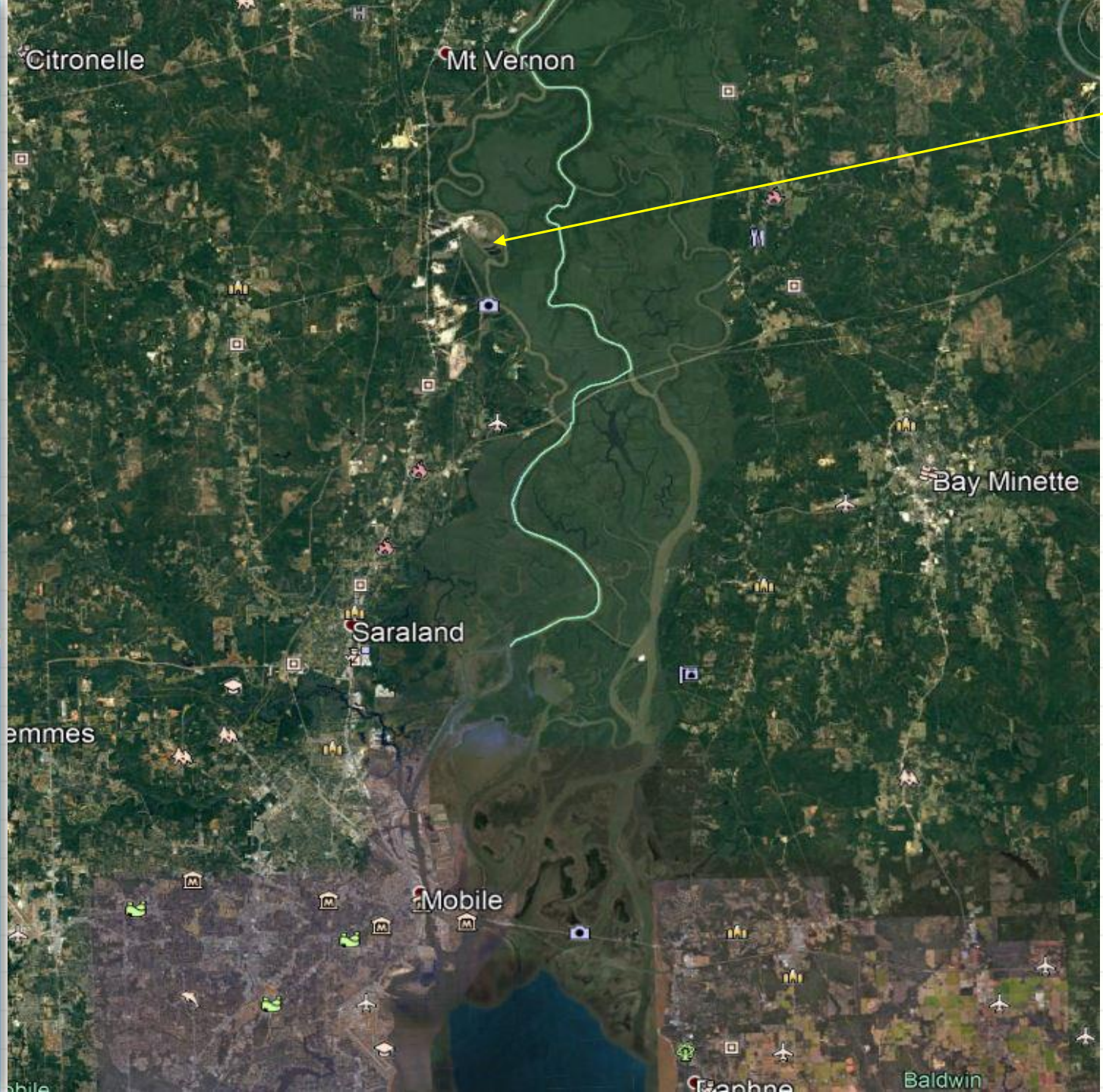
PLANT BARRY HYDROGEOLOGIC CONDITIONS SUMMARY

Marlon Cook

Cook Hydrogeology LLC


Citronelle
Mt Vernon
Plant
Barry
Ash
Pond
Bay Minette
Saraland
emmes
Mobile
Baldwin

Local and Regional Reaction to Plant Barry Coal Ash Pond Closure Plan

Reactions for many citizens of Baldwin and Mobile Counties are informed by Perception and Passion

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PRIMARY HYDROGEOLOGIC ISSUES RELATED TO COAL ASH POND CLOSURE

1. Isolation of the coal ash and its included contaminants.
2. Migration of the Alabama River channel.
3. Flooding and future impacts on the coal ash pond.

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REVIEWED DOCUMENTS

Alabama Power Company Plant Barry 2017 and 2018

Annual Groundwater Monitoring and Corrective Action Reports

Alabama Power Ash Pond History of Construction Report

Alabama Power Initial Safety Factor Assessment

Alabama Power Assessment of Corrective Measures 2019

Mobile Baykeeper Pollution Report: Coal Ash at Alabama Power's Plant Barry

Available well records for the Buck, Alabama area

Geologic Maps

Groundwater Availability Reports

Topographic maps and aerial imagery

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Primary Hydrogeologic Issues

- Hydrogeologic Isolation of Coal Ash and Chemical Constituents
- Mobile River Channel Migration
- Catastrophic Flooding Potential

Geologic Map

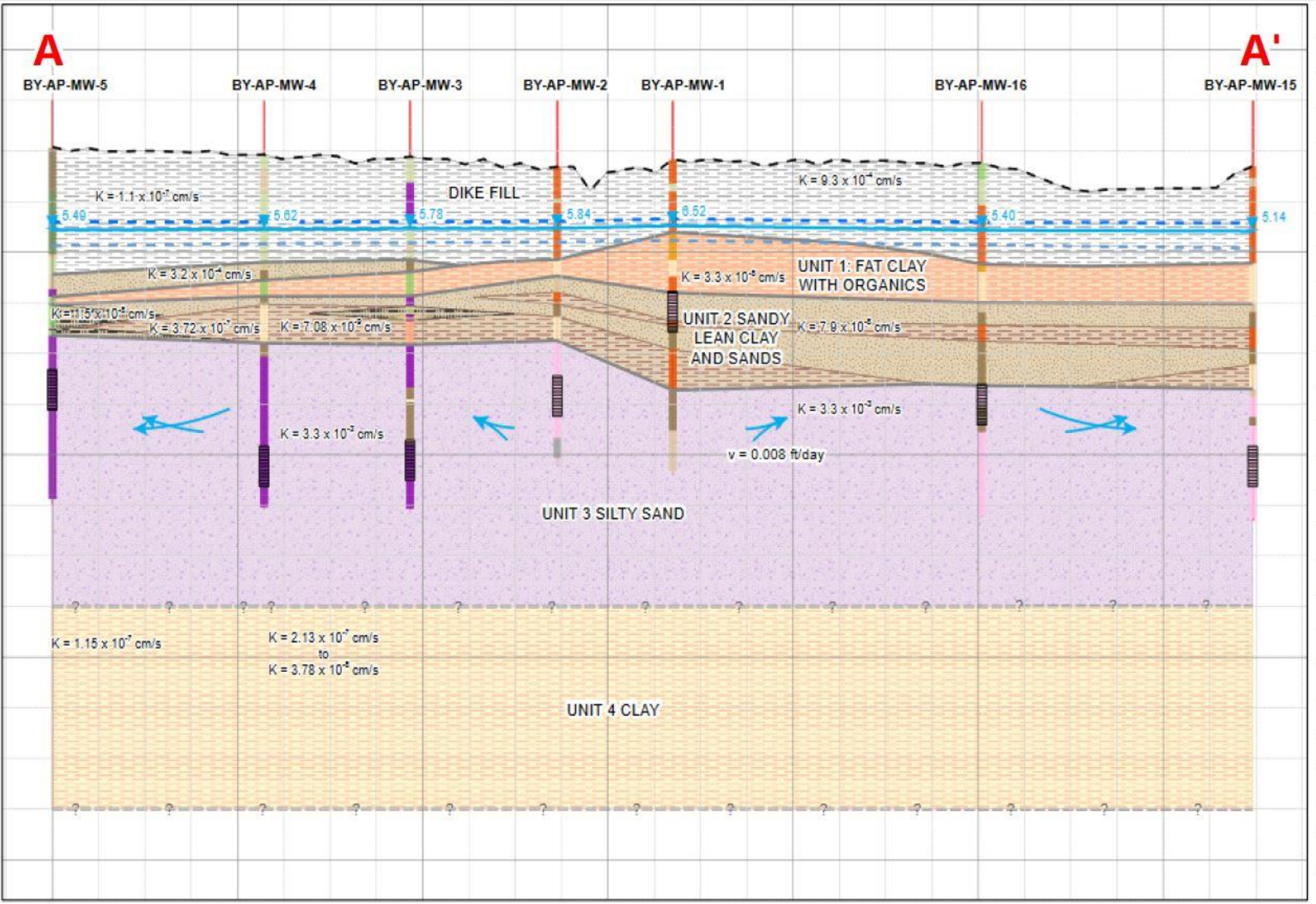
Coal Ash Pond Monitoring Wells

Vertical Isolation

Are the clay layers underlying
the ash pond homogeneous, impervious,
and continuous?

Line of Cross Section

Hydrogeologic Cross Section



Are the clay layers underlying the ash pond homogeneous, impervious, and continuous?

No. The clay layers are not homogeneous. There are massive clay layers, but in some areas the unit contains silt and fine-grained sand.

Overall, average permeability is 10^{-7}

The clay unit is continuous but varies in thickness from 4 to 28 feet and is lithologically variable.

Conclusion: The clay unit is an effective aquiclude.

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If clay layers underlying the ash pond are an effective aquiclude and if the alluvial aquifer is confined, why have contaminants been found?

During the most recent compliance sampling event (May 2019), arsenic and cobalt exceeded their respective groundwater protection standards.

For arsenic the standard is the MCL (drinking water standard). For cobalt the standard is the statistically calculated background concentration.

Arsenic exceeded the MCL of 0.01 mg/L and concentrations at the site ranged between Non-Detect (<0.005 mg/L) and a maximum concentration of 0.0671 mg/L.

Cobalt exceeded the background concentration of 0.01794 mg/L and the concentrations at the site ranged between Non-detect (<0.005 mg/L) and a maximum concentration of 0.0343 mg/L.

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If clay layers underlying the ash pond are an effective aquiclude and if the alluvial aquifer is confined, why have contaminants been found?

The aquiclude is not homogeneous and is variable in lithology and thickness.

One of Alabama Power's consultants stated in a report that the ash pond is a "perched aquifer", which has been repeated by Alabama Power officials in presentations. The ash pond is actually a surface-water impoundment consisting of ash, interstitial water and free water. Coal ash chemical constituents are mobilized in water.

Water in the pond forms a substantial hydraulic head that forces pond water and ash chemical constituents downward in places through the aquiclude.

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If clay layers underlying the ash pond are an effective aquiclude and if the alluvial aquifer is confined, why have contaminants been found?

One of the primary tasks in the ash pond closure plan is to dewater the ash. This will accomplish two important goals:

1) Mobilization of chemical constituents will not occur in dry ash.

2) Dewatering the ash and removing free water in the pond will reduce the hydraulic head in the pond, thereby reducing the downward pressure and means for introduction of contaminants into the alluvial aquifer.

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Vertical Isolation

Is the alluvial aquifer, underlying the ash pond confined?

The Mobile Baykeeper report (section 4.3) states "*In the vicinity of the ash pond, there are two major aquifers, the alluvial coastal aquifer, which is of Holocene age, and the Miocene and Pleistocene aquifer. These aquifers are regionally important as they are unconfined, which means groundwater is in direct contact with the atmosphere through open pore spaces of soil or rock. They are considered to be highly susceptible to contamination because they are hydraulically connected to surface water and each other.*"

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MOBILE RIVER
BY-AP-MW-8
1.32
BY-AP-MW-7
1.81
BY-AP-MW-9
1.09
BY-AP-MW-6
1.63
BY-AP-MW-5
1.78
BY-AP-MW-10
1.26
BY-AP-MW-4
2.04
BY-AP-MW-3
2.31
BY-AP-MW-11
1.52
BY-AP-MW-2
2.46
BY-AP-MW-1
3.67
BY-AP-MW-12
1.19
BY-AP-MW-16
1.93
BY-AP-MW-13
1.17
BY-AP-MW-15
1.18
BY-AP-MW-14
0.61
2
1.5
2.5
2.5
2
1.5
1
January 2018
Potentiometric Surface Map

Hydraulic Head in Ash Pond Monitoring Wells, January 2018

Well Name	Installation Date	Northing	Easting	Ground Elevation	Top of Casing Elevation	Top of Screen Elevation	Bottom of Screen Elevation	Purpose
BY-AP-MW-1	10/7/2015	362905.452	1811513.200	22.91	25.80	-10.304	-20.304	Downgradient
BY-AP-MW-2	10/7/2015	363375.014	1811104.860	21.10	23.89	-31.515	-41.515	Upgradient
BY-AP-MW-3	10/7/2015	364009.973	1810627.965	23.60	26.61	-46.581	-56.581	Upgradient
BY-AP-MW-4	10/7/2015	364620.885	1810128.368	24.05	26.97	-47.942	-57.942	Upgradient
BY-AP-MW-5	10/7/2015	365528.959	1809431.284	25.97	28.93	-30.023	-40.023	Downgradient
BY-AP-MW-6	10/7/2015	365906.041	1810555.372	23.78	26.69	-51.821	-61.821	Downgradient
BY-AP-MW-7	10/7/2015	366714.007	1811745.255	22.90	25.94	-53.98	-63.98	Downgradient
BY-AP-MW-8	10/7/2015	367064.508	1813172.112	25.57	28.45	-29.688	-39.688	Downgradient
BY-AP-MW-9	10/7/2015	366387.185	1814330.505	21.91	24.39	-37.082	-47.082	Downgradient
BY-AP-MW-10	10/7/2015	365296.811	1815400.957	23.61	26.89	-34.578	-44.578	Downgradient
BY-AP-MW-11	10/7/2015	364079.137	1815715.187	23.20	26.08	-37.999	-47.999	Downgradient
BY-AP-MW-12	10/7/2015	362704.953	1815677.689	21.24	23.88	-49.054	-59.054	Downgradient
BY-AP-MW-13	10/7/2015	361251.169	1815627.420	21.29	24.22	-39.29	-49.29	Downgradient
BY-AP-MW-14	10/1/2013	360520.621	1814694.666	8.89	11.74	-36.284	-46.284	Downgradient
BY-AP-MW-15	10/7/2015	360594.416	1813618.877	21.23	23.89	-48.791	-58.791	Downgradient
BY-AP-MW-16	10/7/2015	361610.794	1812571.016	22.05	25.01	-32.706	-42.706	Downgradient

Notes: 1. Northing and easting are in feet relative to the State Plane Alabama West North America Datum of 1983.

2. Elevations are in feet relative to the North American Vertical Datum of 1988.

Well	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	MW-10	MW-11	MW-12	MW-13	MW-14	MW-15	MW-16
Head	13.97	33.98	48.89	49.98	31.8	53.45	55.7	31.01	38.17	35.84	39.51	50.24	40.46	36.89	49.97	34.64

Vertical Isolation

Is the alluvial aquifer, underlying the ash pond confined?

All 16 monitoring wells constructed in the alluvial aquifer have positive hydraulic heads from 13.97 to 55.7 feet.

Conclusion: Clay layers underlying the ash pond form an effective confining unit.

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Horizontal Isolation

What is the direction of groundwater flow in the Plant Barry area and what impact does the Mobile River have on groundwater flow?

If contaminants get into the alluvial aquifer, where will they go and is there any possibility that contaminants will move into the Miocene aquifer?

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MOBILE RIVER
BY-AP-MW-8
1.32
BY-AP-MW-7
1.81
BY-AP-MW-9
1.09
BY-AP-MW-6
1.63
BY-AP-MW-5
1.78
BY-AP-MW-10
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2.31
BY-AP-MW-11
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BY-AP-MW-1
3.67
BY-AP-MW-12
1.19
BY-AP-MW-16
1.93
BY-AP-MW-13
1.17
BY-AP-MW-15
1.18
BY-AP-MW-14
0.61
2
1.5
2.5
2.5
2
1.5
1
January 2018
Potentiometric Surface Map

Area Water –Supply Wells

Horizontal Isolation

All regional groundwater flow (Alluvial and upper Miocene aquifers) in the Plant Barry/Bucks area is eastward to the Mobile River.

The hydraulic gradient in the alluvial aquifer in the ash pond area is 0.0003, which is extremely flat, meaning that groundwater movement is slow. Groundwater flow velocity calculated for the site is 2.92 feet per year. Local groundwater flow direction is variable due to the river meander at the pond site.

Contaminants in the alluvial aquifer will eventually flow into the Mobile River.

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Horizontal Isolation

Horizontal movement of the coal ash and its chemical constituents at ground surface is dependent on the dike around the pond. This is an engineered structure and was not evaluated in this assessment.

Mobile River Channel Migration

What is the potential for the Mobile River channel to relocate through Plant Barry and the coal ash pond?

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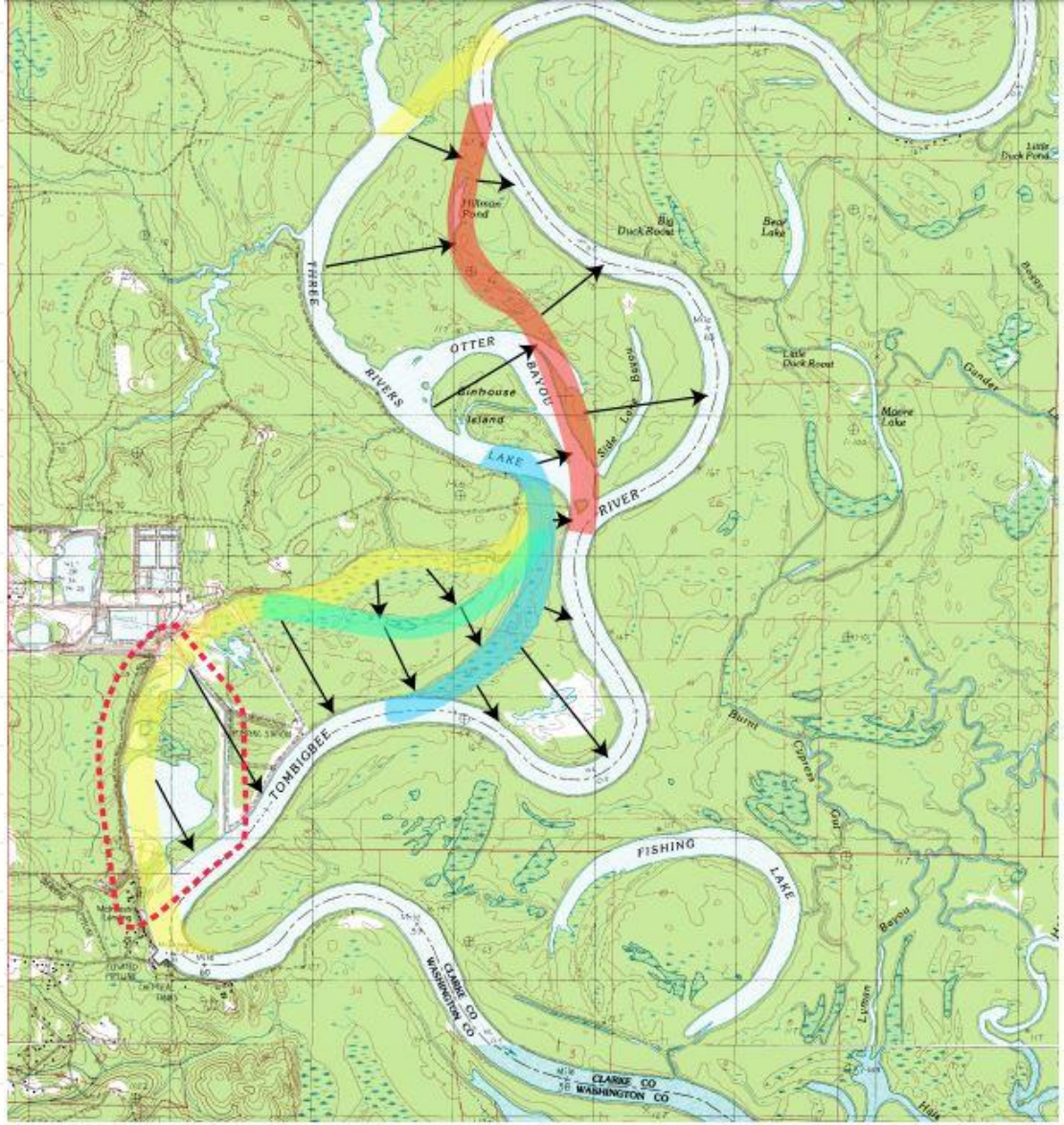
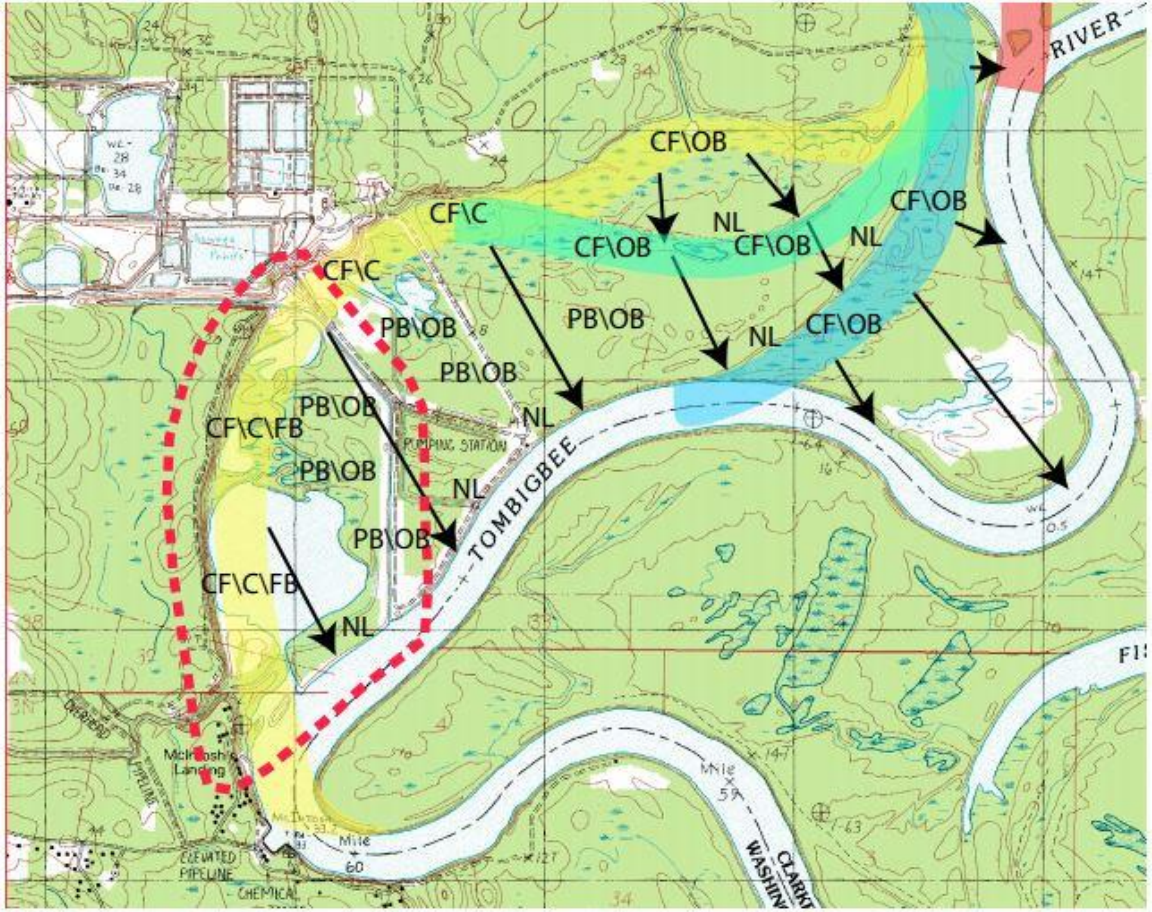
The Ciba-Geigy/ Olin Example



Probable Fluvial Environments of Deposition



Explanation

Abandoned Tombigbee River channel

Tombigbee River channel movement due to chute cutoffs

Project area

Scale

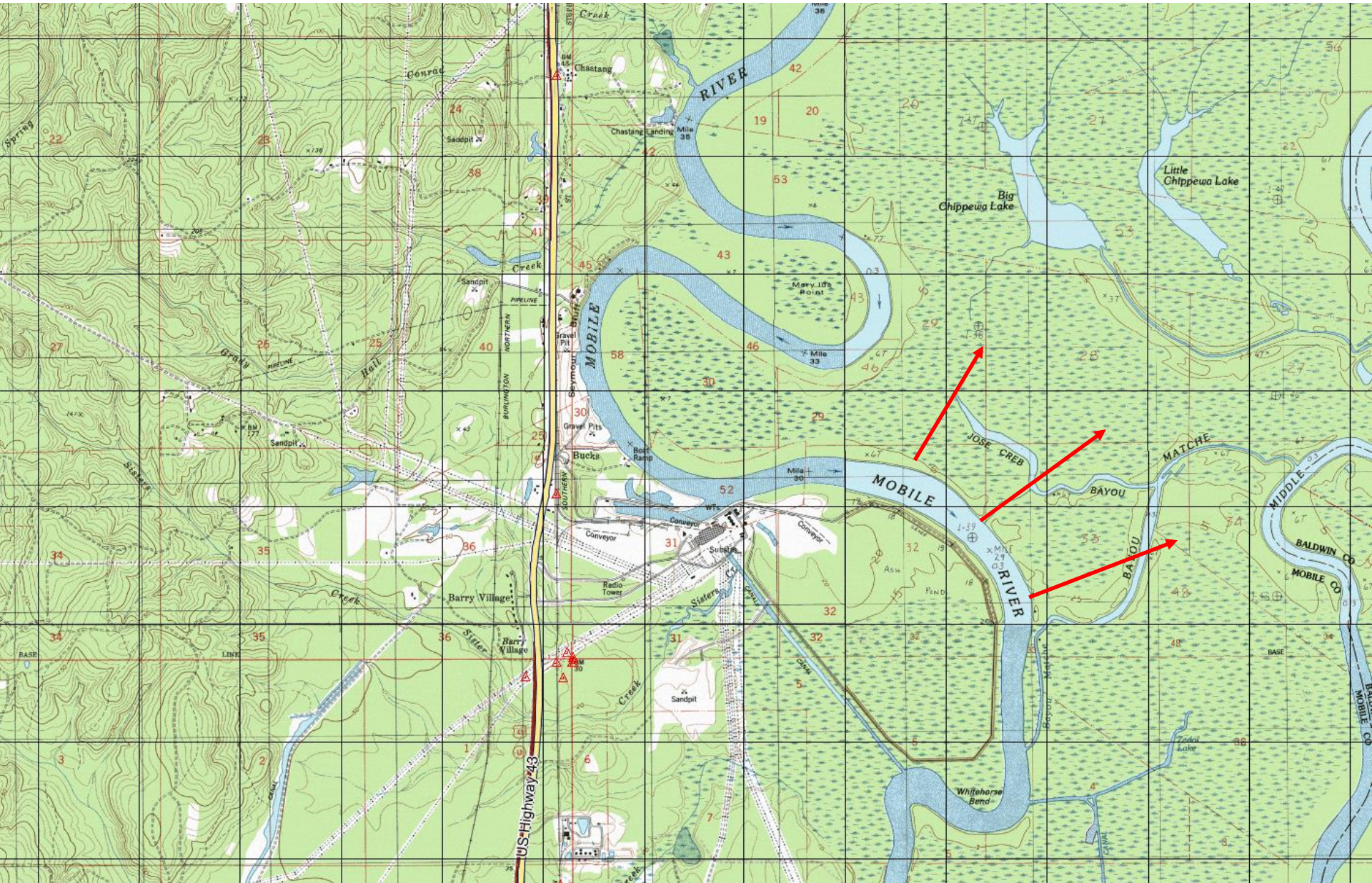
1000 0 1000 2000 3000 4000

Feet

Fluvial Environments of Deposition

CF\C\FB	Channel fill, colluvium, flood basin
CF\C	Channel fill, colluvium
CF\OB	Channel fill, over-bank
PB\OB	Point bar, over-bank
NL	Natural levee

The Mobile River at Plant Barry



Mobile River Channel Migration

What is the potential for the Mobile River channel to relocate through Plant Barry and the coal ash pond?

Conclusion: The potential for a meander cut-off at Plant Barry is not realistic. In fact, the channel is most likely migrating eastward away from the facility.

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Is it possible for Mobile River flooding to overtop the coal ash pond dike?

Alabama Power reports:
The dike around the coal ash pond was constructed to withstand a 1,000 year-24-hour rainfall event at the facility.
The dike was constructed to an elevation of 21.5 feet.
The 100-year flood elevation is 16 feet.
The flood of record was 18.19 feet in 1961.

Combinations of future climate factors, including rising sea level, a major upstream flood, and a severe tropical storm could cause a catastrophic flood event on the Mobile River that could result in erosion of the coal ash.

Is it possible for Mobile River flooding to overtop the coal ash pond dike?

Conclusion: A catastrophic level flood event on the Mobile River at the coal ash pond site has not been simulated. Whether the coal as is excavated and relocated or capped in place, the impacts of a flood of this magnitude during the next 20 to 30 years should be considered and impacts on an encapsulation structure for an indefinite time period should be a part of an in-place closure plan.

Cook Hydrogeology has recommended to Alabama Power on multiple occasions that simulations of various major flood scenarios is warranted.