam



Water Temperature: 89.0 °F
Sediment Temperature: 81.7 °F

July 18, 2012
Sheen observed collecting along the boom above Ceresco Dam



Water Temperature: 87.6 °F
Sediment Temperature: 79.6 °F

July 18, 2012
Sheen observed above Ceresco Dam at MP5.63 LDB



Water Temperature: 87.6 °F
Sediment Temperature: 79.6 °F

July 18, 2012
Sheen observed above Ceresco Dam at MP5.63 LDB



Water Temperature: 87.6 °F
Sediment Temperature: 79.6 °F

July 19, 2012
Sheen observed collecting along the boom above Ceresco Dam



Water Temperature: 72.3 °F
Sediment Temperature: 72.8 °F

July 19, 2012
Sheen observed at the C0.4 Boat Launch



Water Temperature: 72.3 °F
Sediment Temperature: 72.8 °F

July 24, 2012
Sheen observed at
MP5.25 RDB



Water Temperature: 78.0 °F
Sediment Temperature: 77.6 °F

July 24, 2012
Sheen observed at
MP5.5 RDB



Water Temperature: 78.0 °F
Sediment Temperature: 77.6 °F

July 24, 2012
Sheen observed at
MP5.55 RDB

Water Temperature: 78.0 °F
Sediment Temperature: 77.6 °F



July 24, 2012
Sheen observed at
MP5.75 RDB



Water Temperature: 78.0 °F
Sediment Temperature: 77.6 °F

July 24, 2012
Sheen observed along the boom above Ceresco Dam



Water Temperature: 78.0 °F
Sediment Temperature: 77.6 °F

July 26, 2012
Sheen observed above Ceresco Dam



Water Temperature: 80.7 °F
Sediment Temperature: 79.0 °F

July 26, 2012
Sheen observed above Ceresco Dam



Water Temperature: 80.7 °F
Sediment Temperature: 79.0 °F

July 26, 2012
Sheen observed above Ceresco Dam



Water Temperature: 80.7 °F
Sediment Temperature: 79.0 °F

August 3, 2012
Sheen observed above Ceresco Dam at MP5.63 LDB



Water Temperature: 74.8 °F
Sediment Temperature: 75.3 °F

August 7, 2012
Sheen observed above Ceresco Dam at MP5.63 LDB



Water Temperature: 71 °F

August 8, 2012
Sheen observed above Ceresco Dam at MP5.63 LDB



Water Temperature: 75 °F

August 13, 2012
Sheen observed above Ceresco Dam at MP5.63 LDB



Water Temperature: 66 °F
Sediment Temperature: 65 °F

August 13, 2012
Sheen observed collecting along the boom at Ceresco Dam



Water Temperature: 66 °F
Sediment Temperature: 65 °F

August 14, 2012
Sheen observed above Ceresco Dam at MP5.63 LDB



Water Temperature: 67 °F
Sediment Temperature: 68.5 °F

August 16, 2012
Sheen observed above Ceresco Dam at MP5.63 LDB



Water Temperature: 67.1 °F
Sediment Temperature: 65.7 °F

August 16, 2012
Sheen observed collecting along the boom at Ceresco Dam



Water Temperature: 67.1 °F
Sediment Temperature: 65.7 °F

August 18, 2012
Sheen observed above Ceresco Dam at MP5.63



Water Temperature: NA
Sediment Temperature: NA

August 18, 2012
Sheen and tar glob observed at Ceresco Dam



Water Temperature: NA °F
Sediment Temperature: NA °F

August 20, 2012
Sheen and tar globs observed at MP5.00 LDB during observation



Water Temperature: 69.0 °F
Sediment Temperature: 68.8 °F

V

August 20, 2012
Sheen and tar globs observed at MP5.25 LDB during observation



Water Temperature: 69.0 °F
Sediment Temperature: 68.8 °F

August 20, 2012
Sheen and tar globs observed at MP5.00 LDB during observation



Water Temperature: 69.0 °F
Sediment Temperature: 68.8 °F

August 20, 2012
Sheen and tar globs observed at MP5.75 during observation



Water Temperature: 69.0 °F
Sediment Temperature: 68.8 °F

August 24, 2012
Sheen and tar globs observed above Ceresco Dam at MP5.63 LDB



Water Temperature: 74.8 °F
Sediment Temperature: 75.3 °F

August 24, 2012
Sheen and tar globs observed above Ceresco Dam at MP5.55 RDB



Water Temperature: 74.8 °F
Sediment Temperature: 75.3 °F

August 24, 2012
Sheen and tar globs observed above Ceresco Dam at MP5.63 LDB



Water Temperature: 74.8 °F
Sediment Temperature: 75.3 °F

August 24, 2012
Sheen and tar globs observed above Ceresco Dam at MP5.63 LDB



Water Temperature: 74.8 °F
Sediment Temperature: 75.3 °F

August 24, 2012
Sheen observed above Ceresco Dam at MP5.75 LDB



Water Temperature: 74.8 °F
Sediment Temperature: 75.3 °F

August 27, 2012
Sheen observed above Ceresco Dam at MP5.75 LDB



Water Temperature: 74.8 °F
Sediment Temperature: 75.3 °F

August 28, 2012
Sheen observed above Ceresco Dam at MP5.8 LDB



Water Temperature: N/A
Sediment Temperature: N/A

V

August 30, 2012
Sheen observed above Ceresco during poling activities



Water Temperature: N/A
Sediment Temperature: N/A

August 30, 2012
Sheen observed above Ceresco Dam



Water Temperature: N/A
Sediment Temperature: N/A

September 1, 2012
Sheen observed above Ceresco Dam at MP5.50 LDB



Water Temperature: N/A
Sediment Temperature: N/A

September 1, 2012
Sheen observed above Ceresco Dam at MP5.63



Water Temperature: N/A
Sediment Temperature: N/A

September 4, 2012
Sheen observed above Ceresco Dam at MP5.50 LDB



Water Temperature: N/A
Sediment Temperature: N/A

September 4, 2012
Sheen observed above Ceresco Dam at MP5.63 LDB



Water Temperature: N/A
Sediment Temperature: N/A

September 5, 2012
Sheen observed above Ceresco Dam at MP5.75



Water Temperature: 77 °F
Sediment Temperature: 75 °F

September 6, 2012
Sheen observed above Ceresco Dam at MP5.5



Water Temperature: 74.8 °F
Sediment Temperature: 75.3 °F

September 7, 2012
Sheen observed at Ceresco Control Point



Water Temperature: 74.8 °F
Sediment Temperature: 75.3 °F

V

September 8, 2012
Sheen observed above Ceresco Dam at MP5.63 LDB



Water Temperature: 74.8 °F
Sediment Temperature: 75.3 °F

V

September 8, 2012
Sheen observed above Ceresco Dam at MP5.63 LDB



Water Temperature: 74.8 °F
Sediment Temperature: 75.3 °F

V

September 8, 2012
Sheen observed above Ceresco Dam at MP5.63 LDB



Water Temperature: 74.8 °F
Sediment Temperature: 75.3 °F

V

September 8, 2012
Sheen observed above Ceresco Dam at MP5.63 LDB



Water Temperature: 74.8 °F
Sediment Temperature: 75.3 °F

V

September 10, 2012
Sheen observed
above Ceresco Dam
at MP5.9 LDB



Water Temperature: 74.8 °F
Sediment Temperature: 75.3 °F

V

September 10, 2012
Sheen observed above Ceresco Dam at MP5.63 LDB



Water Temperature: 74.8 °F
Sediment Temperature: 75.3 °F

V

September 11, 2012
Sheen observed above Ceresco Dam at MP5.63 RDB



Water Temperature: 66.0 °F
Sediment Temperature: 67.0 °F

V

September 11, 2012
Sheen observed
above Ceresco Dam
at MP5.63 RDB



Water Temperature: 66.0 °F
Sediment Temperature: 67.0 °F

September 11, 2012
Sheen observed above Ceresco Dam at MP5.63 RDB



Water Temperature: 66.0 °F
Sediment Temperature: 67.0 °F

September 11, 2012
Sheen observed above Ceresco Dam at MP5.63 RDB



Water Temperature: 66.0 °F
Sediment Temperature: 67.0 °F

V

September 12, 2012
Sheen observed
above Ceresco Dam



Water Temperature: 65.0 °F
Sediment Temperature: 62.67 °F

September 12, 2012
Sheen observed
above Ceresco Dam



Water Temperature: 65.0 °F
Sediment Temperature: 62.67 °F

September 12, 2012
Sheen observed
above Ceresco Dam



Water Temperature: 65.0 °F
Sediment Temperature: 62.67 °F

September 13, 2012
Sheen observed above
Ceresco Dam at
MP4.5 LDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 13, 2012
Sheen observed above
Ceresco Dam at
MP4.5 LDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 13, 2012
Sheen observed above
Ceresco Dam at
MP5.55 LDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 13, 2012
Sheen observed above
Ceresco Dam at
MP5.55 LDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 13, 2012
Sheen observed above
Ceresco Dam at
MP5.55 LDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 13, 2012
Sheen observed above
Ceresco Dam at
MP5.55 LDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

V

September 13, 2012
Sheen observed above
Ceresco Dam at
MP5.63 LDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

V

September 13, 2012
Sheen observed above
Ceresco Dam
Reverse Thrust



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 13, 2012
Sheen observed above
Ceresco Dam
Reverse Thrust



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 13, 2012
Sheen observed above
Ceresco Dam
Reverse Thrust



Water Temperature: N/A °F
Sediment Temperature: N/A °F

V

September 14, 2012
Sheen observed above
Ceresco Dam at
MP5.63 LDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 14, 2012
Sheen observed above
Ceresco Dam at
MP5.63 LDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 14, 2012
Sheen observed above
Ceresco Dam at
MP5.63 LDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 14, 2012
Sheen observed above
Ceresco Dam at
MP5.63 LDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

V

September 17, 2012
Sheen observed above
Ceresco Dam at
MP5.63 RDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 17, 2012
Sheen observed above
Ceresco Dam at
MP5.63 RDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 17, 2012
Sheen observed above
Ceresco Dam at
MP5.63 RDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

V

September 19, 2012
Sheen observed above
Ceresco Dam at
MP5.75 RDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 19, 2012
Sheen observed above
Ceresco Dam at
MP5.75 RDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 19, 2012
Sheen observed above
Ceresco Dam at
MP5.75 RDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 19, 2012
Sheen observed above
Ceresco Dam at
MP5.63 LDB



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 19, 2012
Sheen observed above
Ceresco Dam at
MP5.63 LDB



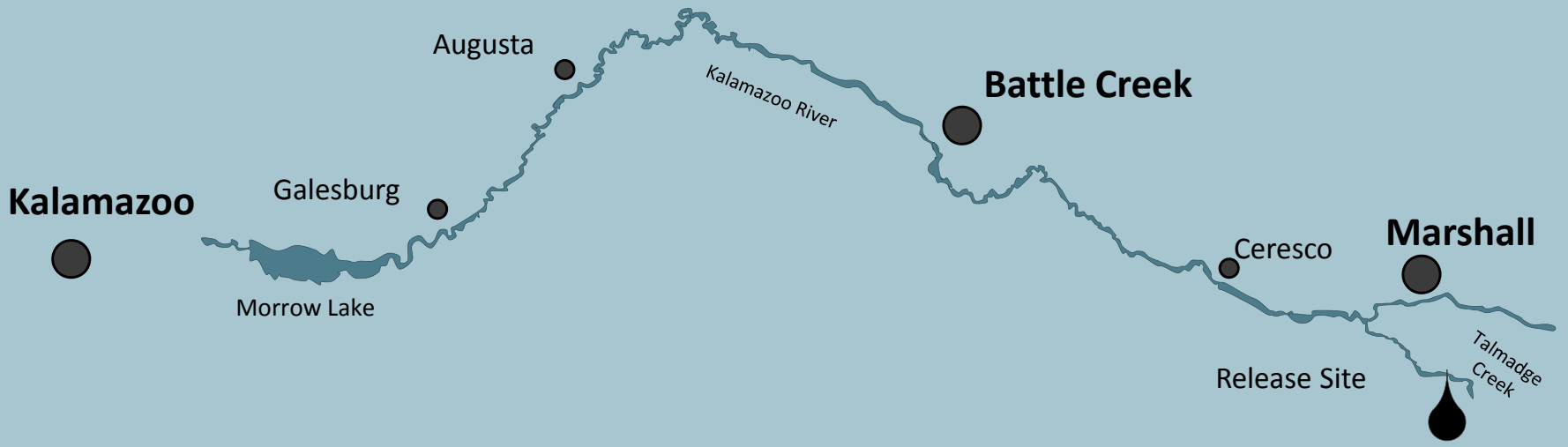
Water Temperature: N/A °F
Sediment Temperature: N/A °F

Enbridge Ceresco Dam Position

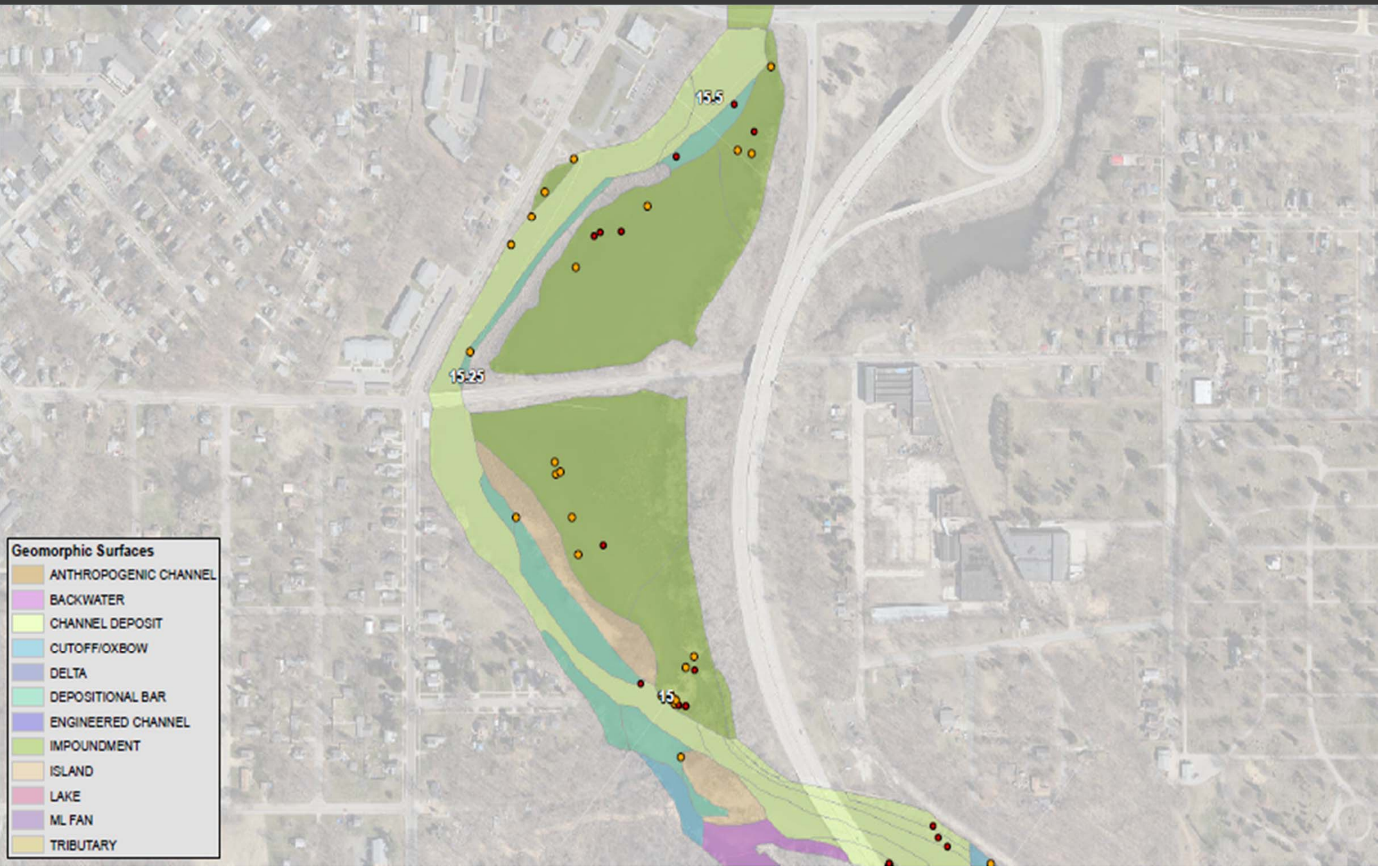
- No active recovery until volume calculations and agitation effects studies complete
- Further invasive activities would do more harm than good
- Sheen management in 2012 has effectively controlled sheen in the river, but only recovered 1.38 gallons and utilized 3,000 gallons of gallons of gasoline to do it
- Definitions of Heavy and Moderate Submerged Oil have changed
- Sediment Samples Evaluation for Texture, Chemistry, & Toxicity
- Water Quality - Groundwater, Drinkwater, & Designated Uses low risk
- Biota - Low adverse impacts or risk to river biota from Line 6B release
- Aesthetics – Removal requested only for aesthetic purposes
- Evaluation of potential duration of continued aesthetic impacts should be determined prior to active recovery

MDEQ Position

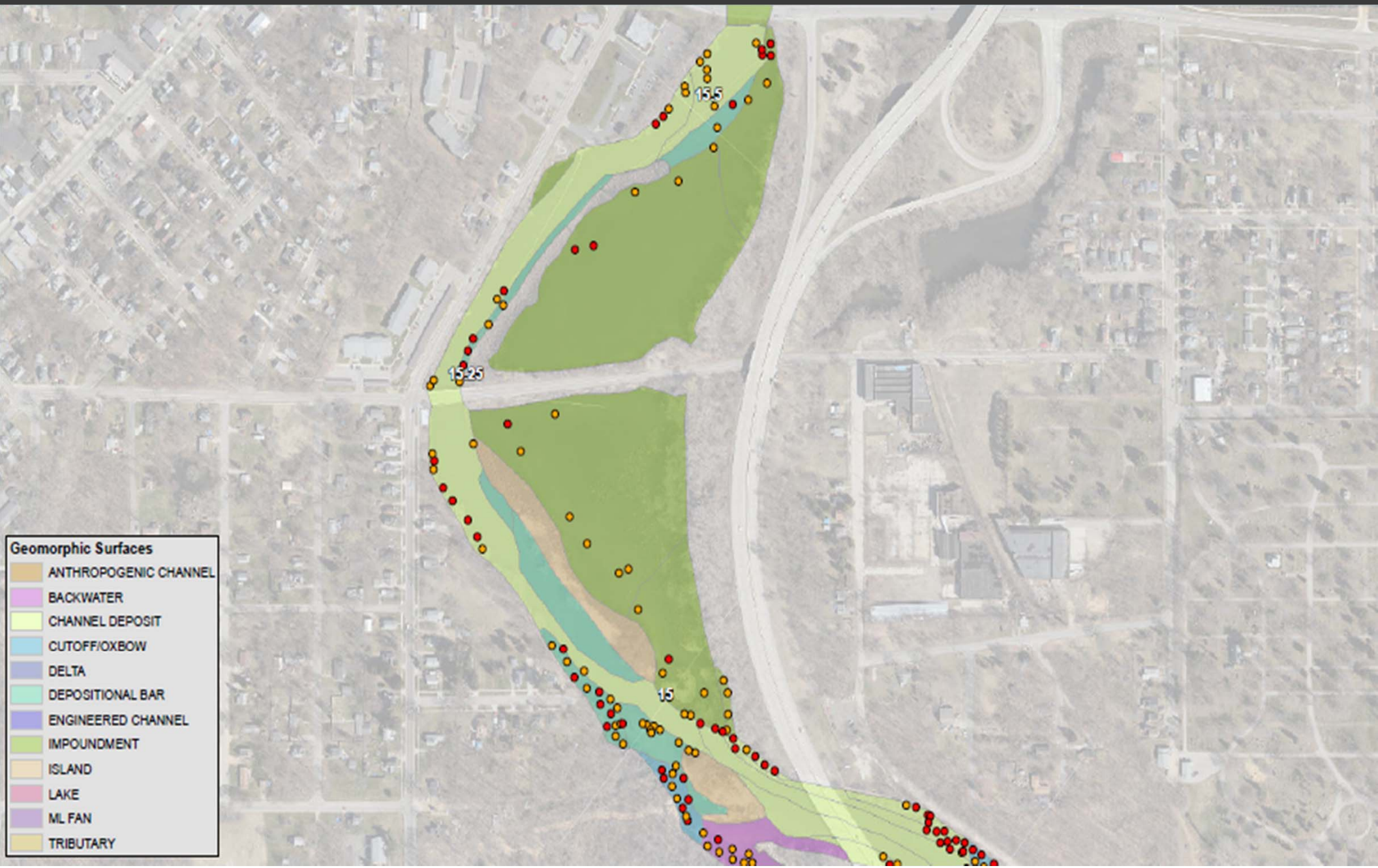
Mill Pond Conditions



Mill Pond Late Summer Reassessment 2011



Mill Pond Spring 2012 Reassessment



Mill Pond 2012 Late Summer Reassessment



Mill Pond NEBA Analysis

NEBA

.

•Sheen collection, increase monitoring frequency, continue to evaluate for possible future recovery actions

Mill Pond Heavy & Moderate Impact Areas

Impacted Area & Volume

.

- Area of impacted sediment defined by heavy and moderate poling results based on the Fall 2012 Late Summer Reassessment results. Area =

- Volume of impacted sediment defined by Area and dredging depth of 12 inches. Volume =

Mill Pond Heavy & Moderate Impact Areas

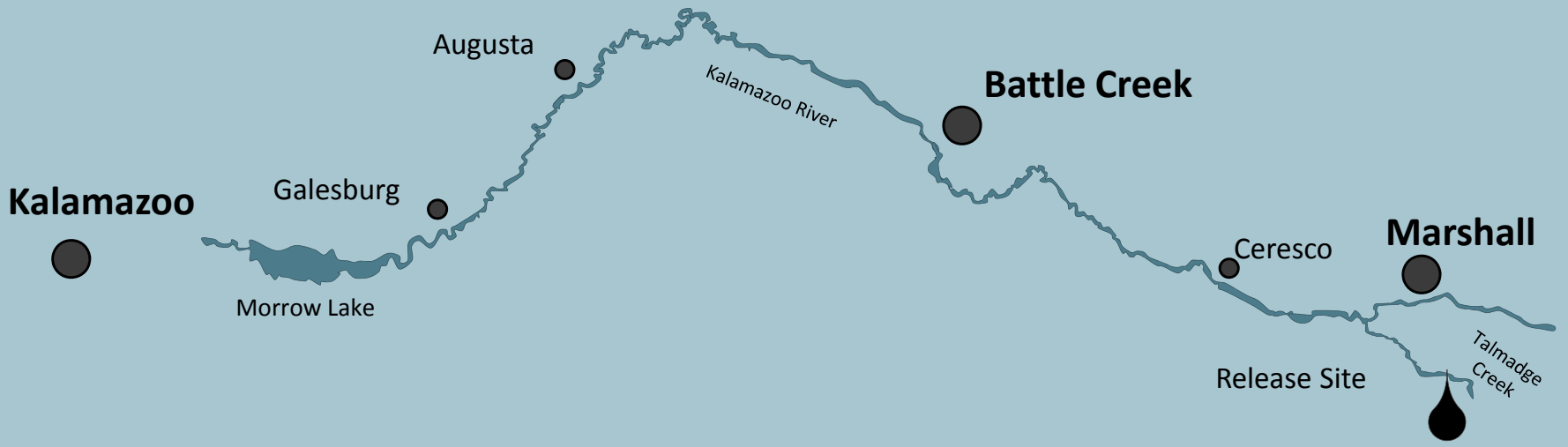
Impacted Area & Volume

.

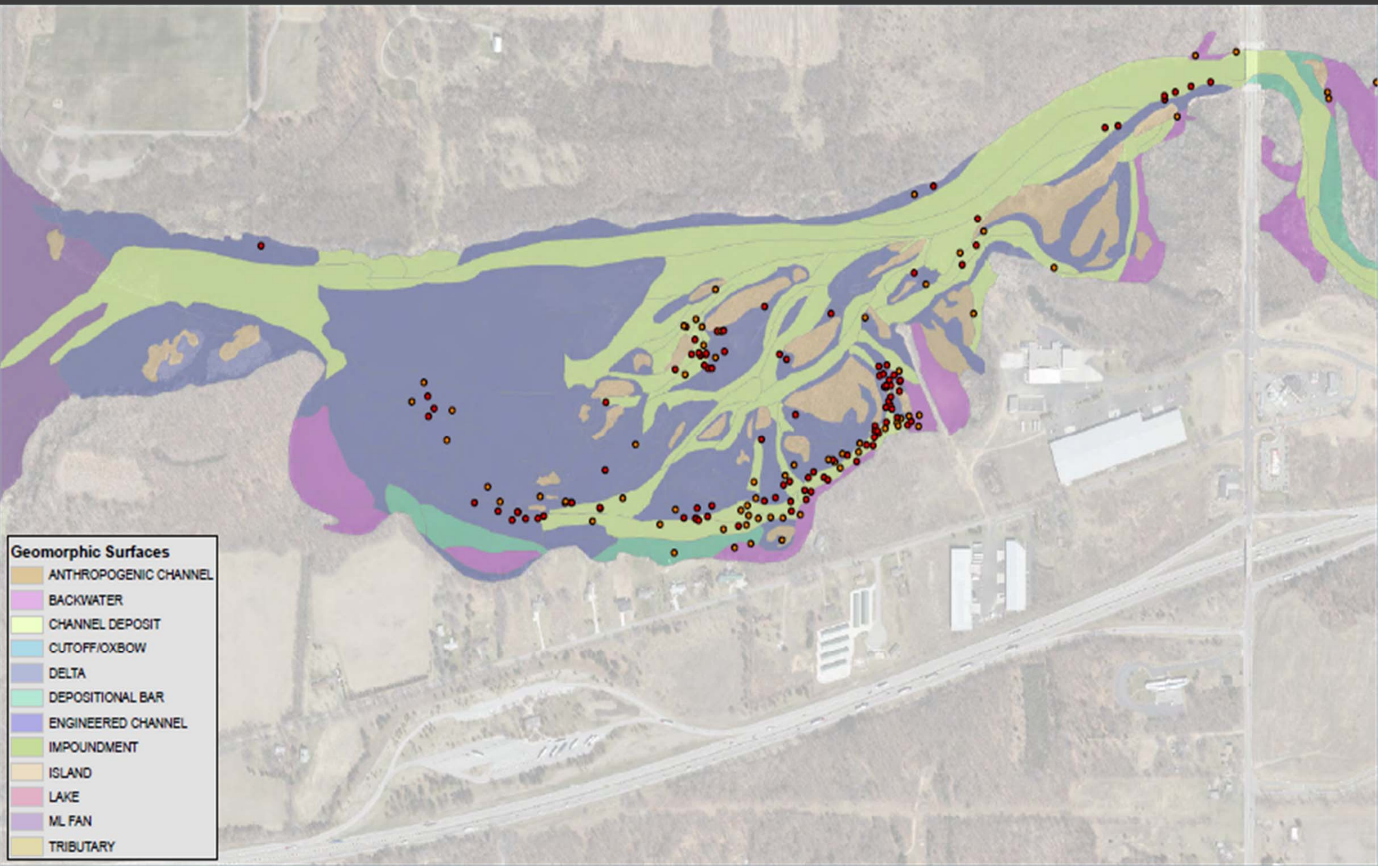
- Area of impacted sediment defined by heavy and moderate poling results based on the Fall 2012 Late Summer Reassessment results. Area = 10 Acres

- Volume of impacted sediment defined by Area and dredging depth of 12 inches. Volume = 16,100 CY

Morrow Lake Delta Sub Oil Conditions



Morrow Lake Delta Fall 2010 Assessment



Morrow Lake Delta/ Neck August 2, 2010





August 2, 2010
Morrow Lake Delta during early response activities





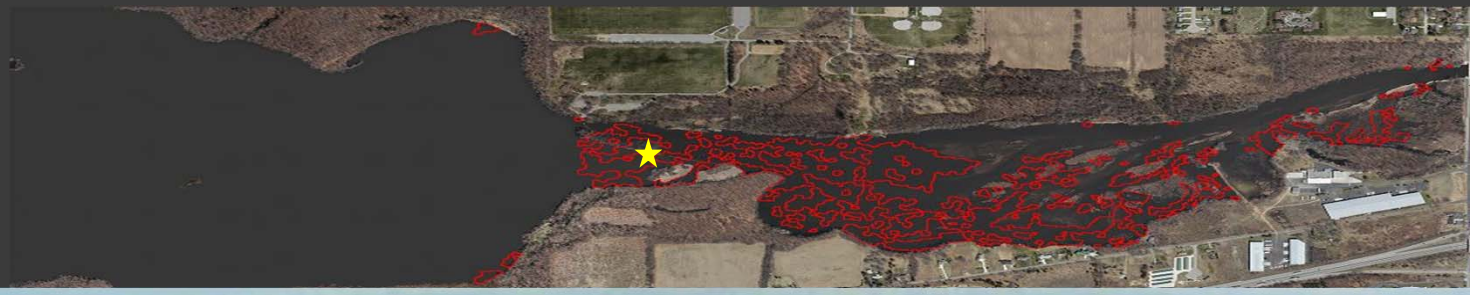
August 2, 2010
Morrow Lake Delta
during early
response activities





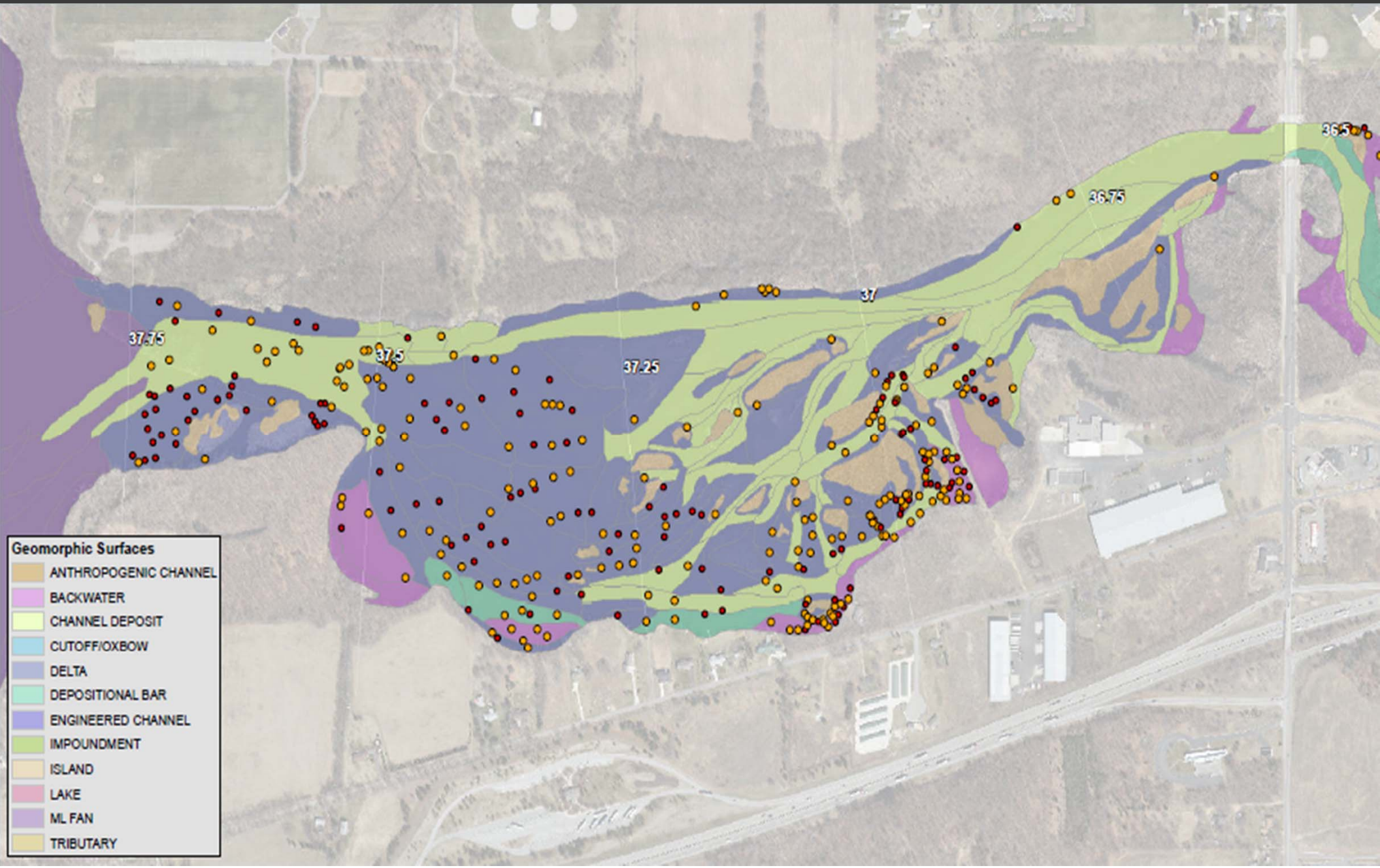
V

August 2, 2010
Morrow Lake Delta
during early
response activities





Morrow Lake Delta Fall 2011 Late Summer Reassessment



July 18, 2011
Morrow Lake Delta
agitation activities



July 18, 2011
Morrow Lake Delta
agitation activities





July 23, 2011
Morrow Lake Delta agitation activities





July 23, 2011
Morrow Lake Delta
agitation activities





July 23, 2011
Morrow Lake Delta
agitation activities





July 23, 2011
Morrow Lake Delta
agitation activities





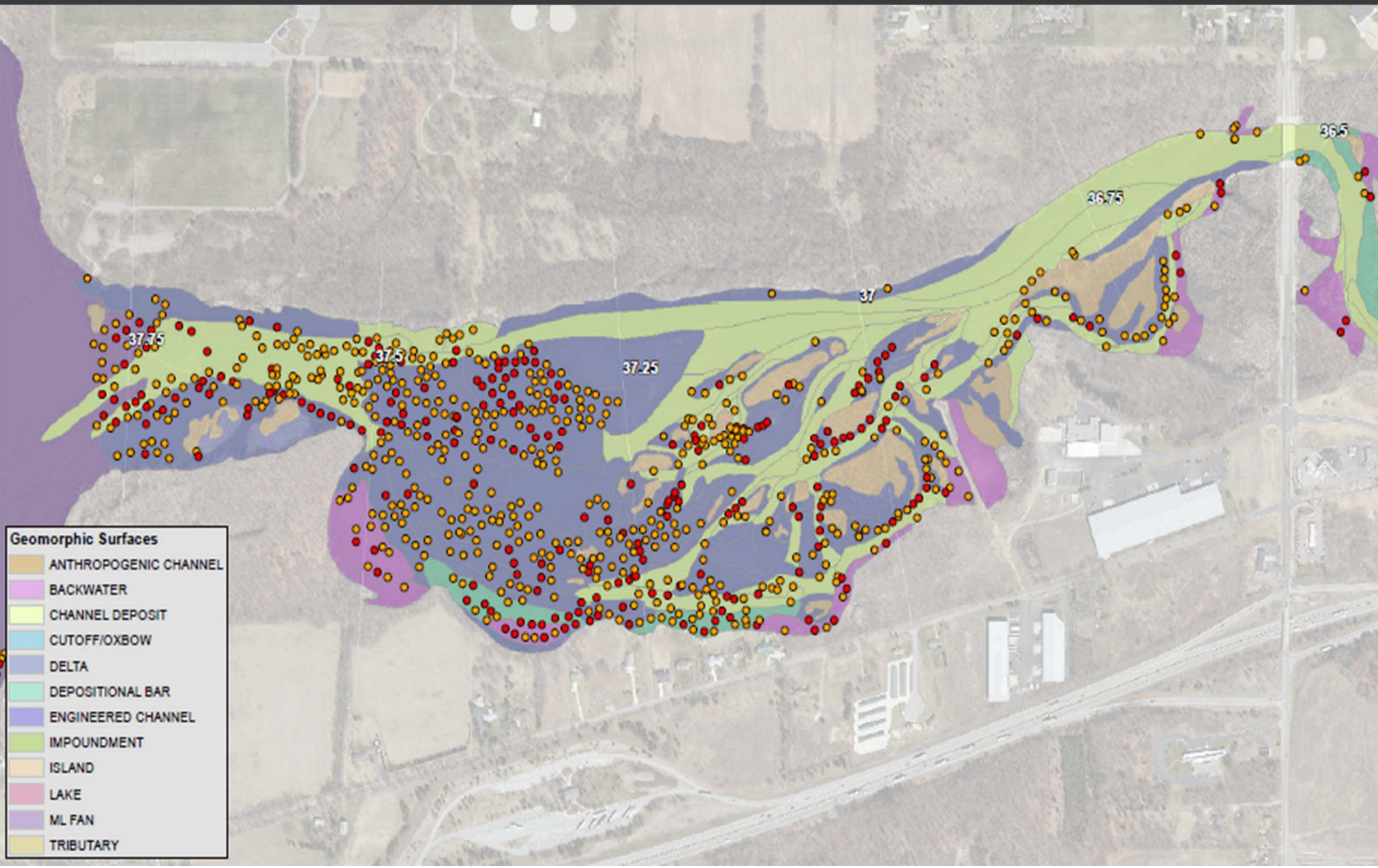
Morrow Lake Delta Spring 2012 Reassessment

Heavy, Moderate, Light, & None Poling Results



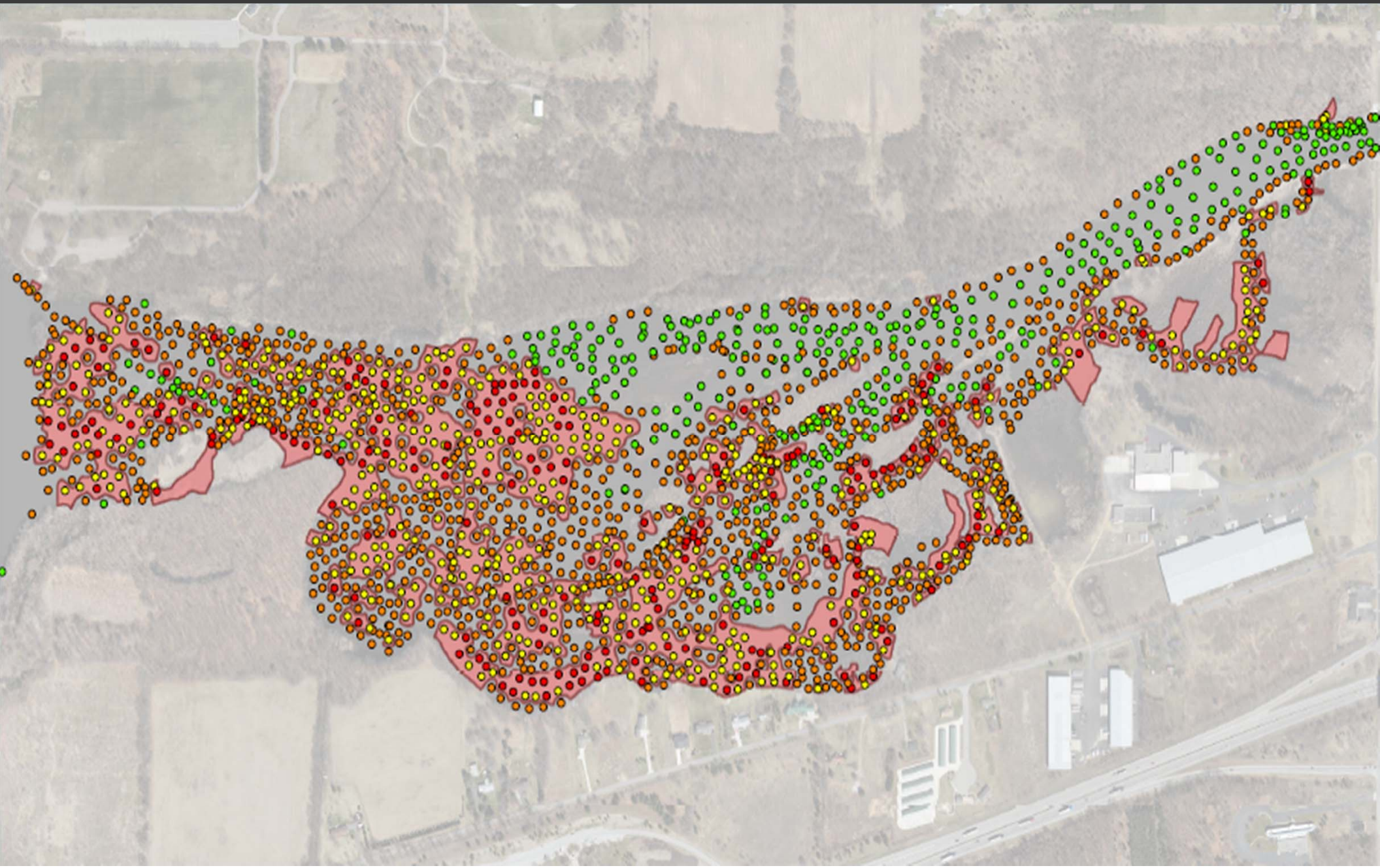
Morrow Lake Delta Spring 2012 Reassessment

Heavy & Moderate Poling Results



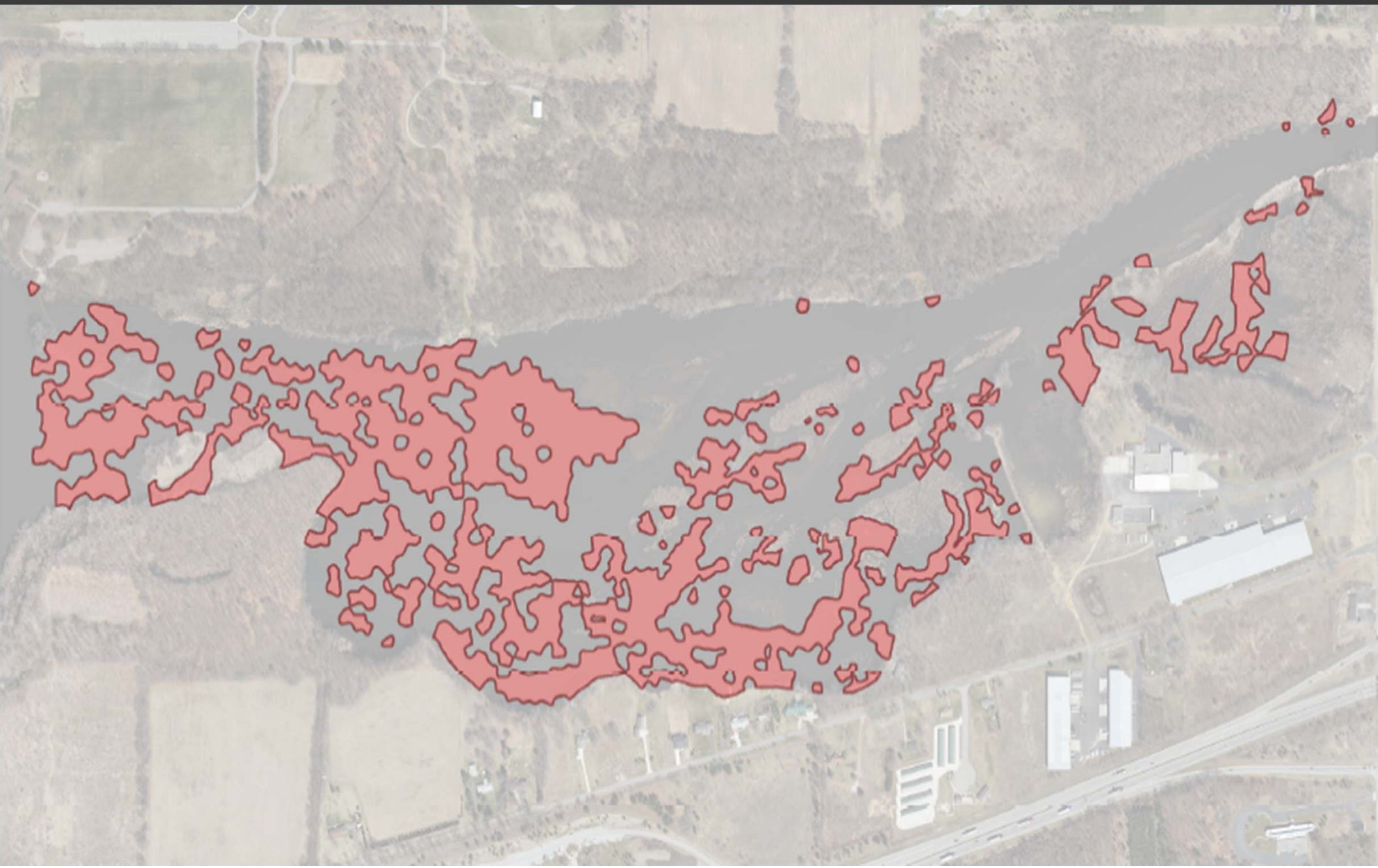
Morrow Lake Delta Spring 2012 Reassessment

All Poling Data

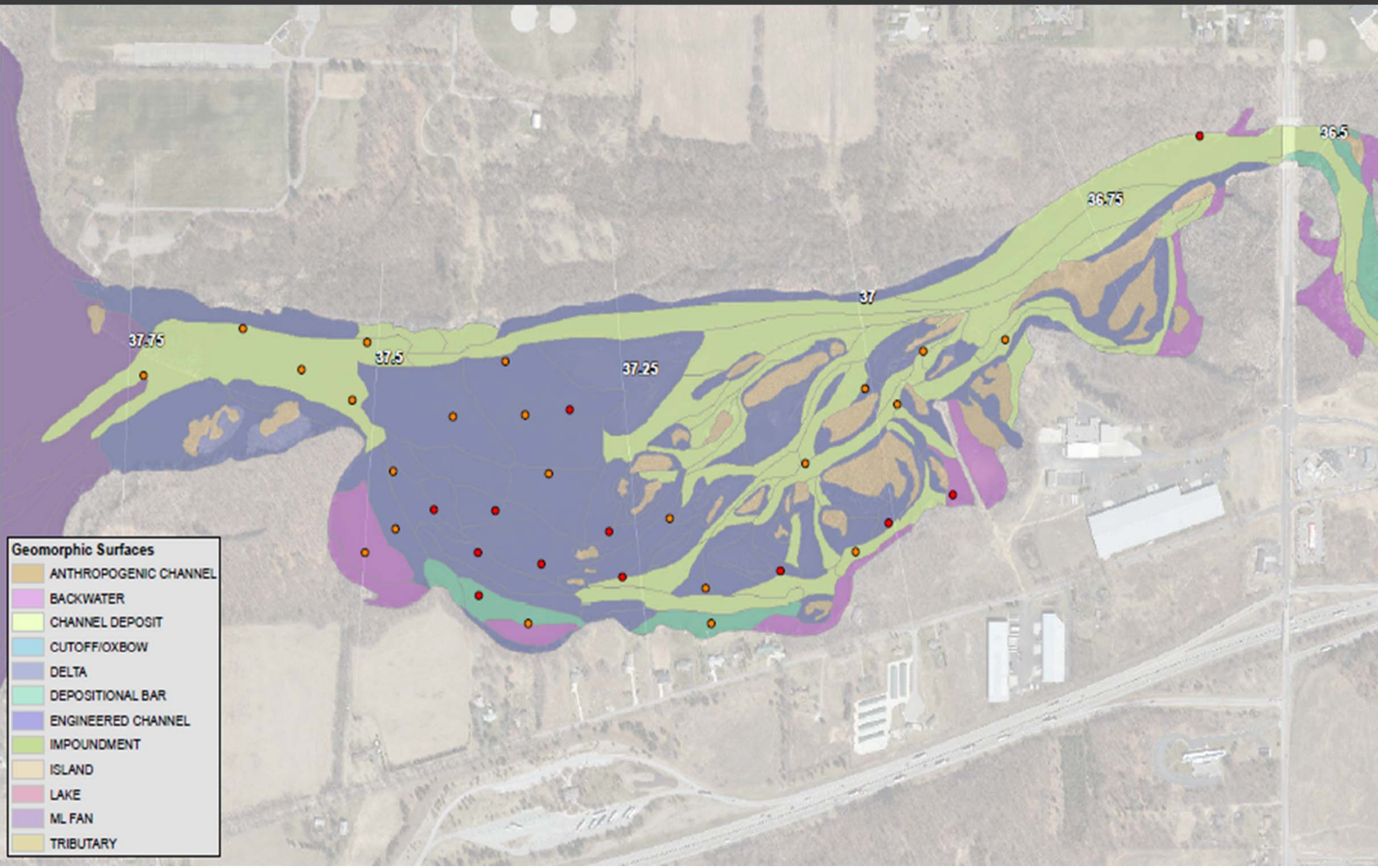


Morrow Lake Delta Spring 2012 Reassessment

Heavy & Moderate Poling Delineations

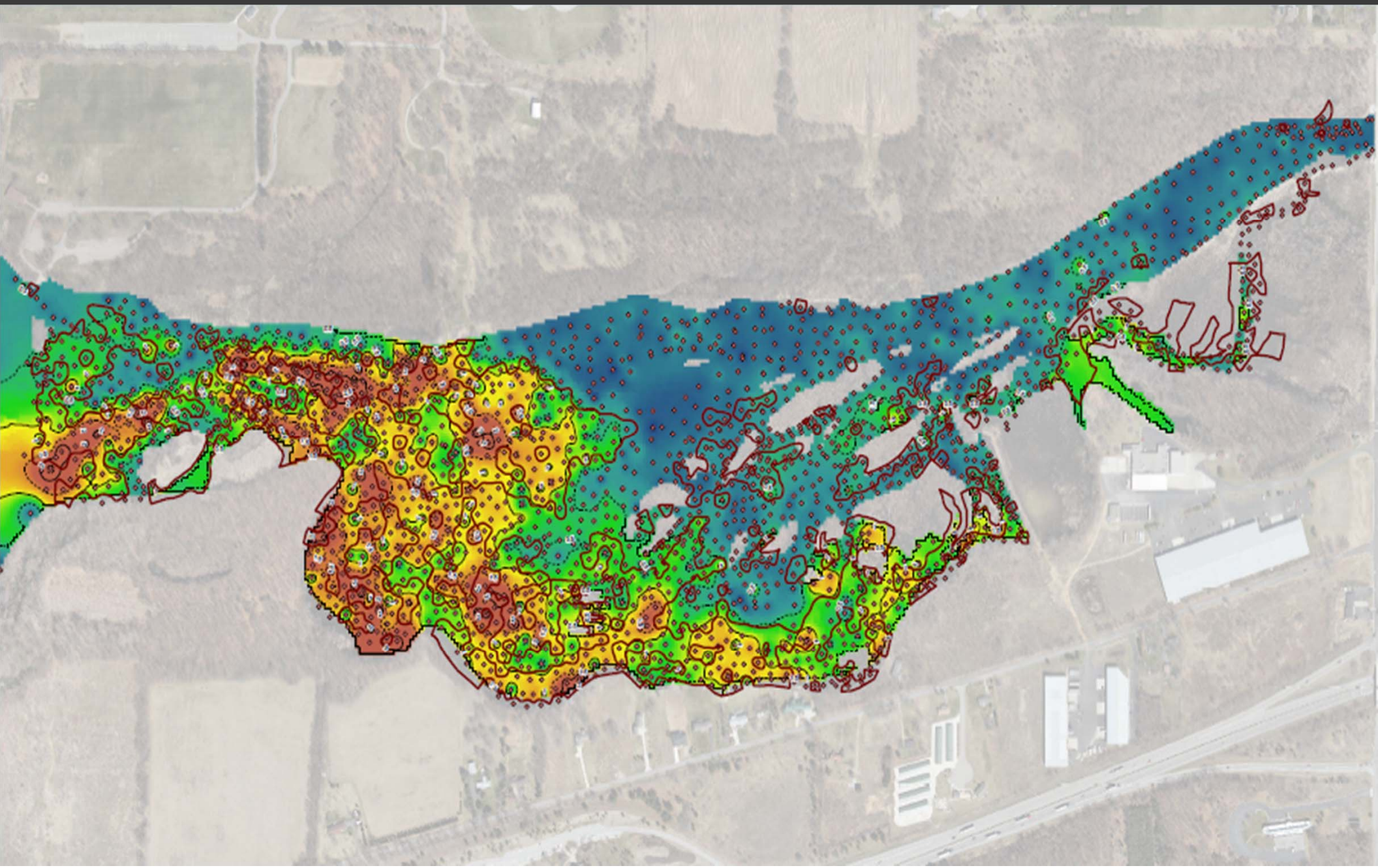


Morrow Lake Delta Summer 2012 Monitoring



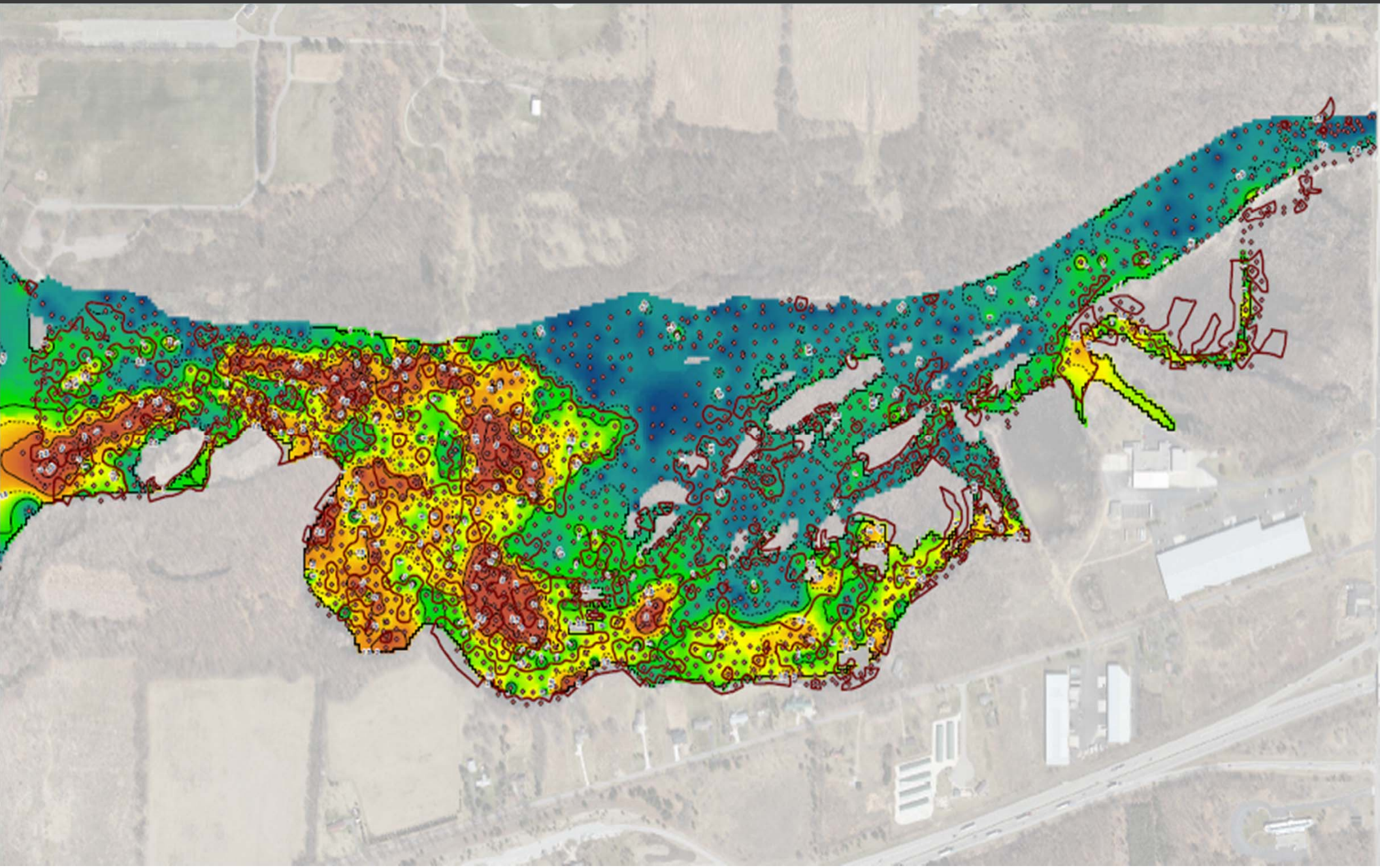
Morrow Lake Delta Sediment Thickness – One Push Poling

Based on Spring 2012 Sub Oil Reassessment



Morrow Lake Delta Sediment Thickness – Two Push Poling

Based on Spring 2012 Sub Oil Reassessment

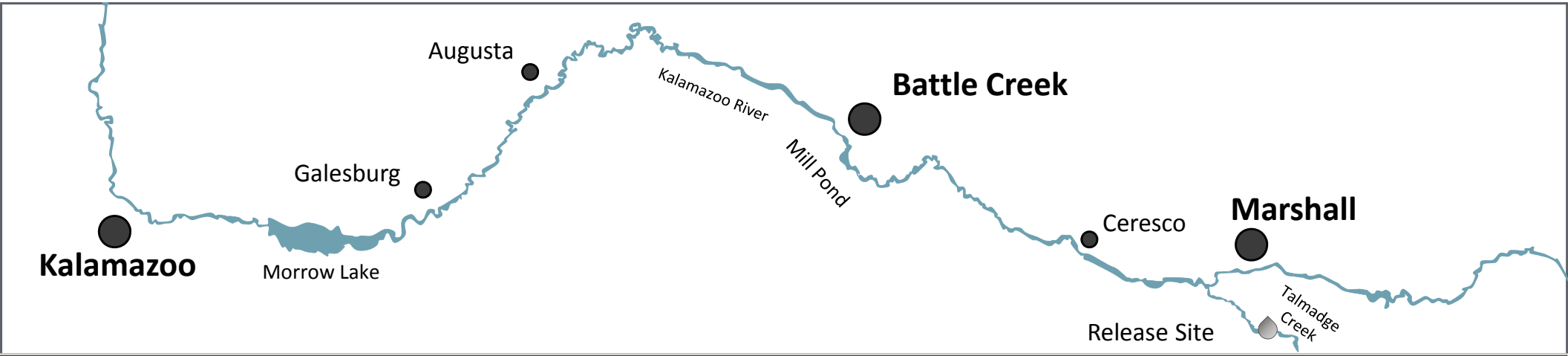


Morrow Lake Delta and Upstream

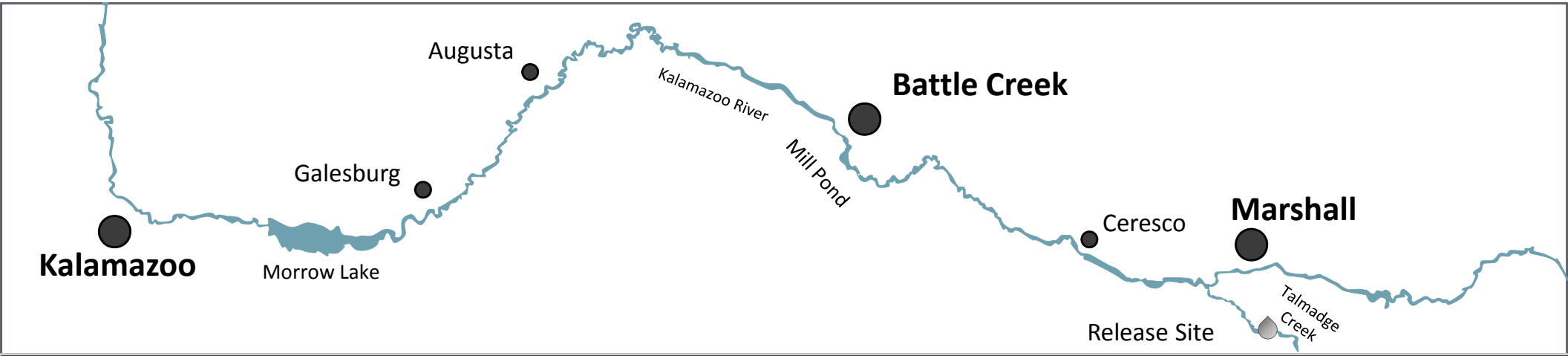
Spring 2012 Reassessment Poling Results

Heavy and Moderate Sub-Oil Categories

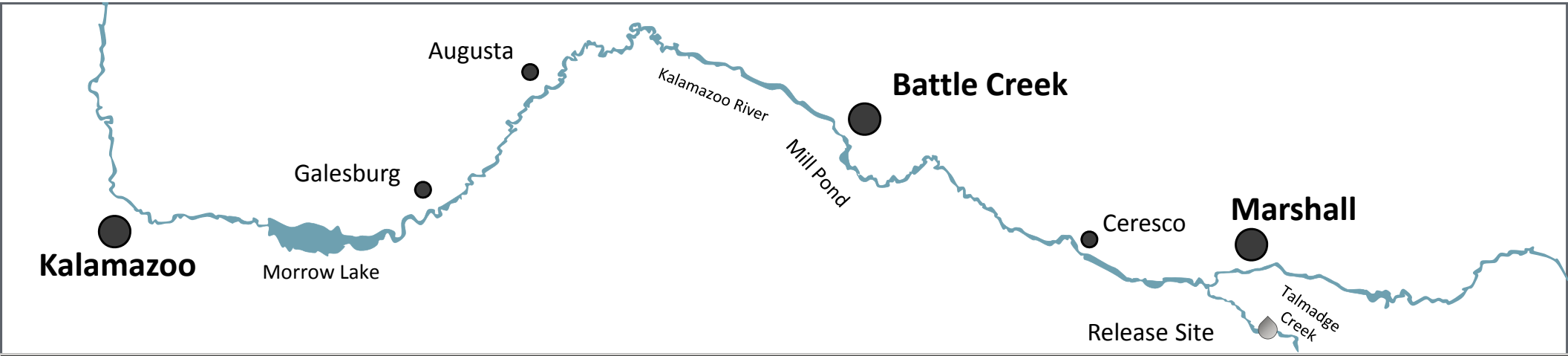




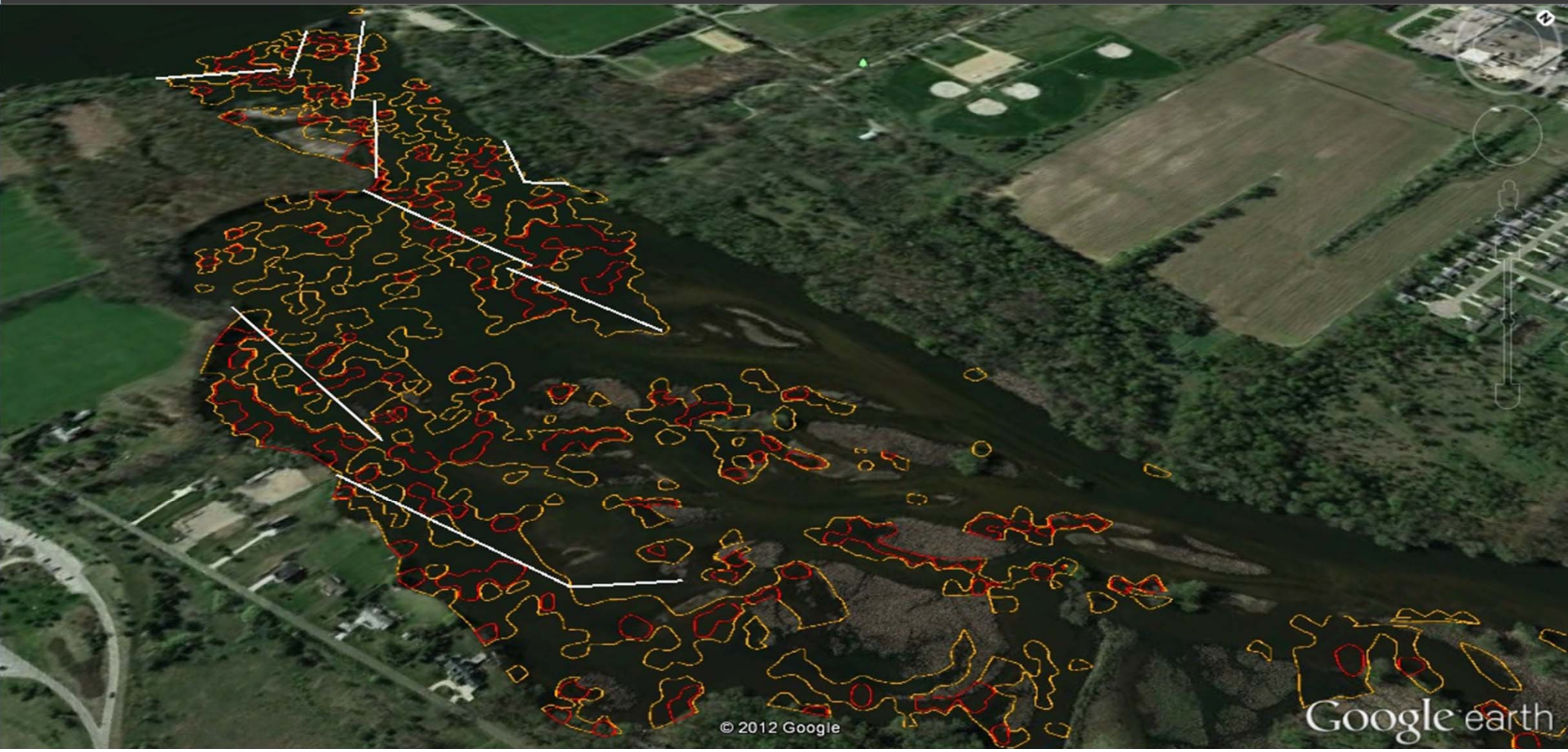
E4 Containment System at Morrow Lake and Delta – Installed July 2012



E4 Containment System at Morrow Lake and Delta – Installed July 2012

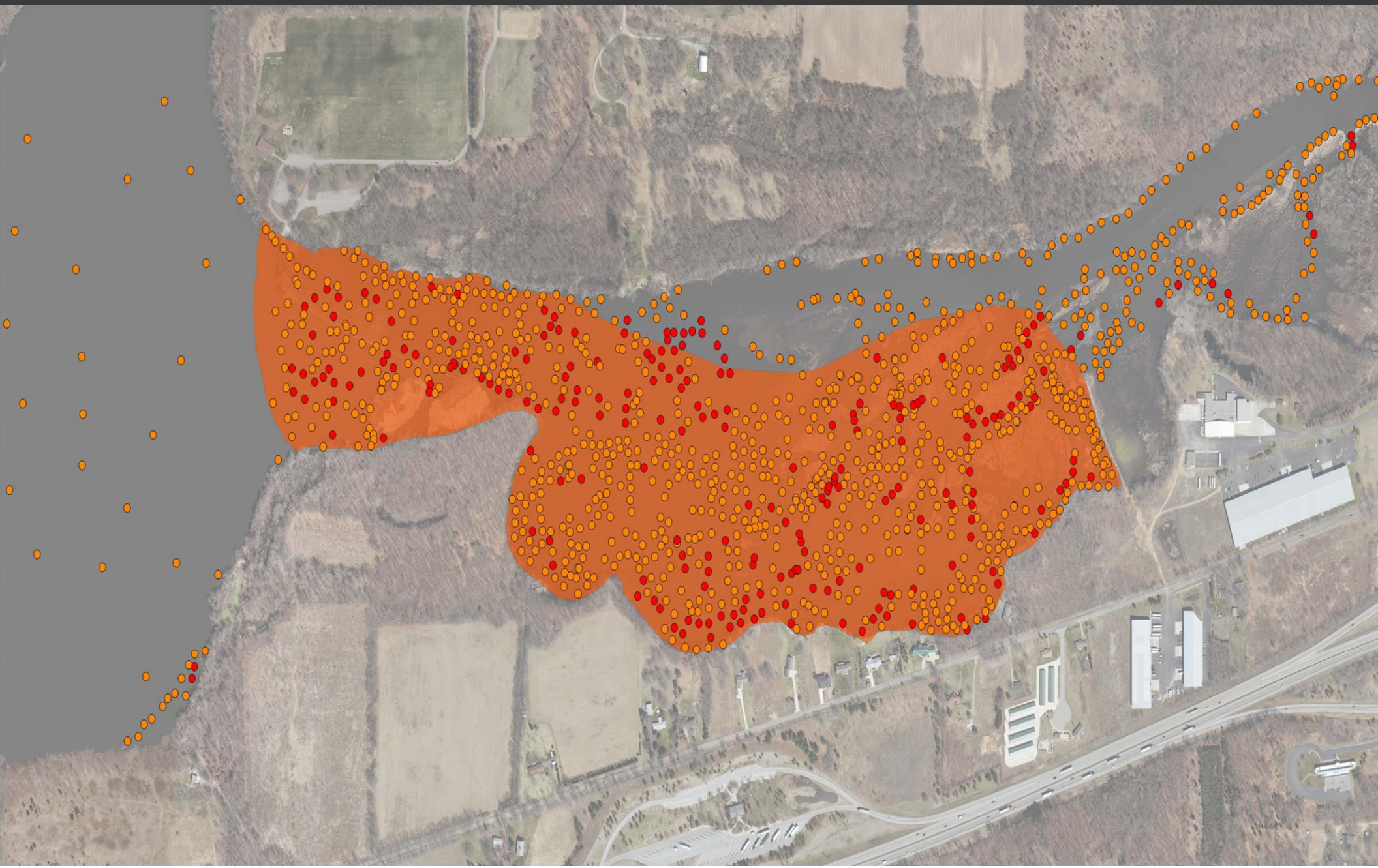


E4 Containment System at Morrow Lake and Delta – Installed July 2012



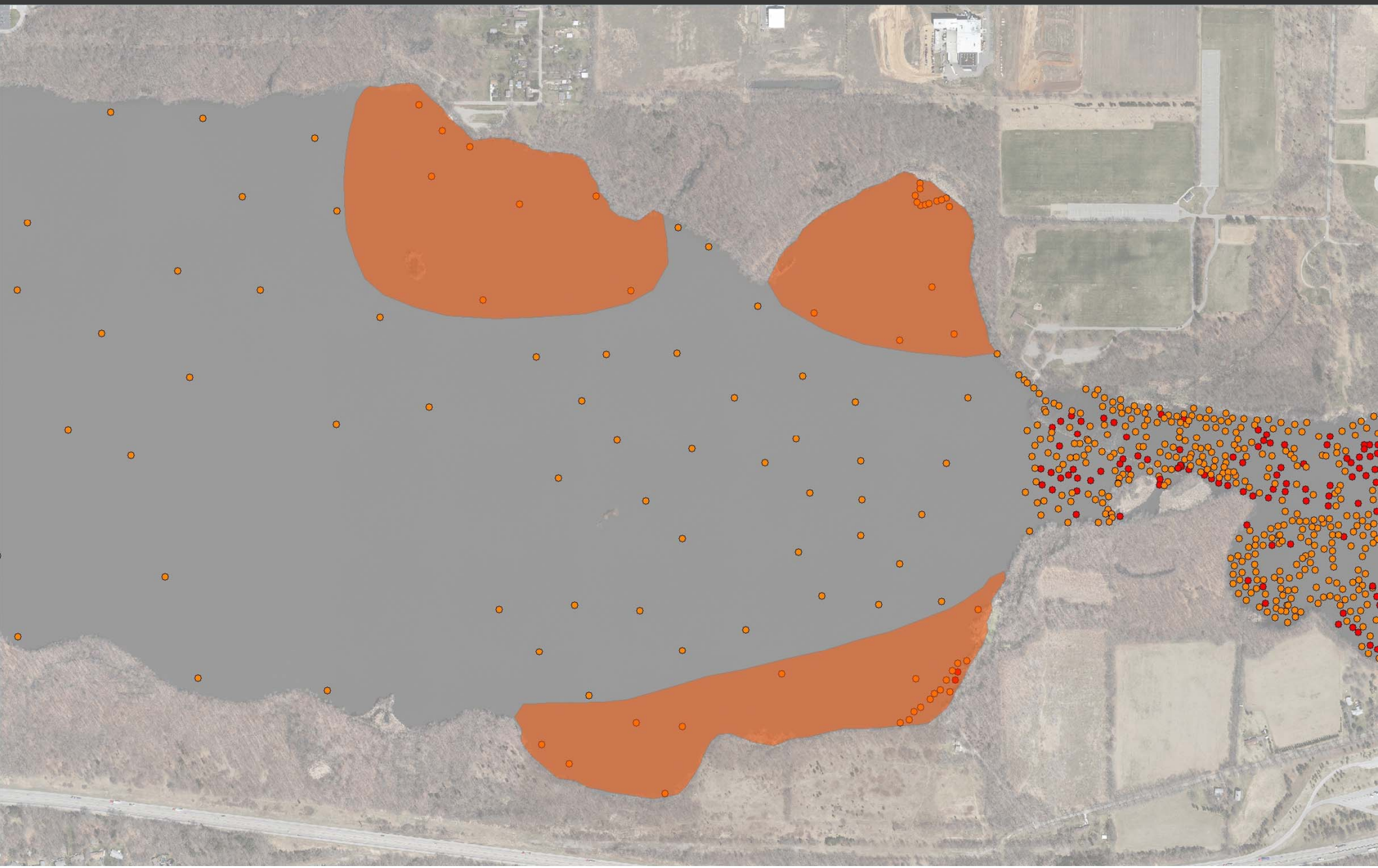
Morrow Lake Delta Sheen Observations & Responses

June 1 through September 19 2012



Morrow Lake Delta Sheen Observations & Responses

June 1 through September 19 2012



April 30, 2012 Sheen and tar globs observed downstream of the E4 Boom



Water Temperature: 54.06 °F
Sediment Temperature: 53.96 °F

May 8, 2012 Sheen observed along the E4 Control Point in the Morrow Lake Delta



Water Temperature: N/A °F
Sediment Temperature: N/A °F

May 8, 2012 Sheen observed along the E4 Control Point in the Morrow Lake Delta



Water Temperature: N/A °F
Sediment Temperature: N/A °F

May 8, 2012 Sheen observed along the E4 Control Point in the Morrow Lake Delta



Water Temperature: N/A °F
Sediment Temperature: N/A °F

May 12, 2012 Sheen and tar globs observed around a poling crew operating in the Delta



Water Temperature: 61.55 °F
Sediment Temperature: 59.09 °F

May 12, 2012 Sheen and tar globs observed around a poling crew operating in the Delta



Water Temperature: 61.55 °F
Sediment Temperature: 59.09 °F

May 12, 2012 Sheen observed between MP37.35 – MP37.75 in the Morrow Lake Delta



Water Temperature: 61.55 °F
Sediment Temperature: 59.09 °F

May 12, 2012 Sheen observed between MP37.35 – MP37.75 in the Morrow Lake Delta



Water Temperature: 61.55 °F
Sediment Temperature: 59.09 °F

May 12, 2012 Sheen observed between MP37.35 – MP37.75 in the Morrow Lake Delta



Water Temperature: 61.55 °F
Sediment Temperature: 59.09 °F

May 18, 2012 Sheen observed along the northern shoreline above E4 Control Point in the Morrow Lake Delta



Water Temperature: 67 °F
Sediment Temperature: 65 °F

May 29, 2012 Sheen observed coming off the sand bar at MP37.5 in the Morrow Lake Delta



Water Temperature: N/A °F
Sediment Temperature: N/A °F

June 2, 2012 Sheen observed within an island in the southeast corner of the Morrow Lake Delta



Water Temperature: N/A °F
Sediment Temperature: N/A °F

June 5, 2012 Sheen observed downstream of a poling crew in the Morrow Lake Delta



Water Temperature: 68.32 °F
Sediment Temperature: 64.51 °F

June 5, 2012 Sheen observed within an island in the southeast corner of the Morrow Lake Delta



Water Temperature: 68.32 °F
Sediment Temperature: 64.51 °F

June 5, 2012 Sheen observed within an island in the southeast corner of the Morrow Lake Delta



Water Temperature: 68.32 °F
Sediment Temperature: 64.51 °F

June 6, 2012 Sheen and tar globs observed southeast corner of the Delta



Water Temperature: 68.32 °F
Sediment Temperature: 64.51 °F

June 6, 2012 Sheen and tar globs observed at MP37.75 E4 Boom in the Delta



Water Temperature: 68.32 °F
Sediment Temperature: 64.51 °F

June 6, 2012 Sheen and tar globs observed at MP37.75 E4 Boom in the Delta



Water Temperature: 68.32 °F
Sediment Temperature: 64.51 °F

June 19, 2012 Sheen observed in the southeast corner of the Morrow Lake Delta



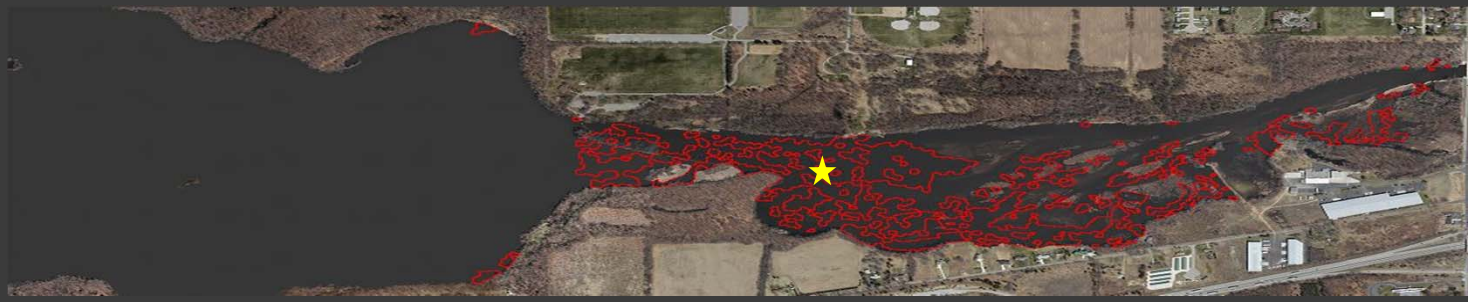
Water Temperature: 72.79 °F
Sediment Temperature: 68.71 °F

June 29, 2012 Sheen and tar globs observed at MP37.5 in the Delta



Water Temperature: 77.63 °F
Sediment Temperature: 73.96 °F

June 29, 2012 Sheen and tar globs observed in the Delta



Water Temperature: 79.69 °F
Sediment Temperature: 76.41 °F

June 30, 2012 Sheen and tar globs observed in the southeast corner of the Delta



Water Temperature: 79.69 °F
Sediment Temperature: 76.41 °F

July 2, 2012 Sheen observed in the central portion of the Morrow Lake Delta



Water Temperature: 77.97 °F
Sediment Temperature: 70.95 °F

July 3, 2012 Sheen and tar globs observed around the pontoon barge in the Delta



Water Temperature: 77.97 °F
Sediment Temperature: 70.95 °F

July 5, 2012 Sheen observed along the southern shoreline of the Morrow Lake Delta during boom installation



Water Temperature: 87 °F
Sediment Temperature: 79 °F

July 5, 2012 Sheen observed along the southern shoreline of the Morrow Lake Delta during boom installation



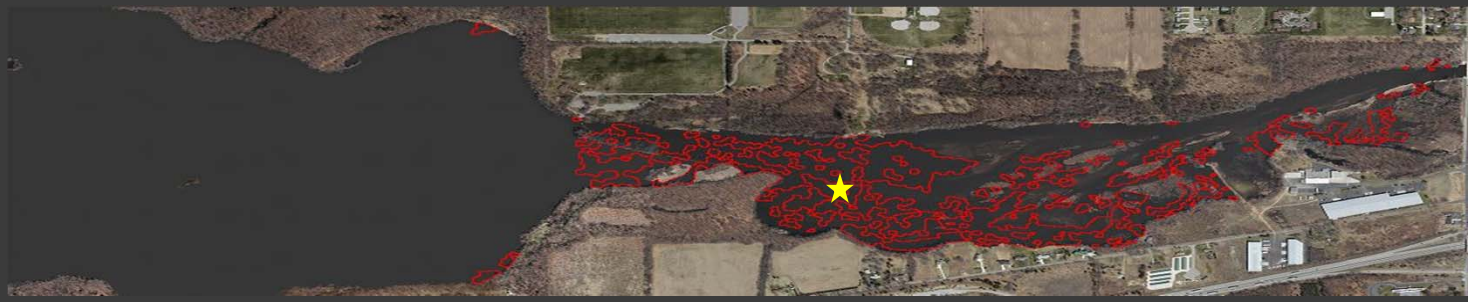
Water Temperature: 87 °F
Sediment Temperature: 79 °F

July 17, 2012 Sheen observed along Gate A of the Morrow Lake Delta



Water Temperature: 83.46 °F
Sediment Temperature: 79.30 °F

July 19, 2012 Sheen and tar globs observed collecting along Boom C in the Delta



Water Temperature: 82.71 °F
Sediment Temperature: 79.37 °F

July 21, 2012 Sheen and tar globs observed collecting along Boom B in the Delta



Water Temperature: N/A °F
Sediment Temperature: N/A °F

July 24, 2012 Sheen observed along Gate D of the Morrow Lake Delta



Water Temperature: 79.63 °F
Sediment Temperature: 77.50 °F

July 25, 2012 Sheen and tar globs observed near Boom C in the Delta when the boat reversed.



Water Temperature: 77.86 °F
Sediment Temperature: 76.79 °F

August 4, 2012 Sheen and tar globs observed collecting along Boom E in the Delta



Water Temperature: 78.07 °F
Sediment Temperature: 76.60 °F

August 6, 2012 Sheen and tar globs observed collecting along Boom E in the Delta



Water Temperature: N/A °F
Sediment Temperature: N/A °F

August 9, 2012 Sheen and tar globs observed collecting along Boom C in the Delta



Water Temperature: 72.00 °F
Sediment Temperature: 73.00 °F

August 10, 2012 Sheen and tar globs observed collecting along Boom C in the Delta. The sheen was generated from a poling crew



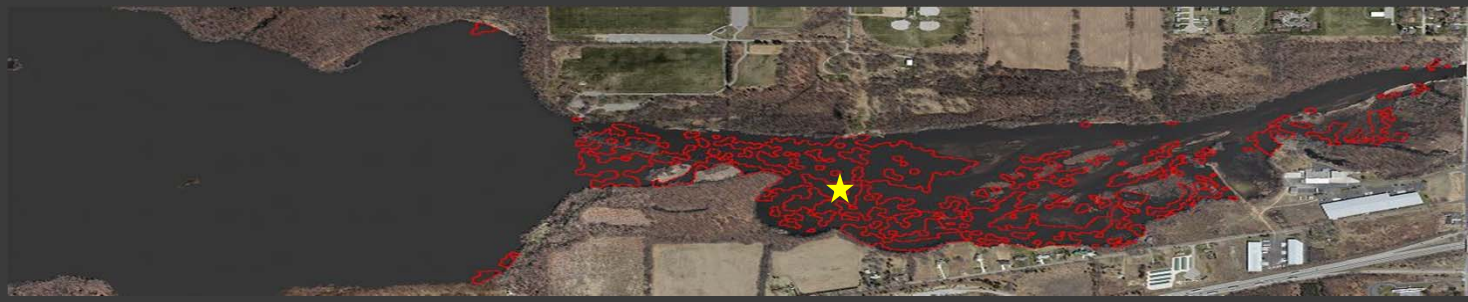
Water Temperature: 66.00 °F
Sediment Temperature: 69.00 °F

August 10, 2012
Sheen observed generated by Poling Crew along Gate C



Water Temperature: 66.00 °F
Sediment Temperature: 69.00 °F

August 13, 2012
Sheen and tar globs observed collecting along Boom C in the Delta



Water Temperature: 66.00 °F
Sediment Temperature: 65.00 °F

August 15, 2012
Sheen and tar globs observed during a reverse thrust in Delta Gate A



Water Temperature: 70.00 °F
Sediment Temperature: 67.50 °F

August 18, 2012
Sheen observed
collecting at Gate C



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 10, 2012
Sheen observed near Boom A generated by the boat



Water Temperature: 66.67 °F
Sediment Temperature: 67.00 °F

September 10, 2012
Sheen observed near Boom A generated by the boat



Water Temperature: 66.67 °F
Sediment Temperature: 67.00 °F

September 13, 2012
Sheen observed at Delta A during reverse thrust



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 13, 2012
Sheen observed at
Delta A



Water Temperature: N/A °F
Sediment Temperature: N/A °F

September 17, 2012
Sheen and tar globs observed collecting along Boom C in the Delta



Water Temperature: N/A °F
Sediment Temperature: N/A °F

2012/09/17 09:58

September 17, 2012
Sheen and tar globs observed collecting along Boom C in the Delta



Water Temperature: N/A °F
Sediment Temperature: N/A °F

2012/09/17 09:58

Morrow Lake Delta NEBA Analysis

NEBA

.

- **Delta:** Subdivide into subareas, evaluate recovery actions after subarea delineations, follow existing sediment trap monitoring and maintenance plan, for heavy oiled areas consider recovery (dredging)

- **Delta E-E':** Sheen collection; consider recovery (dredging) and making an enhanced (deepened) sediment trap"

- **Delta Sediment Traps:** Follow sediment trap monitoring/maintenance plan and evaluate for possible future recovery.

Morrow Lake Delta Heavy & Moderate Impact Areas

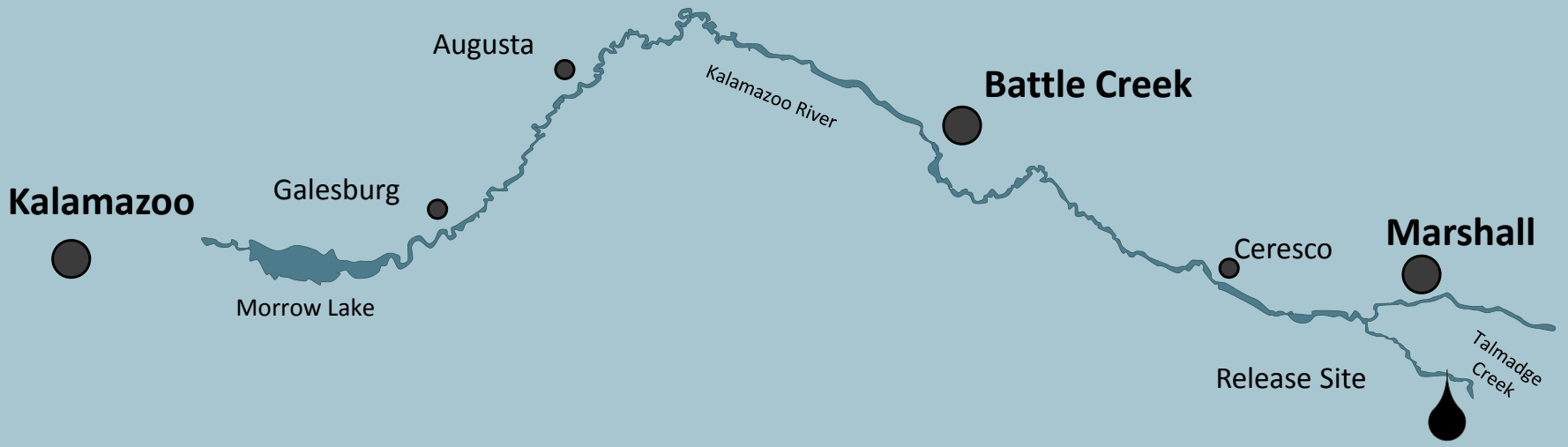
Impacted Area & Volume

.

- Area of impacted sediment defined by heavy and moderate poling results based on Spring 2012 Submerged Oil Reassessment results. Area = 63 Acres

- Volume of impacted sediment defined by Area and dredging depth of 12 inches. Volume = 102,000 CY

Morrow Lake Sub Oil Conditions



April 13, 2012 Sheen observed in the western end of Morrow Lake ★



Water Temperature: N/A °F
Sediment Temperature: N/A °F

April 13, 2012 Sheen observed in the western end of Morrow Lake ★



Water Temperature: N/A °F
Sediment Temperature: N/A °F

April 13, 2012 Sheen observed in the western end of Morrow Lake



Water Temperature: N/A °F
Sediment Temperature: N/A °F

April 30, 2012 Sheen observed E4 boat launch of Morrow Lake



Water Temperature: 54.06 °F
Sediment Temperature: 53.96 °F

April 30, 2012 Sheen observed E4 boat launch of Morrow Lake



Water Temperature: 54.06 °F
Sediment Temperature: 53.96 °F

May 1, 2012 Sheen observed along the northern shoreline of Morrow Lake



Water Temperature: 57.46 °F
Sediment Temperature: 55.87 °F

May 1, 2012 Sheen observed along the northern shoreline of Morrow Lake



Water Temperature: 57.46 °F
Sediment Temperature: 55.87 °F

May 26, 2012 Sheen observed in the northern cove of Morrow Lake



Water Temperature: 68 °F
Sediment Temperature: 66 °F

May 31, 2012 Sheen observed in the northern cove of Morrow Lake



Water Temperature: 64.81 °F
Sediment Temperature: 65.13 °F

May 31, 2012 Sheen observed MP38.25 of Morrow Lake



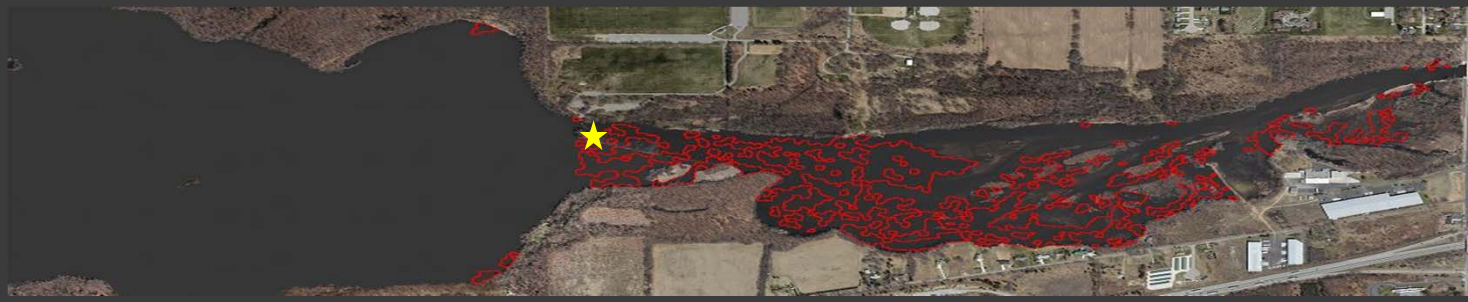
Water Temperature: 64.81 °F
Sediment Temperature: 65.13 °F

May 31, 2012 Sheen observed in the northern cove of Morrow Lake



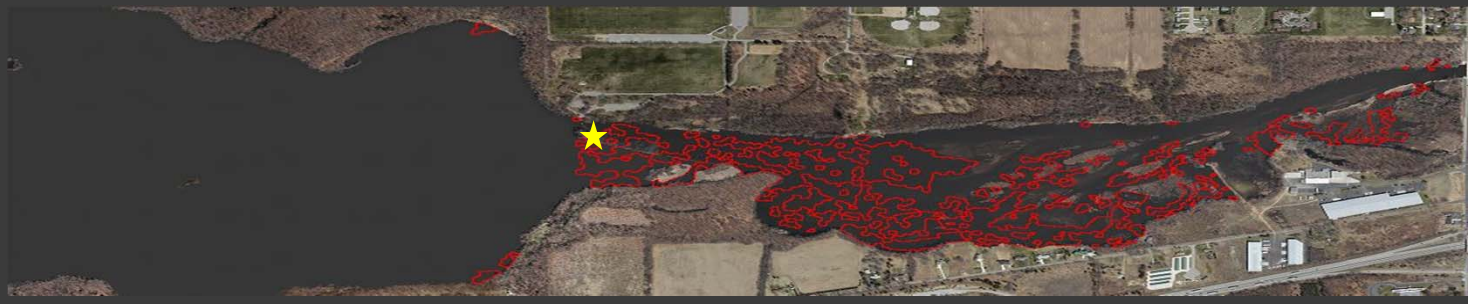
Water Temperature: 64.81 °F
Sediment Temperature: 65.13 °F

June 22, 2012 Sheen observed at the E4 boat launch of Morrow Lake



Water Temperature: 76.22 °F
Sediment Temperature: 71.46 °F

June 22, 2012 Sheen observed at the E4 boat launch of Morrow Lake



Water Temperature: 76.22 °F
Sediment Temperature: 71.46 °F

June 22, 2012 Sheen observed southeast side of Rowe Island of Morrow Lake



Water Temperature: 76.22 °F
Sediment Temperature: 71.46 °F

June 22, 2012 Sheen observed southeast side of Rowe Island of Morrow Lake



Water Temperature: 76.22 °F
Sediment Temperature: 71.46 °F

June 22, 2012 Sheen observed north of the small island within Morrow Lake



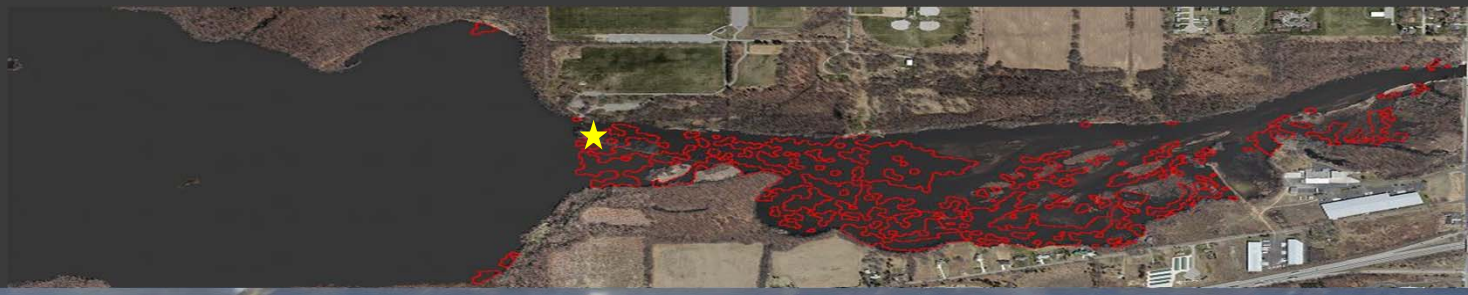
Water Temperature: 76.22 °F
Sediment Temperature: 71.46 °F

June 22, 2012 Sheen observed north of the small island within Morrow Lake



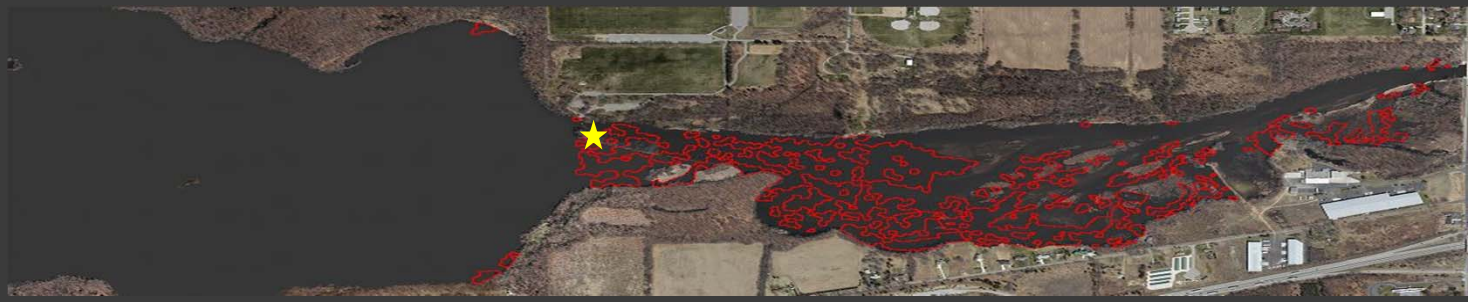
Water Temperature: 76.22 °F
Sediment Temperature: 71.46 °F

June 23, 2012 Sheen observed at the E4 boat launch of Morrow Lake



Water Temperature: 76.22 °F
Sediment Temperature: 71.46 °F

June 23, 2012 Sheen observed at the E4 boat launch of Morrow Lake



Water Temperature: 76.22 °F
Sediment Temperature: 71.46 °F

June 23, 2012 Sheen observed the fan of Morrow Lake



Water Temperature: 76.22 °F
Sediment Temperature: 71.46 °F

June 28, 2012 Sheen observed the fan of Morrow Lake



Water Temperature: 77.63 °F
Sediment Temperature: 73.96 °F

June 29, 2012 Sheen observed the fan of Morrow Lake



Water Temperature: 76.69 °F
Sediment Temperature: 76.41 °F

June 29, 2012 Sheen observed the fan of Morrow Lake



Water Temperature: 76.69 °F
Sediment Temperature: 76.41 °F

June 29, 2012 Sheen observed the fan of Morrow Lake



Water Temperature: 76.69 °F
Sediment Temperature: 76.41 °F

July 2, 2012 Sheen observed in the southern cove of Morrow Lake



Water Temperature: 77.97 °F
Sediment Temperature: 70.95 °F

July 6, 2012 Sheen observed in the southern cove of Morrow Lake



Water Temperature: 84 °F
Sediment Temperature: 81°F

July 16, 2012 Sheen observed between Rowe Island and the small island the E4.5 Boom was previously anchored to Morrow Lake



Water Temperature: 80.79 °F
Sediment Temperature: 77.83°F

July 16, 2012 Sheen observed between Rowe Island and the small island the E4.5 Boom was previously anchored to Morrow Lake



Water Temperature: 80.79 °F
Sediment Temperature: 77.83°F

July 19, 2012 Sheen observed in the northern cove of Morrow Lake



Water Temperature: 80.79 °F
Sediment Temperature: 77.83°F

July 21, 2012 Sheen observed between Rowe Island and the small island the E4.5 Boom was previously anchored to Morrow Lake



Water Temperature: N/A °F
Sediment Temperature: N/A°F

July 21, 2012 Sheen observed between Rowe Island and the small island the E4.5 Boom was previously anchored to Morrow Lake



Water Temperature: N/A °F
Sediment Temperature: N/A°F

July 24, 2012 Sheen observed in the northern cove of Morrow Lake



Water Temperature: 79.63 °F
Sediment Temperature: 77.50°F

July 25, 2012 Sheen observed in the southern cove of Morrow Lake



Water Temperature: 77.86 °F
Sediment Temperature: 76.79°F

July 25, 2012 Sheen observed in the southern cove of Morrow Lake



Water Temperature: 77.86 °F
Sediment Temperature: 76.79°F

July 30, 2012 Sheen observed in the northern cove of Morrow Lake



Water Temperature: 76.39 °F
Sediment Temperature: 75.60°F

July 30, 2012 Sheen observed in the northern cove of Morrow Lake



Water Temperature: 76.39 °F
Sediment Temperature: 75.60°F

August 2, 2012 Sheen observed in the southern cove of Morrow Lake



Water Temperature: 75.42 °F
Sediment Temperature: 75.93°F

August 4, 2012 Sheen observed near Rowe Island Morrow Lake



Water Temperature: 78.07 °F
Sediment Temperature: 76.60°F

August 4, 2012 Sheen observed near Rowe Island Morrow Lake



Water Temperature: 78.07 °F
Sediment Temperature: 76.60°F

August 8, 2012 Sheen observed in the northern cove of Morrow Lake



Water Temperature: N/A °F
Sediment Temperature: N/A°F

August 9, 2012 Sheen observed in the northern cove of Morrow Lake



Water Temperature: 72 °F
Sediment Temperature: 73°F

August 9, 2012 Sheen observed in the southern cove of Morrow Lake



Water Temperature: 72 °F
Sediment Temperature: 73°F

August 15, 2012
Sheen observed between the islands of Morrow Lake



Water Temperature: 70 °F
Sediment Temperature: 67.5°F

August 15, 2012
Sheen observed between the islands of Morrow Lake



Water Temperature: 70 °F
Sediment Temperature: 67.5°F

August 15, 2012
Sheen observed between the islands of Morrow Lake



Water Temperature: 70 °F
Sediment Temperature: 67.5°F

August 16, 2012
Sheen observed within the southern cove of Morrow Lake



Water Temperature: 67.1°F
Sediment Temperature: 65.7°F

August 17, 2012
Sheen observed between the islands of Morrow Lake



Water Temperature: 69°F
Sediment Temperature: 67°F

2012.08.17 09:19

August 17, 2012
Sheen observed between the islands of Morrow Lake



Water Temperature: 69°F
Sediment Temperature: 67°F

2012.08.17 09:19

August 18, 2012
Sheen observed between the islands of Morrow Lake



Water Temperature: N/A°F
Sediment Temperature: N/A°F

August 18, 2012
Sheen observed between the islands of Morrow Lake



Water Temperature: N/A°F
Sediment Temperature: N/A°F

August 20, 2012
Sheen observed in the north cove of Morrow Lake



Water Temperature: 68.99°F
Sediment Temperature: 68.77°F

August 20, 2012
Sheen observed in the southern cove of Morrow Lake



Water Temperature: 68.99°F
Sediment Temperature: 68.77°F

August 31, 2012
Sheen observed in the northern cove of Morrow Lake



Water Temperature: N/A°F
Sediment Temperature: N/A°F

September 6, 2012
Sheen observed in the northern cove of Morrow Lake



Water Temperature: 76°F
Sediment Temperature: 76.5°F

September 10, 2012
Sheen observed in the southern cove of Morrow Lake



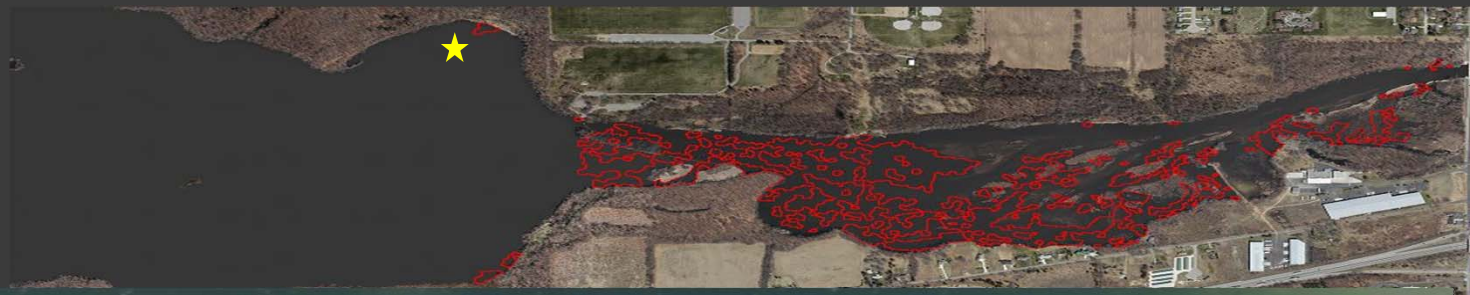
Water Temperature: 66.67°F
Sediment Temperature: 67°F

September 10, 2012
Sheen observed in the southern cove of Morrow Lake



Water Temperature: 66.67°F
Sediment Temperature: 67°F

September 10, 2012
Sheen observed in the northern cove of Morrow Lake



Water Temperature: 66.67°F
Sediment Temperature: 67°F

September 15, 2012
Sheen observed in the southern cove of Morrow Lake



Water Temperature: N/A°F
Sediment Temperature: N/A°F

September 15, 2012
Sheen observed in the southern cove of Morrow Lake



Water Temperature: N/A°F
Sediment Temperature: N/A°F

September 15, 2012
Sheen observed in the southern cove of Morrow Lake



Water Temperature: N/A°F
Sediment Temperature: N/A°F

September 17, 2012
Sheen observed
west of Rowe Island
in Morrow Lake



Water Temperature: N/A°F
Sediment Temperature: N/A°F

2012/09/17 09:04

September 17, 2012
Sheen and tar globs observed between MP38.25 – MP38.5 north shore in Morrow Lake



Water Temperature: N/A°F
Sediment Temperature: N/A°F

2012/09/17 09:09

September 17, 2012
Sheen and tar globs observed between MP38.25 – MP38.5 north shore in Morrow Lake



Water Temperature: N/A°F
Sediment Temperature: N/A°F

2012/09/17 09:12

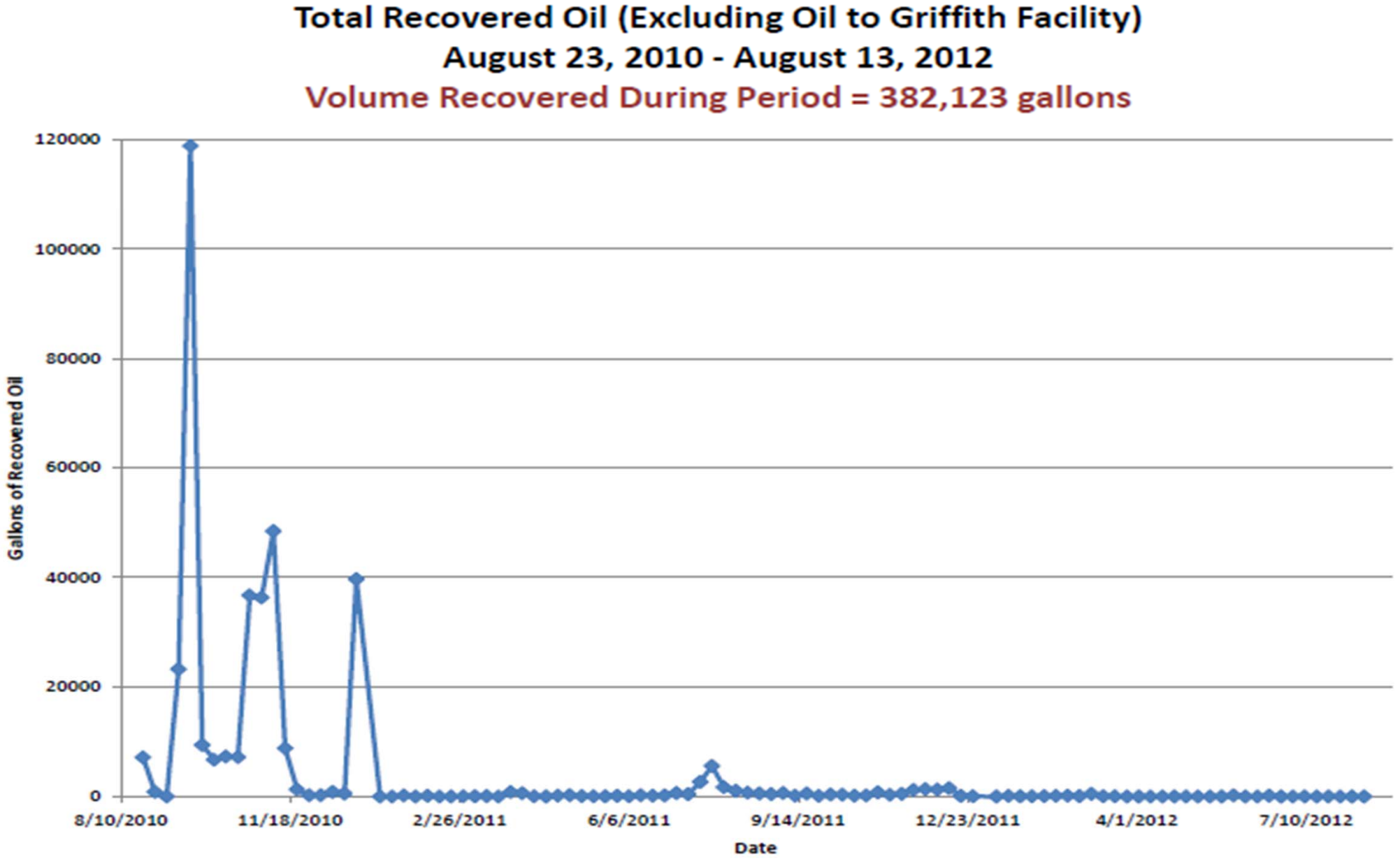
September 17, 2012
Sheen and tar globs observed southern cove of Morrow Lake



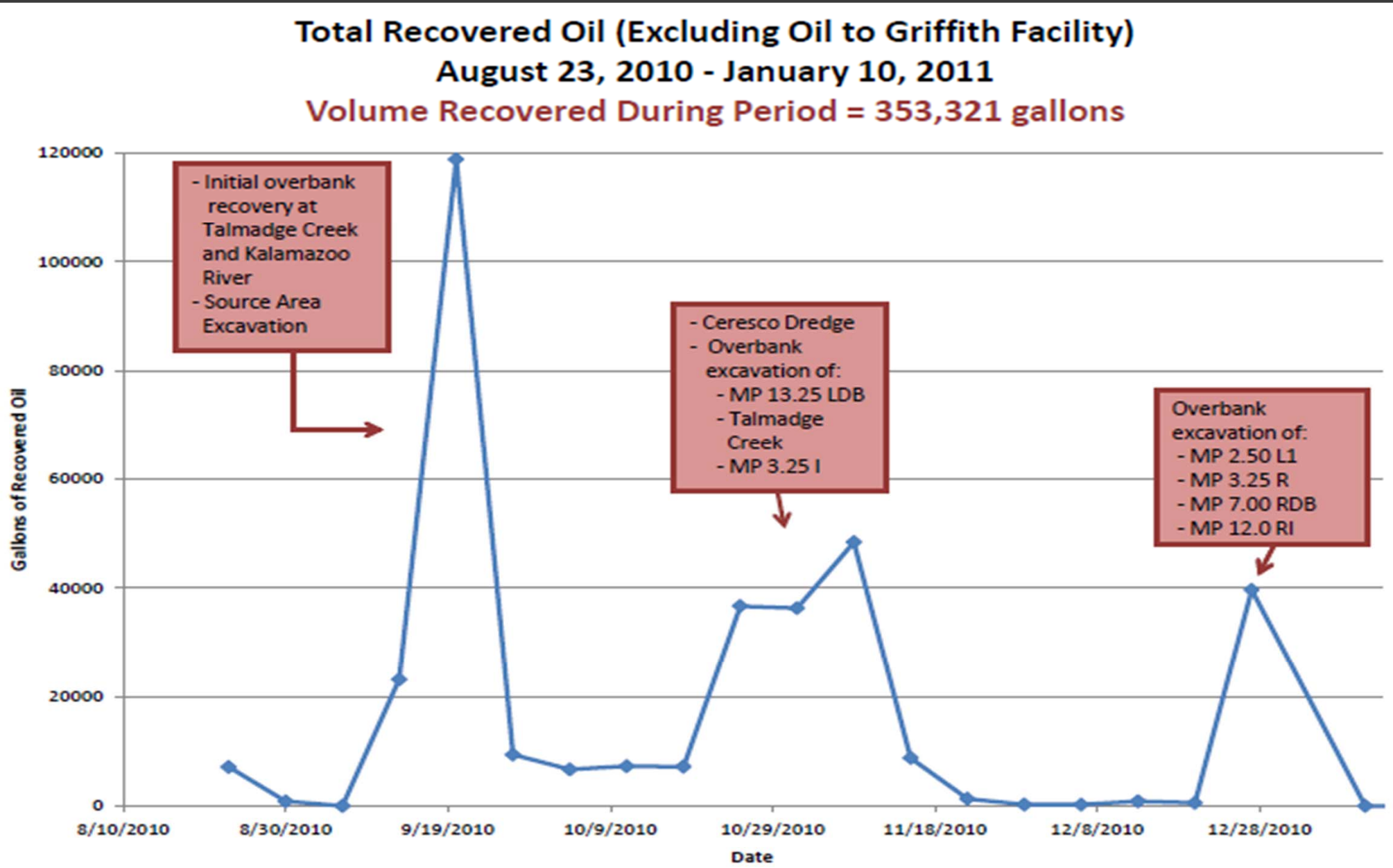
Water Temperature: N/A°F
Sediment Temperature: N/A°F

2012/09/17 09:39

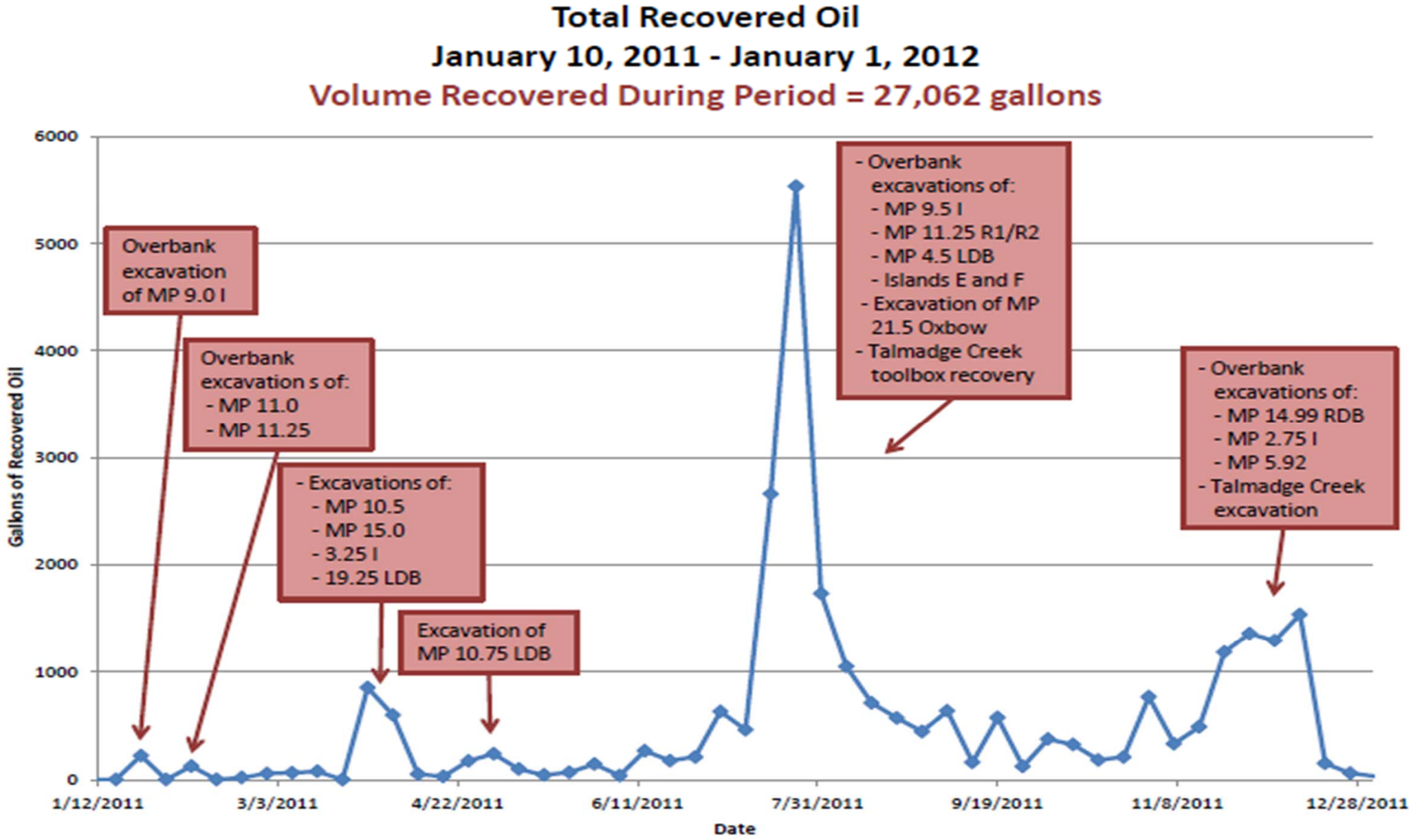
Recovered Oil Timeline



2010 Recovered Oil Timeline



2011 Recovered Oil Timeline



2012 Recovered Oil Timeline

