

**UPPER MISSISSIPPI RIVER
FLOOD RISK MANAGEMENT
EXISTING CONDITIONS HYDRAULIC MODEL
DOCUMENTATION REPORT - APPENDICES**



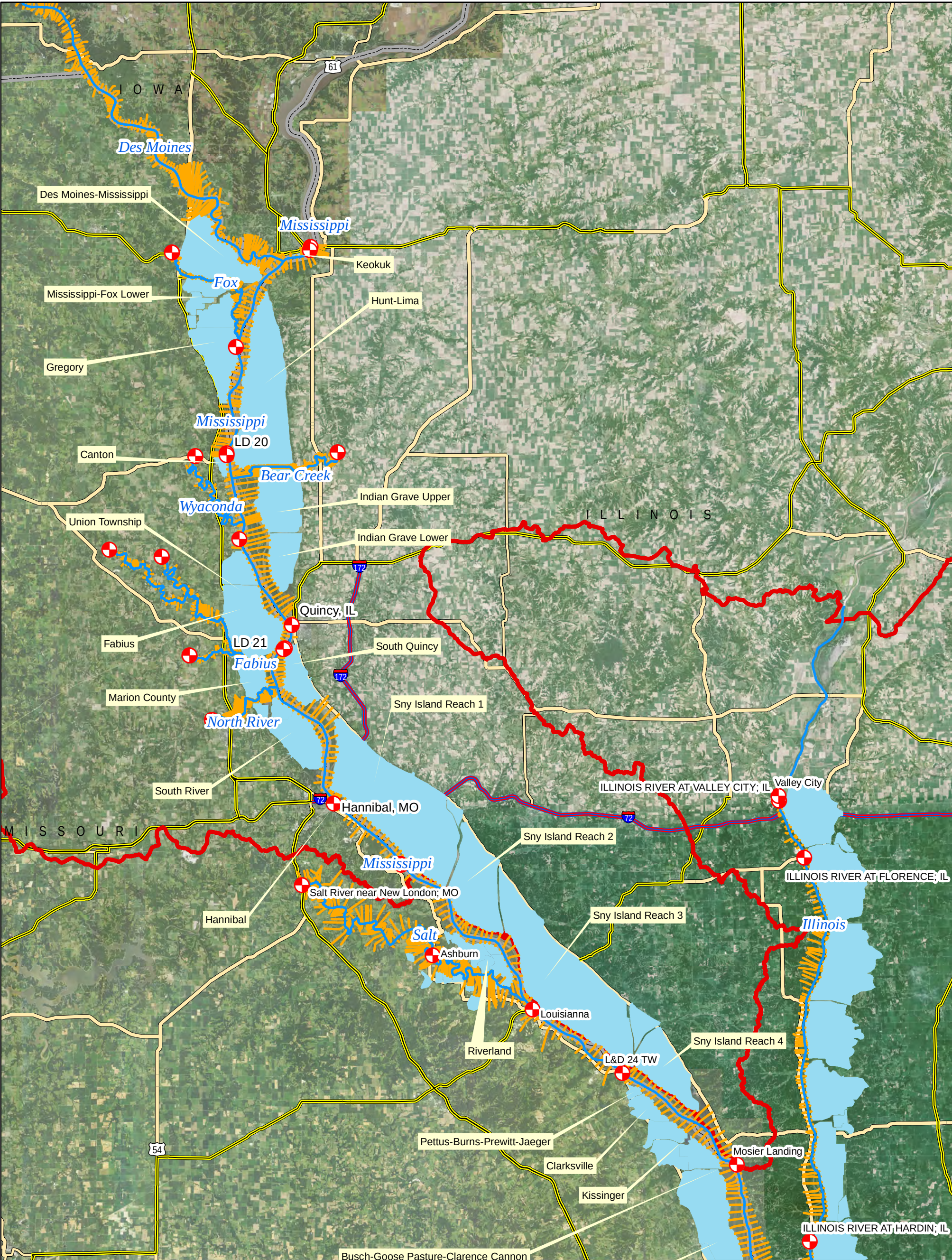
Final
January 2018

Appendices

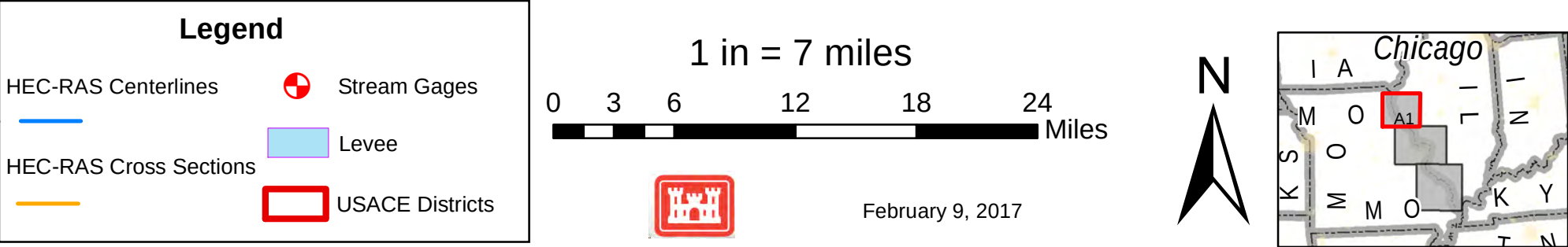
Appendix A-1 – Model Extent Map
Appendix A-2 – Model Map with Inflows
Appendix B – Datum Conversions
Appendix C-1 – Model Calibration Hydrographs
Appendix C-2 – Model Calibration Profile Plots
Appendix C-3 – Model Calibration Statistics
Appendix C-4 – Summary of Gage Data (Maximum Elevations) and High Water Marks
Appendix C-5 – 1993 Inflows Profile Plots
Appendix D-1 – High Water Data Correspondence
Appendix D-2 – High Water Data Supplied by Others
Appendix E – Maps of Non-NLD Leveed Areas

Appendix A-1
Model Extent Map

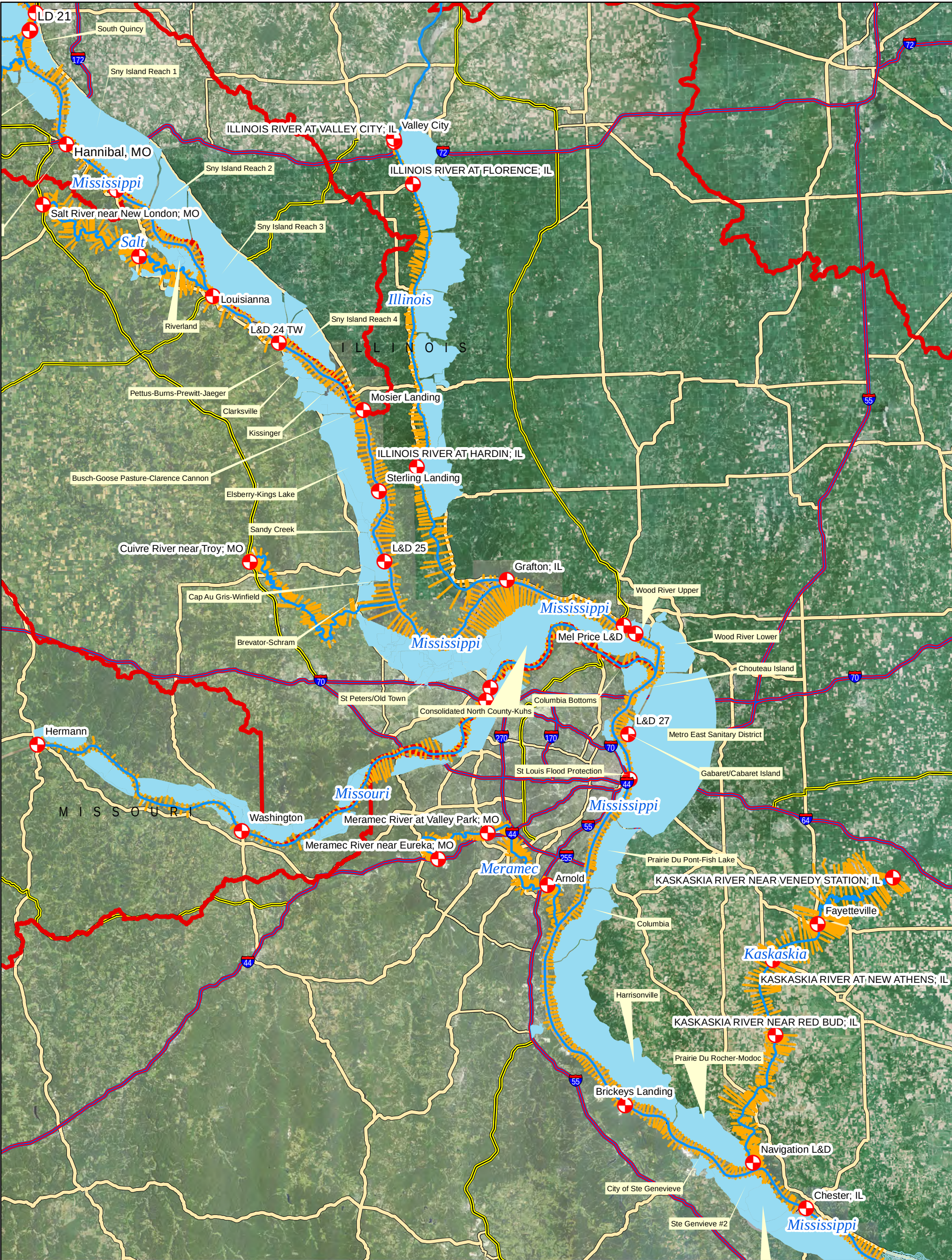
Upper Mississippi River Hydraulic Model Geometry



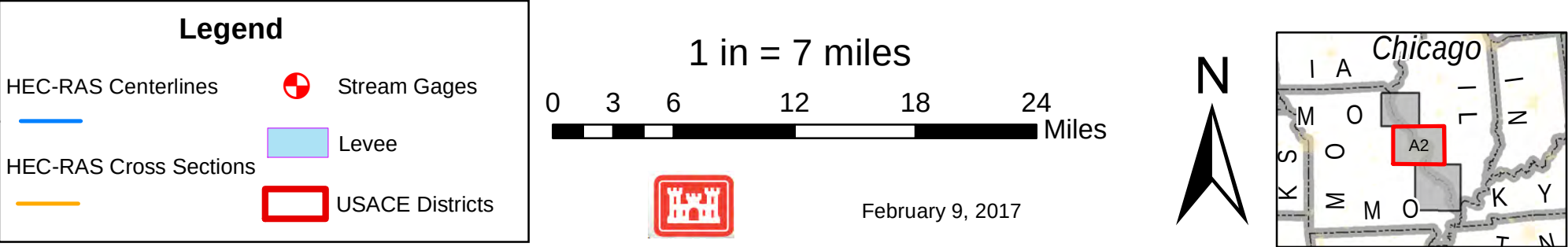
Upper Mississippi River Hydraulic Model Geometry



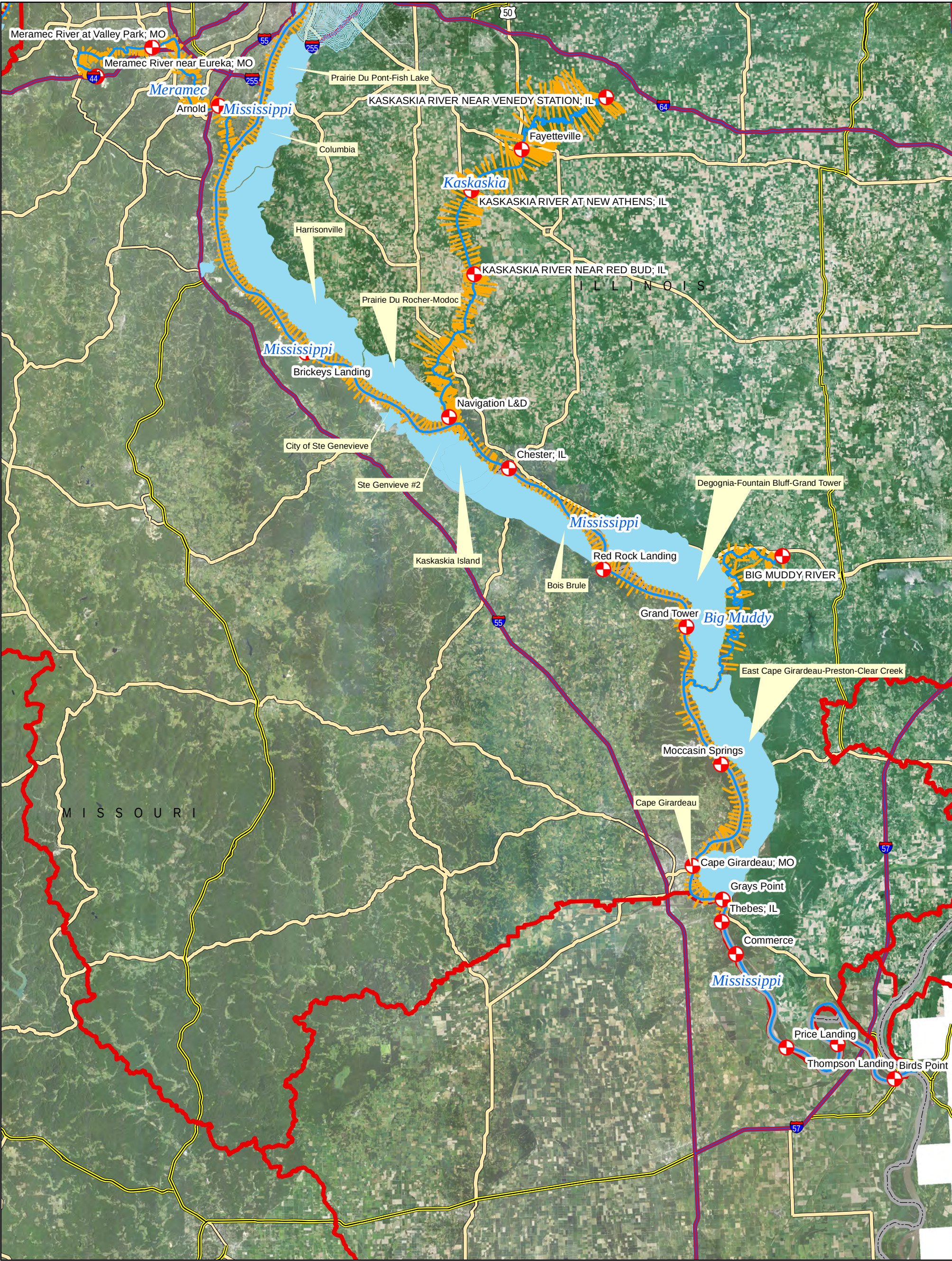
Upper Mississippi River Hydraulic Model Geometry



Upper Mississippi River Hydraulic Model Geometry



Upper Mississippi River Hydraulic Model Geometry



Upper Mississippi River Hydraulic Model Geometry

Legend

HEC-RAS Centerlines	Stream Gages
HEC-RAS Cross Sections	Levee
	USACE Districts

1 in = 7 miles

0 3 6 12 18 24 Miles

February 9, 2017

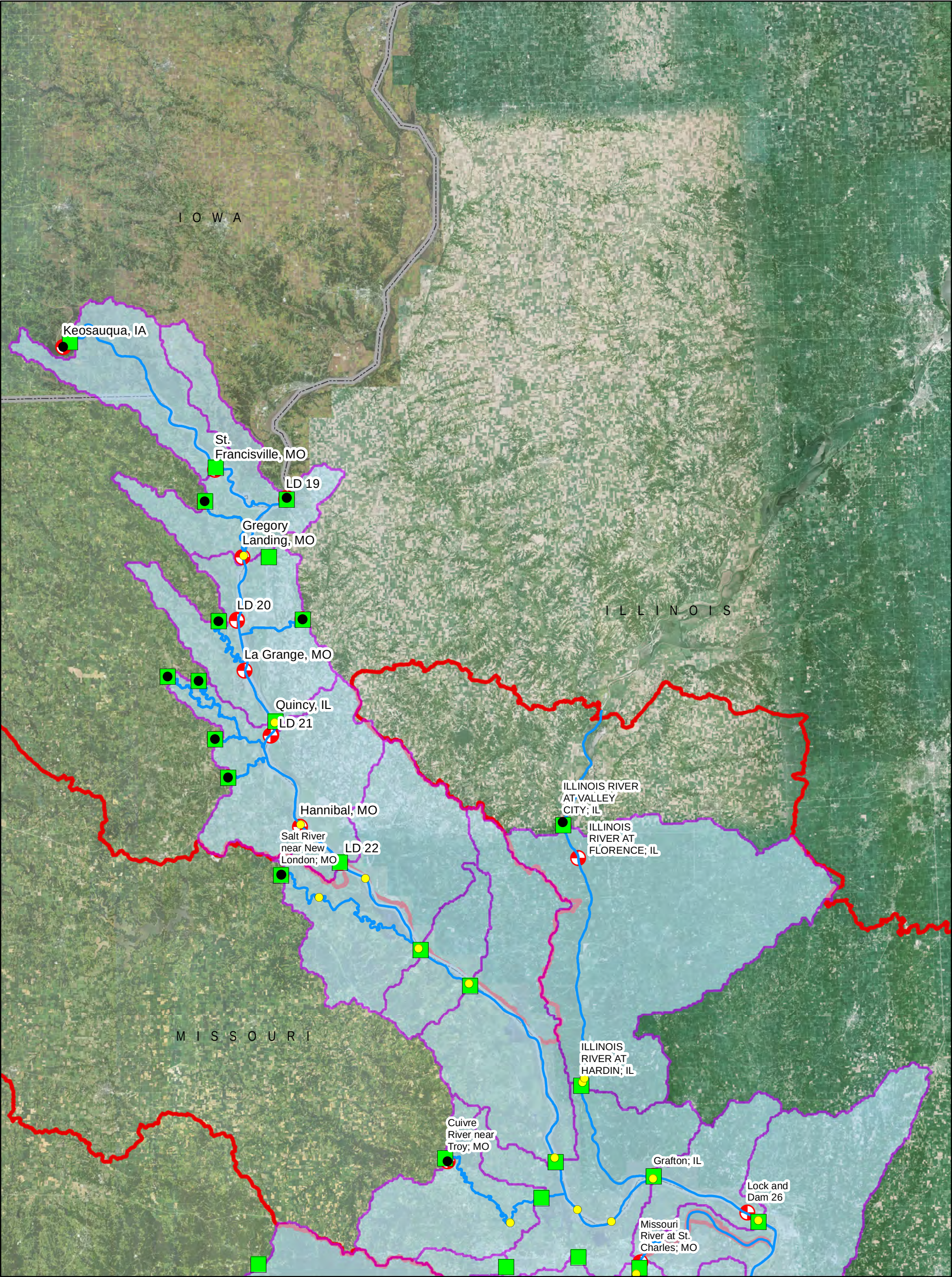
N

Chicago

A3

Appendix A-2
Model Map with Inflow Locations

UMR Hydraulic Model Inflows



Legend

Ungaged Inflow Pts (RFC Model Input)

RAS Centerlines

Stream Gage

NCRFC Basin Outlets

Ungaged Inflow Basins

USACE Districts

Gaged Inflow Pts (Model Boundary Conditions)

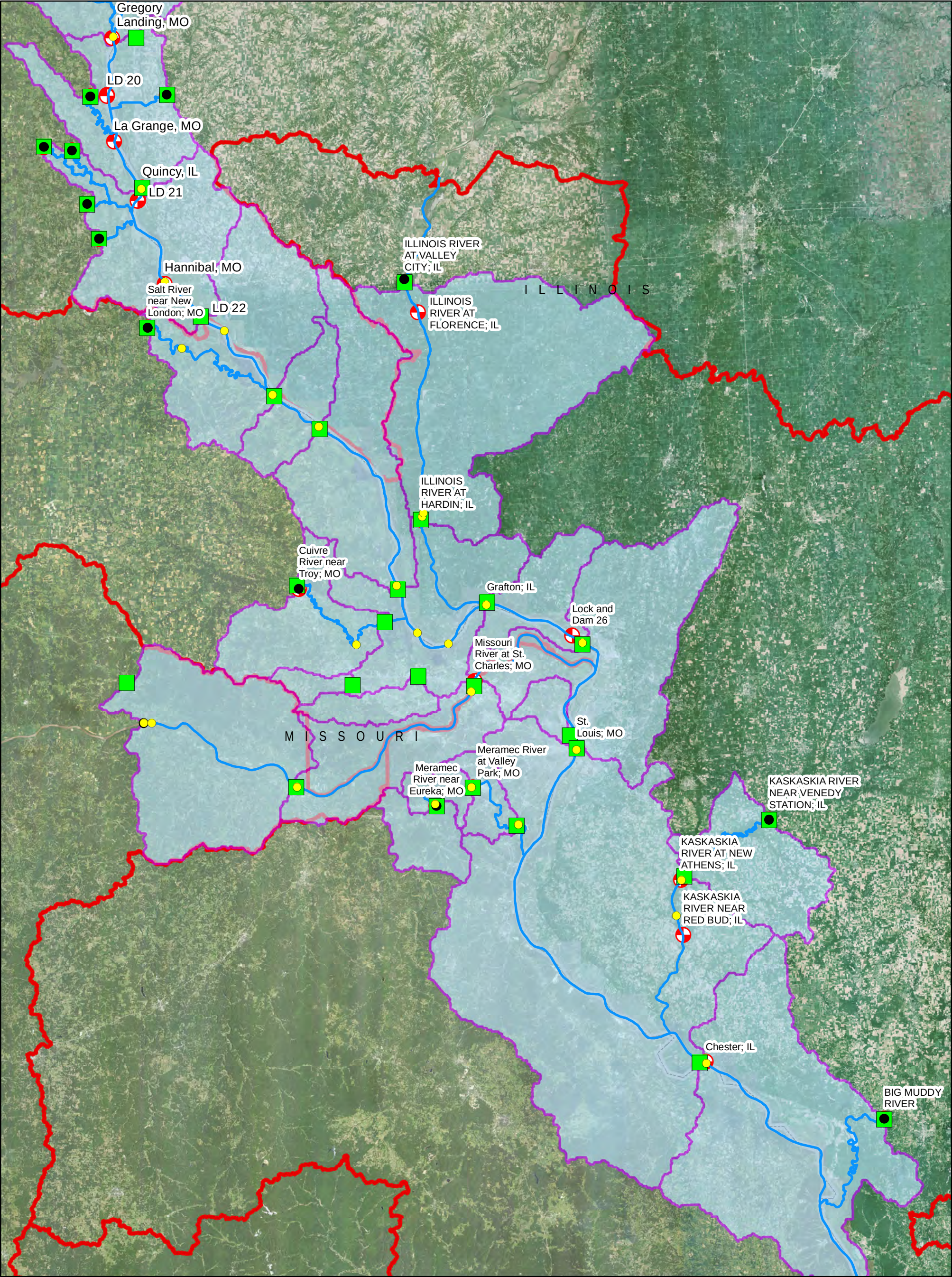
1 inch = 13 miles

0510203040

Miles

October 10, 2017

UMR Hydraulic Model Inflows



Legend

Ungaged Inflow Pts (RFC Model Input)

RAS Centerlines

Stream Gauge

NCRFC Basin Outlets

Ungaged Inflow Basins

USACE Districts

Gaged Inflow Pts (Model Boundary Conditions)

1 inch = 14 miles

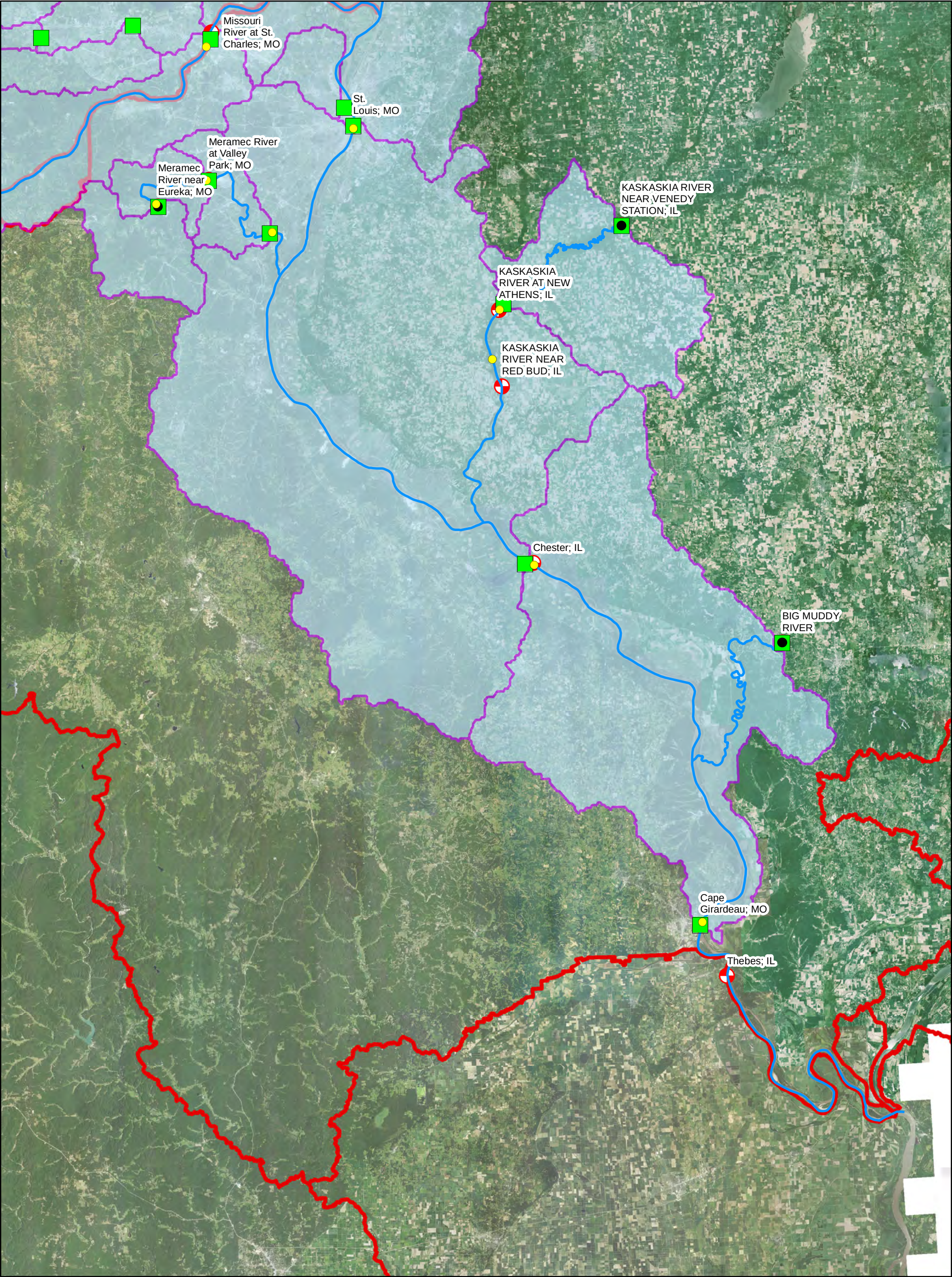
0510203040

Miles



October 10, 2017

UMR Hydraulic Model Inflows



Legend

Ungaged Inflow Pts (RFC Model Input)

RAS Centerlines

Stream Gage

NCRFC Basin Outlets

Ungaged Inflow Basins

USACE Districts

Gaged Inflow Pts (Model Boundary Conditions)

1 inch = 10 miles

0

4.25

8.5

17

25.5

34

Miles



October 10, 2017

Chicago

A3

Appendix B

Vertical Datum Conversions

River Mile	Convert elevations in NGVD 1929 to NAVD 1988 (feet)	Convert elevations in MSL 1912 to NAVD 1988 (feet)
365.00	-0.151	-0.571
364.70	-0.154	-0.574
364.50	-0.154	-0.574
364.40	-0.154	-0.564
364.30	-0.154	-0.564
364.20	-0.154	-0.564
363.90	-0.154	-0.564
363.80	-0.154	-0.564
363.50	-0.154	-0.564
363.00	-0.151	-0.561
362.50	-0.151	-0.561
362.00	-0.154	-0.564
361.50	-0.154	-0.564
361.00	-0.157	-0.567
360.40	-0.161	-0.571
360.00	-0.161	-0.571
359.50	-0.167	-0.577
359.20	-0.171	-0.581
359.00	-0.171	-0.581
358.40	-0.174	-0.584
358.00	-0.177	-0.587
357.40	-0.177	-0.587
357.00	-0.18	-0.59
356.40	-0.184	-0.594
356.00	-0.184	-0.594
355.40	-0.187	-0.597
355.00	-0.187	-0.597
354.40	-0.19	-0.6
354.00	-0.19	-0.6
353.40	-0.194	-0.594
353.00	-0.194	-0.594
352.60	-0.194	-0.594
352.00	-0.197	-0.597
351.30	-0.2	-0.6
351.00	-0.2	-0.6
350.50	-0.2	-0.6
350.00	-0.203	-0.603
349.40	-0.203	-0.603
349.00	-0.203	-0.603
348.50	-0.203	-0.603
348.10	-0.203	-0.603
347.80	-0.203	-0.603
347.60	-0.203	-0.603
347.00	-0.207	-0.607
346.40	-0.213	-0.613
346.00	-0.217	-0.617

River Mile	Convert elevations in NGVD 1929 to NAVD 1988 (feet)	Convert elevations in MSL 1912 to NAVD 1988 (feet)
345.70	-0.217	-0.617
345.10	-0.217	-0.617
344.50	-0.217	-0.617
343.90	-0.217	-0.617
343.70	-0.22	-0.62
343.20	-0.22	-0.62
343.00	-0.22	-0.62
342.60	-0.223	-0.623
342.30	-0.226	-0.616
342.00	-0.226	-0.616
341.60	-0.23	-0.62
341.40	-0.23	-0.62
341.00	-0.233	-0.623
340.50	-0.236	-0.626
339.90	-0.24	-0.63
339.50	-0.243	-0.633
339.00	-0.246	-0.636
338.50	-0.249	-0.639
338.00	-0.249	-0.639
337.50	-0.253	-0.643
337.00	-0.256	-0.646
336.40	-0.259	-0.649
336.00	-0.262	-0.652
335.50	-0.266	-0.656
335.00	-0.269	-0.659
334.60	-0.272	-0.662
334.00	-0.276	-0.666
333.60	-0.279	-0.669
333.00	-0.282	-0.672
332.50	-0.285	-0.675
332.00	-0.289	-0.679
331.50	-0.292	-0.682
331.00	-0.295	-0.675
330.60	-0.295	-0.675
330.00	-0.299	-0.679
329.60	-0.299	-0.679
329.00	-0.299	-0.679
328.50	-0.295	-0.675
328.00	-0.292	-0.672
327.60	-0.289	-0.669
327.10	-0.285	-0.665
326.80	-0.282	-0.662
326.50	-0.282	-0.662
326.00	-0.282	-0.662
325.40	-0.285	-0.665
325.00	-0.285	-0.665

River Mile	Convert elevations in NGVD 1929 to NAVD 1988 (feet)	Convert elevations in MSL 1912 to NAVD 1988 (feet)
324.80	-0.285	-0.665
324.00	-0.285	-0.665
323.40	-0.285	-0.665
323.00	-0.282	-0.662
322.50	-0.279	-0.659
322.00	-0.276	-0.656
321.60	-0.276	-0.656
321.40	-0.272	-0.652
321.00	-0.272	-0.652
320.50	-0.269	-0.649
320.00	-0.266	-0.646
319.60	-0.262	-0.632
319.00	-0.262	-0.632
318.60	-0.262	-0.632
318.00	-0.266	-0.636
317.50	-0.266	-0.636
317.00	-0.262	-0.632
316.70	-0.262	-0.632
316.00	-0.262	-0.632
315.50	-0.262	-0.632
315.00	-0.262	-0.632
314.50	-0.259	-0.629
314.00	-0.253	-0.623
313.50	-0.246	-0.616
313.00	-0.243	-0.613
312.70	-0.24	-0.61
312.00	-0.233	-0.603
311.40	-0.223	-0.593
311.00	-0.22	-0.59
310.50	-0.213	-0.583
310.00	-0.21	-0.58
309.85	-0.21	-0.58
309.80	-0.21	-0.58
309.75	-0.21	-0.58
309.50	-0.21	-0.58
309.25	-0.207	-0.577
309.20	-0.207	-0.577
309.15	-0.207	-0.577
309.00	-0.21	-0.58
308.50	-0.207	-0.577
308.00	-0.207	-0.577
307.50	-0.21	-0.57
307.00	-0.21	-0.57
306.50	-0.21	-0.57
306.00	-0.207	-0.567
305.40	-0.203	-0.563

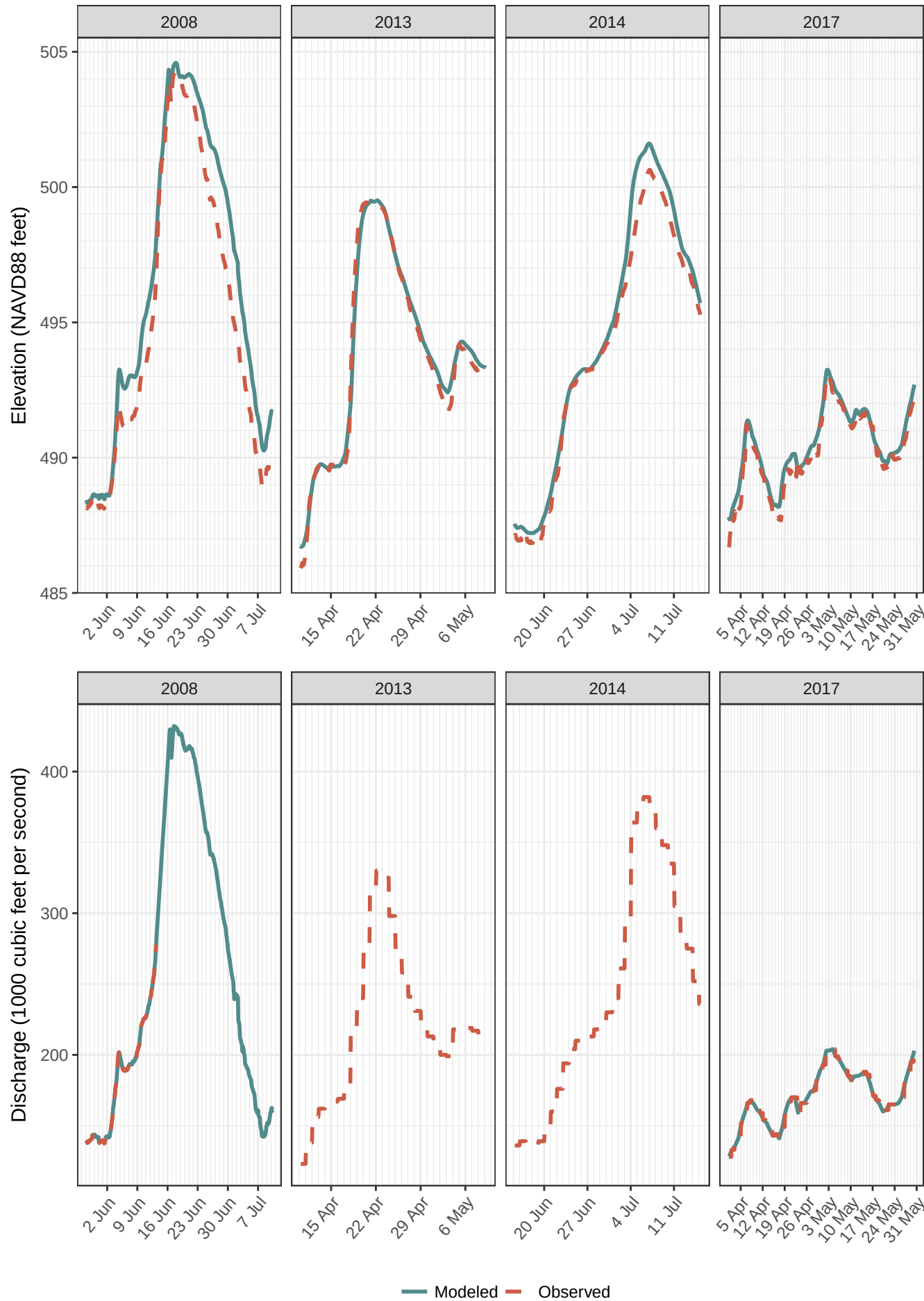
River Mile	Convert elevations in NGVD 1929 to NAVD 1988 (feet)	Convert elevations in MSL 1912 to NAVD 1988 (feet)
305.00	-0.203	-0.563
304.50	-0.203	-0.563
304.00	-0.207	-0.567
303.60	-0.207	-0.567
303.00	-0.207	-0.567
302.50	-0.207	-0.567
302.00	-0.207	-0.567
301.70	-0.207	-0.567
301.40	-0.207	-0.567
300.63	-0.2	
300.04	-0.2	
299.45	-0.2	
298.86	-0.207	
298.17	-0.213	
297.81	-0.217	
297.3	-0.22	
296.8	-0.22	
296.15	-0.22	
295.6	-0.217	
294.97	-0.213	
294.55	-0.21	
293.86	-0.207	
293.37	-0.207	
293.00	-0.265	
282.90	-0.298	
273.50	-0.202	
273.20	-0.245	
265.00	-0.610	
260.30	-0.460	
250.80	-0.305	
241.50	-0.500	
241.20	-0.531	
228.30	-.0396	
218.60	-0.575	
203.00	-0.338	
201.10	-0.442	
200.50	-0.438	
196.80	-0.002	
190.40	-0.332	
190.28	-0.334	
185.30	-0.514	
185.10	-0.502	
179.60	-0.367	
176.80	-0.596	
168.70	-0.347	
158.50	-0.288	

River Mile	Convert elevations in NGVD 1929 to NAVD 1988 (feet)	Convert elevations in MSL 1912 to NAVD 1988 (feet)
145.80	-0.442	
136.00	-0.404	
125.50	-0.389	
109.90	-0.302	
100.80	-0.674	
94.10	-0.542	
81.90	-0.495	
66.30	-0.562	
52.10	-0.291	
46.30	-0.389	
43.70	-0.215	

Appendix C-1
Model Calibration Hydrographs

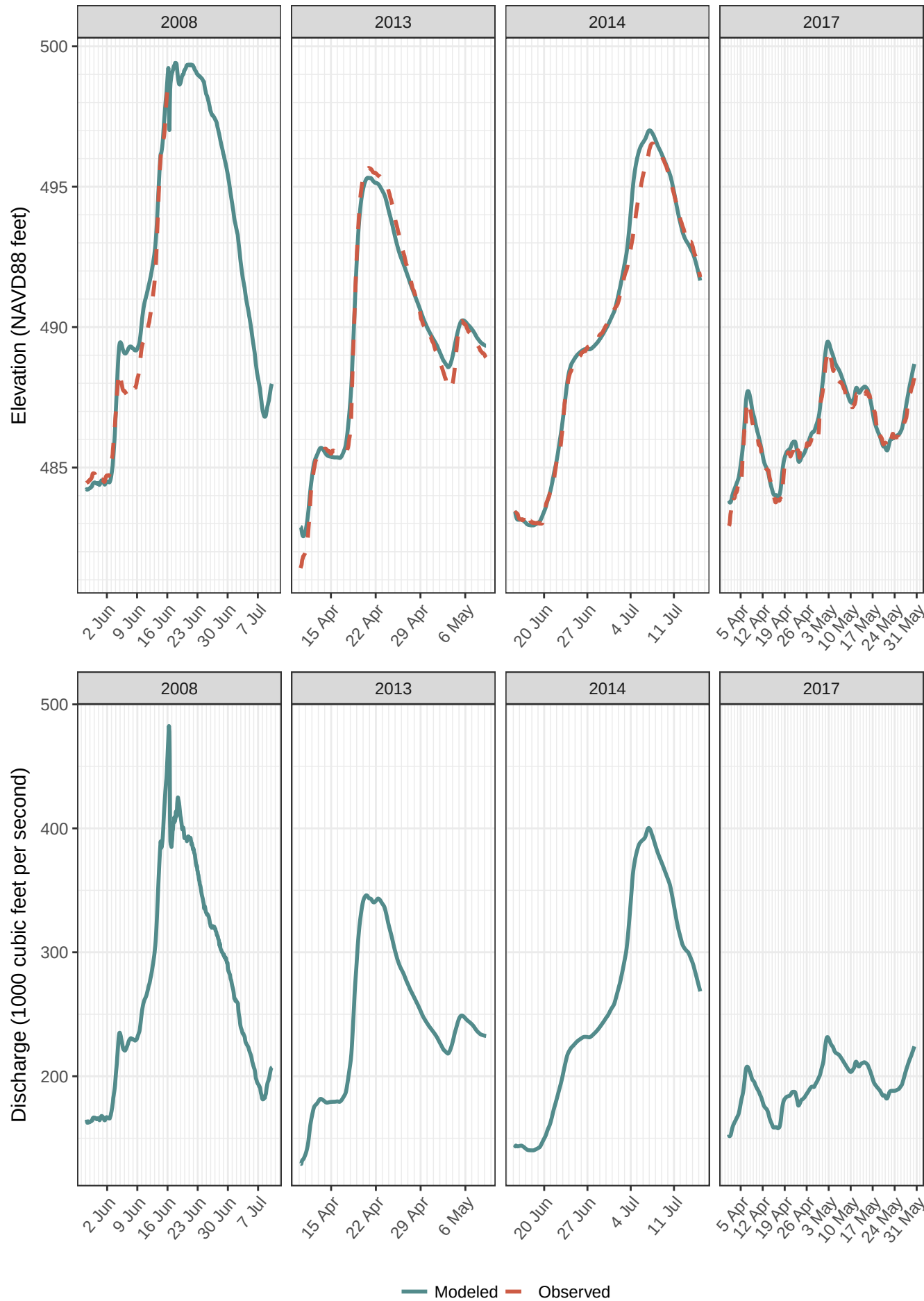
Mississippi River, Iowa to Des Moines Reach,
River Station 364.27, Gauge L&D_19_TAIL

Existing Levee Elevation Calibration



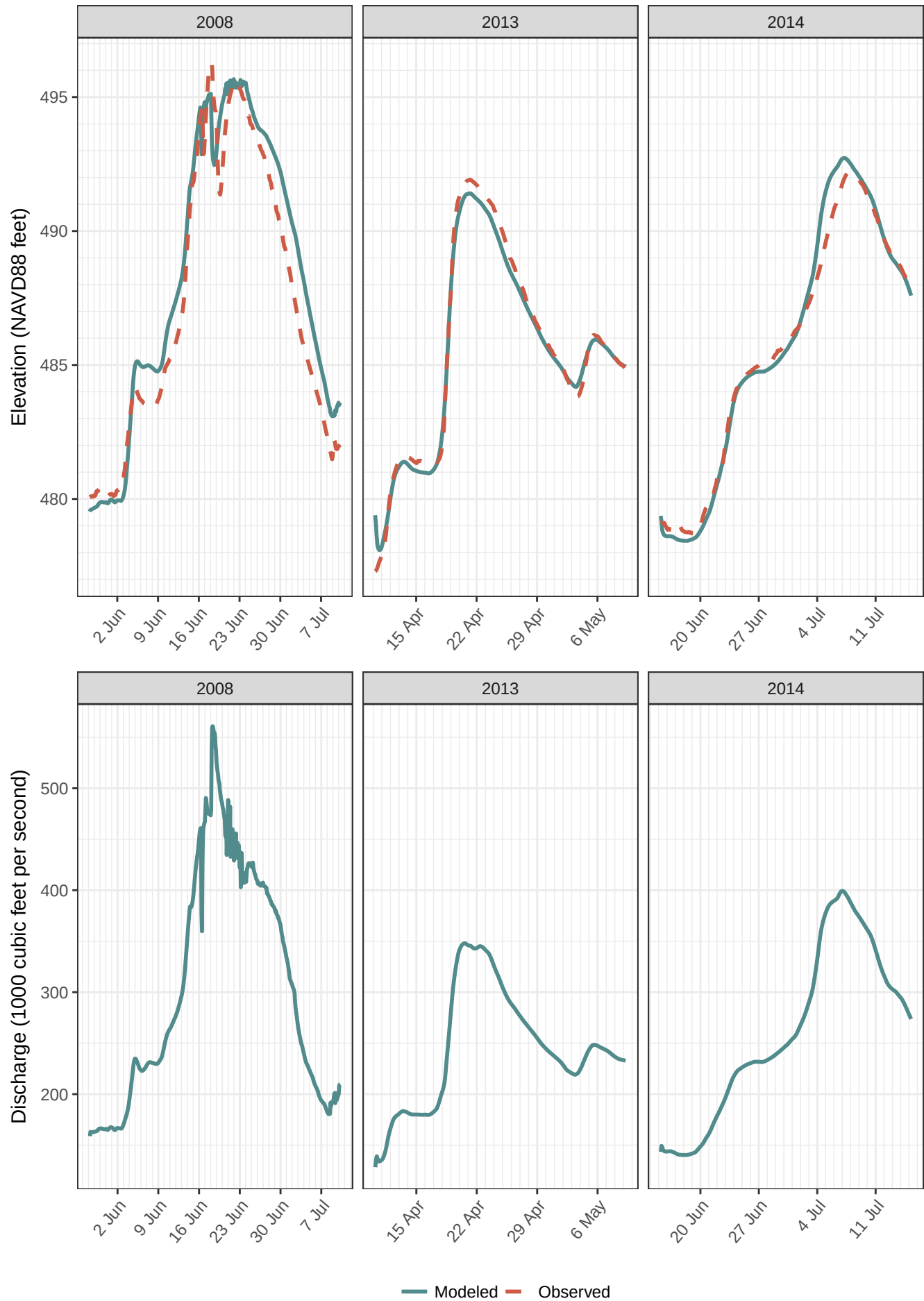
Mississippi River, Fox to Bear Reach,
River Station 353.04, Gauge GREGORY_LANDING

Existing Levee Elevation Calibration



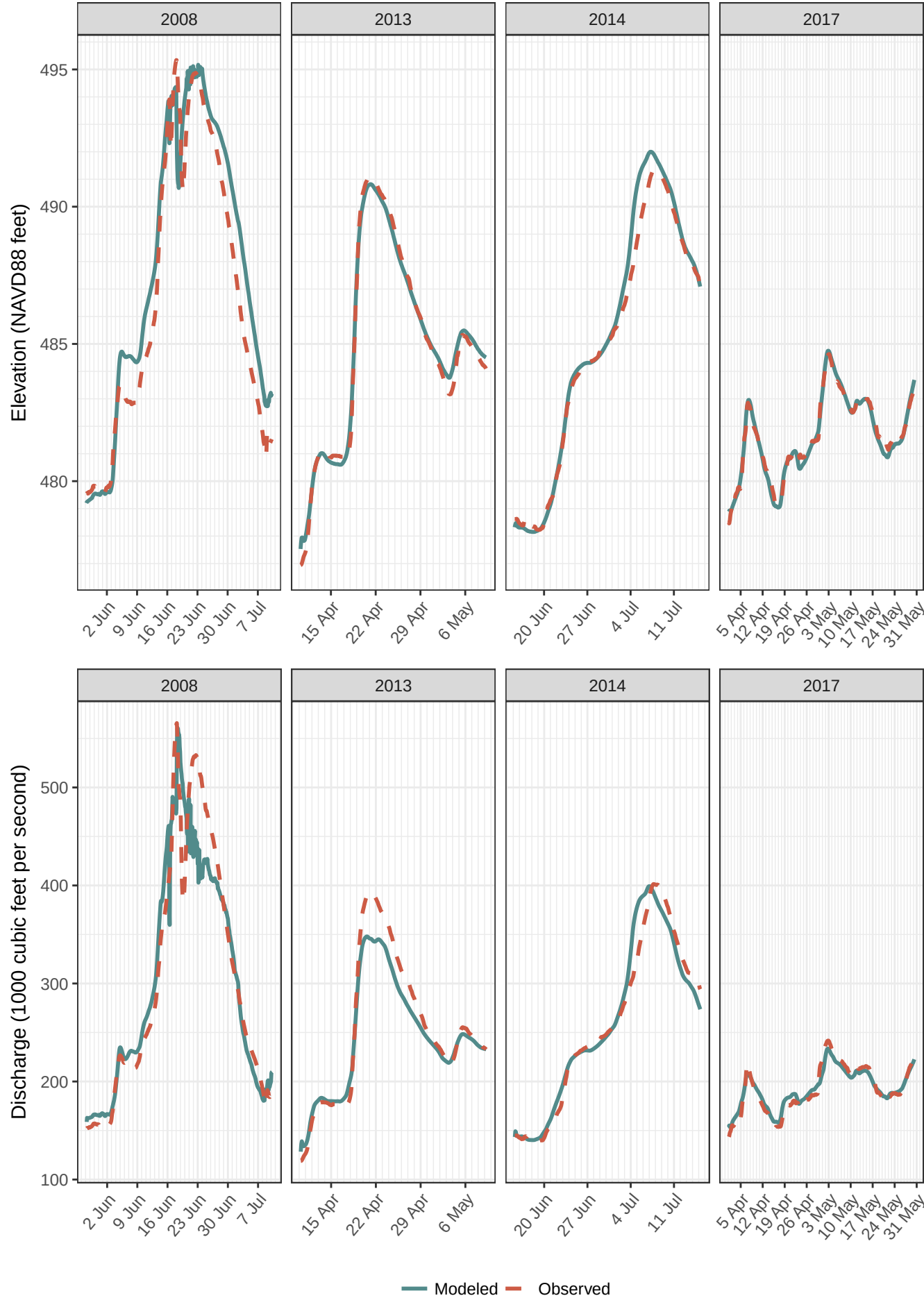
Mississippi River, Fox to Bear Reach,
River Station 343.32, Gauge L&D_20_POOL

Existing Levee Elevation Calibration



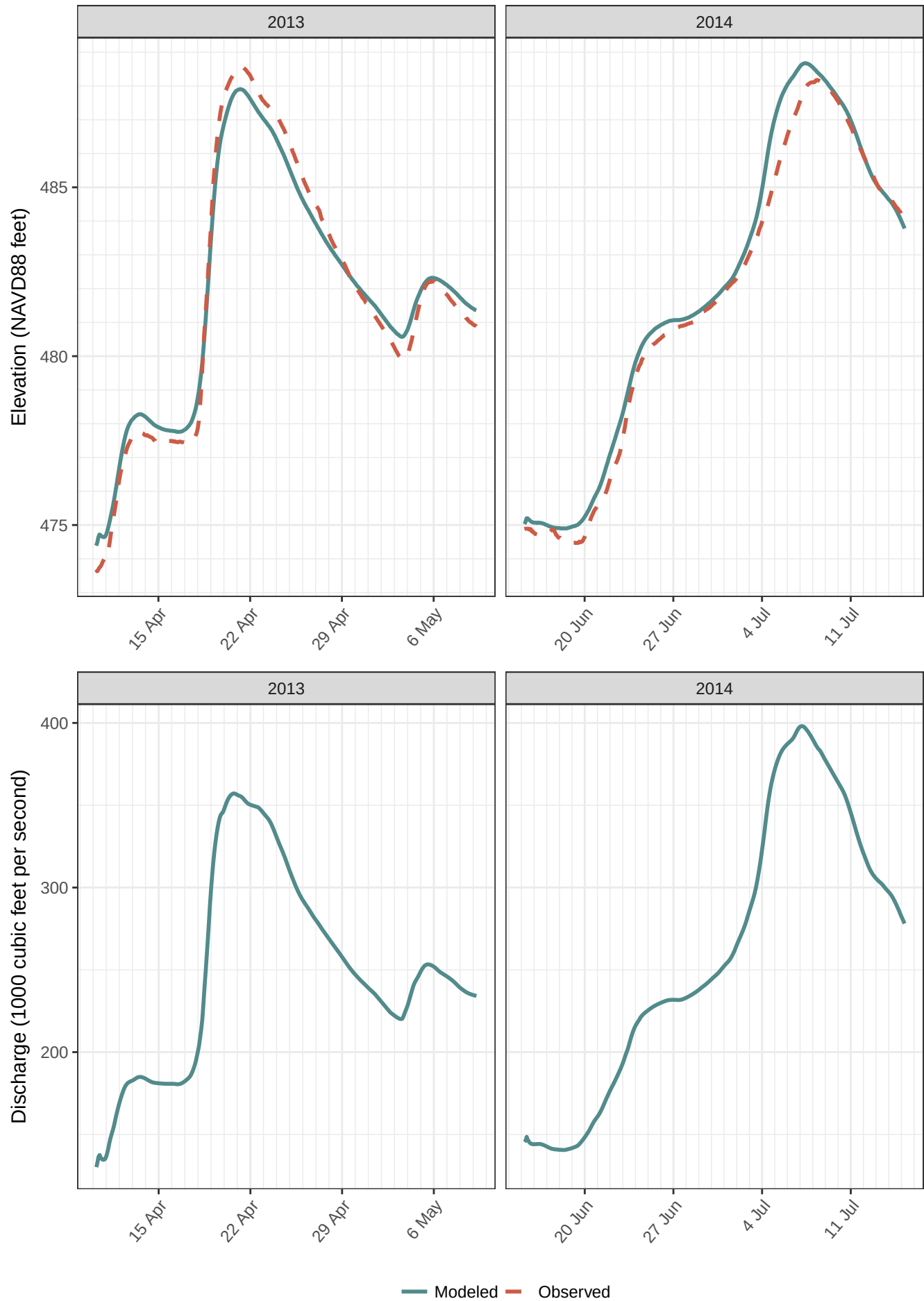
Mississippi River, Fox to Bear Reach,
River Station 343.19, Gauge L&D_20_TAIL

Existing Levee Elevation Calibration



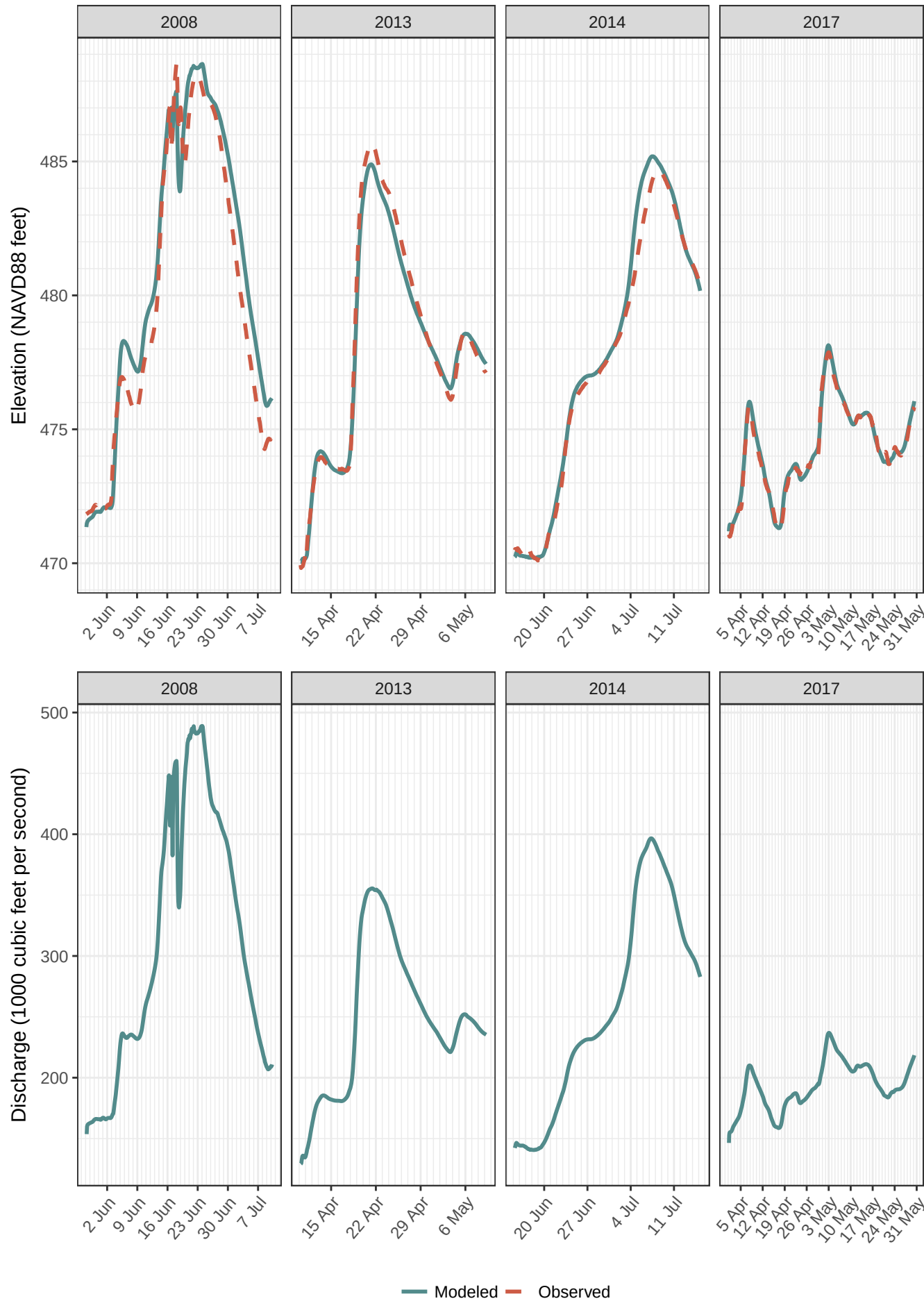
Mississippi River, Wyaconda to Fabius Reach,
River Station 335.98, Gauge LA_GRANGE

Existing Levee Elevation Calibration



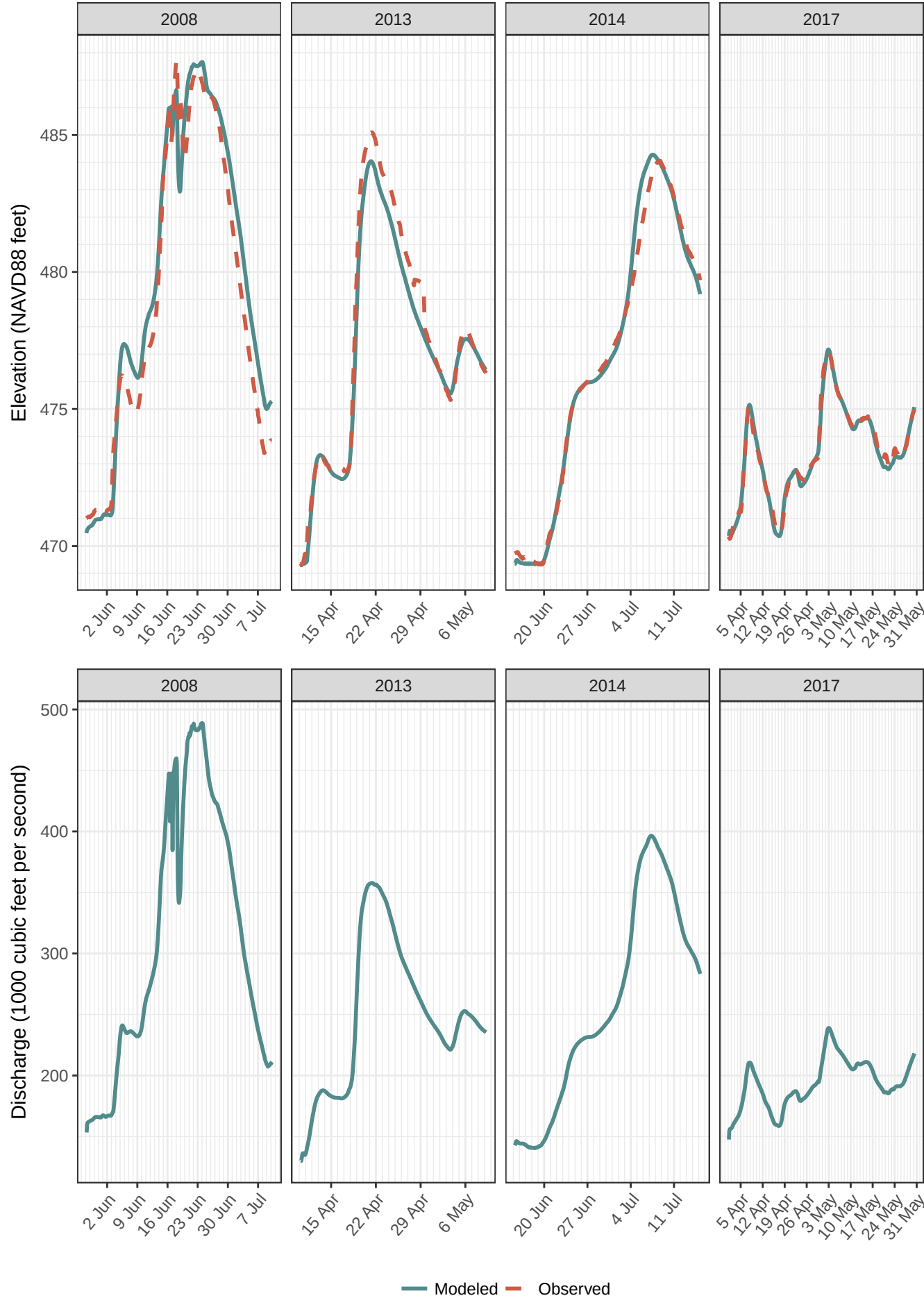
Mississippi River, Wyaconda to Fabius Reach,
River Station 326.98, Gauge QUINCY

Existing Levee Elevation Calibration



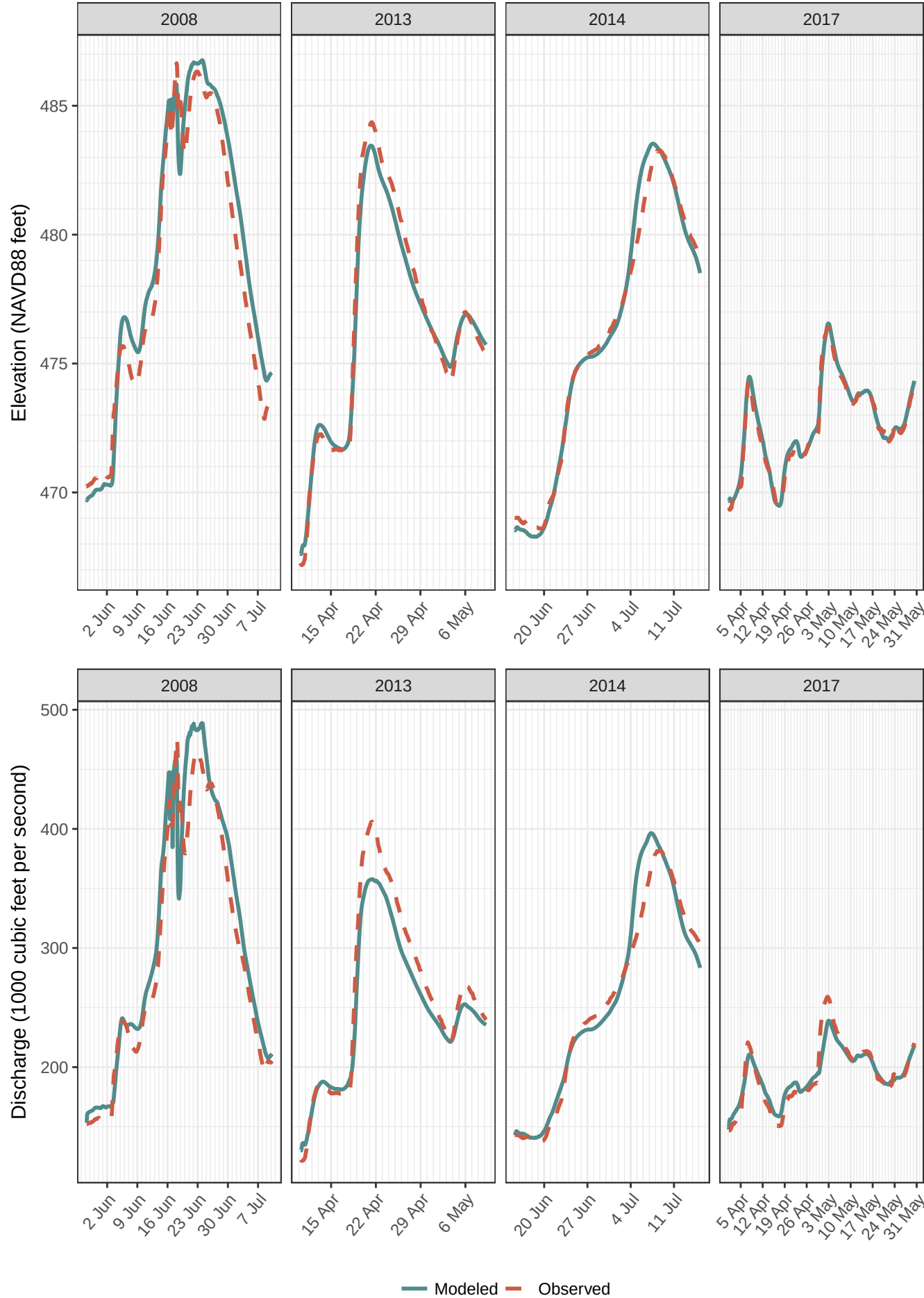
Mississippi River, Wyaconda to Fabius Reach,
River Station 325.03, Gauge L&D_21_POOL

Existing Levee Elevation Calibration



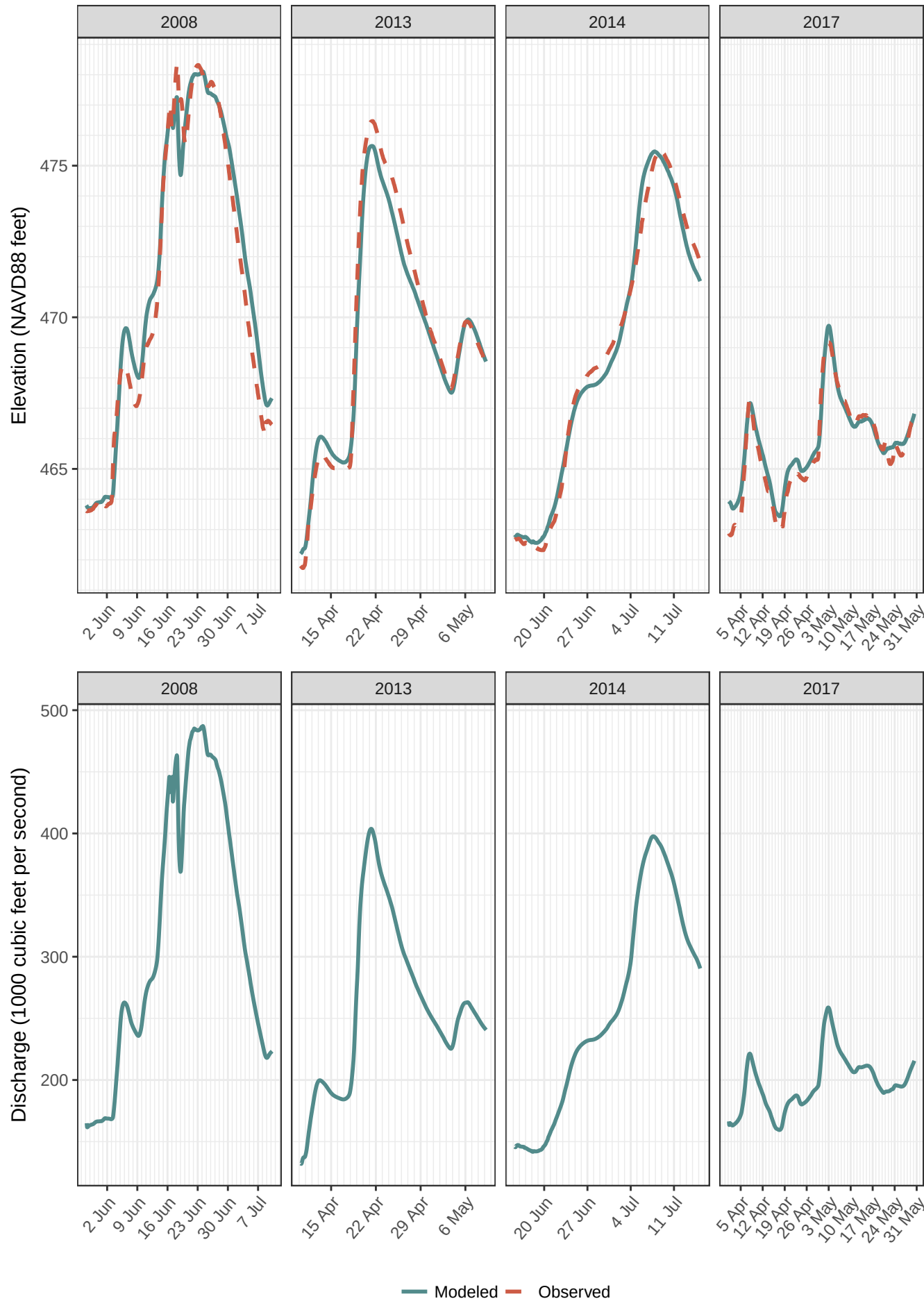
Mississippi River, Wyaconda to Fabius Reach,
River Station 324.81, Gauge L&D_21_TAIL

Existing Levee Elevation Calibration



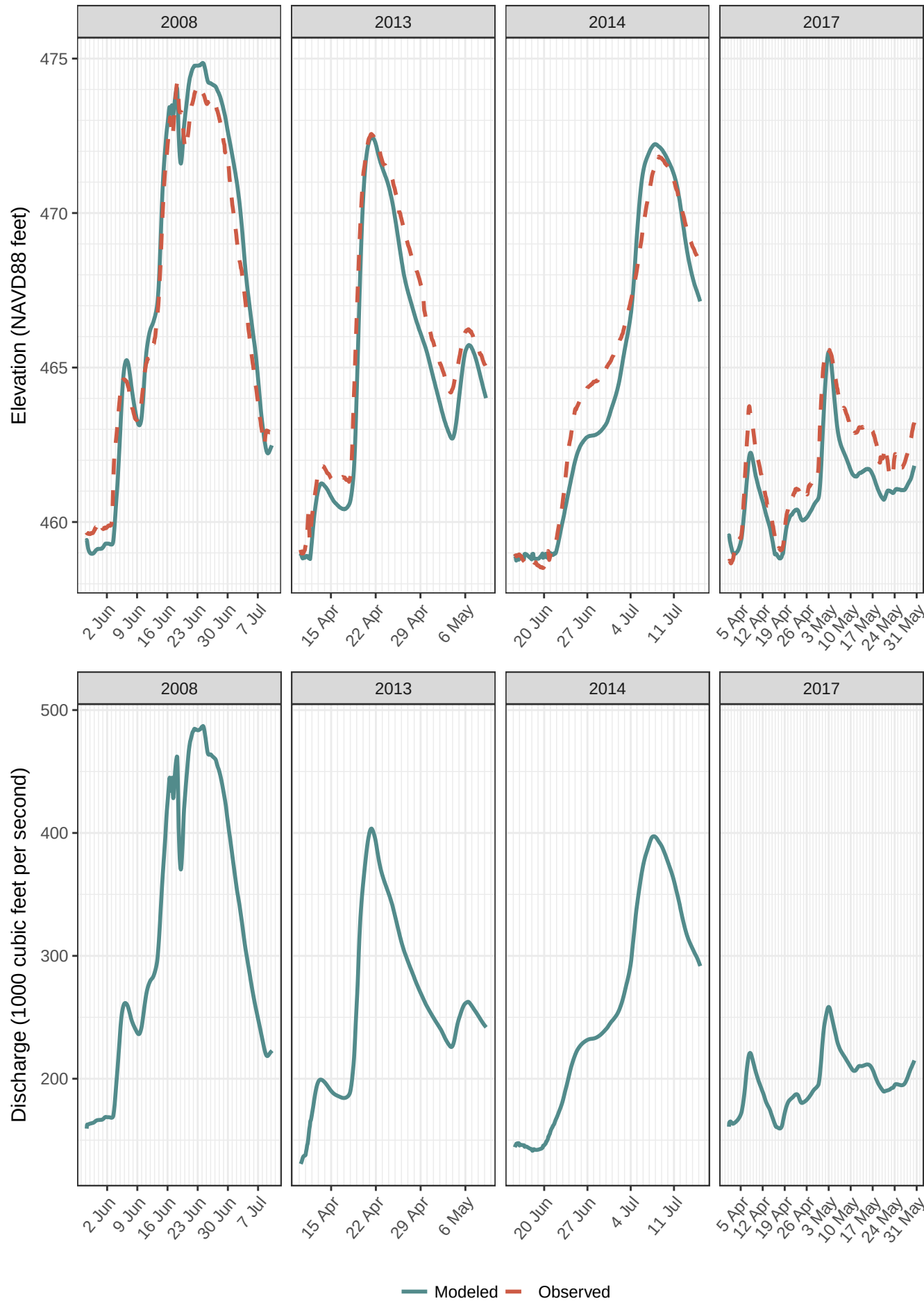
Mississippi River, North to Salt Reach,
River Station 308.94, Gauge HANNIBAL

Existing Levee Elevation Calibration



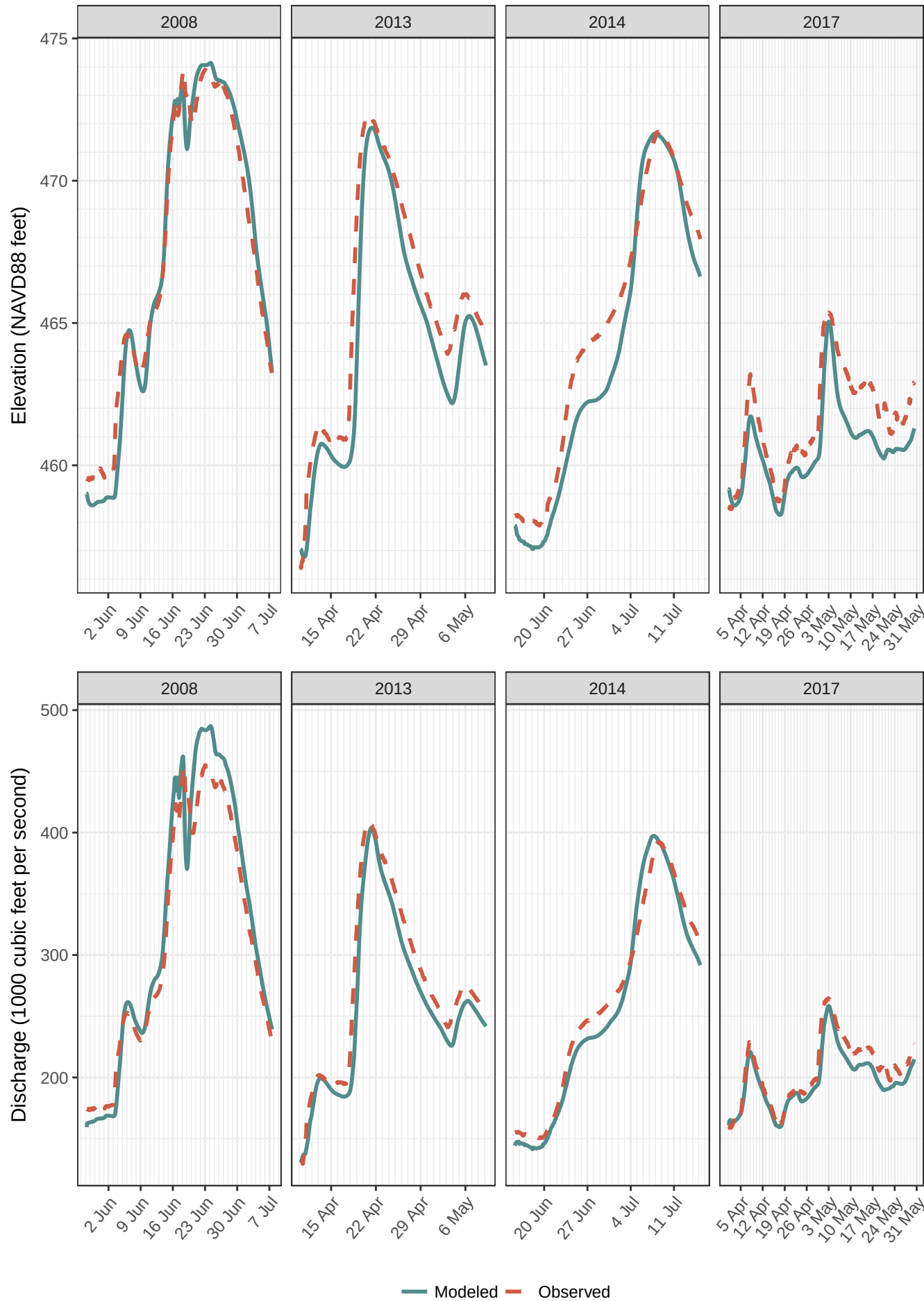
Mississippi River, North to Salt Reach,
River Station 301.25, Gauge L&D_22_POOL

Existing Levee Elevation Calibration

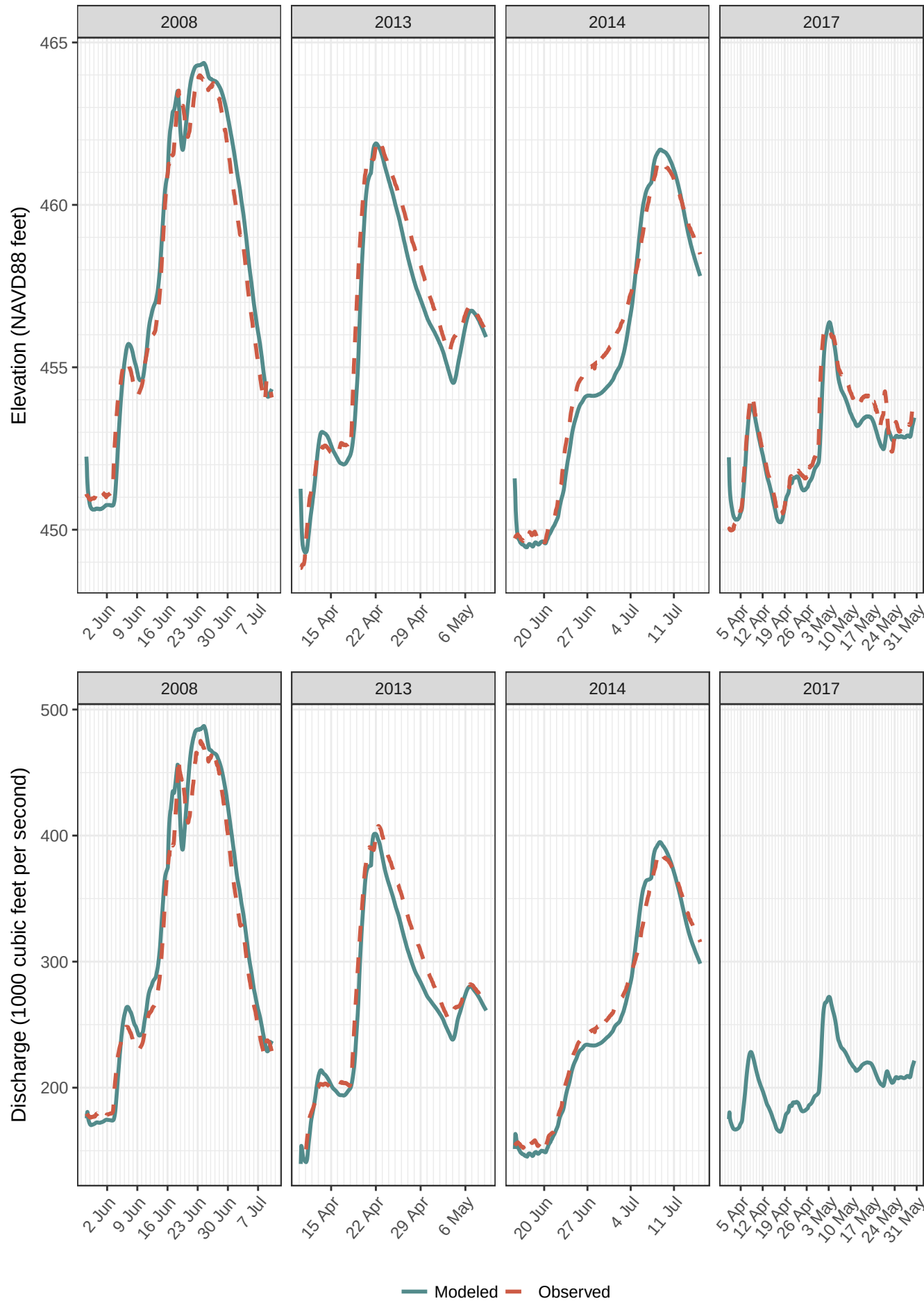


Mississippi River, North to Salt Reach,
River Station 300.7, Gauge L&D_22_TW

Existing Levee Elevation Calibration

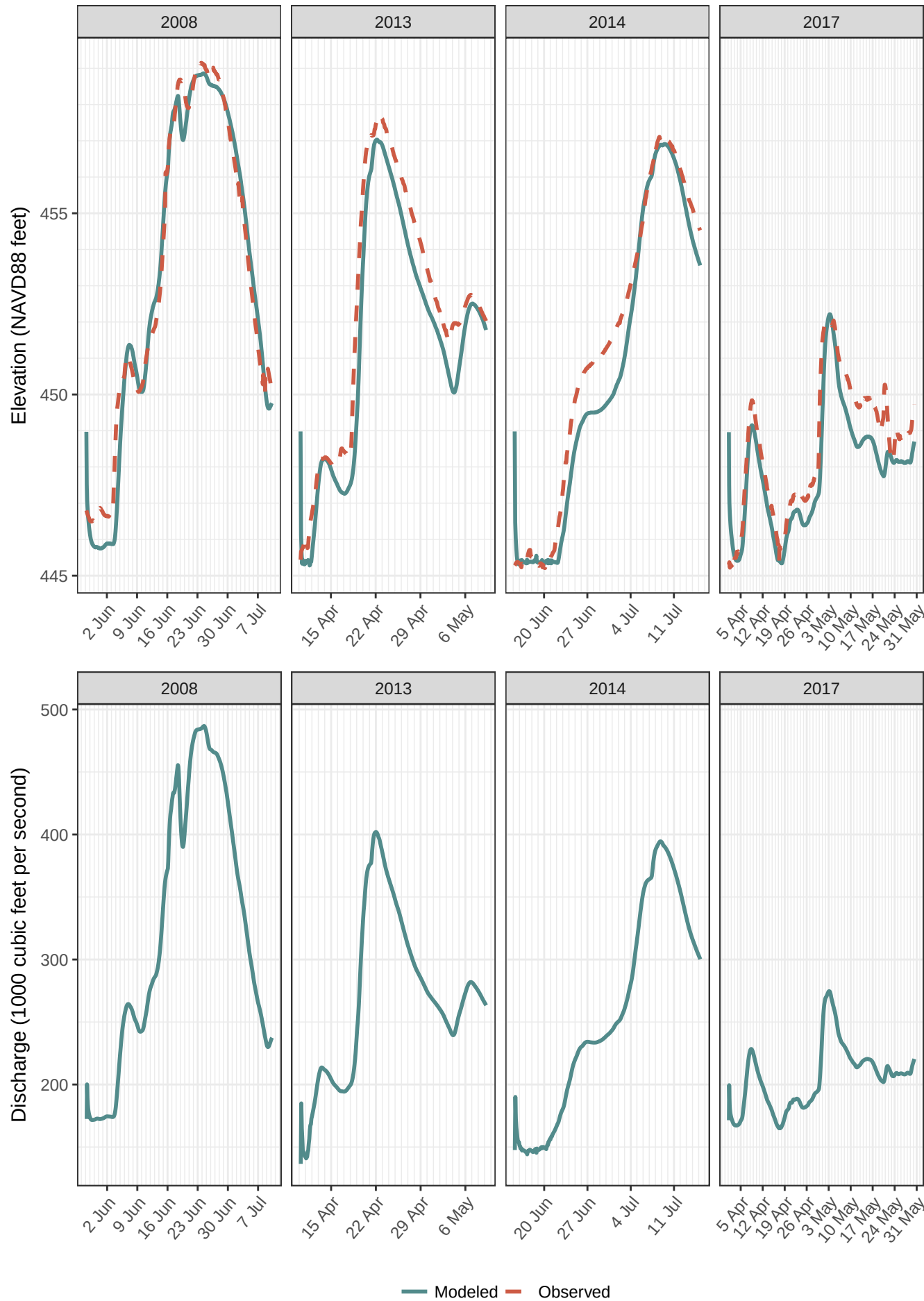


Mississippi River, Salt to Cuivre Reach,
River Station 282.5, Gauge LOUISIANA
Existing Levee Elevation Calibration

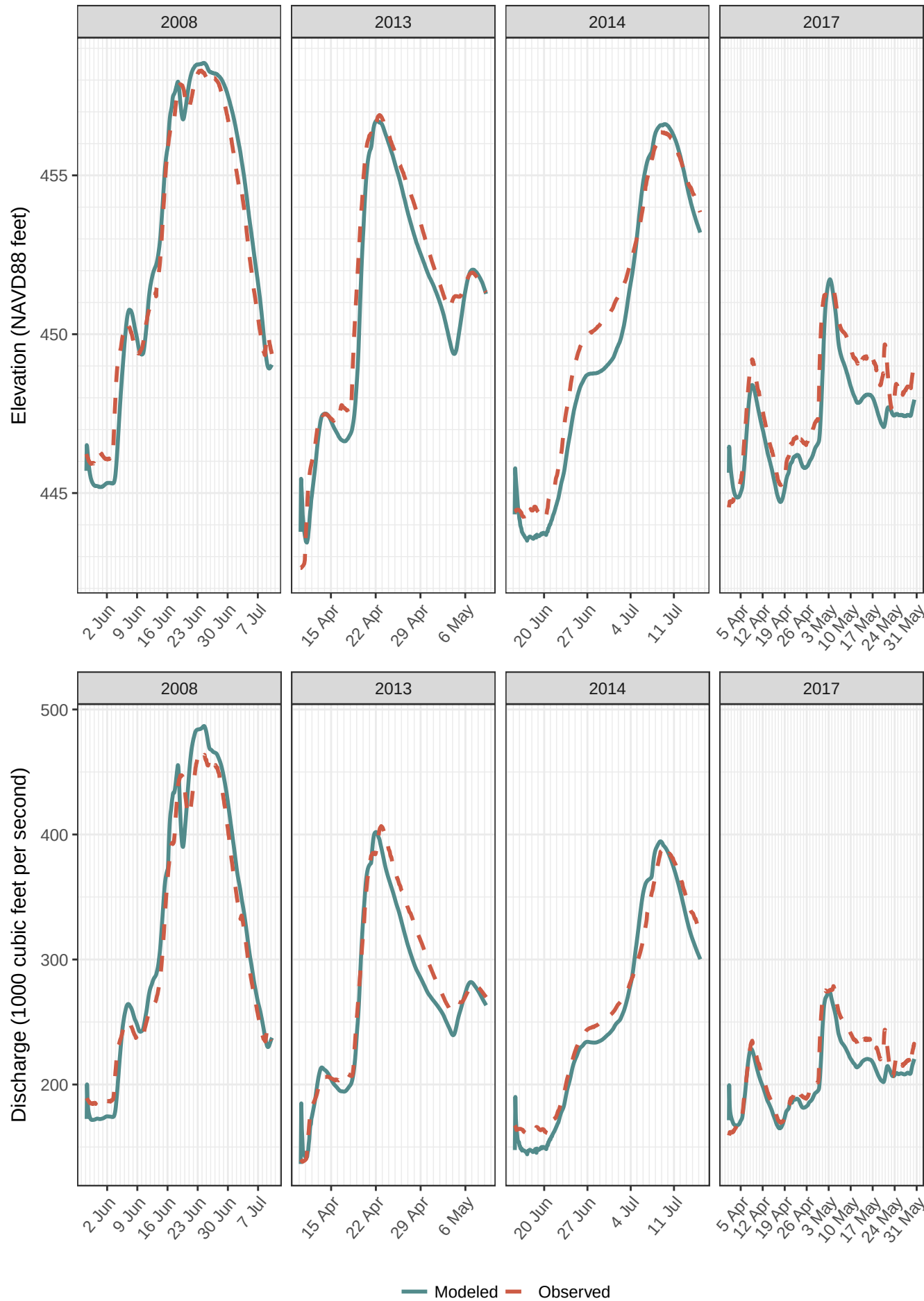


Mississippi River, Salt to Cuivre Reach,
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Existing Levee Elevation Calibration

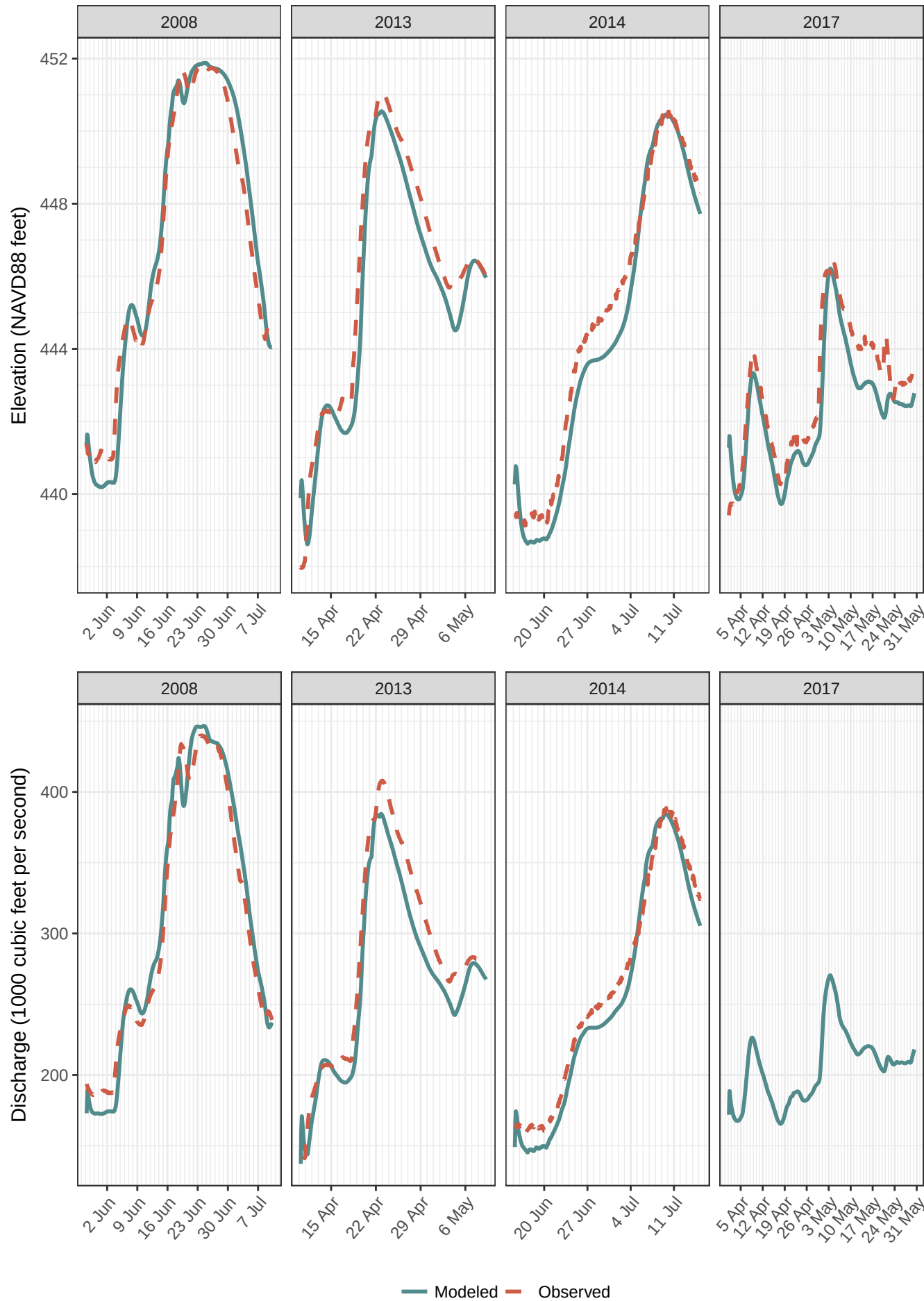


Mississippi River, Salt to Cuivre Reach,
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Existing Levee Elevation Calibration



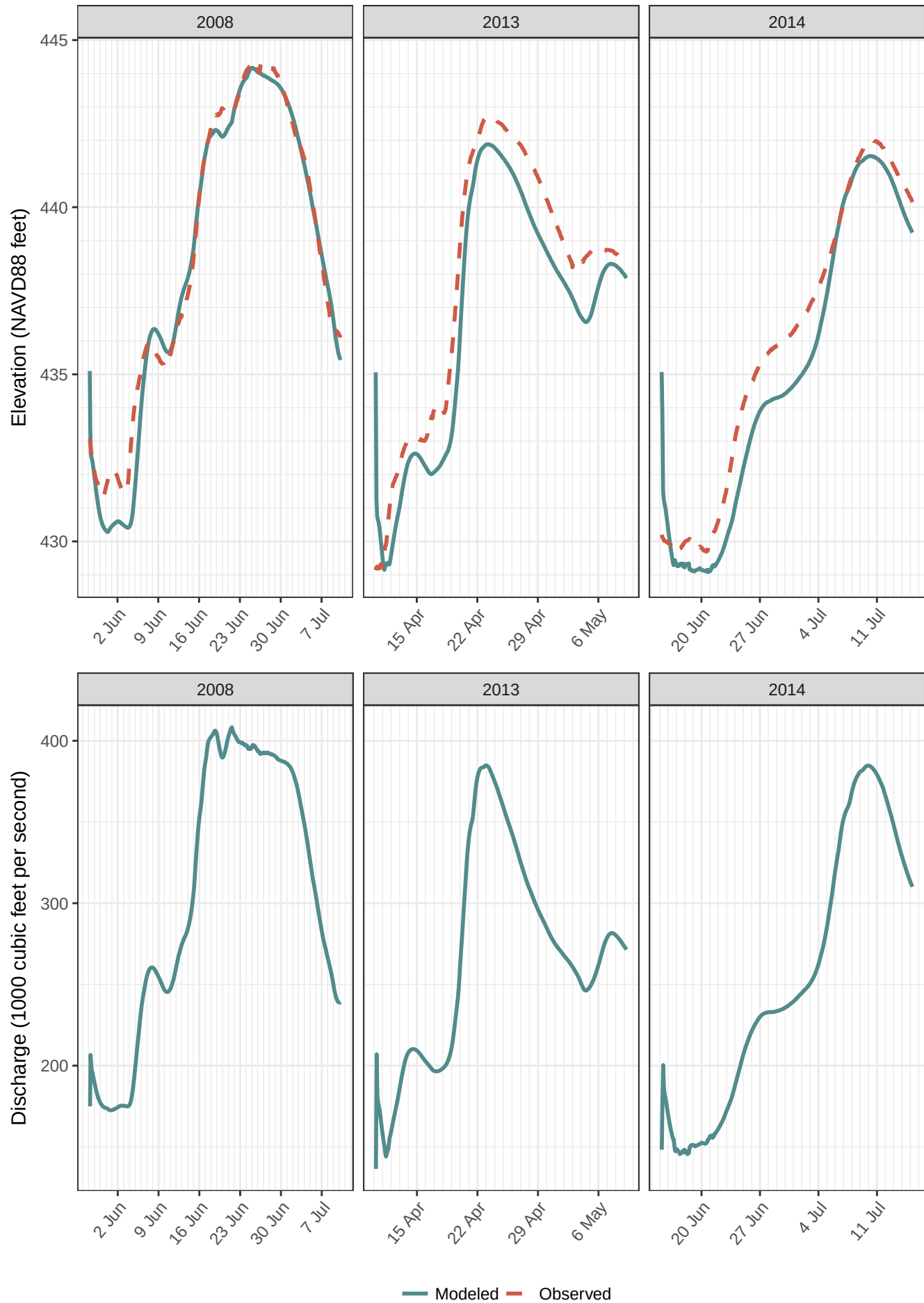
Mississippi River, Salt to Cuivre Reach,
River Station 260.17, Gauge MOSIER_LANDING

Existing Levee Elevation Calibration

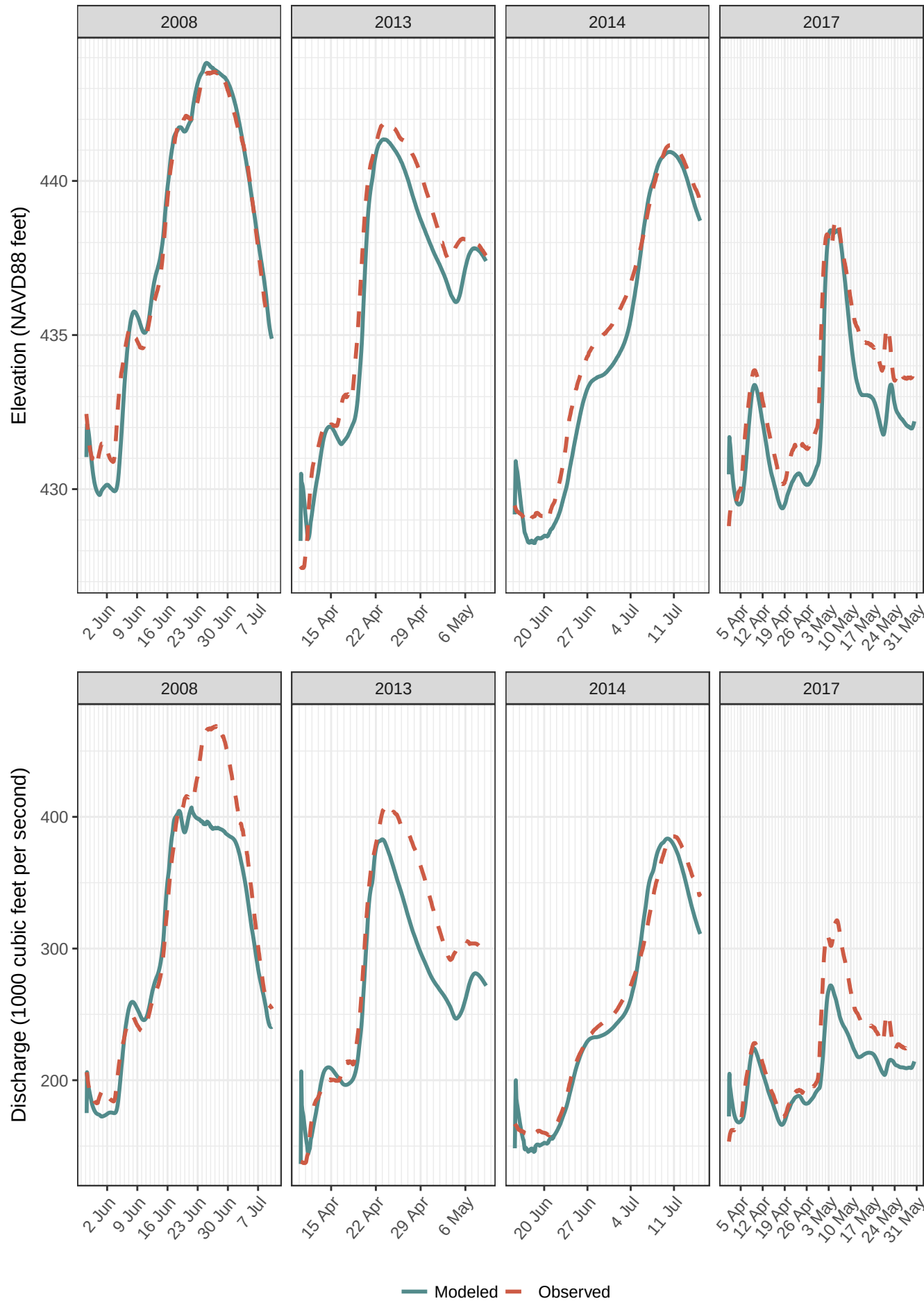


Mississippi River, Salt to Cuivre Reach,
River Station 241.49, Gauge L&D_25_POOL

Existing Levee Elevation Calibration

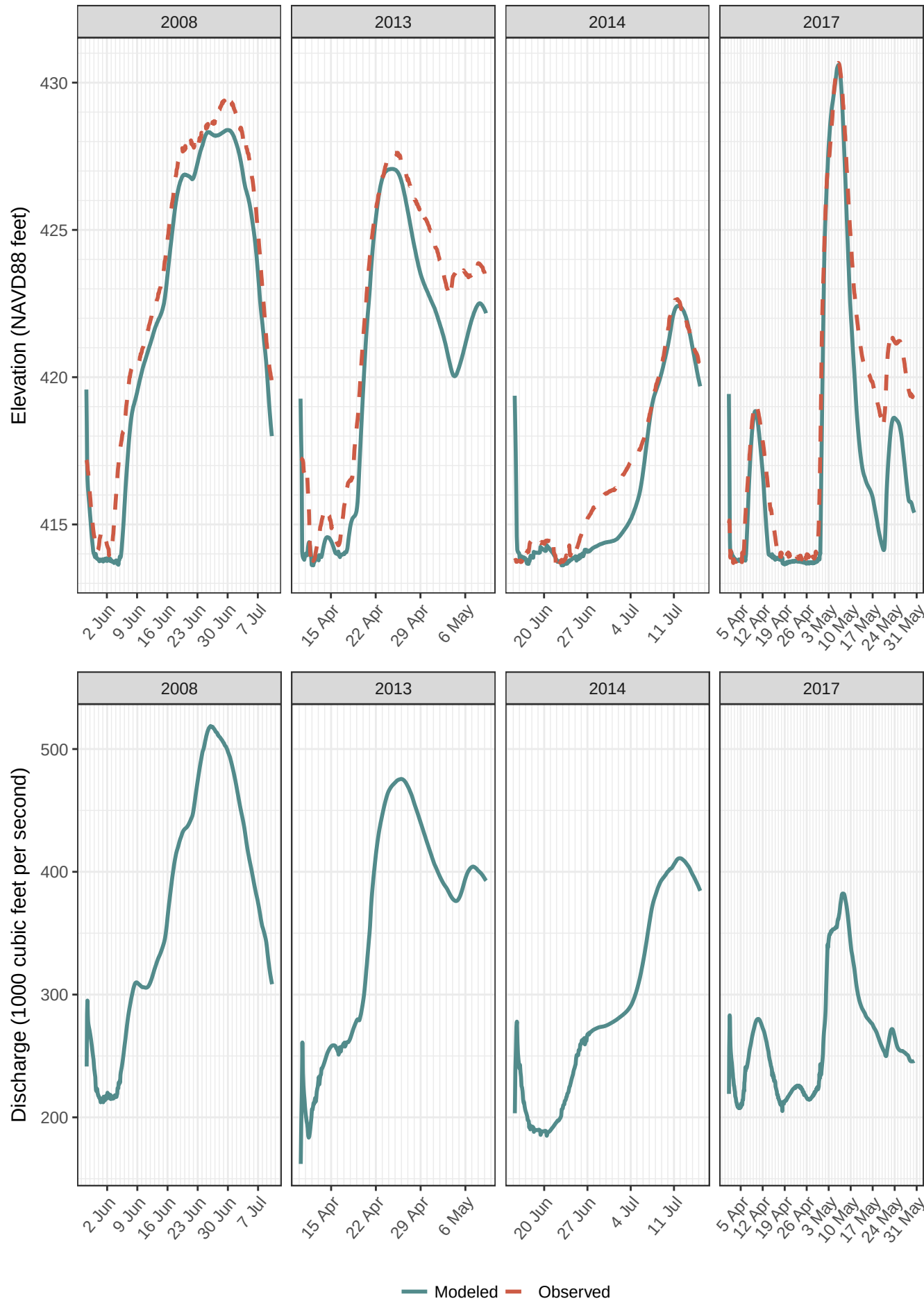


Mississippi River, Salt to Cuivre Reach,
River Station 241.23, Gauge L&D_25_TW
Existing Levee Elevation Calibration



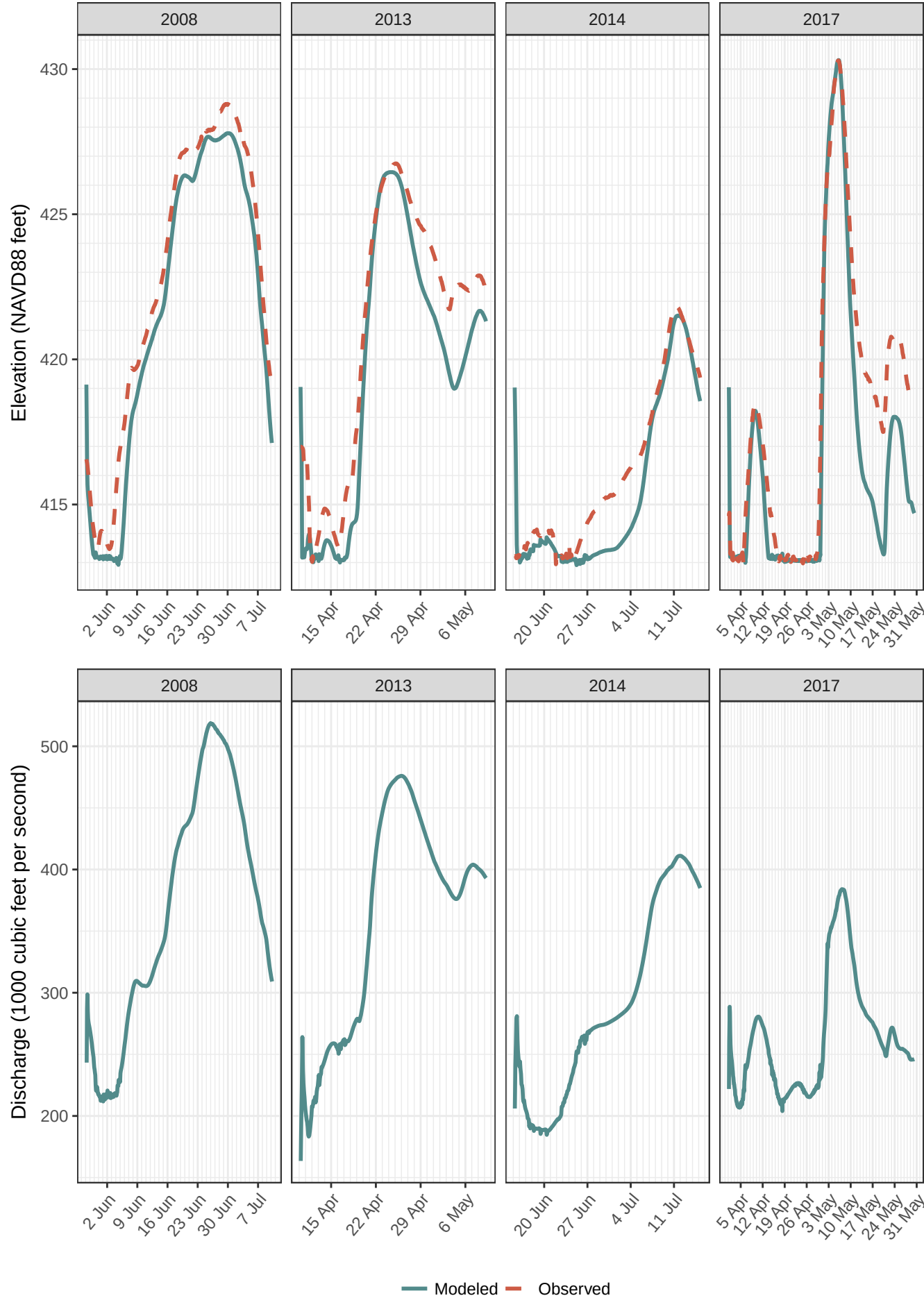
Mississippi River, Illinois to Mizzou Reach,
River Station 202.57, Gauge ALTON

Existing Levee Elevation Calibration



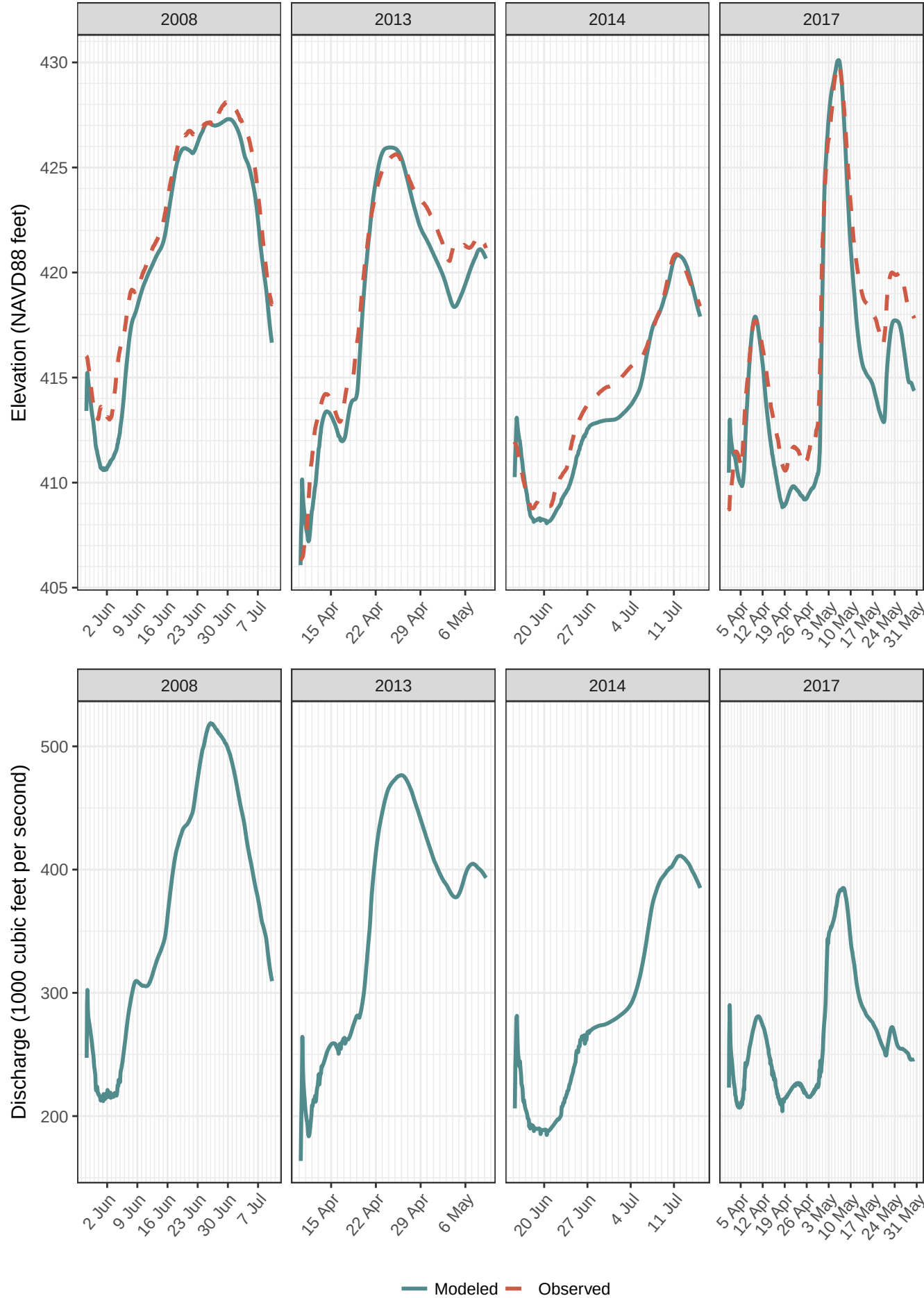
Mississippi River, Illinois to Mizzou Reach,
River Station 200.85, Gauge MEL_PRICE_L&D_POOL

Existing Levee Elevation Calibration



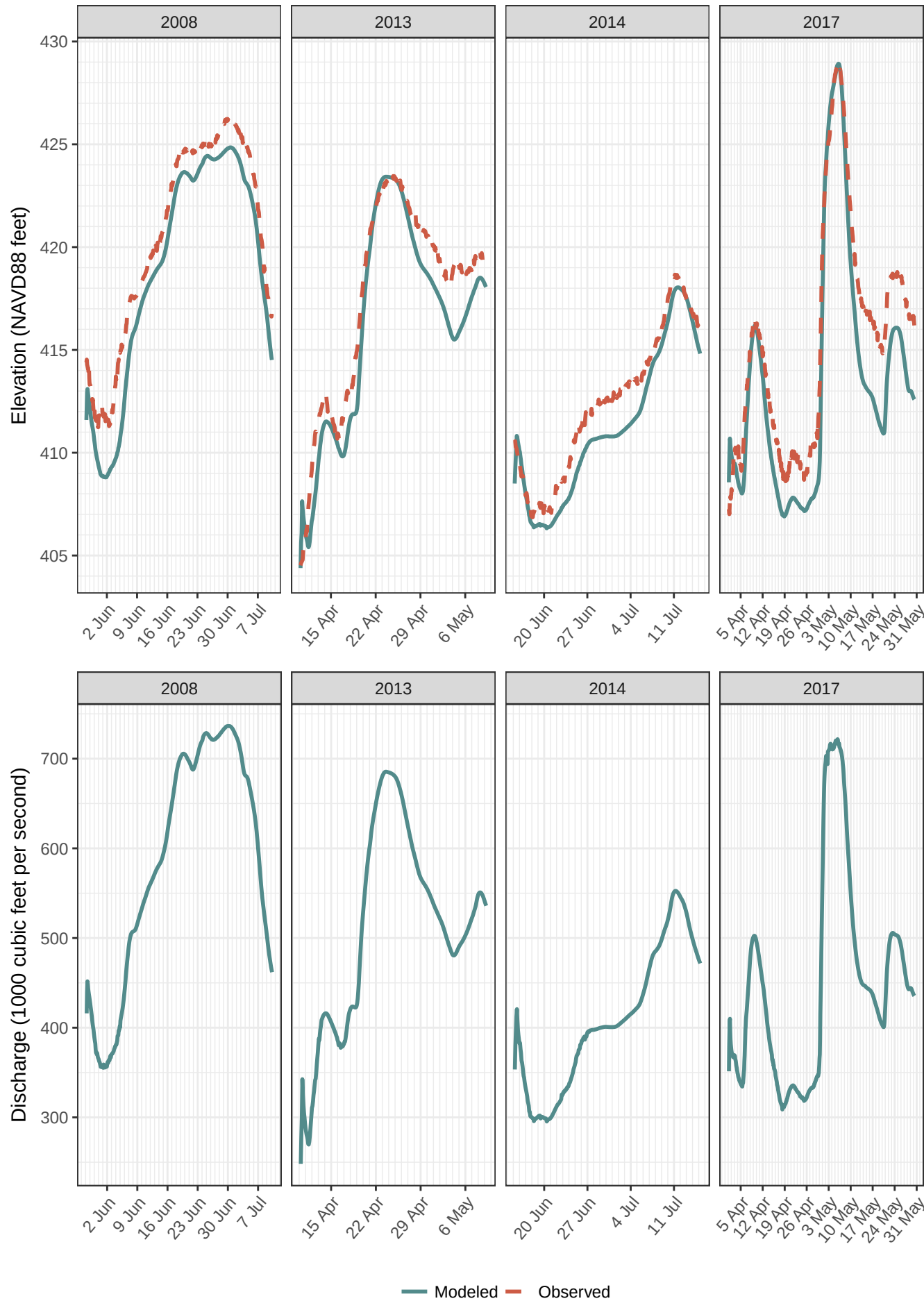
Mississippi River, Illinois to Mizzou Reach,
River Station 200.31, Gauge MEL_PRICE_L&D_TW

Existing Levee Elevation Calibration



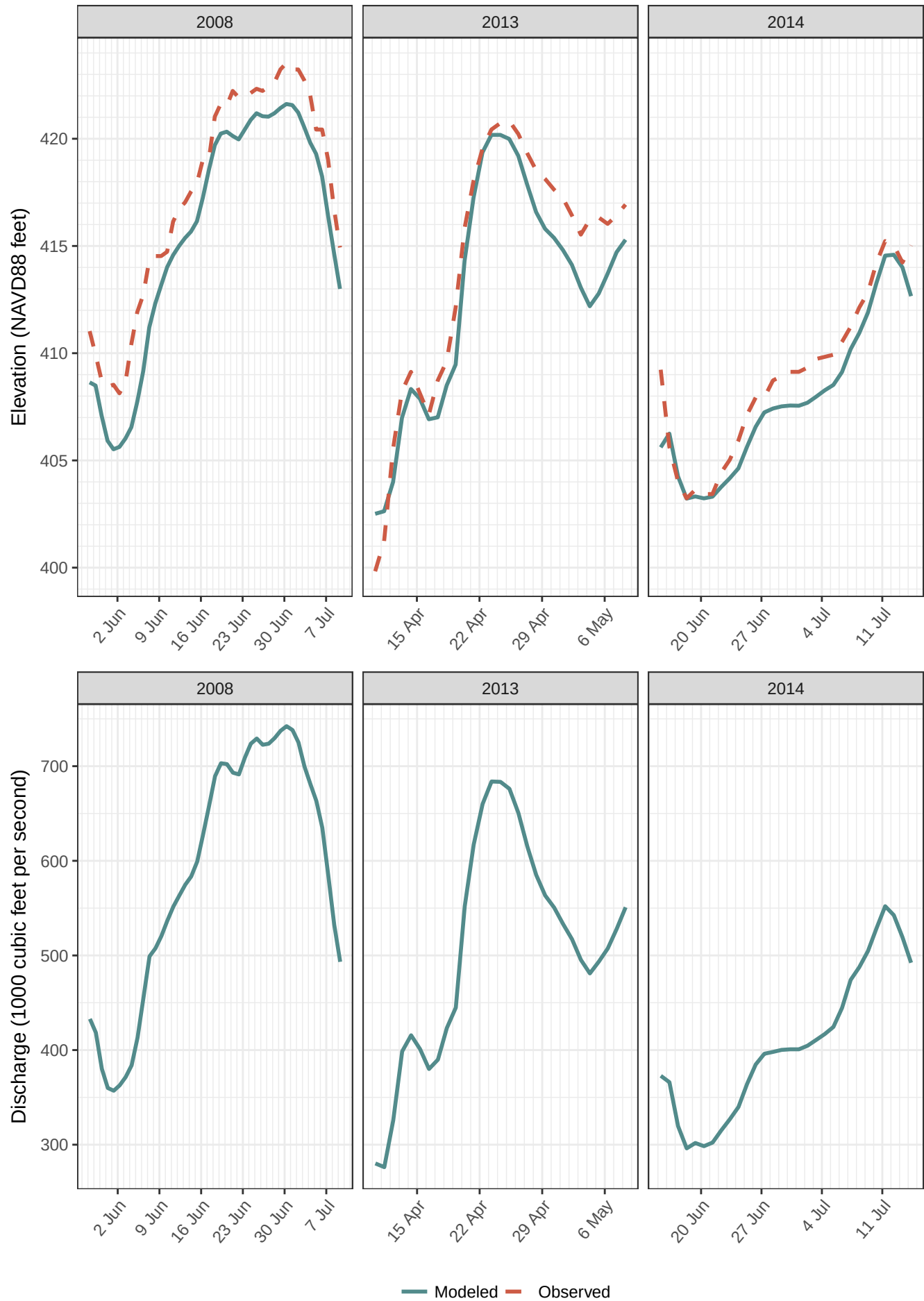
Mississippi River, Missouri to Meramec Reach,
River Station 194.16, Gauge LOCKS_27_POOL

Existing Levee Elevation Calibration



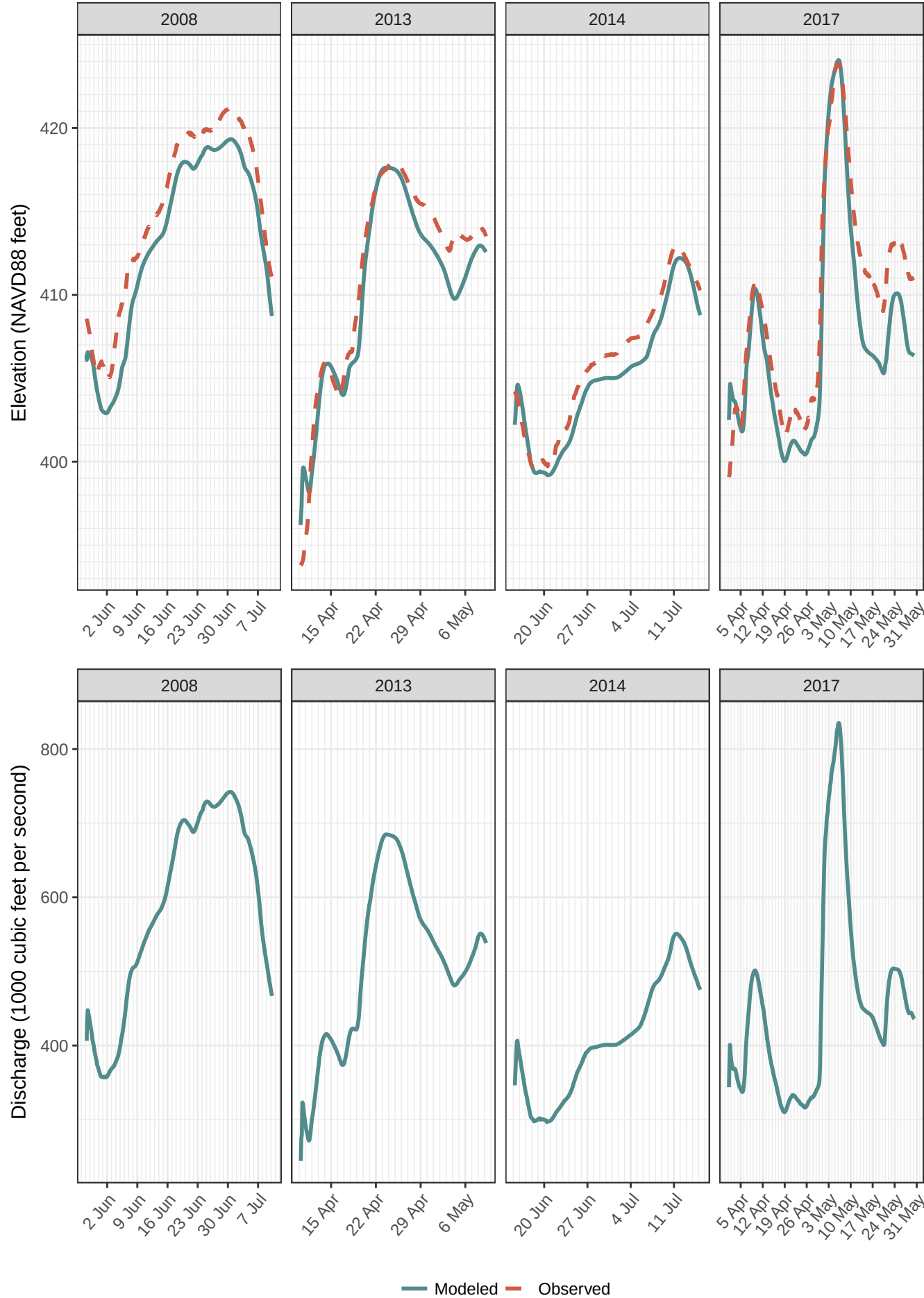
Mississippi River, Missouri to Meramec Reach,
River Station 190.32, Gauge CHAIN_OF_ROCKS

Existing Levee Elevation Calibration



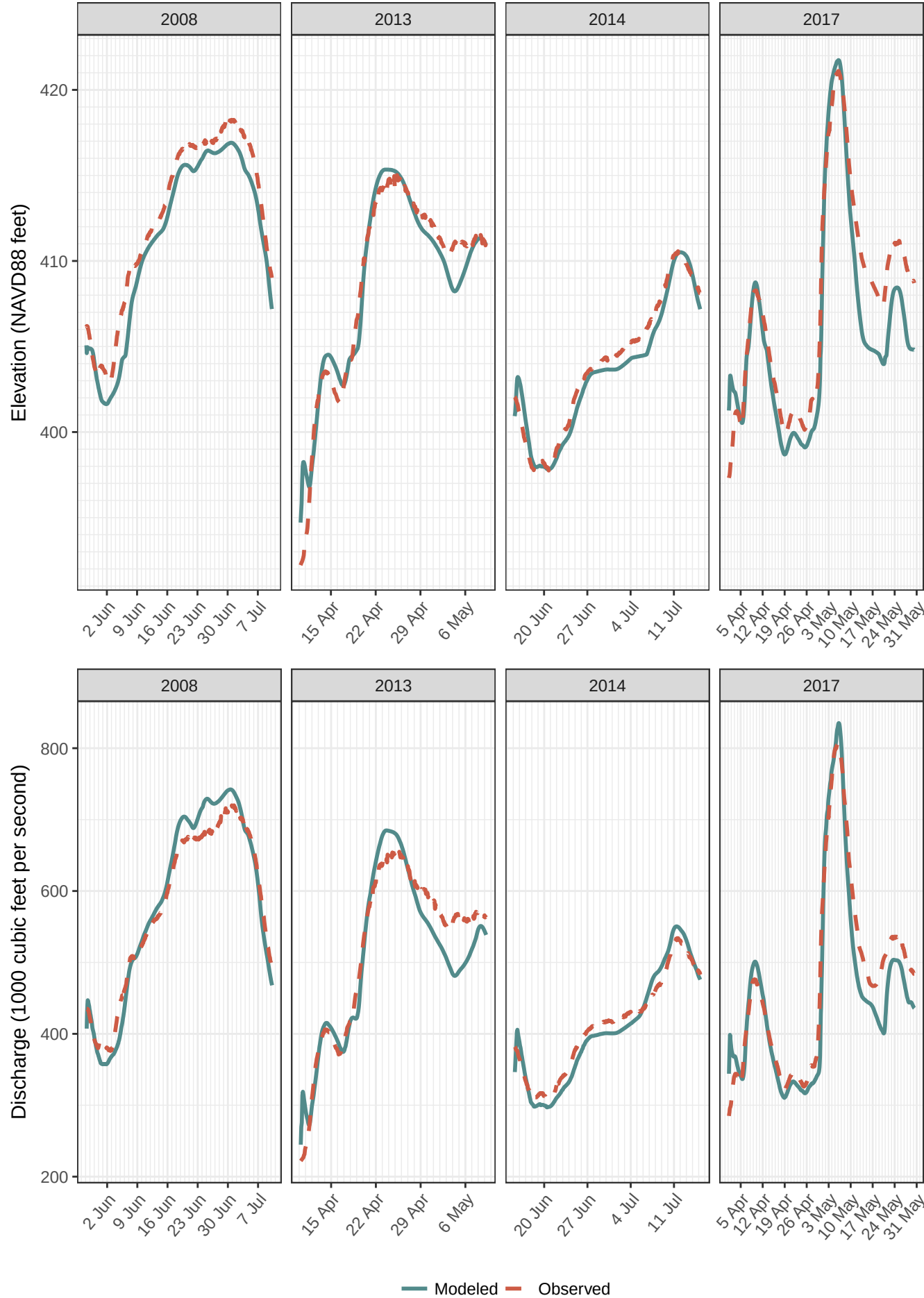
Mississippi River, Missouri to Meramec Reach,
River Station 183.98, Gauge LOCKS_27_TW

Existing Levee Elevation Calibration

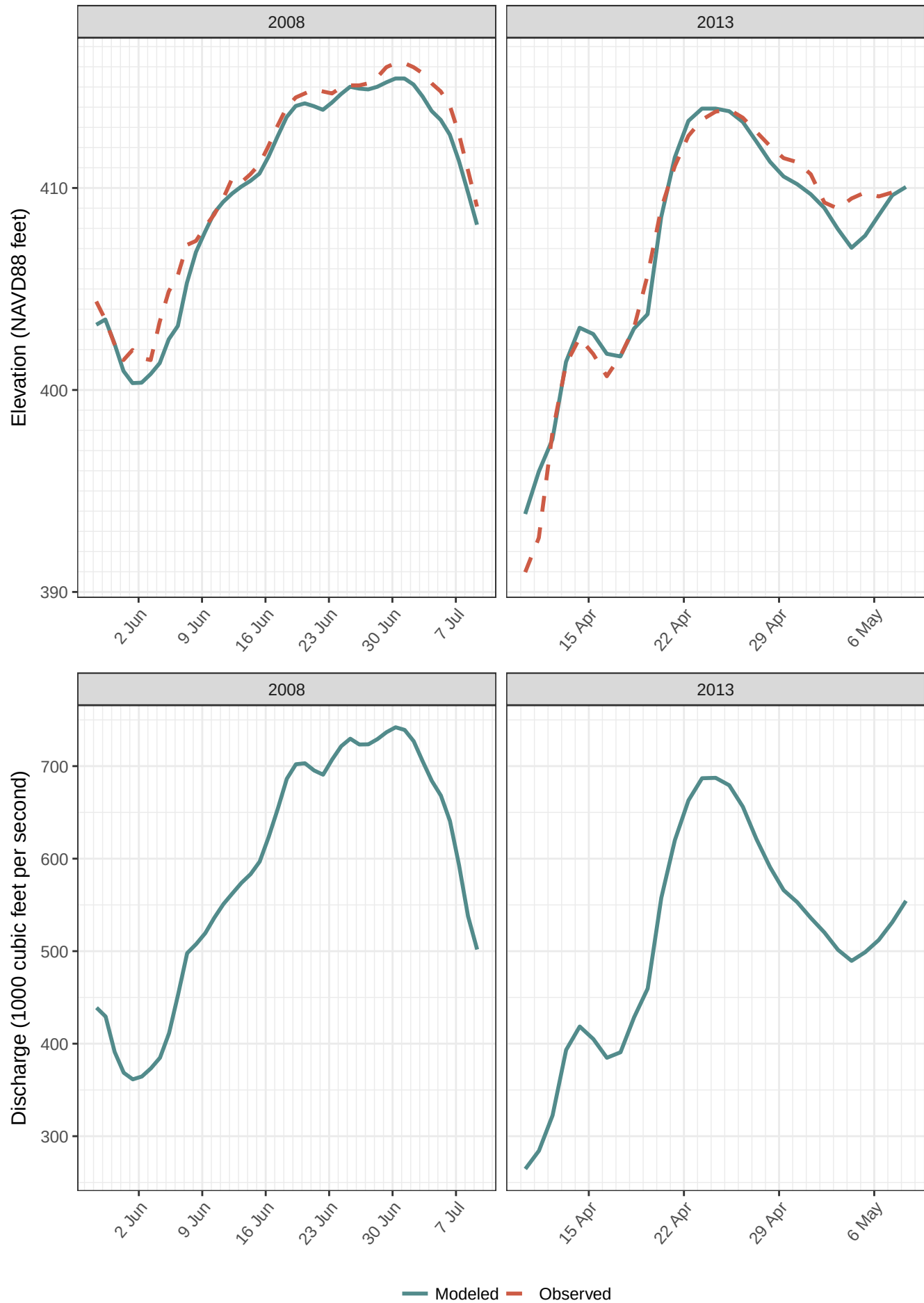


Mississippi River, Missouri to Meramec Reach,
River Station 180.01, Gauge ST._LOUIS

Existing Levee Elevation Calibration

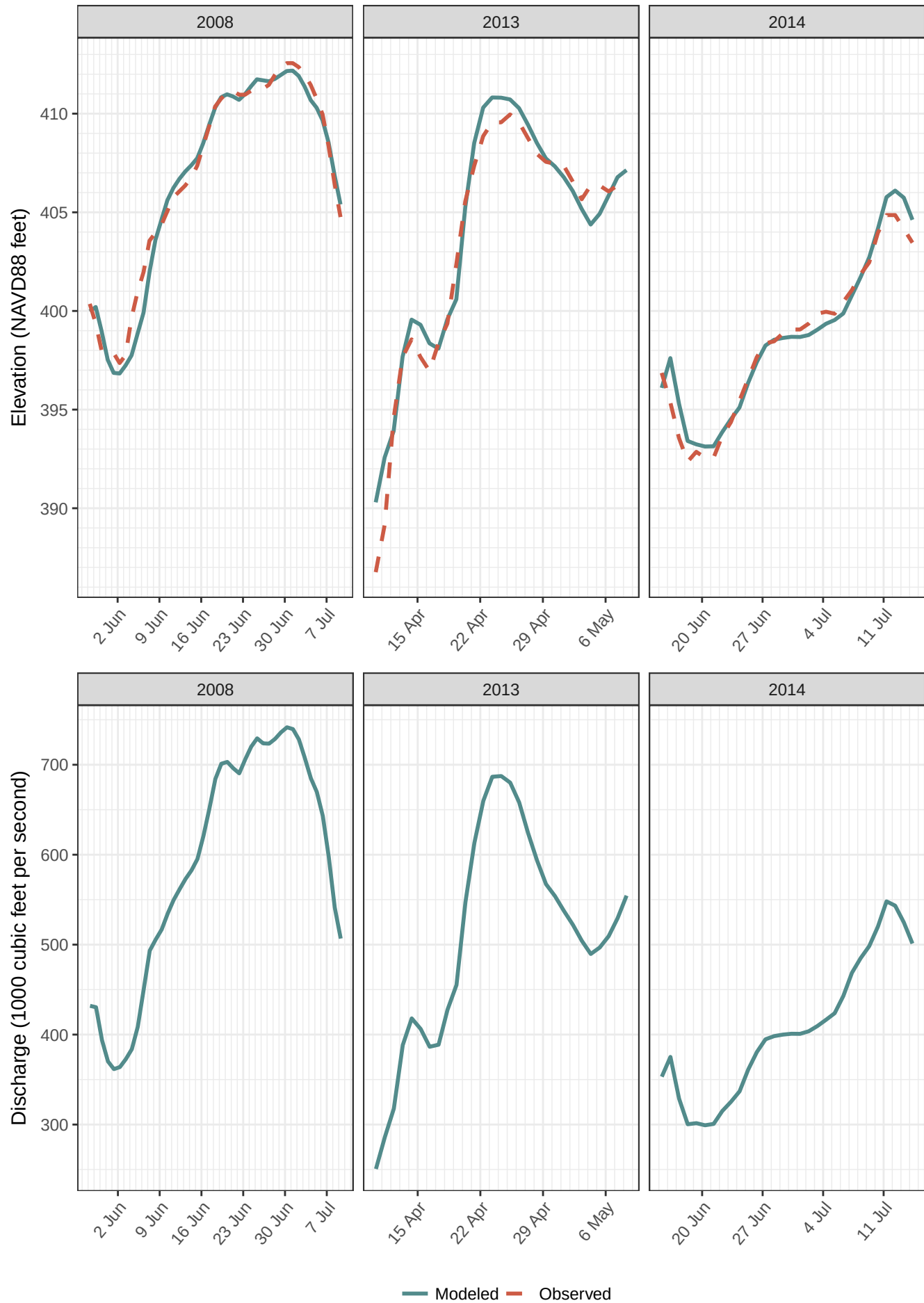


Mississippi River, Missouri to Meramec Reach,
River Station 176.96, Gauge ENGINEERS_DEPOT
Existing Levee Elevation Calibration



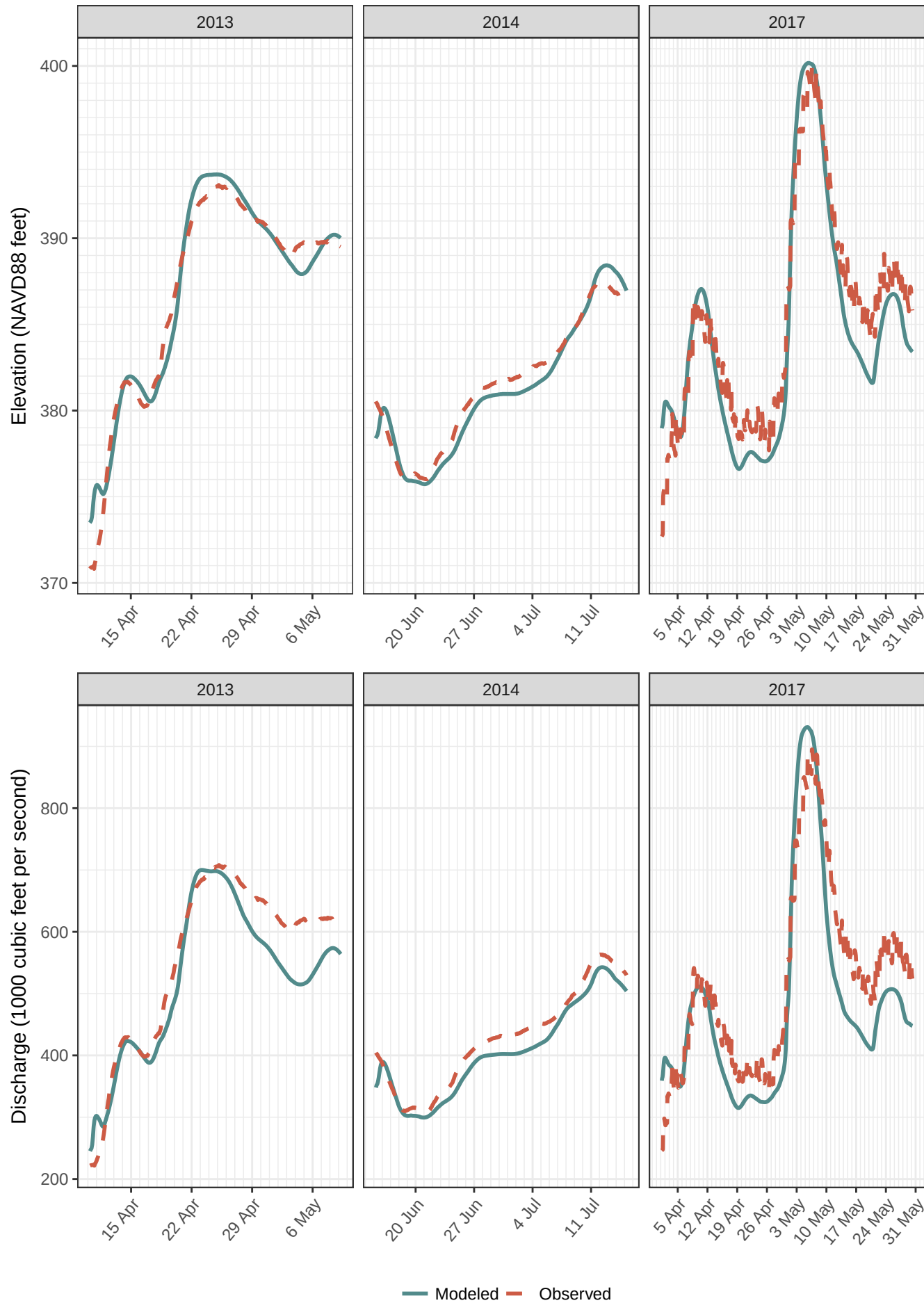
Mississippi River, Missouri to Meramec Reach,
River Station 168.75, Gauge JEFFERSON_BARRACKS

Existing Levee Elevation Calibration



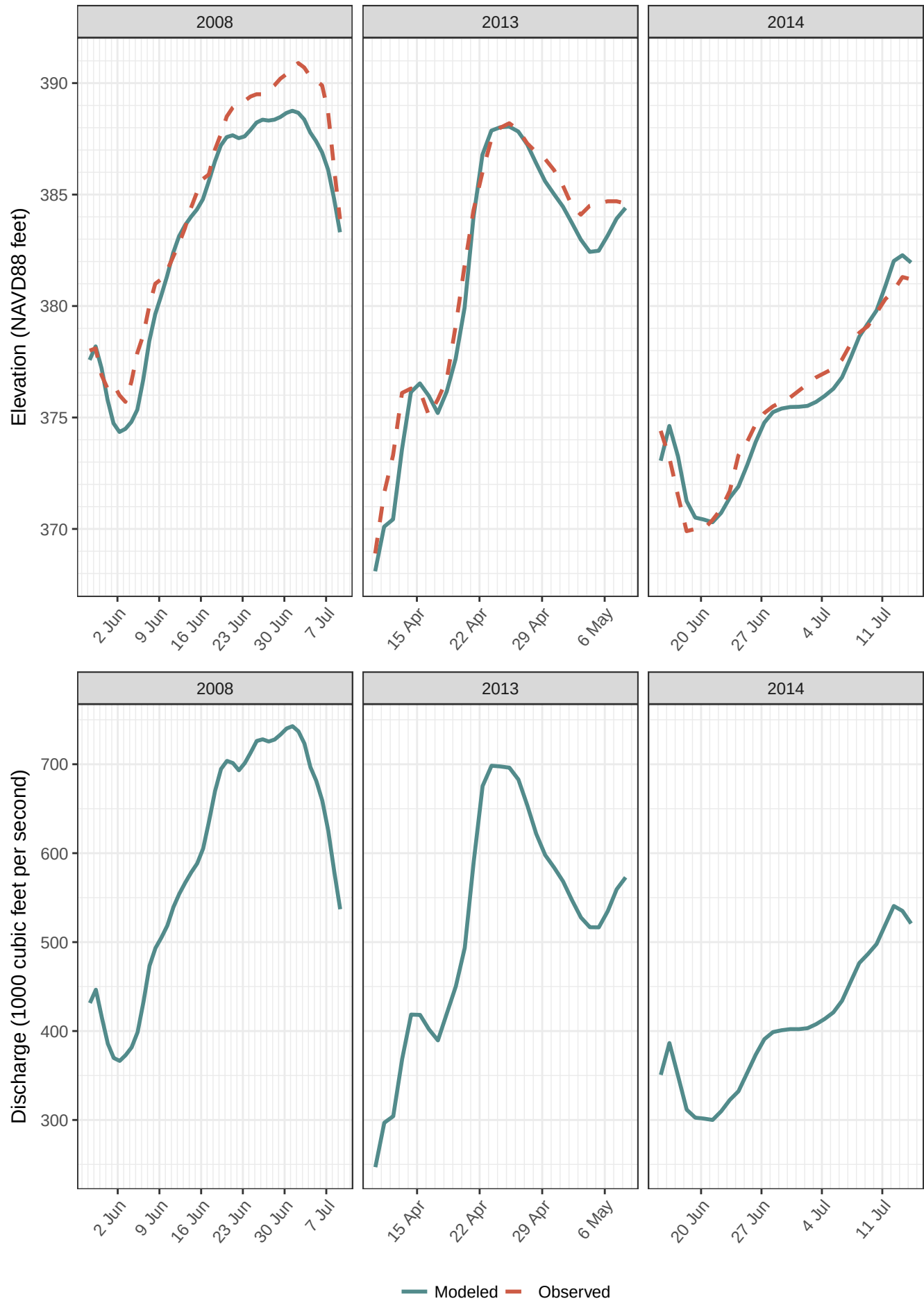
Mississippi River, Meramec to Kaskaskia Reach,
River Station 135.5, Gauge BRICKEYS

Existing Levee Elevation Calibration



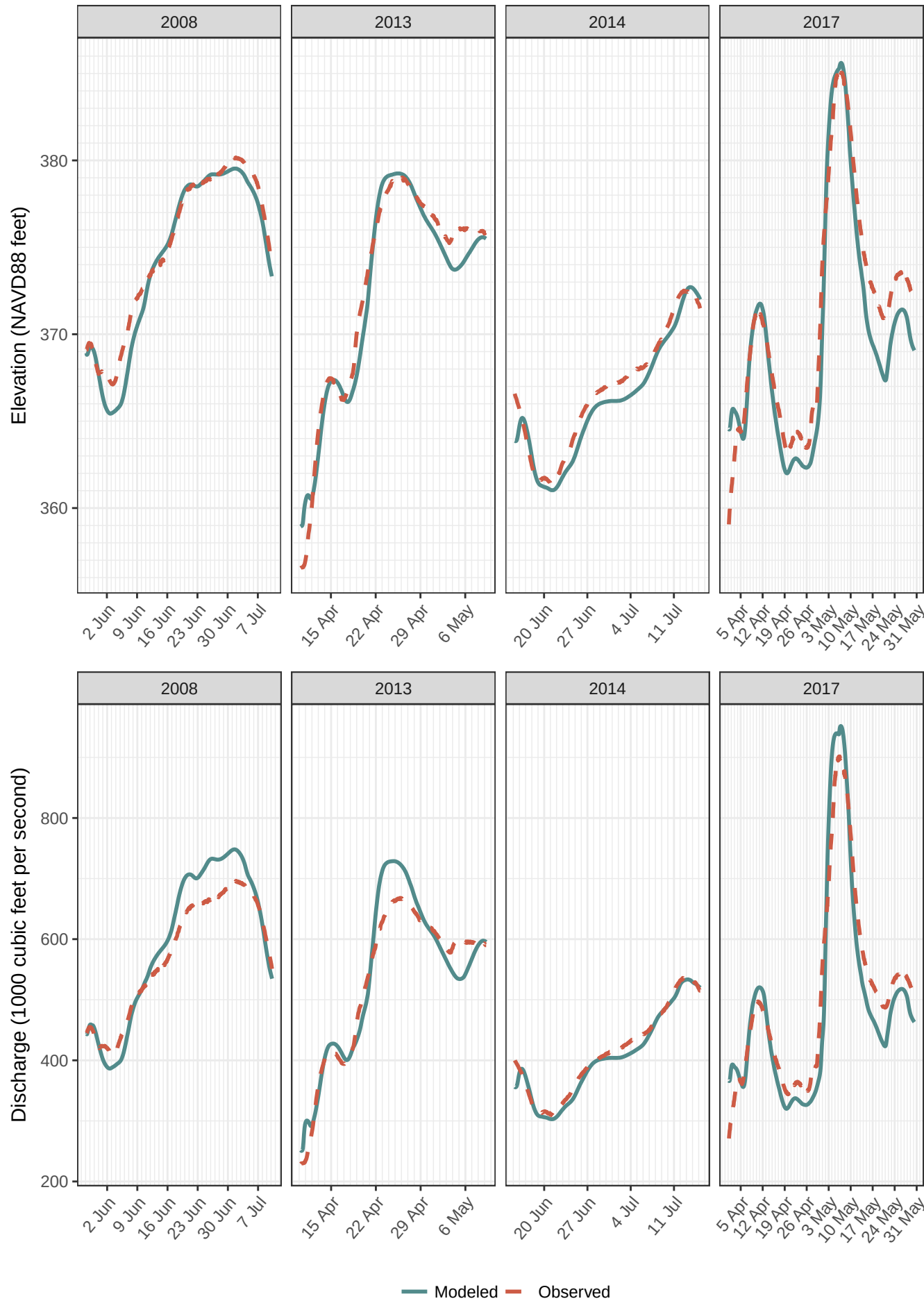
Mississippi River, Meramec to Kaskaskia Reach,
River Station 125.6, Gauge LITTLE_ROCK_LANDING

Existing Levee Elevation Calibration



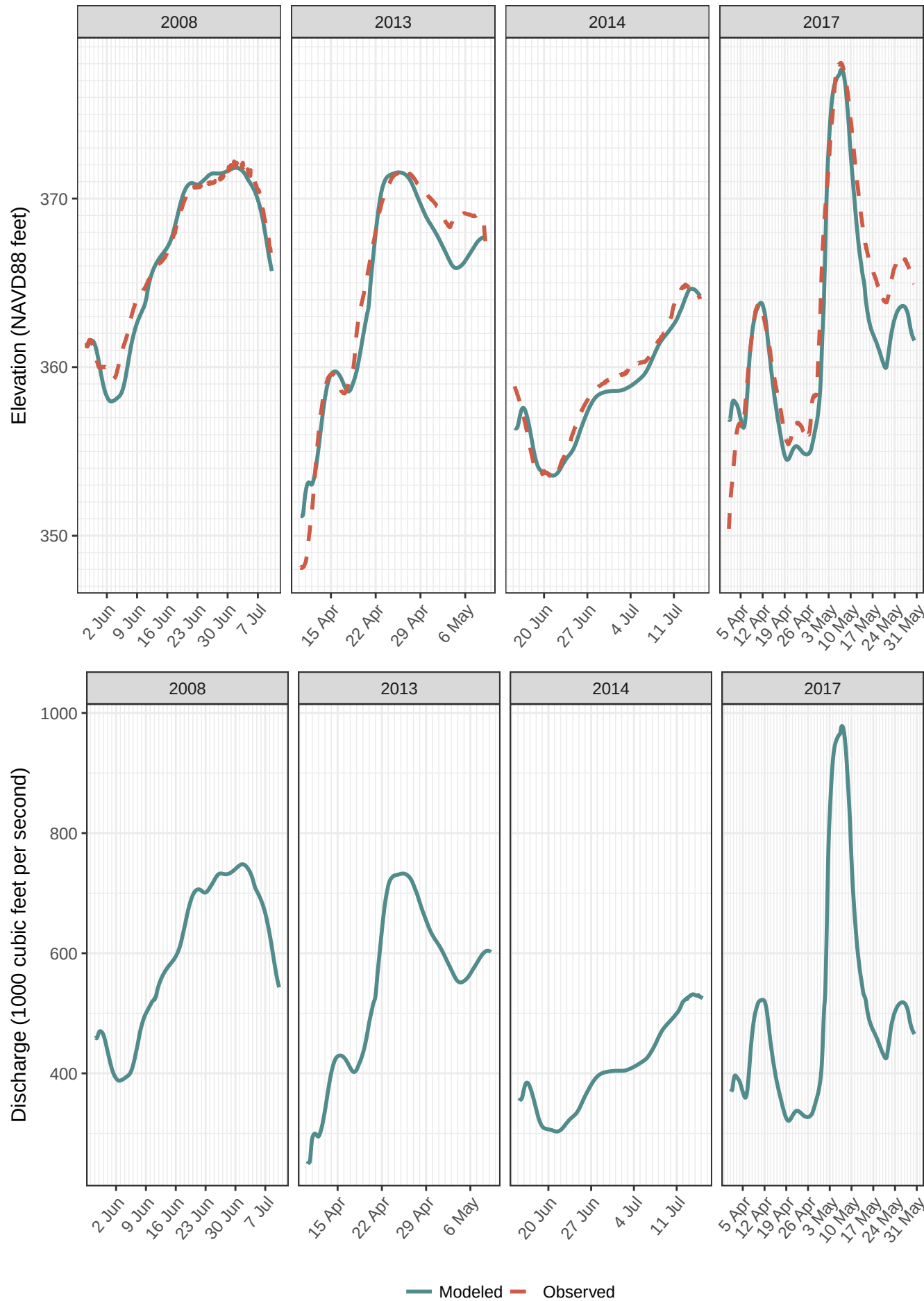
Mississippi River, Kaskaskia to Big Muddy Reach,
River Station 109.9, Gauge CHESTER

Existing Levee Elevation Calibration



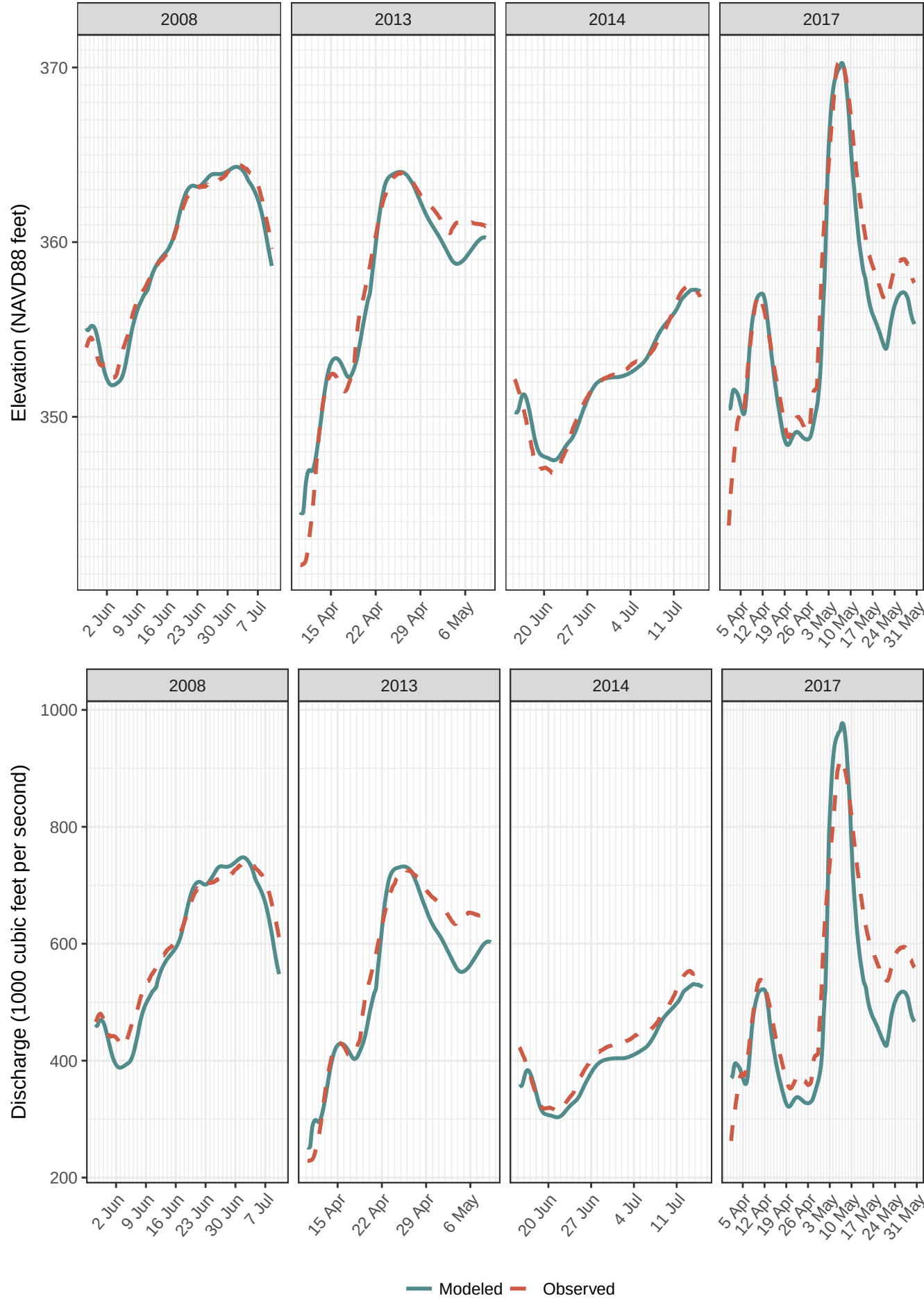
Mississippi River, Kaskaskia to Big Muddy Reach,
River Station 93.97, Gauge RED_ROCK_LANDING

Existing Levee Elevation Calibration



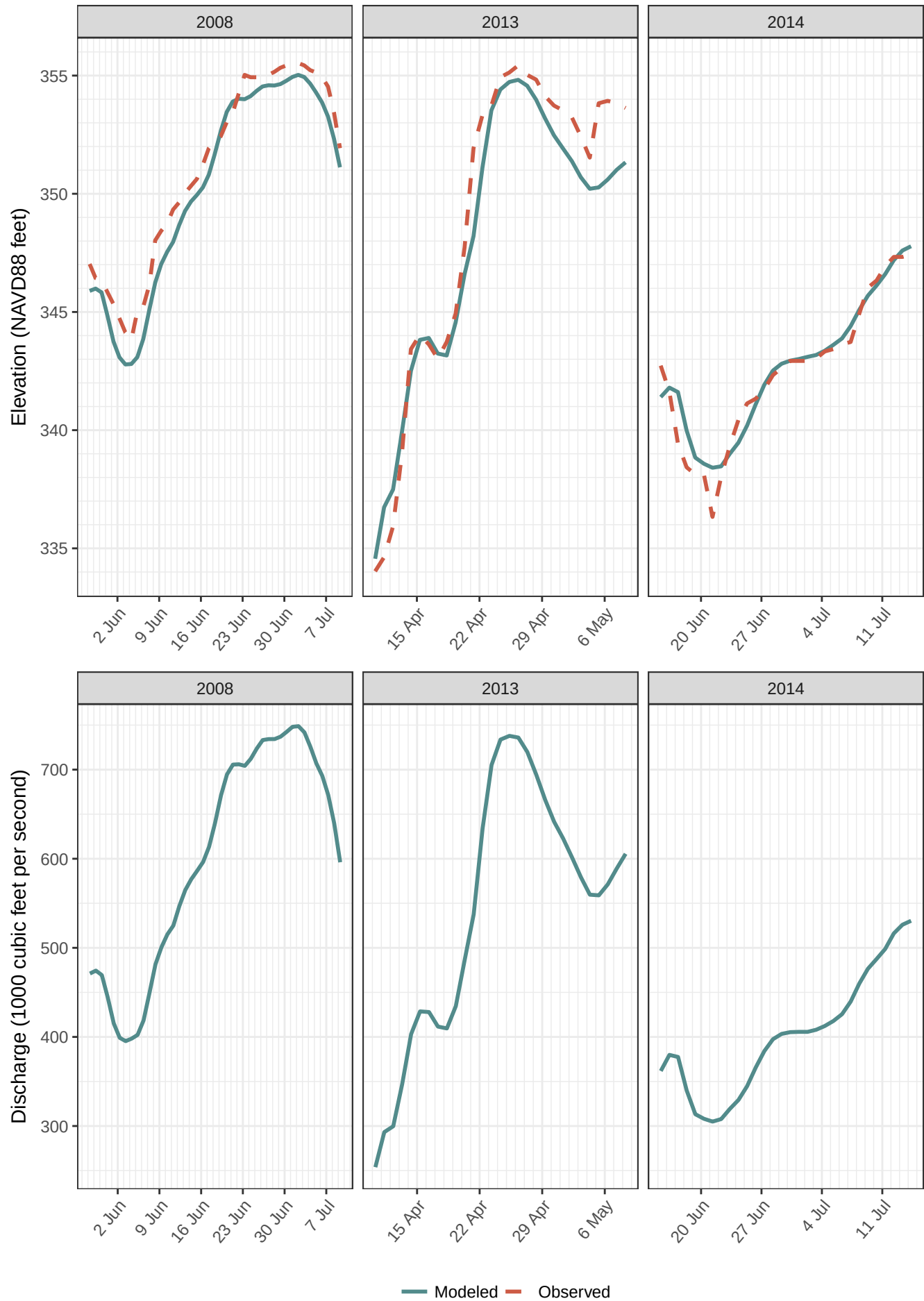
Mississippi River, Kaskaskia to Big Muddy Reach,
River Station 81.6, Gauge GRAND_TOWER

Existing Levee Elevation Calibration



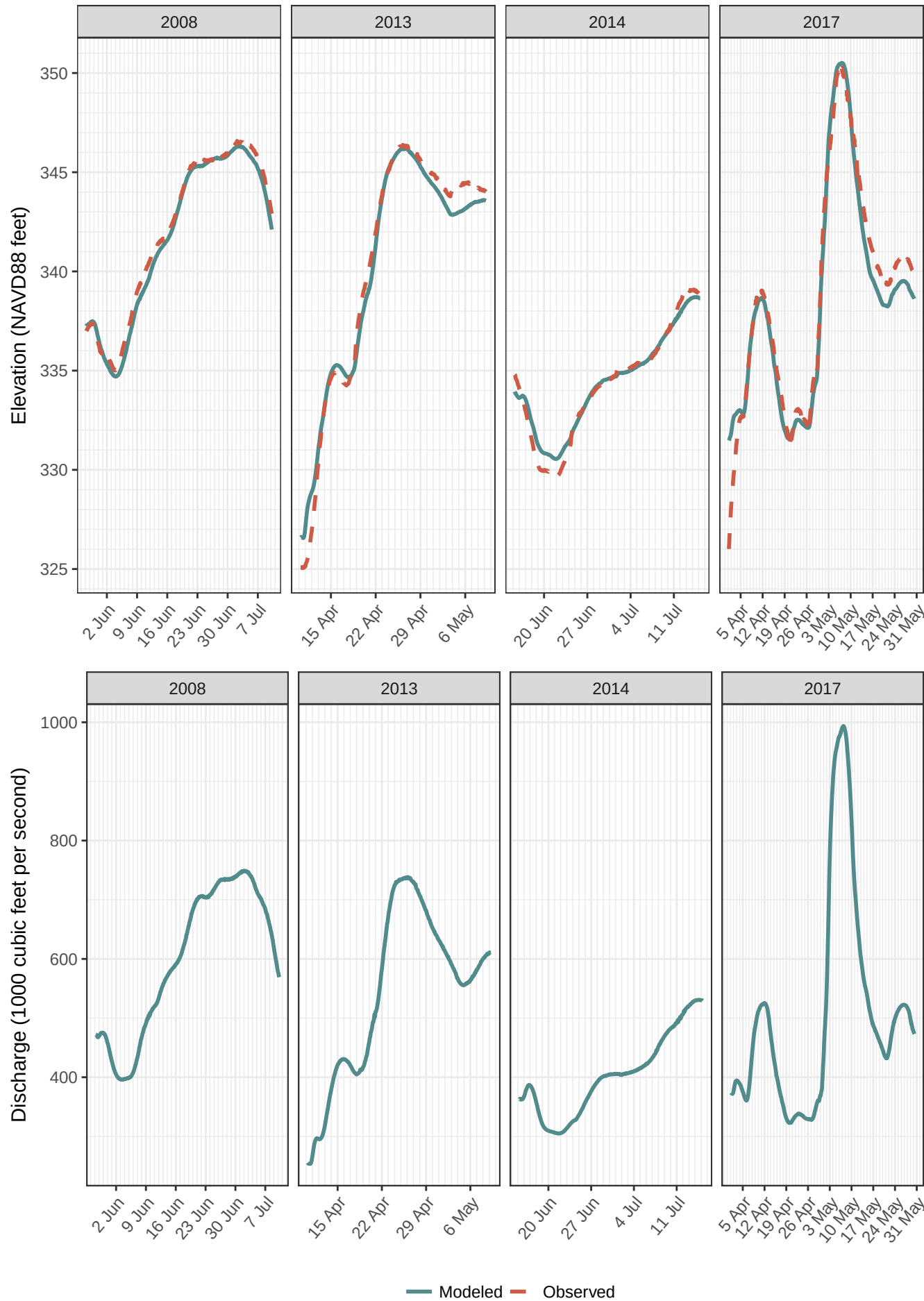
Mississippi River, Big Muddy to Ohio Reach,
River Station 66.3, Gauge MOCCASIN_SPRINGS

Existing Levee Elevation Calibration



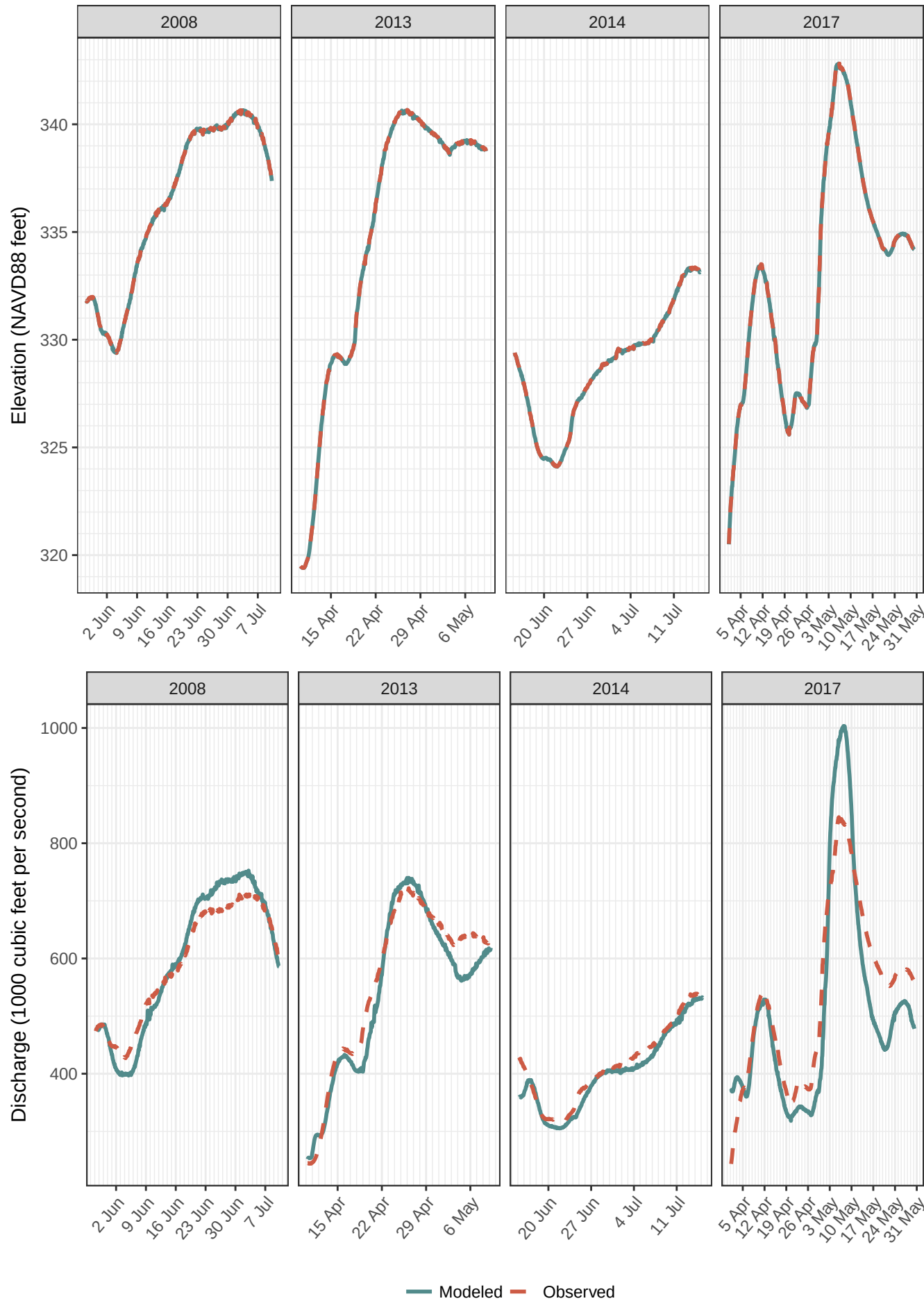
Mississippi River, Big Muddy to Ohio Reach,
River Station 52.15, Gauge CAPE_GIRARDEAU

Existing Levee Elevation Calibration



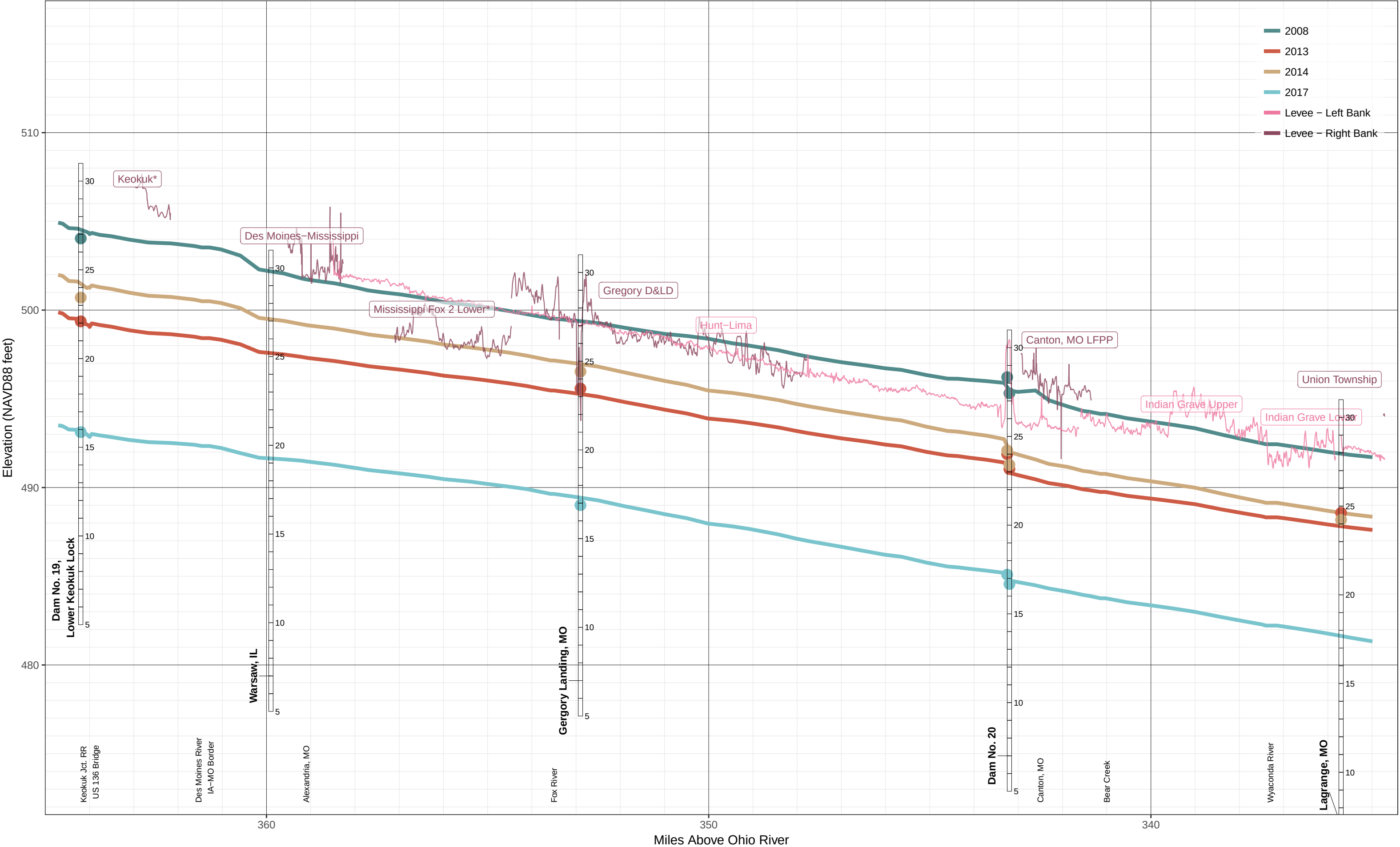
Mississippi River, Big Muddy to Ohio Reach,
River Station 43.702, Gauge THEBES

Existing Levee Elevation Calibration

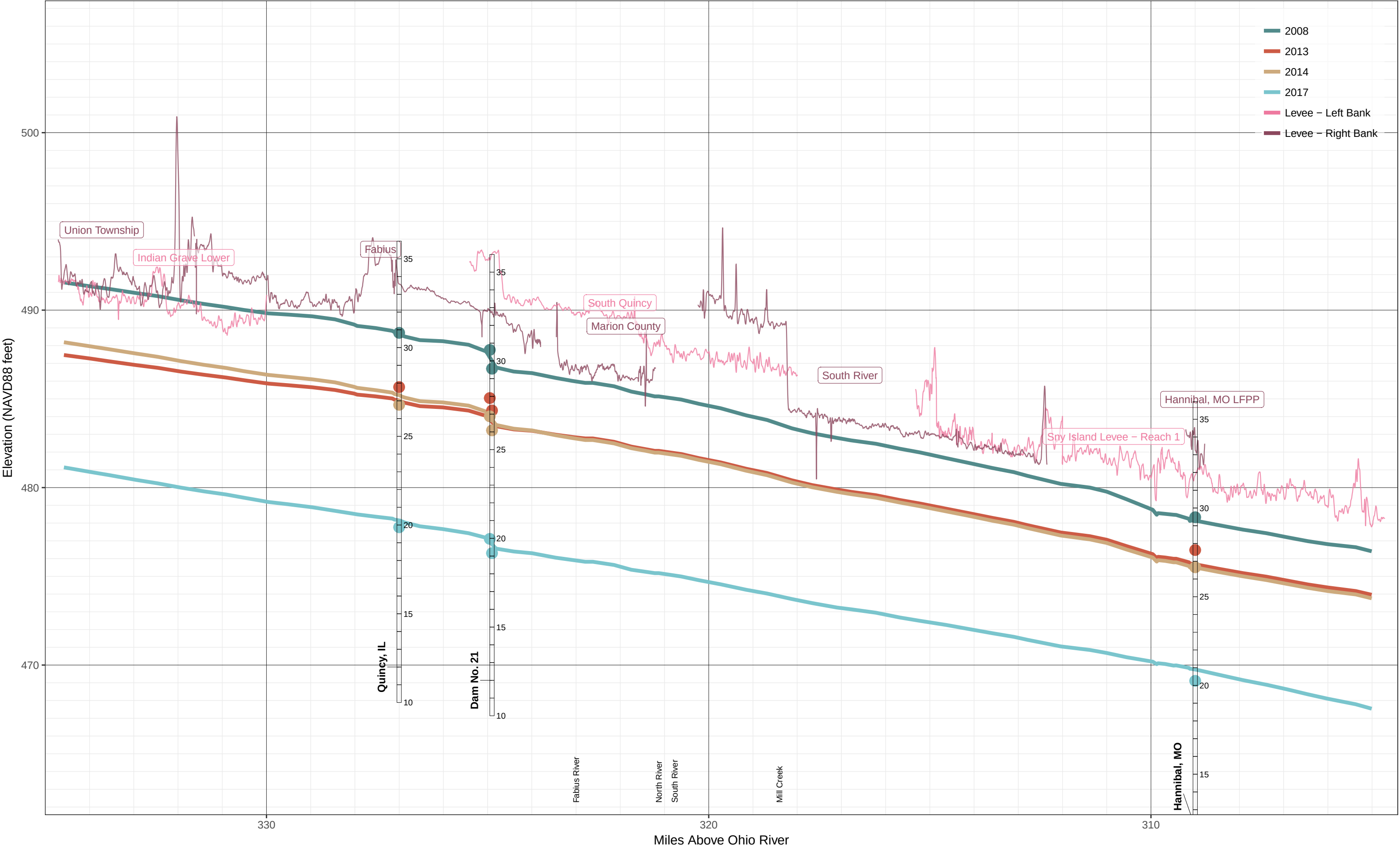


Appendix C-2
Model Calibration Profile Plots

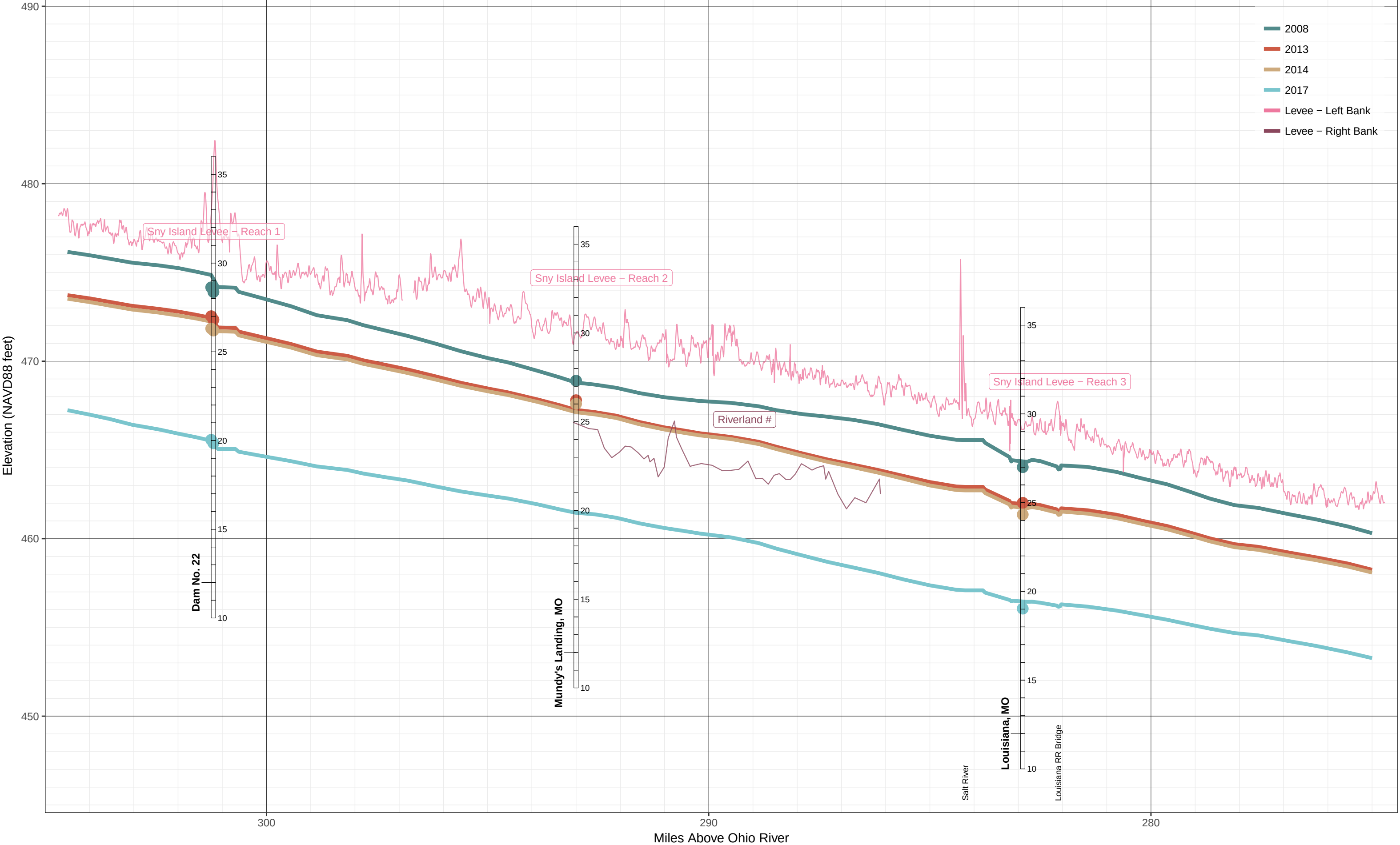
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



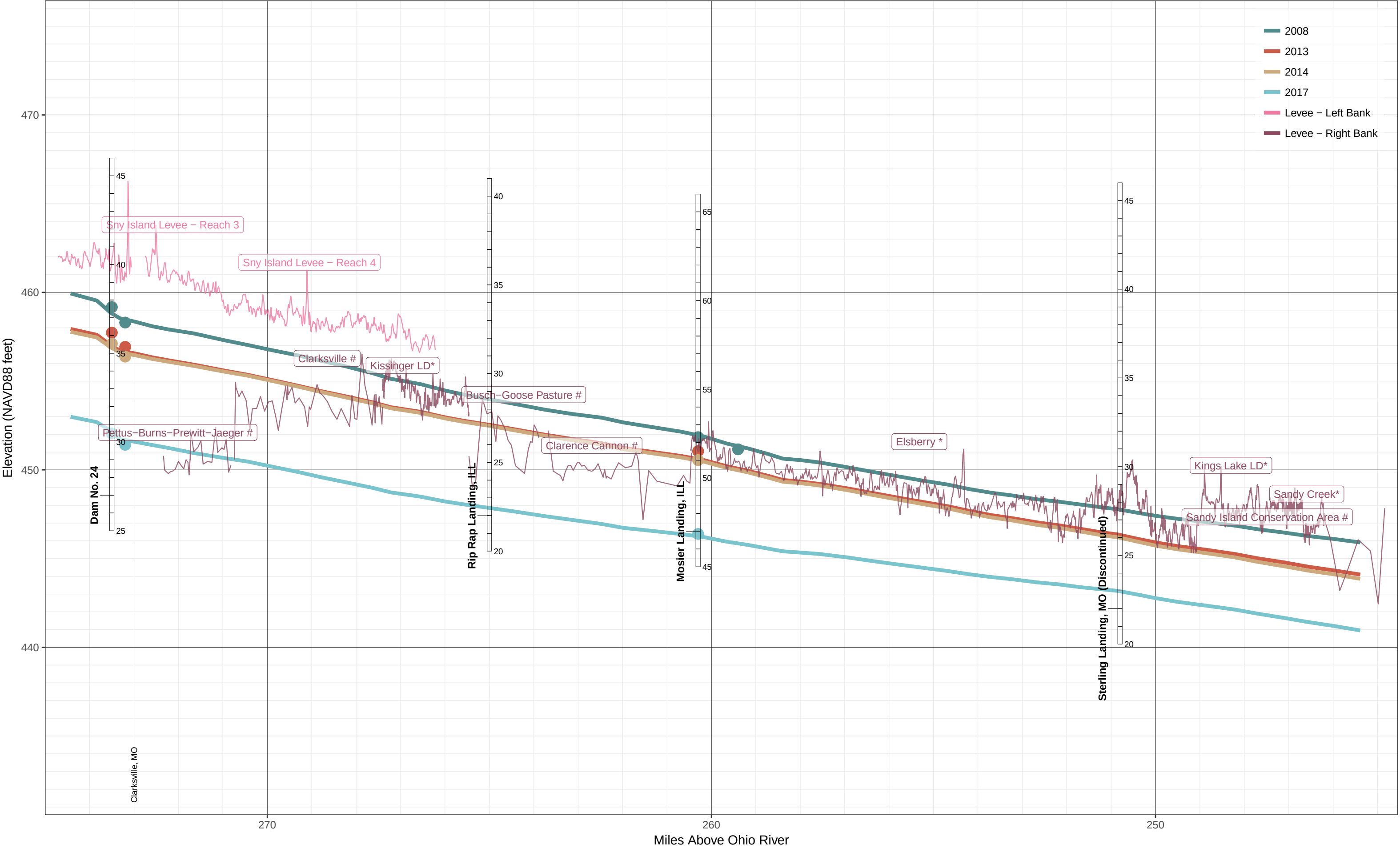
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



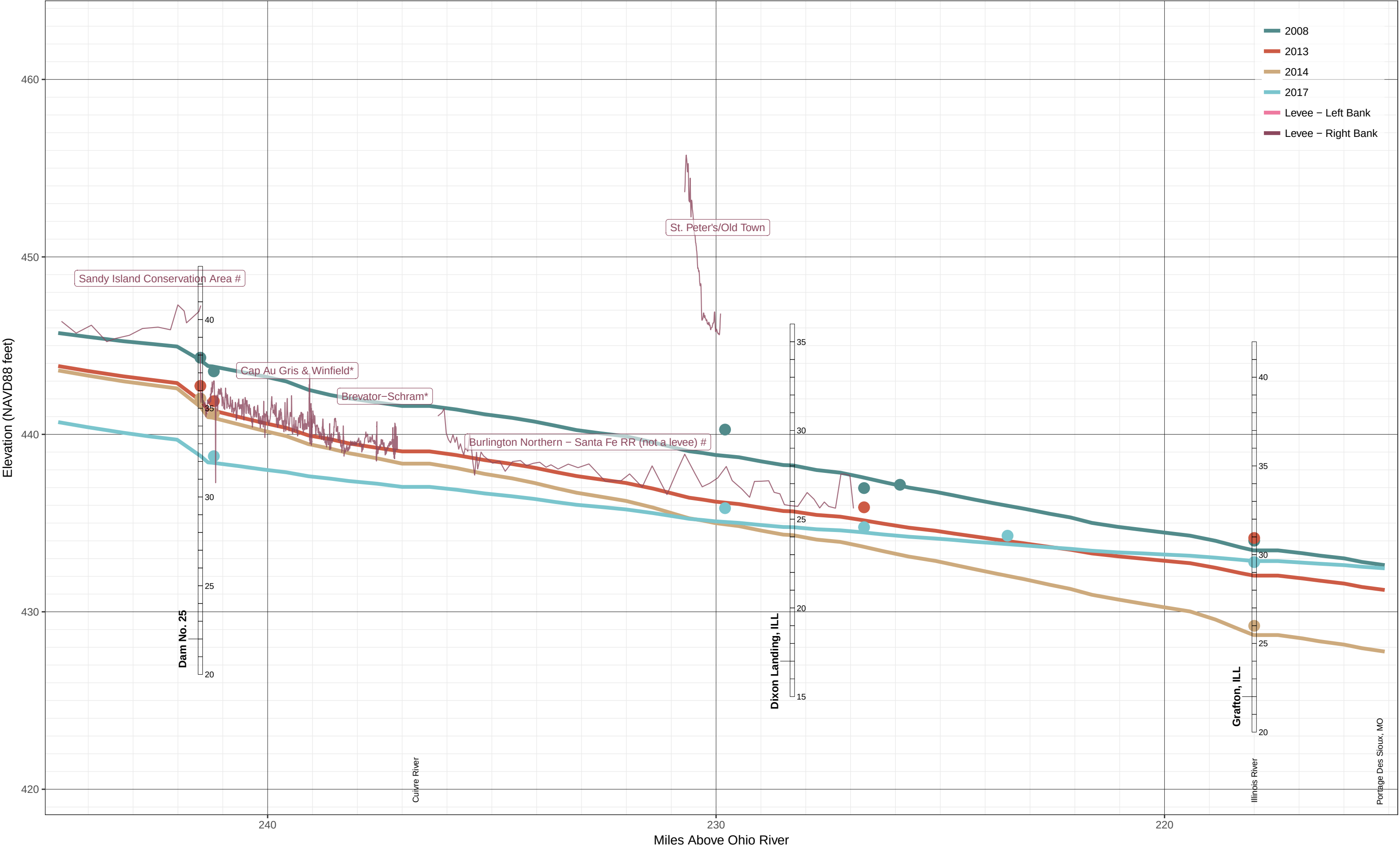
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



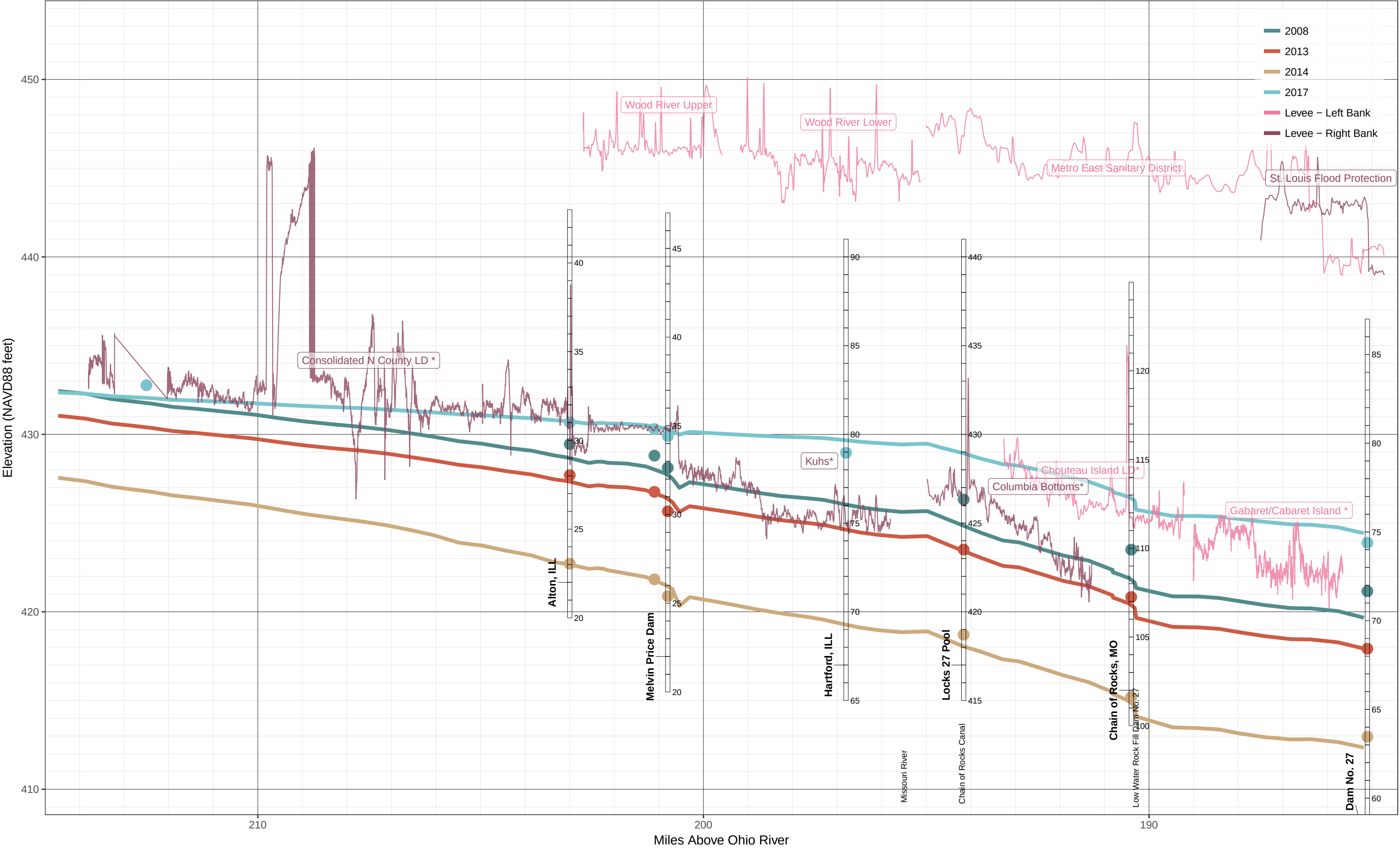
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



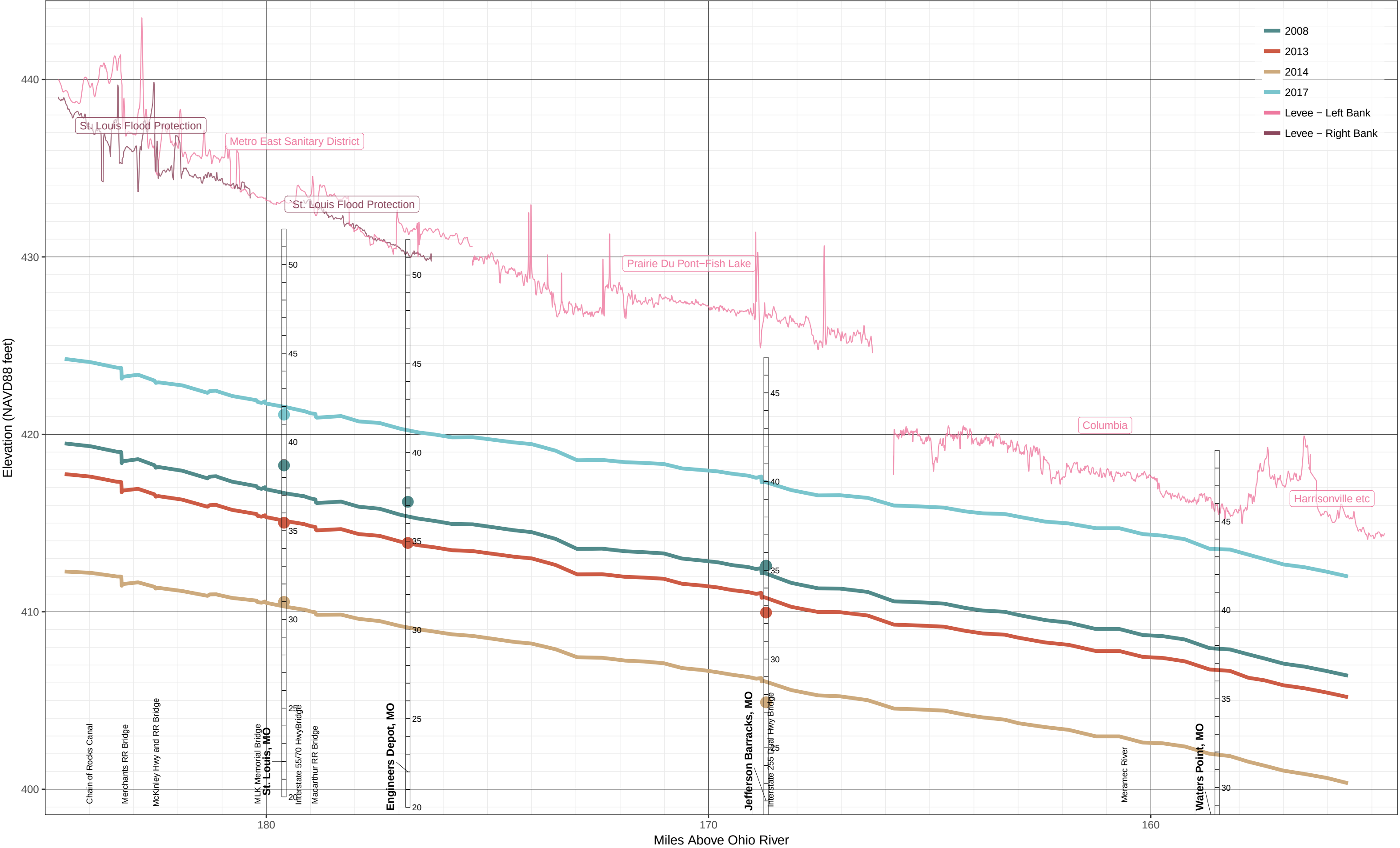
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



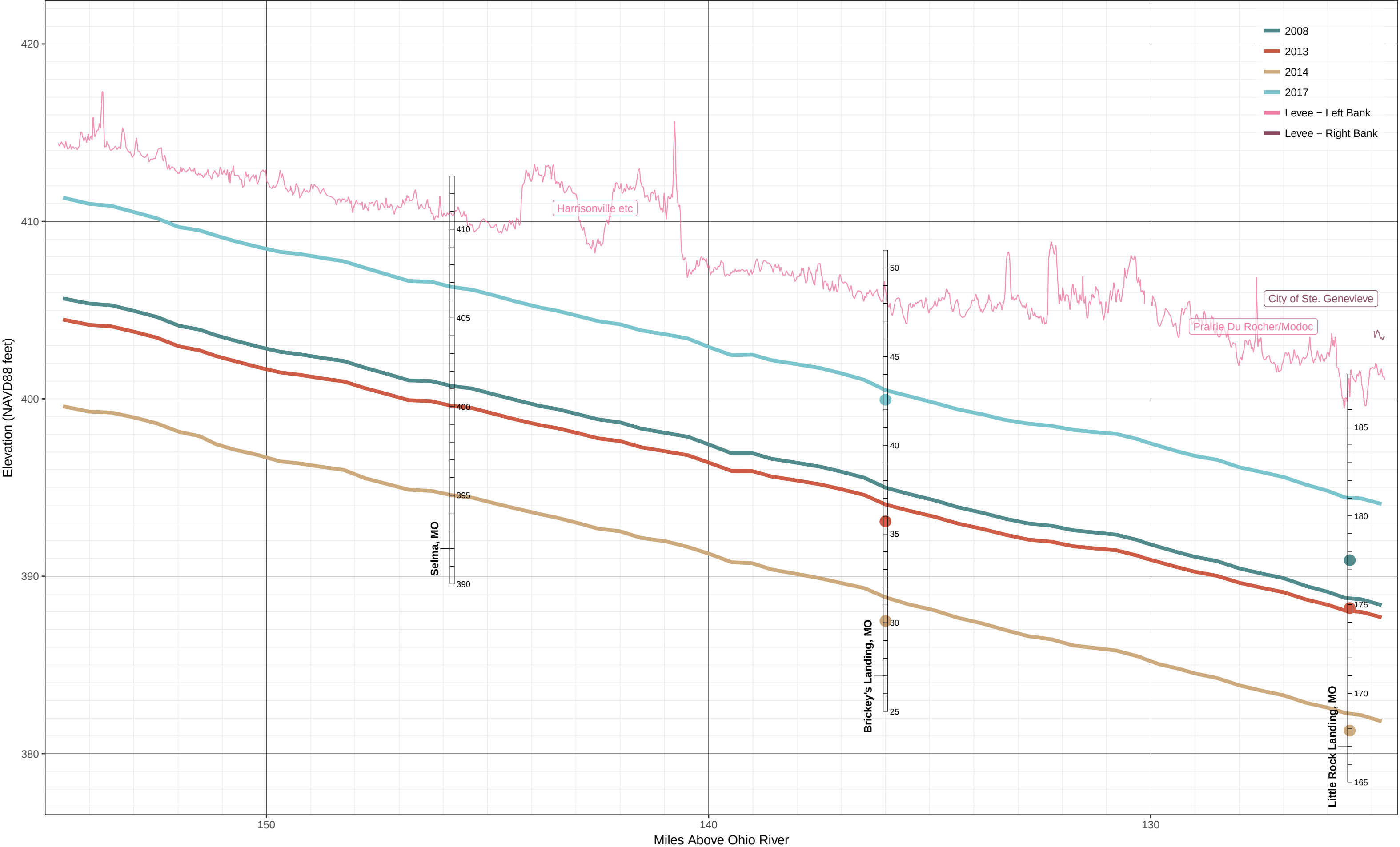
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



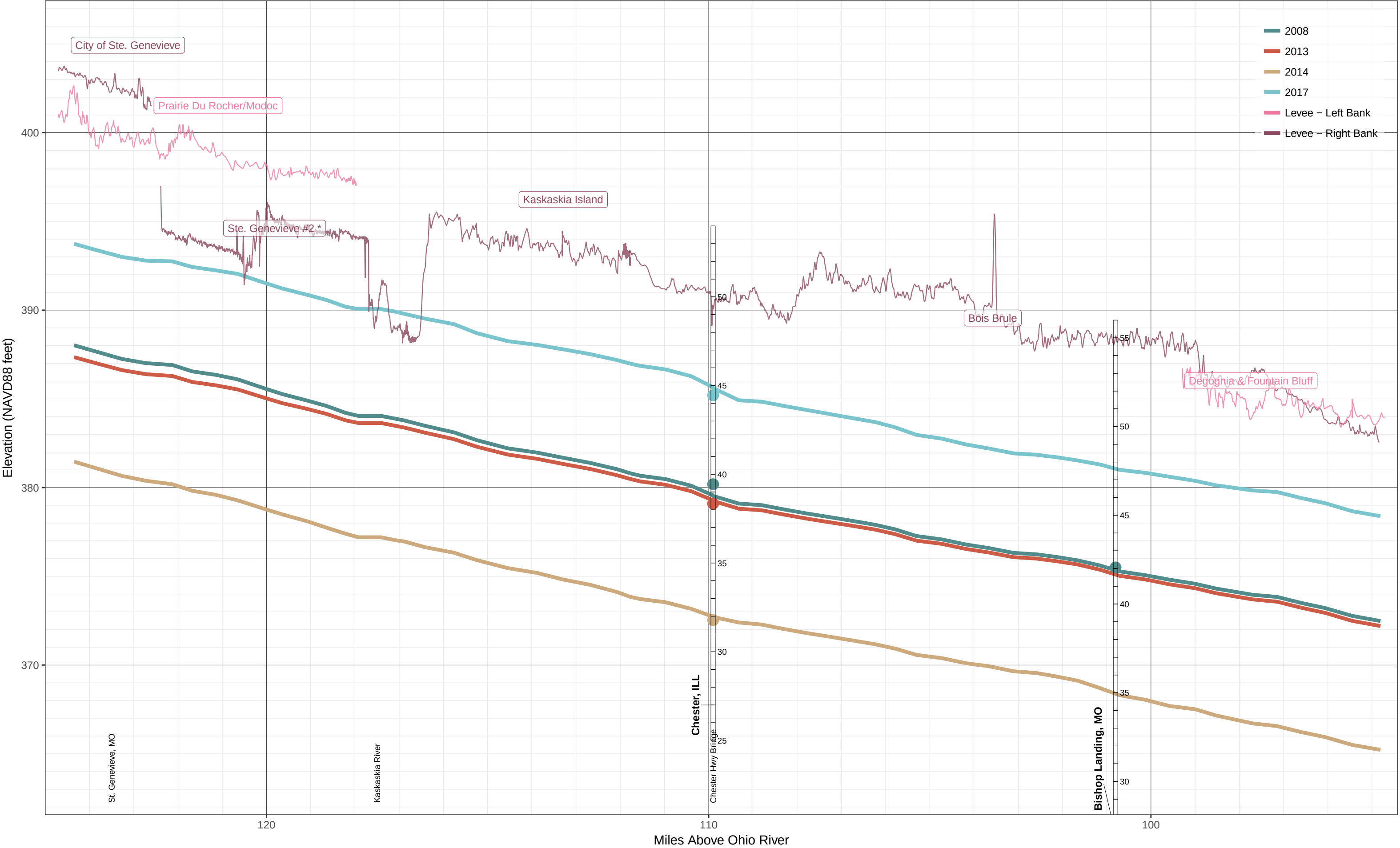
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



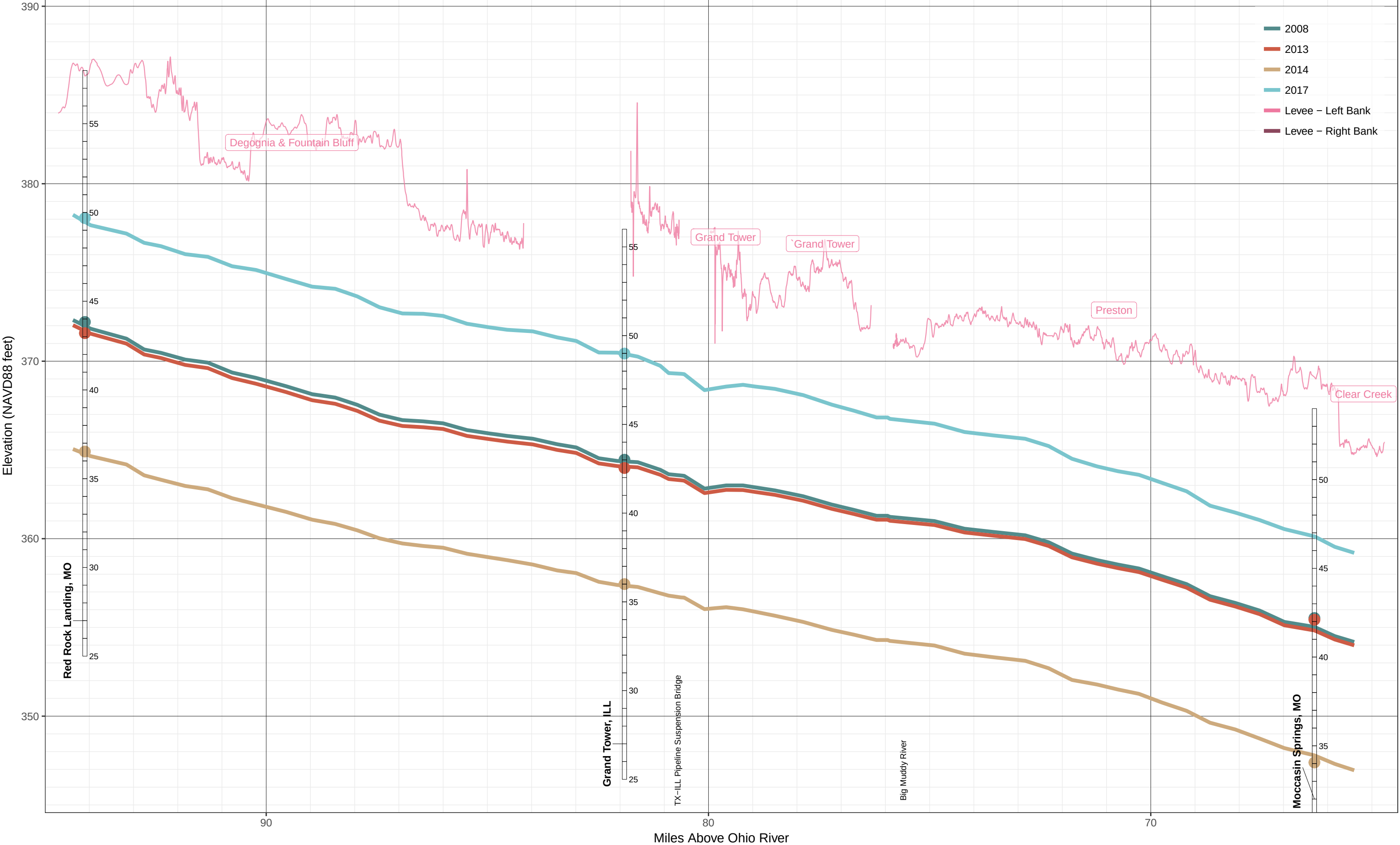
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



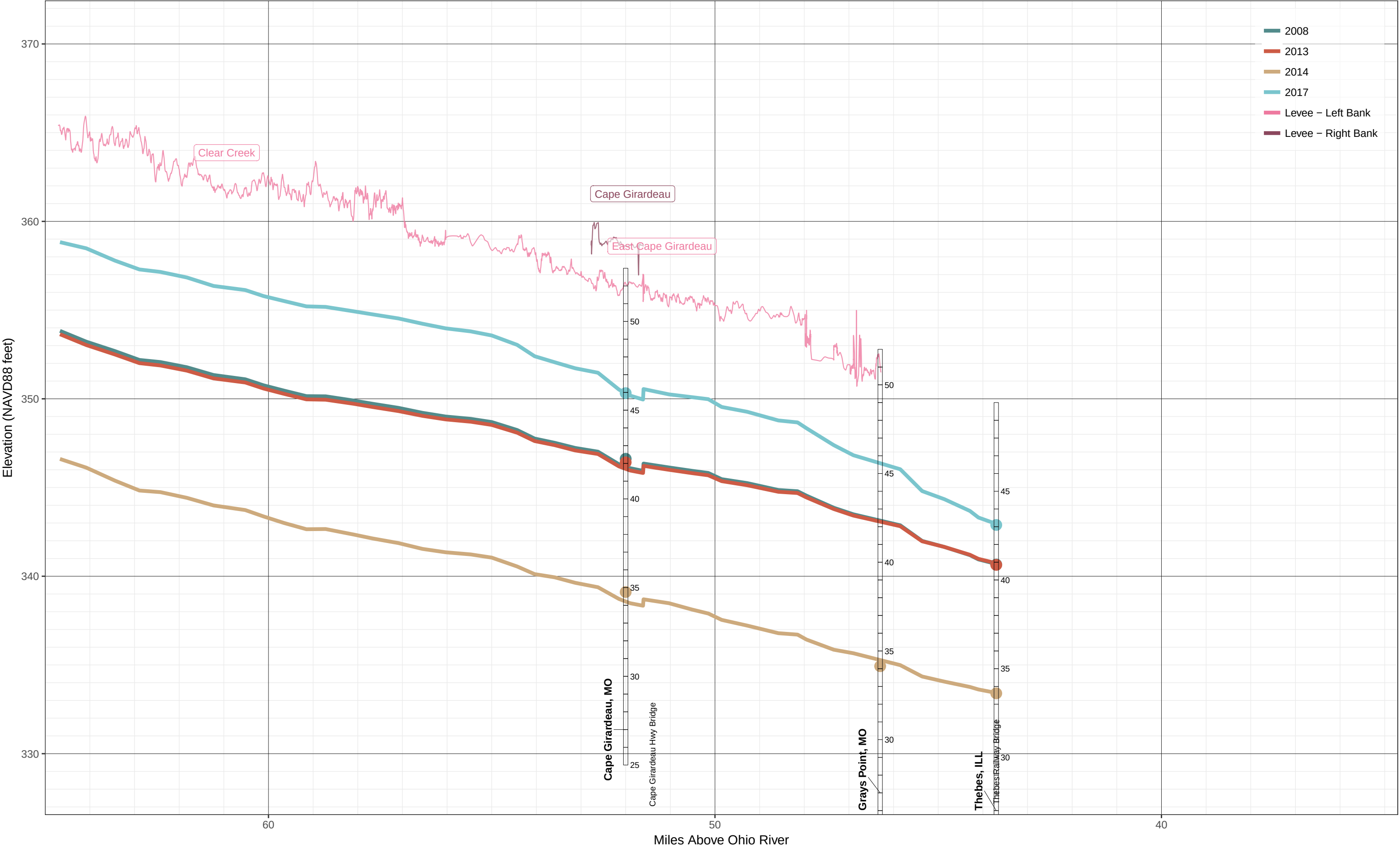
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



Appendix C-3
Model Calibration Statistics

Appendix C-3 – Model Calibration Statistics

Table 1 Final calibration statistical measures for 2008 calibration event

River Mile	Gage Name	R ²	RMSE	MAE
364.2	LD 19 Tailwater	0.98	1.53	1.30
352.9	Gregory Landing, MO	0.97	0.90	0.74
343.25	LD 20 Pool	0.96	1.37	1.18
343.2	LD 20 Tailwater	0.95	1.48	1.24
335.7	La Grange, MO	NA	NA	NA
327	Quincy, IL	0.97	1.30	1.10
324.95	LD 21 Pool	0.97	1.19	1.00
324.9	LD 21 Tailwater	0.97	1.21	1.06
309	Hannibal, MO	0.98	0.90	0.71
301.25	LD 22 Pool	0.98	0.94	0.82
301.2	LD 22 Tailwater	0.98	0.85	0.67
282.9	Louisiana, MO	0.98	0.77	0.67
273.5	LD 24 Pool	0.98	0.71	0.55
273.2	LD 24 Tailwater	0.98	0.83	0.70
260.3	Mosier Landing, IL	0.97	0.74	0.59
241.5	LD 25 Pool	0.98	0.74	0.50
241.2	LD 25 Tailwater	0.98	0.69	0.50
203	Alton, IL	0.98	1.25	1.07
201.1	Mel Price LD Pool	0.98	1.30	1.11
200.5	Mel Price LD Tailwater	0.99	1.44	1.17
194.16	Locks 27 Pool	0.99	1.78	1.60
190.28	Chain of Rocks	0.99	2.09	1.94
185.1	Locks 27 Tailwater	0.98	2.09	1.95
179.6	St. Louis, MO	0.98	1.47	1.31
176.8	Engineers Depot	0.99	1.01	0.81
168.7	Jefferson Barracks	0.98	0.75	0.55
135.5	Brickeys	NA	NA	NA
125.5	Little Rock Landing	0.97	1.51	1.28
109.9	Chester, IL	0.98	1.07	0.78
94.1	Red Rock Landing, MO	0.98	0.86	0.65
81.9	Grand Tower, IL	0.98	0.58	0.46
66.3	Moccasin Springs, MO	0.99	0.98	0.89
52	Cape Girardeau, MO	1.00	0.43	0.36
43.7	Thebes, IL	1.00	0.01	0.01
Average		0.98	1.09	0.91

Table 2 Final calibration observed and modeled peak time and stages for the 2008 calibration event

River Mile	Gage Name	Peak Stage NAVD88 (Observed)	Peak Stage Time (Observed)	Peak Stage NAVD88 (Modeled)	Peak Stage Time (Modeled)
364.2	LD 19 Tailwater	504.16	17-Jun 1200	504.59	18-Jun 0000
352.9	Gregory Landing, MO	500.99	18-Jun 0500	499.40	18-Jun 0200
343.25	LD 20 Pool	496.27	18-Jun 0000	495.67	22-Jun 0000
343.2	LD 20 Tailwater	495.34	18-Jun 0400	495.17	23-Jun 0400
335.7	La Grange, MO	NA	NA	492.00	24-Jun 0200
327	Quincy, IL	488.72	18-Jun 0430	488.64	24-Jun 0200
324.95	LD 21 Pool	487.73	18-Jun 0400	487.66	24-Jun 0400
324.9	LD 21 Tailwater	486.65	18-Jun 0400	486.77	24-Jun 0400
309	Hannibal, MO	478.39	18-Jun 0600	478.11	24-Jun 0600
301.25	LD 22 Pool	474.19	18-Jun 0800	474.86	24-Jun 0600
301.2	LD 22 Tailwater	473.9	18-Jun 0900	474.14	24-Jun 0600
282.9	Louisiana, MO	464.03	23-Jun 1215	464.37	24-Jun 1200
273.5	LD 24 Pool	459.17	23-Jun 0700	458.86	24-Jun 1200
273.2	LD 24 Tailwater	458.3	23-Jun 2200	458.54	24-Jun 1200
264.3	Surveyed **	452.62	NA	452.93	NA
260.3	Mosier Landing, IL	451.84	23-Jun 1400	451.88	24-Jun 1800
259.4	Surveyed **	451.16	NA	451.33	NA
254.9	Surveyed **	446.62	NA	447.73	NA
243.6	Surveyed **	446.50	NA	444.19	NA
241.5	LD 25 Pool	444.32	26-Jun 1900	444.17	25-Jun 0200
241.2	LD 25 Tailwater	443.55	27-Jun 0500	443.83	25-Jun 0200
232.38	Surveyed *	440.25	NA	438.72	NA
229.8	Surveyed **	440.27	NA	438.79	NA
226.7	Surveyed **	436.97	NA	437.53	NA
225.9	Surveyed **	437.16	NA	437.07	NA
203	Alton, IL	429.45	29-Jun 1300	428.39	29-Jun 2200
201.1	Mel Price LD Pool	428.8	29-Jun 1400	427.79	30-Jun 0400
200.5	Mel Price LD Tailwater	428.12	29-Jun 2200	427.30	30-Jun 1000
194.16	Locks 27 Pool	426.33	30-Jun 0500	424.85	30-Jun 1600
190.28	Chain of Rocks	423.53	30-Jun 0800	421.64	30-Jun 1800
185.1	Locks 27 Tailwater	421.16	30-Jun 1200	419.33	30-Jun 1800
179.6	St. Louis, MO	418.25	30-Jun 2200	416.91	30-Jun 2000
176.8	Engineers Depot	416.18	30-Jun 0600	415.46	30-Jun 2000
168.7	Jefferson Barracks	412.56	30-Jun 0600	412.20	30-Jun 2200
135.5	Brickeys	NA	NA	394.65	01-Jul 0800
125.5	Little Rock Landing	390.9	2-Jul 0800	388.77	01-Jul 1000
109.9	Chester, IL	380.19	1-Jul 1200	379.53	01-Jul 1800
94.1	Red Rock Landing, MO	372.21	1-Jul 1200	371.83	01-Jul 2200
81.9	Grand Tower, IL	364.45	2-Jul 0900	364.31	02-Jul 0000
66.3	Moccasin Springs, MO	355.53	1-Jul 0800	355.03	02-Jul 0800
52	Cape Girardeau, MO	346.62	3-Jul 1700	346.31	02-Jul 1800
43.7	Thebes, IL	340.66	2-Jul 2300	340.65	03-Jul 1600

*Surveyed by Pickett, Ray & Silver, Inc. Furnished by Great River Habitat Alliance.

** Surveyed by Crawford, Murphy & Tilly, Inc. Furnished by Neighbors of the Mississippi.

Table 3 Final calibration statistical measures for 2013 calibration event

River Mile	Gage Name	R²	RMSE	MAE
364.2	LD 19 Tailwater	0.99	0.41	0.29
352.9	Gregory Landing, MO	0.99	0.43	0.34
343.25	LD 20 Pool	0.99	0.39	0.31
343.2	LD 20 Tailwater	0.99	0.31	0.26
335.7	La Grange, MO	1.00	0.52	0.47
327	Quincy, IL	0.99	0.49	0.39
324.95	LD 21 Pool	0.99	0.76	0.56
324.9	LD 21 Tailwater	0.99	0.58	0.47
309	Hannibal, MO	0.99	0.68	0.55
301.25	LD 22 Pool	0.98	1.07	0.93
301.2	LD 22 Tailwater	0.94	1.57	1.22
282.9	Louisiana, MO	0.97	0.83	0.65
273.5	LD 24 Pool	0.96	1.12	0.92
273.2	LD 24 Tailwater	0.96	0.96	0.72
260.3	Mosier Landing, IL	0.96	0.94	0.76
241.5	LD 25 Pool	0.96	1.38	1.23
241.2	LD 25 Tailwater	0.96	1.16	0.99
203	Alton, IL	0.96	1.74	1.48
201.1	Mel Price LD Pool	0.95	1.73	1.44
200.5	Mel Price LD Tailwater	0.96	1.42	1.20
194.16	Locks 27 Pool	0.96	1.67	1.41
190.28	Chain of Rocks	0.95	1.89	1.63
185.1	Locks 27 Tailwater	0.94	1.77	1.42
179.6	St. Louis, MO	0.95	1.35	0.98
176.8	Engineers Depot	0.97	1.22	0.86
168.7	Jefferson Barracks	0.96	1.31	0.98
135.5	Brickeys	0.96	1.16	0.87
125.5	Little Rock Landing	0.98	1.21	0.95
109.9	Chester, IL	0.96	1.24	0.98
94.1	Red Rock Landing, MO	0.95	1.67	1.31
81.9	Grand Tower, IL	0.96	1.42	1.06
66.3	Moccasin Springs, MO	0.97	1.68	1.33
52	Cape Girardeau, MO	0.99	0.85	0.65
43.7	Thebes, IL	1.00	0.01	0.01
Average		0.97	1.09	0.87

Table 4 Final calibration observed and modeled peak time and stages for the 2013 calibration event

River Mile	Gage Name	Peak Stage NAVD88 (Observed)	Peak Stage Time (Observed)	Peak Stage NAVD88 (Modeled)	Peak Stage Time (Modeled)
364.2	LD 19 Tailwater	499.45	20-Apr 1330	499.51	22-Apr 0600
352.9	Gregory Landing, MO	495.67	20-Apr 1530	495.32	20-Apr 1800
343.25	LD 20 Pool	491.92	21-Apr 0000	491.41	21-Apr 0600
343.2	LD 20 Tailwater	491.06	21-Apr 0200	490.82	21-Apr 0600
335.7	La Grange, MO	488.57	21-Apr 0200	487.91	21-Apr 0600
327	Quincy, IL	485.67	21-Apr 0200	484.89	21-Apr 0600
324.95	LD 21 Pool	485.09	21-Apr 0200	484.04	21-Apr 0600
324.9	LD 21 Tailwater	484.36	21-Apr 0200	483.45	21-Apr 0600
309	Hannibal, MO	476.48	21-Apr 0430	475.65	21-Apr 1000
301.25	LD 22 Pool	472.56	21-Apr 0200	472.44	21-Apr 1000
301.2	LD 22 Tailwater	472.34	20-Apr 1900	471.86	21-Apr 1200
282.9	Louisiana, MO	462.02	22-Apr 1115	461.89	22-Apr 0200
273.5	LD 24 Pool	457.73	22-Apr 1630	457.03	22-Apr 0400
273.2	LD 24 Tailwater	456.93	22-Apr 0700	456.72	22-Apr 0400
260.3	Mosier Landing, IL	451.05	22-Apr 2300	450.55	22-Apr 2200
241.5	LD 25 Pool	442.73	23-Apr 0700	441.88	23-Apr 0400
241.2	LD 25 Tailwater	441.87	23-Apr 0830	441.35	23-Apr 0600
226.7	Surveyed **	435.89	NA	435.13	NA
203	Alton, IL	427.7	25-Apr 0630	427.07	24-Apr 1200
201.1	Mel Price LD Pool	426.76	25-Apr 0030	426.45	24-Apr 1000
200.5	Mel Price LD Tailwater	425.64	25-Apr 0030	425.95	24-Apr 0800
194.16	Locks 27 Pool	423.51	24-Apr 1130	423.42	23-Apr 1600
190.28	Chain of Rocks	420.83	25-Apr 0800	420.21	23-Apr 1600
185.1	Locks 27 Tailwater	417.92	24-Apr 1700	417.62	23-Apr 1600
179.6	St. Louis, MO	415.03	25-Apr 0630	415.34	23-Apr 1600
176.8	Engineers Depot	413.88	25-Apr 0600	413.95	23-Apr 1600
168.7	Jefferson Barracks	409.96	25-Apr 0800	410.83	23-Apr 1200
135.5	Brickeys	393.09	25-Apr 0400	393.71	24-Apr 2200
125.5	Little Rock Landing	388.2	25-Apr 0800	388.06	25-Apr 0000
109.9	Chester, IL	379.08	25-Apr 1630	379.25	25-Apr 1200
94.1	Red Rock Landing, MO	371.58	25-Apr 2030	371.55	25-Apr 1600
81.9	Grand Tower, IL	363.98	25-Apr 2000	364.02	25-Apr 2000
66.3	Moccasin Springs, MO	355.43	26-Apr 0800	354.83	26-Apr 0200
52	Cape Girardeau, MO	346.39	26-Apr 0500	346.19	26-Apr 0400
43.7	Thebes, IL	340.7	26-Apr 1900	340.66	26-Apr 2200

** Surveyed by Crawford, Murphy & Tilly, Inc. Furnished by Neighbors of the Mississippi.

Table 5 Final calibration statistical measures for 2014 calibration event

River Mile	Gage Name	R²	RMSE	MAE
364.2	LD 19 Tailwater	0.99	0.74	0.56
352.9	Gregory Landing, MO	0.99	0.50	0.29
343.25	LD 20 Pool	0.99	0.57	0.38
343.2	LD 20 Tailwater	0.99	0.61	0.37
335.7	La Grange, MO	0.99	0.60	0.43
327	Quincy, IL	0.99	0.59	0.35
324.95	LD 21 Pool	0.99	0.51	0.31
324.9	LD 21 Tailwater	0.99	0.55	0.36
309	Hannibal, MO	0.99	0.48	0.40
301.25	LD 22 Pool	0.96	1.05	0.84
301.2	LD 22 Tailwater	0.97	1.34	1.14
282.9	Louisiana, MO	0.98	0.67	0.57
273.5	LD 24 Pool	0.97	0.94	0.73
273.2	LD 24 Tailwater	0.98	0.95	0.82
260.3	Mosier Landing, IL	0.98	0.77	0.66
241.5	LD 25 Pool	0.97	1.19	1.01
241.2	LD 25 Tailwater	0.98	0.92	0.79
203	Alton, IL	0.92	1.06	0.75
201.1	Mel Price LD Pool	0.91	1.16	0.84
200.5	Mel Price LD Tailwater	0.97	1.08	0.91
194.16	Locks 27 Pool	0.97	1.30	1.16
190.28	Chain of Rocks	0.95	1.32	1.10
185.1	Locks 27 Tailwater	0.97	1.24	1.15
179.6	St. Louis, MO	0.97	0.82	0.70
176.8	Engineers Depot	NA	NA	NA
168.7	Jefferson Barracks	0.96	0.80	0.61
135.5	Brickeys	0.97	0.79	0.70
125.5	Little Rock Landing	0.94	0.87	0.74
109.9	Chester, IL	0.97	0.87	0.77
94.1	Red Rock Landing, MO	0.97	0.76	0.63
81.9	Grand Tower, IL	0.97	0.56	0.41
66.3	Moccasin Springs, MO	0.94	0.76	0.51
52	Cape Girardeau, MO	0.99	0.48	0.35
43.7	Thebes, IL	1.00	0.01	0.01
Average		0.97	0.82	0.65

Table 6 Final calibration observed and modeled peak time and stages for the 2014 calibration event (9-12-17)

River Mile	Gage Name	Peak Stage NAVD88 (Observed)	Peak Stage Time (Observed)	Peak Stage NAVD88 (Modeled)	Peak Stage Time (Modeled)
364.2	LD 19 Tailwater	500.64	07-Jul 0030	501.61	07-Jul 0000
352.9	Gregory Landing, MO	496.54	07-Jul 0430	497.01	07-Jul 0200
343.25	LD 20 Pool	492.16	07-Jul 1000	492.73	07-Jul 0600
343.2	LD 20 Tailwater	491.31	07-Jul 1000	492.00	07-Jul 0600
335.7	La Grange, MO	488.18	08-Jul 0130	488.68	07-Jul 1000
327	Quincy, IL	484.66	08-Jul 0130	485.19	07-Jul 1400
324.95	LD 21 Pool	484.06	08-Jul 1200	484.28	07-Jul 1400
324.9	LD 21 Tailwater	483.27	08-Jul 1400	483.53	07-Jul 1400
309	Hannibal, MO	475.52	08-Jul 0030	475.47	07-Jul 2200
301.25	LD 22 Pool	471.84	08-Jul 0400	472.23	08-Jul 0000
301.2	LD 22 Tailwater	471.73	8-Jul 0300	471.66	08-Jul 0000
282.9	Louisiana, MO	461.36	8-Jul 1215	461.70	08-Jul 2000
273.5	LD 24 Pool	457.11	8-Jul 1500	456.91	09-Jul 1200
273.2	LD 24 Tailwater	456.38	9-Jul 0100	456.61	09-Jul 1200
260.3	Mosier Landing, IL	450.55	10-Jul 0300	450.46	09-Jul 2000
241.5	LD 25 Pool	442.02	10-Jul 1000	441.53	10-Jul 0600
241.2	LD 25 Tailwater	441.17	10-Jul 1130	440.94	10-Jul 0800
232.38	Surveyed *	435.07	NA	434.03	NA
203	Alton, IL	422.71	11-Jul 0900	422.42	11-Jul 1800
201.1	Mel Price LD Pool	421.83	11-Jul 0600	421.51	11-Jul 1600
200.5	Mel Price LD Tailwater	420.88	11-Jul 0830	420.83	11-Jul 1600
194.16	Locks 27 Pool	418.71	11-Jul 0230	481.04	11-Jul 1600
190.28	Chain of Rocks	415.23	11-Jul 0800	414.66	11-Jul 2000
185.1	Locks 27 Tailwater	412.96	11-Jul 0900	412.20	11-Jul 2200
179.6	St. Louis, MO	410.57	11-Jul 1500	410.51	12-Jul 0000
176.8	Engineers Depot	NA	NA	409.19	12-Jul 0200
168.7	Jefferson Barracks	404.86	11-Jul 0800	406.10	12-Jul 0600
135.5	Brickeys	387.48	12-Jul 0100	388.43	12-Jul 2200
125.5	Little Rock Landing	381.3	13-Jul 0800	382.29	13-Jul 0600
109.9	Chester, IL	372.53	12-Jul 1500	372.71	13-Jul 1600
94.1	Red Rock Landing, MO	364.91	12-Jul 2030	364.65	13-Jul 2000
81.9	Grand Tower, IL	357.44	12-Jul 2230	357.28	14-Jul 1400
66.3	Moccasin Springs, MO	347.43	14-Jul 0800	347.79	14-Jul 1600
52	Cape Girardeau, MO	339.11	13-Jul 0900	338.71	14-Jul 1800
43.7	Thebes, IL	333.4	14-Jul 1430	333.34	14-Jul 1000

*Surveyed by Pickett, Ray & Silver, Inc. Furnished by Great River Habitat Alliance.

Table 7 Final calibration statistical measures for 2017 calibration event (9-12-17)

River Mile	Gage Name	R²	RMSE	MAE
364.2	LD 19 Tailwater	0.98	0.37	0.31
352.9	Gregory Landing, MO	0.98	0.29	0.24
343.25	LD 20 Pool	NA	NA	NA
343.2	LD 20 Tailwater	0.99	0.19	0.15
335.7	La Grange, MO	NA	NA	NA
327	Quincy, IL	0.99	0.18	0.14
324.95	LD 21 Pool	0.99	0.17	0.13
324.9	LD 21 Tailwater	0.99	0.20	0.16
309	Hannibal, MO	0.97	0.38	0.31
301.25	LD 22 Pool	0.92	1.02	0.91
301.2	LD 22 Tailwater	0.92	1.17	1.06
282.9	Louisiana, MO	0.93	0.51	0.40
273.5	LD 24 Pool	0.91	0.86	0.74
273.2	LD 24 Tailwater	0.90	0.94	0.83
260.3	Mosier Landing, IL	0.91	0.85	0.73
241.5	LD 25 Pool	NA	NA	NA
241.2	LD 25 Tailwater	0.90	1.32	1.16
203	Alton, IL	0.89	2.24	1.62
201.1	Mel Price LD Pool	0.89	2.25	1.59
200.5	Mel Price LD Tailwater	0.94	2.25	1.96
194.16	Locks 27 Pool	0.94	2.47	2.17
190.28	Chain of Rocks	NA	NA	NA
185.1	Locks 27 Tailwater	0.92	2.76	2.35
179.6	St. Louis, MO	0.91	2.45	2.02
176.8	Engineers Depot	NA	NA	NA
168.7	Jefferson Barracks	NA	NA	NA
135.5	Brickeys	0.90	2.22	1.93
125.5	Little Rock Landing	NA	NA	NA
109.9	Chester, IL	0.93	2.10	1.78
94.1	Red Rock Landing, MO	0.92	2.39	1.96
81.9	Grand Tower, IL	0.93	1.94	1.53
66.3	Moccasin Springs, MO	NA	NA	NA
52	Cape Girardeau, MO	0.97	1.09	0.82
43.7	Thebes, IL	1.00	0.01	0.01
Average		0.94	1.25	1.04

Table 8 Final calibration observed and modeled peak time and stages for the 2017 calibration event (9-12-17)

River Mile	Gage Name	Peak Stage NAVD88 (Observed)	Peak Stage Time (Observed)	Peak Stage NAVD88 (Modeled)	Peak Stage Time (Modeled)
364.2	LD 19 Tailwater	493.12	02-May 1130	493.25	02-May 1600
352.9	Gregory Landing, MO	489.17	02-May 2000	489.48	02-May 1800
343.25	LD 20 Pool	485.09	02-May 1800	485.19	02-May 2000
343.2	LD 20 Tailwater	484.63	02-May 2200	484.75	02-May 2200
335.7	La Grange, MO	NA	NA	481.76	02-May 2200
327	Quincy, IL	477.89	02-May 1730	478.14	02-May 2200
324.95	LD 21 Pool	477.11	02-May 1600	477.17	02-May 2200
324.9	LD 21 Tailwater	476.42	02-May 1600	476.56	02-May 2200
309	Hannibal, MO	469.19	02-May 2030	469.72	03-May 0000
301.25	LD 22 Pool	465.57	03-May 0000	465.52	03-May 0200
301.2	LD 22 Tailwater	465.38	3-May 1100	465.05	03-May 0200
282.9	Louisiana, MO	456.06	1-May 1300	456.39	03-May 0600
273.5	LD 24 Pool	452.05	4-May 1300	452.21	03-May 1000
273.2	LD 24 Tailwater	451.41	4-May 1200	451.73	03-May 1000
260.3	Mosier Landing, IL	446.39	4-May 1300	446.21	03-May 1400
241.5	LD 25 Pool	NA	NA	438.77	03-May 1600
241.2	LD 25 Tailwater	438.77	5-May 1300	438.40	05-May 2200
232.38	Surveyed *	435.07	NA	434.48	NA
229.8	Surveyed **	435.84	NA	435.06	NA
226.7	Surveyed **	434.77	NA	434.45	NA
223.5	Surveyed **	434.29	NA	433.81	NA
212.5	Surveyed **	432.77	NA	432.06	NA
203	Alton, IL	430.67	6-May 0100	430.60	06-May 0400
201.1	Mel Price LD Pool	430.3	6-May 0200	430.31	06-May 0200
200.5	Mel Price LD Tailwater	429.9	6-May 0100	430.11	06-May 0200
194.16	Locks 27 Pool	428.96	5-May 2200	428.92	06-May 0400
190.28	Chain of Rocks	NA	NA	426.26	06-May 0400
185.1	Locks 27 Tailwater	423.89	5-May 2300	424.07	06-May 0400
179.6	St. Louis, MO	421.11	6-May 0200	421.74	06-May 0400
176.8	Engineers Depot	NA	NA	420.31	06-May 0400
168.7	Jefferson Barracks	NA	NA	417.34	05-May 1800
135.5	Brickeys	399.95	6-May 1500	400.17	05-May 2000
125.5	Little Rock Landing	NA	NA	394.43	06-May 1800
109.9	Chester, IL	385.2	6-May 1100	385.61	07-May 0000
94.1	Red Rock Landing, MO	378.06	6-May 1300	377.66	07-May 0200
81.9	Grand Tower, IL	370.43	6-May 1500	370.26	07-May 0400
66.3	Moccasin Springs, MO	NA	NA	360.13	07-May 0600
52	Cape Girardeau, MO	350.32	6-May 2200	350.51	07-May 0600
43.7	Thebes, IL	342.89	6-May 0100	342.82	06-May 0400

*Surveyed by Pickett, Ray & Silver, Inc. Furnished by Great River Habitat Alliance.

** Surveyed by Crawford, Murphy & Tilly, Inc. Furnished by Neighbors of the Mississippi.

Appendix C-4

Summary of Gage Data (Maximum Elevations) and High Water Marks

Gage Peak Stages and
High Water Marks
Calibration

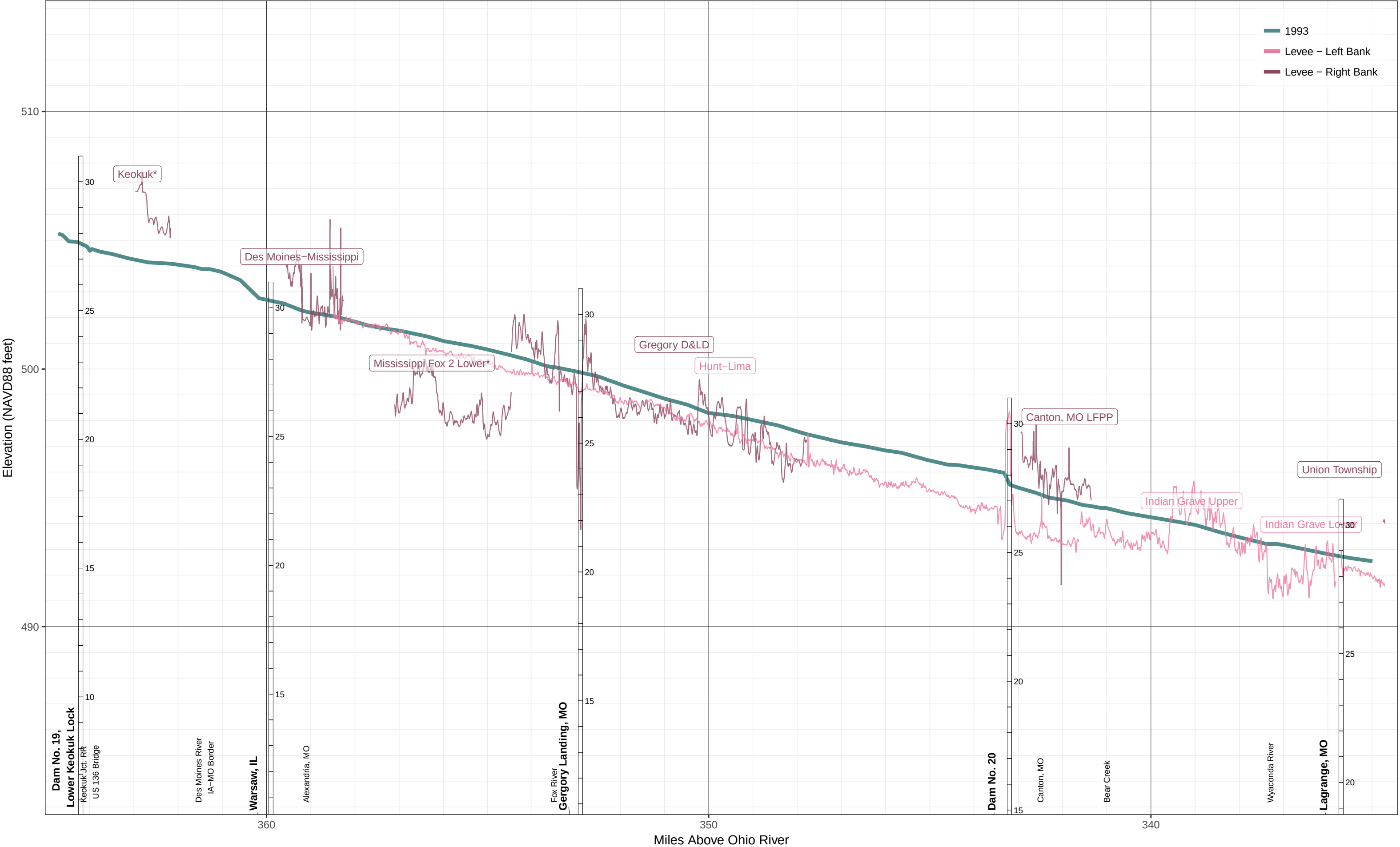
					2008			2013			2014			2017		
River Mile	Gage	Gage Zero	Gage Datum	Conversion Factor	(elevation)	(elevation) NAVD88	(peak date)	(elevation)	(elevation) NAVD88	(peak date)	(elevation)	(elevation) NAVD88	(peak date)	(elevation)	(elevation) NAVD88	(peak date)
364.2	LD 19 (Keokuk, IA)	477.83	MSL12	-0.564	504.6	504.04	18-Jun	499.93	499.37	20-Apr	501.27	500.71	7-Jul		493.12	2-May
352.9	Gregory Landing, MO	472.71	MSL12	-0.594				496.17	495.58	20-Apr	497.13	496.54	7-Jul	489.6	489.006	3-May
343.25	LD 20 POOL	468.5	MSL12	-0.62	496.84	496.22	18-Jun	492.5	491.88	21-Apr	492.71	492.09	7-Jul	485.09	485.09	2-May
343.2	LD 20 (Canton, MO)	468.5	MSL12	-0.62	495.93	495.31	18-Jun	491.66	491.04	21-Apr	491.9	491.28	8-Jul	485.18	484.56	3-May
335.7	La Grange	464.6	MSL12	-0.654				488.57	488.57	21-Apr	488.18	488.18	8-Jul			
327	Quincy, IL	458.59	MSL12	-0.665	489.38	488.72	18-Jun	486.33	485.67	21-Apr	485.33	484.67	8-Jul	478.43	477.765	3-May
324.95	LD 21 POOL	457.8	MSL12	-0.665	488.42	487.76	18-Jun	485.71	485.05	21-Apr	484.68	484.02	8-Jul	477.11	477.11	2-May
324.9	LD 21 (Quincy, IL)	457.8	MSL12	-0.665	487.36	486.70	18-Jun	485.01	484.35	21-Apr	483.89	483.23	8-Jul	476.97	476.305	2-May
309	Hannibal, MO	449.43	MSL12	-0.58	478.91	478.33	18-Jun	477.06	476.48	21-Apr	476.09	475.51	8-Jul	469.69	469.11	3-May
301.25	LD 22 POOL	446.1	MSL12	-0.567	474.73	474.16	18-Jun	473.1	472.53	21-Apr	472.41	471.84	8-Jul	466.137	465.57	3-May
301.2	LD 22 (Saverton, MO)	446.1	NAVD88		473.9	473.90	23-Jun	472.34	472.34	20-Apr	471.73	471.73	8-Jul	465.38	465.38	3-May
293	Mundys Landing, MO	441.59	NAVD88		468.9	468.90	23-Jun	467.8	467.80	21-Apr	467.6	467.60	8-Jul			
282.9	Louisiana, MO	437.03	NAVD88		464.03	464.03	23-Jun	462.02	462.02	22-Apr	461.36	461.36	8-Jul	456.06	456.06	1-May
273.5	LD 24 POOL	421.8	NAVD88		459.17	459.17	23-Jun	457.73	457.73	22-Apr	457.11	457.11	8-Jul	452.05	452.05	4-May
273.2	LD 24 At Clarksville	421.57	NAVD88		458.3	458.30	23-Jun	456.93	456.93	22-Apr	456.38	456.38	9-Jul	451.41	451.41	4-May
264.3	N/A (Surveyed) **	NA	NA		452.623	452.62										
260.3	Mosier Landing, IL	399.54	NAVD88		451.84	451.84	23-Jun	451.05	451.05	22-Apr	450.55	450.55	10-Jul	446.39	446.39	4-May
259.4	N/A (Surveyed) **	NA	NA		451.156	451.16										
254.9	N/A (Surveyed) **	NA	NA		446.62	446.62										
243.6	N/A (Surveyed) **	NA	NA		446.5	446.50										
241.5	LD 25 POOL	407	NAVD88		444.32	444.32	26-Jun	442.73	442.73	23-Apr	442.02	442.02	10-Jul			
241.2	LD 25 at Winfield	406.47	NAVD88		443.55	443.55	27-Jun	441.87	441.87	23-Apr	441.17	441.17	10-Jul	438.77	438.77	5-May
232.38	N/A (Surveyed) *	NA	NA		440.25	440.25					435.07	435.07		435.07	435.07	
229.8	N/A (Surveyed) **	NA	NA		440.269	440.27								435.84	435.84	
226.7	N/A (Surveyed) **	NA	NA		436.973	436.97		435.889	435.89					434.768	434.77	
225.9	N/A (Surveyed) **	NA	NA		437.159	437.16										
223.5	N/A (Surveyed) **	NA	NA											434.289	434.29	
218	Grafton, IL	403.22	NAVD88		434.01	434.01	28-Jun	434.16	434.16	25-Apr	429.21	429.21	11-Jul	432.8	432.80	6-May
212.5	N/A (Surveyed) **	NA	NA											432.767	432.77	
203	Alton, IL	399.66	NAVD88		429.45	429.45	29-Jun	427.7	427.70	25-Apr	422.71	422.71	11-Jul	430.67	430.67	6-May
201.1	Mel Price LD POOL	395.48	NAVD88		428.8	428.80	29-Jun	426.76	426.76	25-Apr	421.83	421.83	11-Jul	430.3	430.30	6-May
200.5	Mel Price LD at Alton	395.04	NAVD88		428.12	428.12	29-Jun	425.66	425.66	25-Apr	420.88	420.88	11-Jul	429.9	429.90	6-May
196.8	Hartford, IL	350	NAVD88											428.96	428.96	5-May
194.16	Locks 27 Pool	350	NAVD88		426.33	426.33	30-Jun	423.51	423.51	24-Apr	418.71	418.71	11-Jul			
190.28	Chain of Rocks, IL	-0.33	NAVD88		423.5	423.50	30-Jun	420.83	420.83	25-Apr	415.2	415.2	11-Jul			
185.1	LD 27	349.5	NAVD88		421.16	421.16	30-Jun	417.92	417.92	24-Apr	412.96	412.96	11-Jul	423.89	423.89	5-May
179.6	St. Louis, MO	379.57	NAVD88		418.25	418.25	30-Jun	415.02	415.02	25-Apr	410.56	410.56	11-Jul	421.11	421.11	6-May
176.8	Engineers Depot, MO	378.98	NAVD88		416.2	416.20	30-Jun	413.88	413.88	25-Apr						
168.7	Jefferson Barracks, MO	377.34	NAVD88		412.6	412.60	30-Jun	409.96	409.96	25-Apr	404.9	404.9	11-Jul			
136	Brickeys, MO	357.38	NAVD88					393.09	393.09	25-Apr	387.48	387.48	12-Jul	399.95	399.95	6-May
125.5	Little Rock Landing, MO	213.4	NAVD88		390.9	390.90	2-Jul	388.2	388.20	25-Apr	381.3	381.3	13-Jul			
109.9	Chester, IL	340.75	NAVD88		380.19	380.19	1-Jul	379.1	379.10	25-Apr	372.53	372.53	12-Jul	385.2	385.20	6-May
100.8	Bishop Landing, MO	333.44	NAVD88		375.5	375.50	2-Jul									
94.1	Red Rock Landing, MO	328.38	NAVD88		372.21	372.21	1-Jul	371.58	371.58	25-Apr	364.91	364.91	12-Jul	378.06	378.06	6-May
81.9	Grand Tower, IL	321.44	NAVD88		364.45	364.45	2-Jul	363.98	363.98	25-Apr	357.44	357.44	11-Jul	370.43	370.43	6-May
66.3	Moccasin Springs, MO	313.33	NAVD88		355.53	355.53	1-Jul	355.43	355.43	26-Apr	347.39	347.39	13-Jul			
52	Cape Girardeau, MO	304.36	NAVD88		346.62	346.62	3-Jul	346.42	346.42	26-Apr	339.11	339.11	13-Jul	350.32	350.32	6-May
46.3	Gray's Point, MO	300.79	NAVD88								334.93	334.93	14-Jul			
43.7	Thebes, IL	299.79	NAVD88		340.66	340.66	3-Jul	340.64	340.64	26-Apr	333.4	333.4	14-Jul	342.89	342.89	6-May

*Surveyed by Pickett, Ray & Silver, Inc. Furnished by Great River Habitat Alliance.

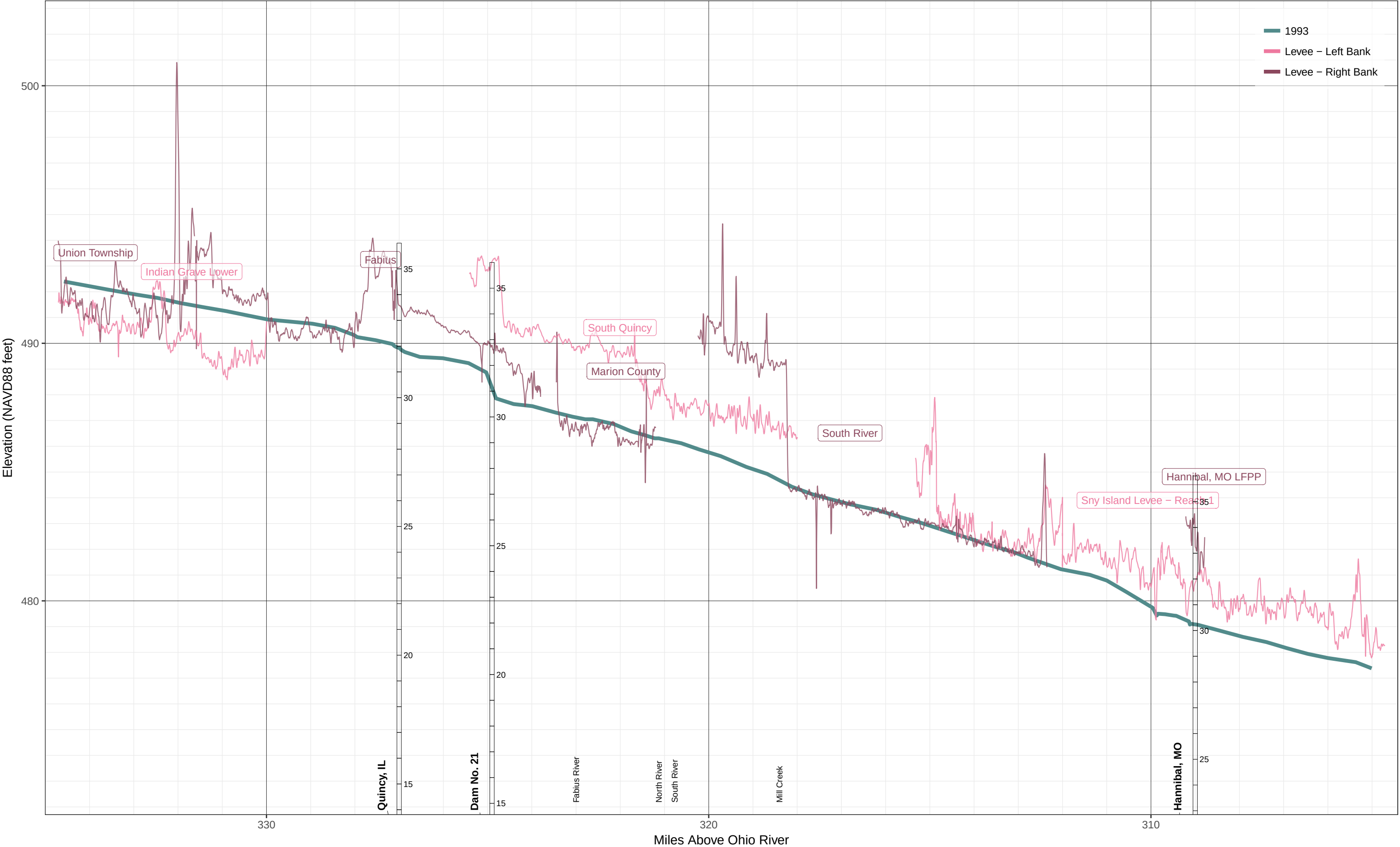
** Surveyed by Crawford, Murphy & Tilly, Inc. Furnished by Neighbors of the Mississippi.

Appendix C-5
1993 Inflows Profile Plots

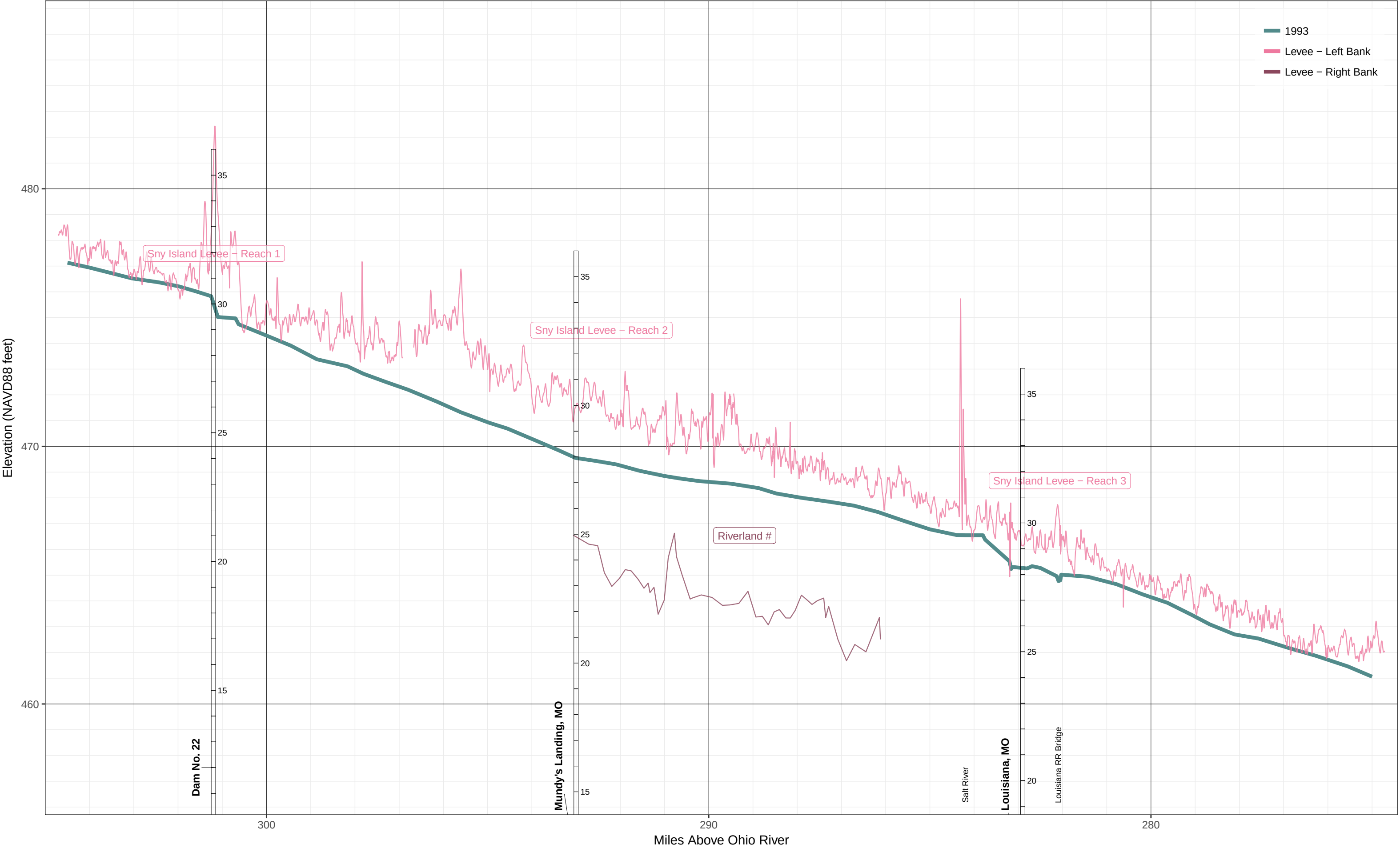
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



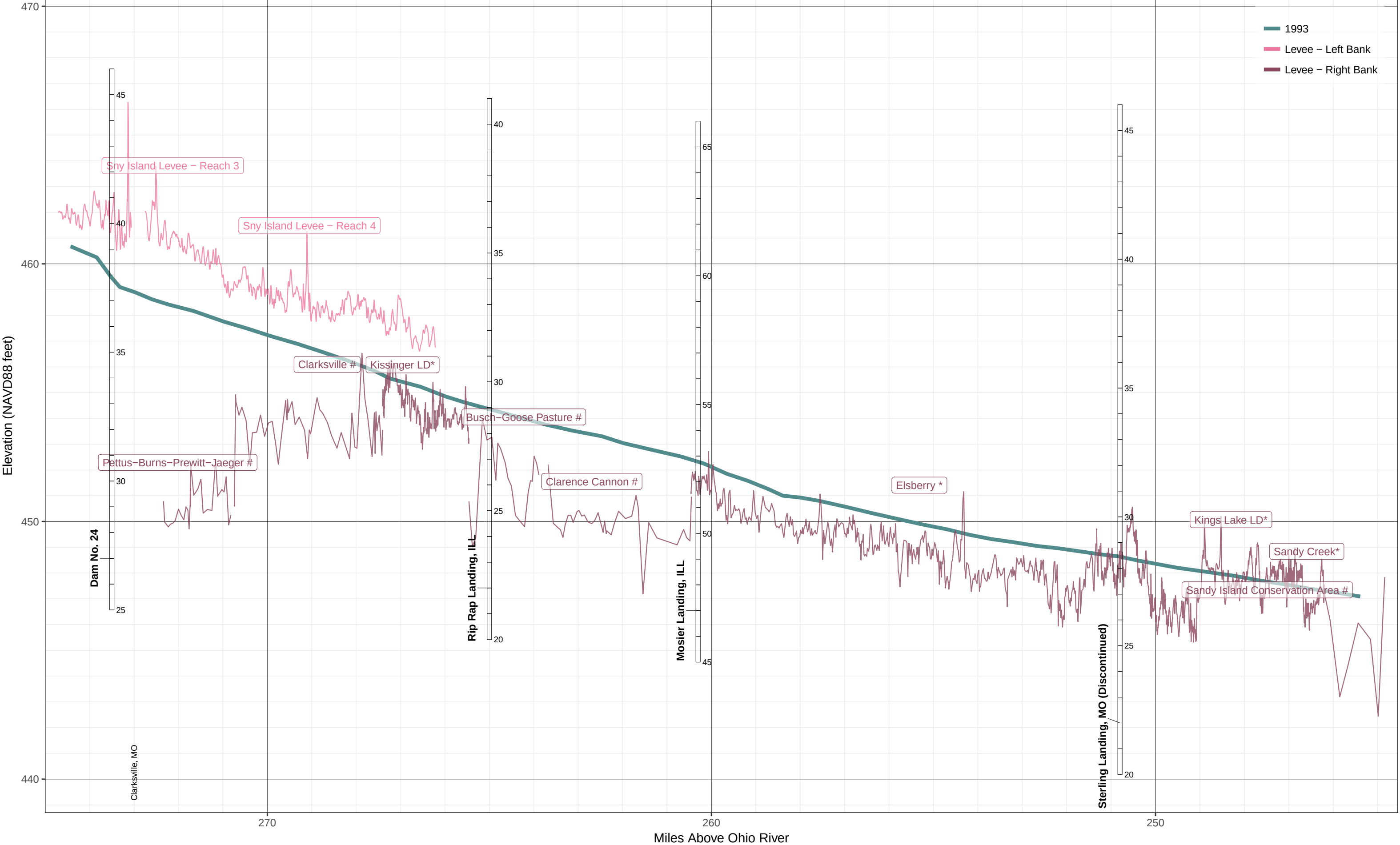
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



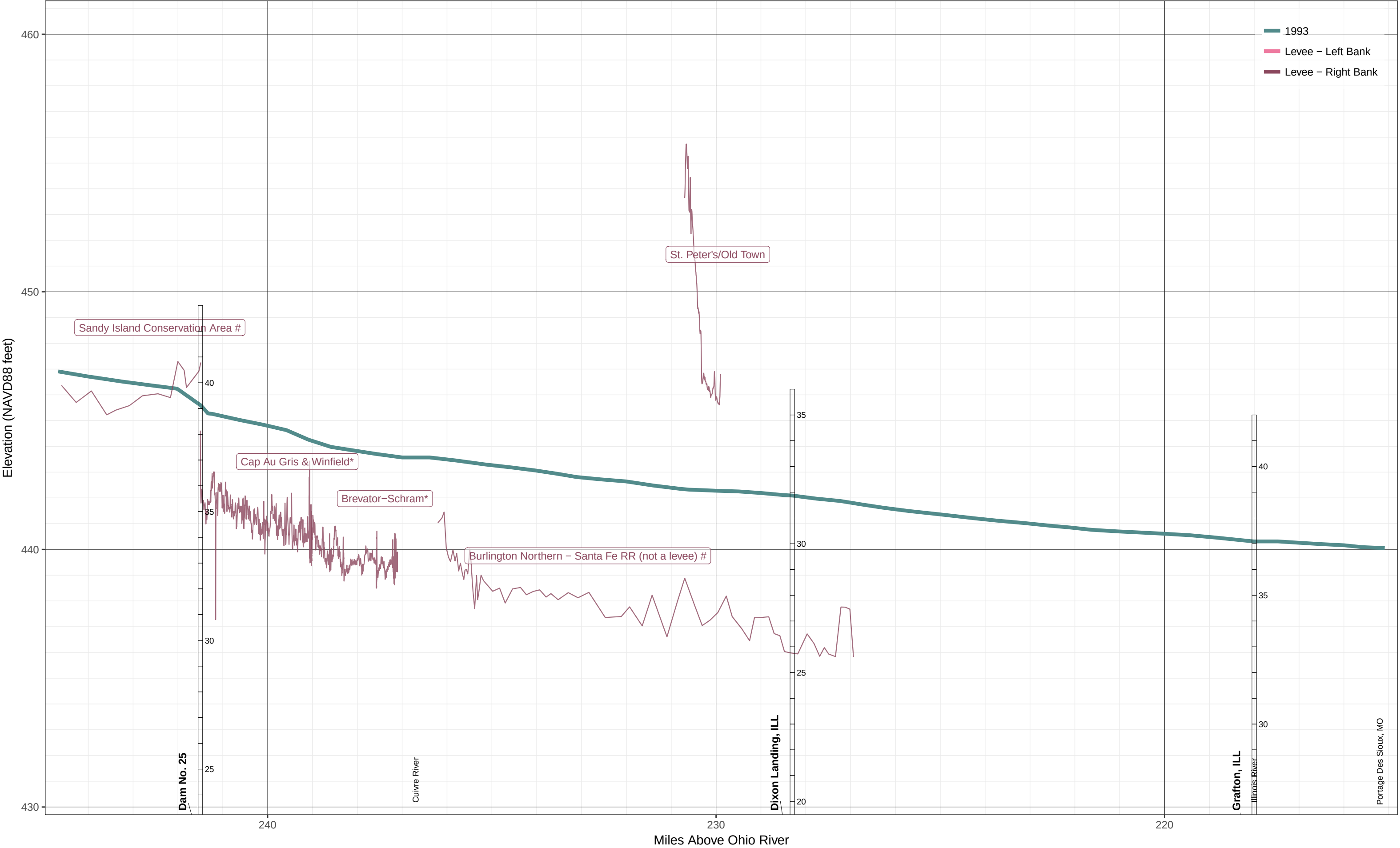
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



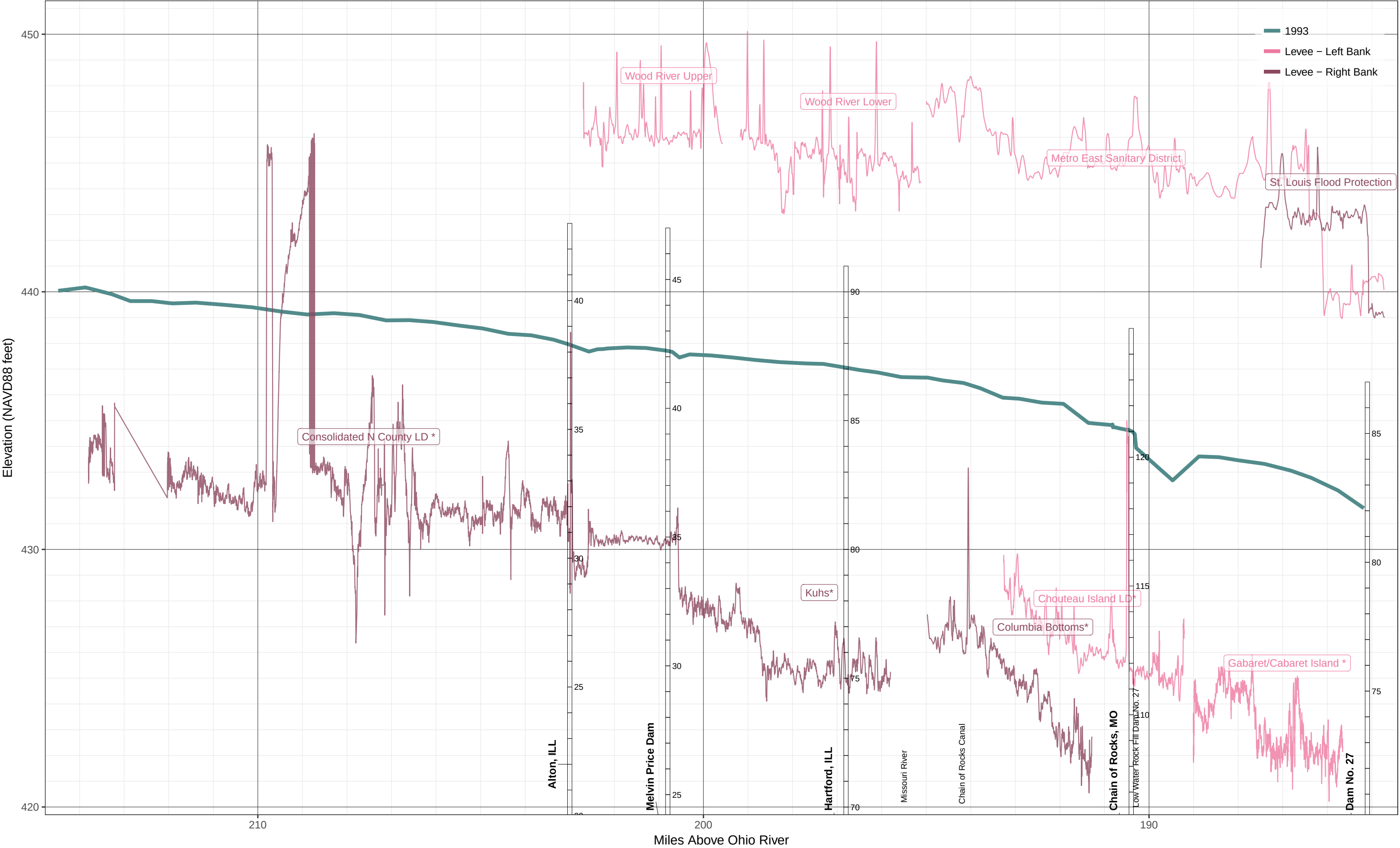
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



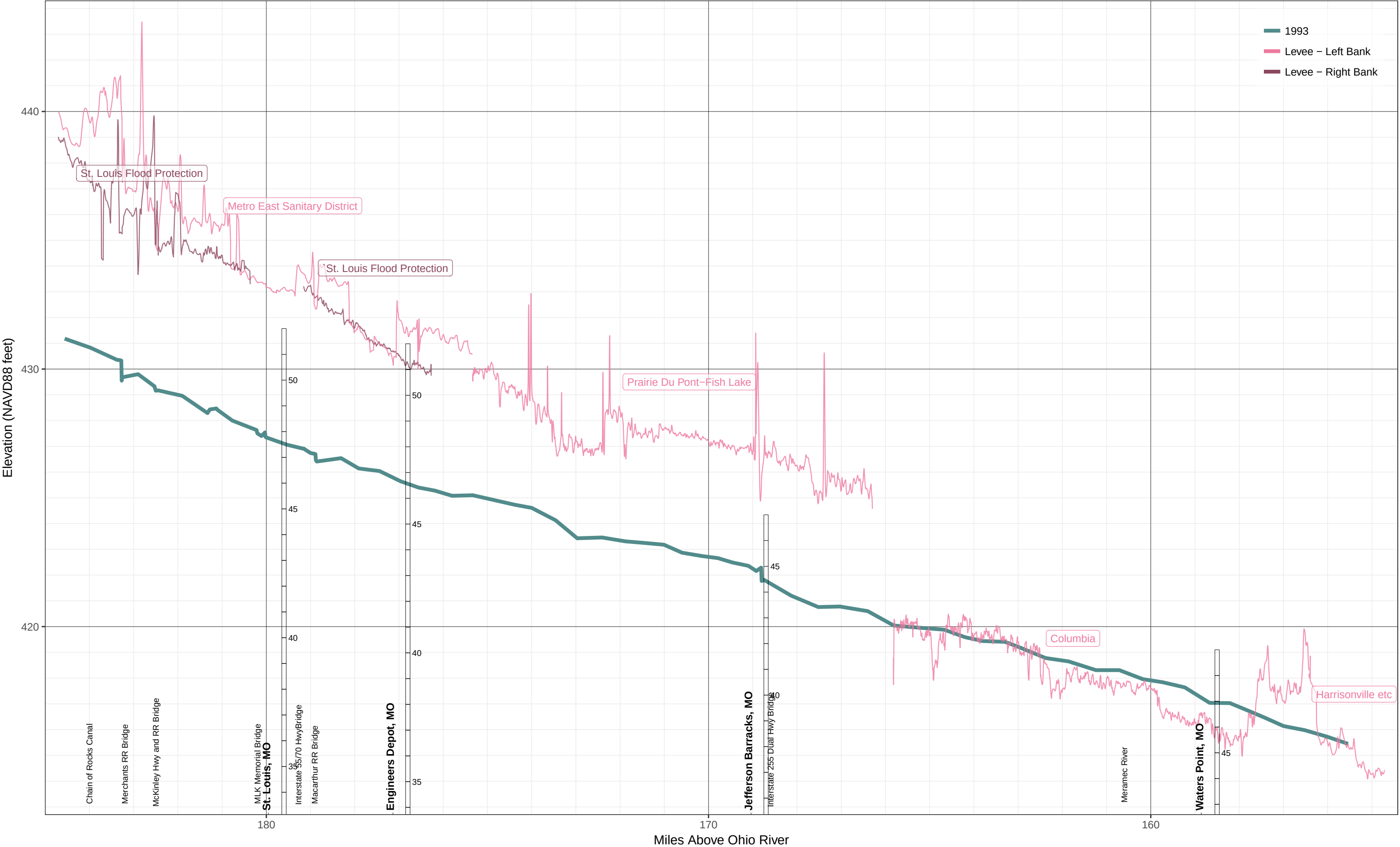
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



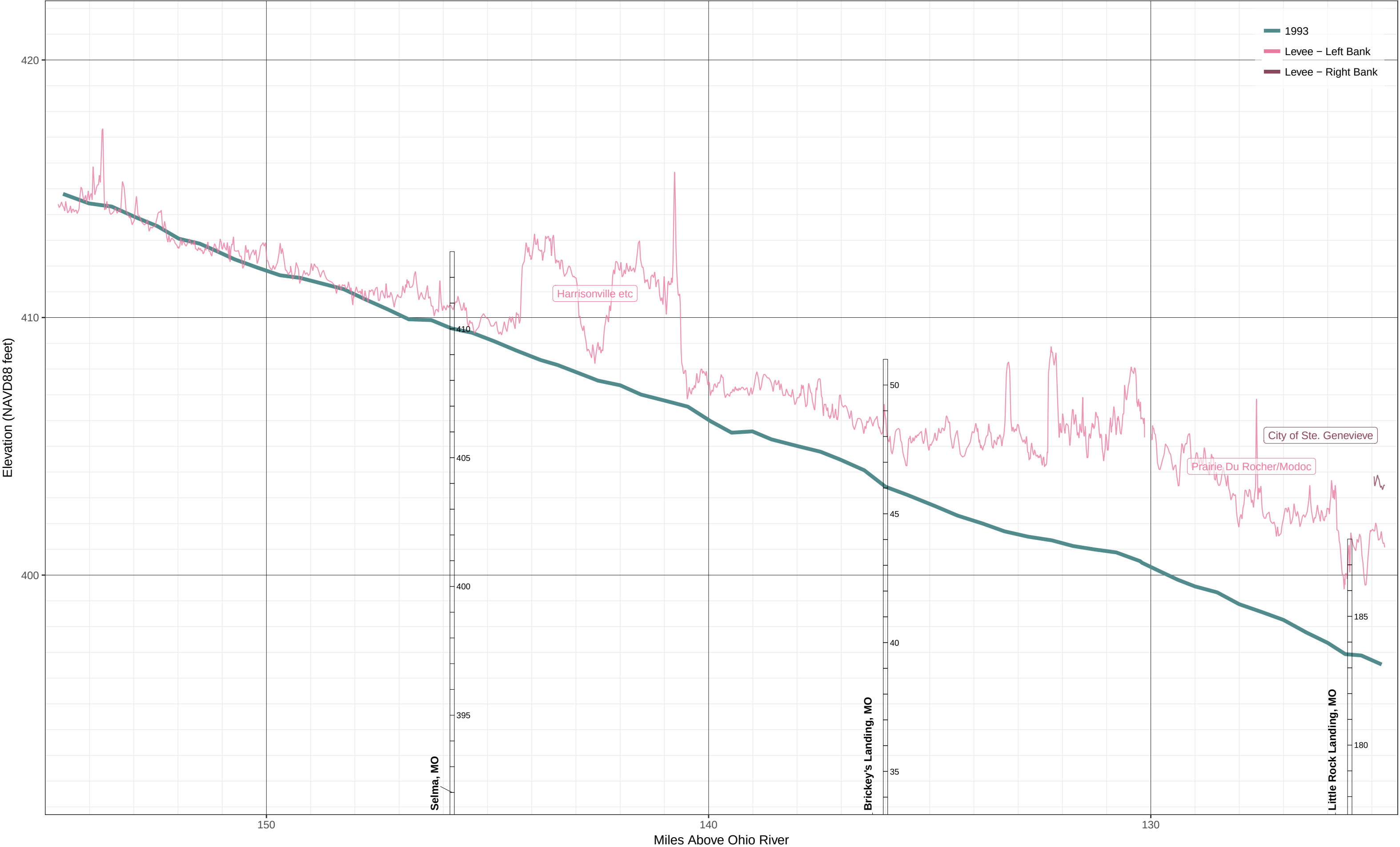
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



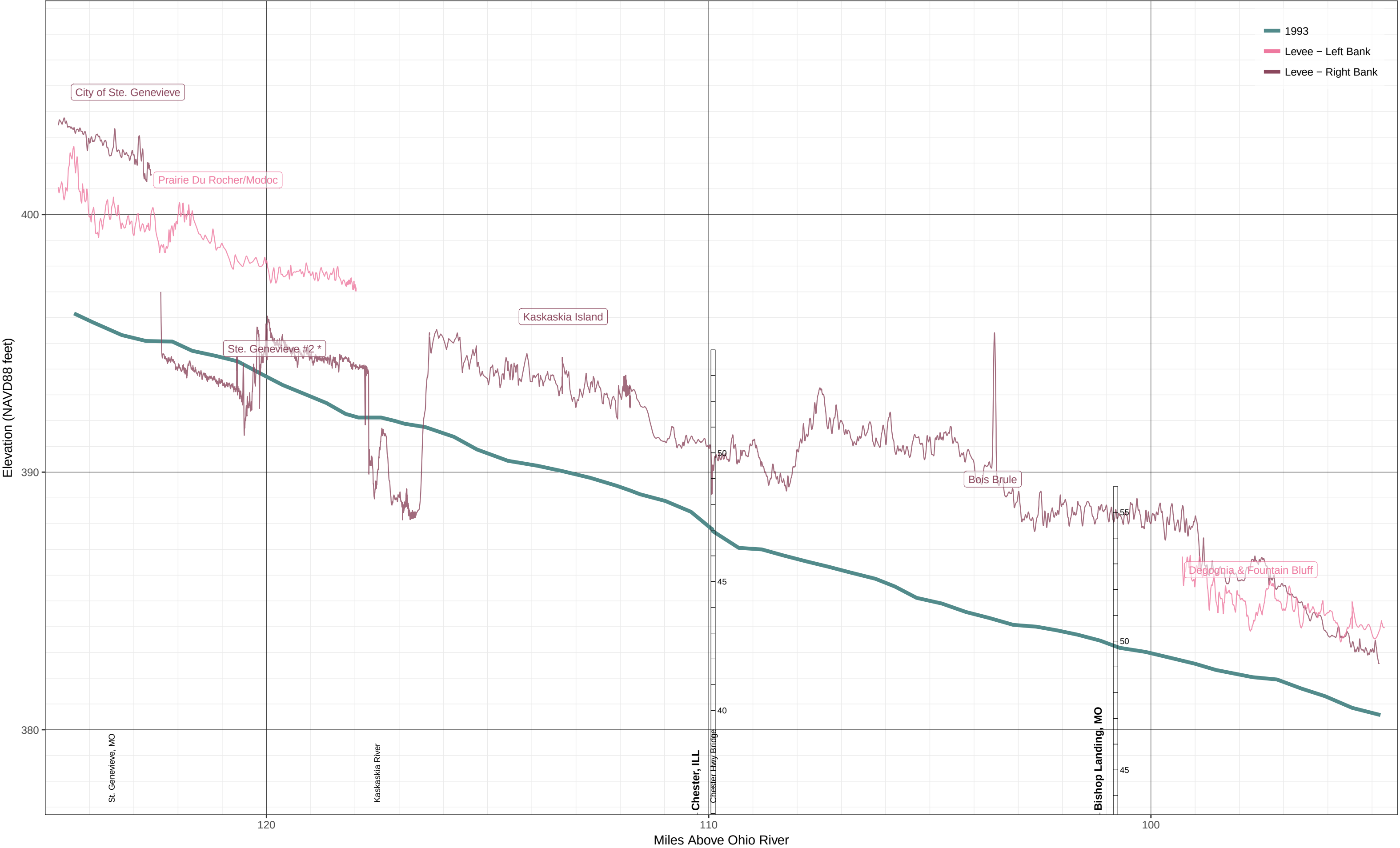
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



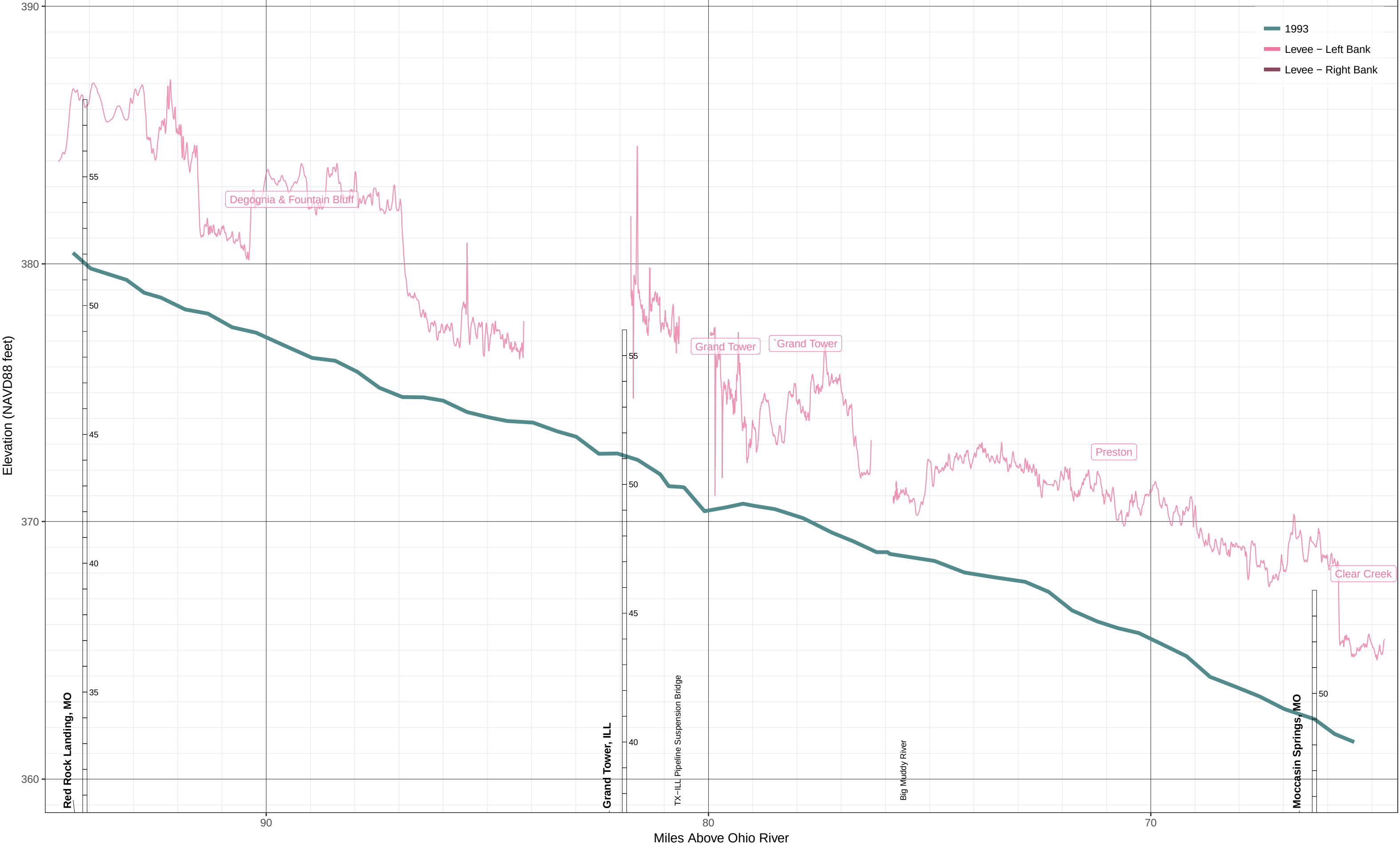
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



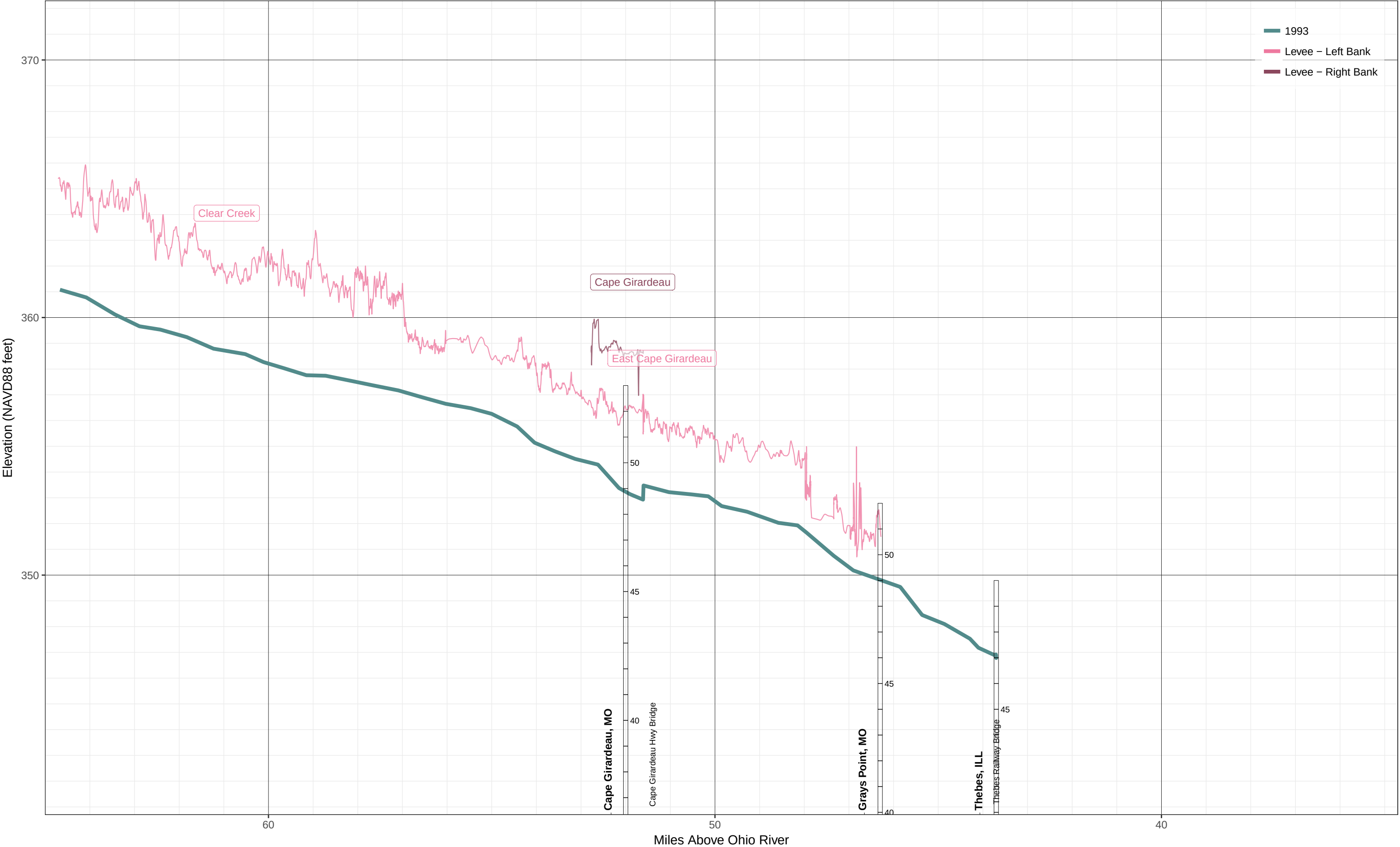
Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



Upper Mississippi River Hydraulic Model – Keokuk to Thebes with Existing Levee Elevations
(#) Levee is Non-Federal Segment – Terrain Data, (*) Levee is Non-Federal Segment – NLD, High Water Marks Represented by Circles



Appendix D-1
High Water Data Correspondence



REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT, CORPS OF ENGINEERS
CLOCK TOWER BUILDING - P.O. BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

February 15, 2017 -

Planning, Programs, and Project
Management Division

TO: Levee Districts and Counties in the Upper Mississippi River (UMR) Flood Risk Management
Hydraulic Model from Keokuk, IA to Thebes, IL

Dear Sir or Madam:

The U.S. Army Corps of Engineers, in partnership with State and Federal agencies, initiated a new hydraulic model for the main-stem Upper Mississippi River from Lock and Dam 19 at Keokuk, Iowa to Thebes, Illinois. The numerical hydraulic model will be calibrated using observed flow and stage data at gauge locations. In order to assist with the calibration process we are seeking high water mark (HWM) information.

Well documented high water mark (HWM) elevation information is valuable part of the modeling effort. To assure that the best available information is used to develop the hydraulic model, we request that you provide high quality and documented high water mark elevation information for the following flood events ~ July/August 1993, June/July 2008, April/May/June 2013, December/January 2015/2016.

We are defining high quality and well documented HWM's to have been collected and documented by a licensed surveyor (L.S.) or under the supervision of a L.S. The HWM data should contain information including: event date, horizontal coordinates, elevation (including vertical and horizontal datum), and nature of data acquisition i.e. field measurement during event, water's edge, debris line, etc. We are requesting the data in text file format, and if available, any supporting photographs.

Due to the timeline of the study, we are asking that you respond to this request **by March 15**. If we do not hear from you by March 15, we will assume that you do not have any HWM information to be used for model calibration purposes.

If you need additional time or have any questions, please call Shirley Johnson, Hydrologist, at 309/794-5276 or email shirley.j.johnson@usace.army.mil.

We are also sending this letter to the Upper Mississippi, Illinois, and Missouri Rivers Association (UMIMRA); to the Missouri Levee and Drainage District Association; to the Iowa counties of Lee and Clark; the Missouri counties of Lewis, Marion, Ralls, Pike; and to the Illinois counties of Hancock, Pike, Adams and Calhoun.

Sincerely,

Bryan Snook, P.E.
Flood Area Engineer
Rock Island District

Appendix D-2

High Water Data Supplied by Others

PICKETT, RAY & SILVER, INC.

CIVIL ENGINEERING, LAND SURVEYING & LAND PLANNING SERVICES

August 2, 2017

Mr. David Stokes
Great River Habitat Alliance
P.O. Box 5014
St. Louis, Missouri 63105
dstokes@grha.org

RE: ADOLPHUS A. BUSCH HIGHWATER MARK LOCATION
PR&S PROJECT NO. 93135.GRHA.00S

Dear Mr. Stokes:

Our field work has been completed at the jobsite on August 2, 2017. The results of our field study for the highwater marks at the locations as specified by you are as follows:

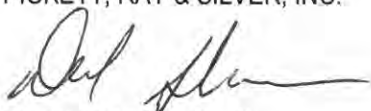
NAME OF STRUCTURE	MoDOT DRS GNSS NAVD 88 DATUM	BENCHMARK RM 70 NGVD 29
Bridge Abutment 2008 Highwater Mark Reading	440.25	440.38
Abutment 2015 Reading	436.05	436.18
Abutment 2014 Reading	435.07	435.20
Abutment 2017 Reading	435.07	435.20
Maintenance Shed Concrete Pad 1993	443.80	443.93
Top of Abutment	441.60	441.73
Top of Maintenance Shed Concrete Pad	436.07	436.20

Please note the above readings were obtained using two datum networks. The first network was MoDOT's VRSGNSS Network Coordinate System and was checked with NGVD 29, more particularly based from RM 70. The horizontal locations for the bridge abutment and the maintenance shed concrete pad per the MoDOT's VRSGNSS Coordinate System are as follows:

NAME OF STRUCTURE	NORTHING	EASTING
Abutment Reading	1094758.219	774327.555
Maintenance Concrete Pad	1095566.513	771635.949

If additional information is required, please contact me at your earliest convenience at 636-397-1211 or by email at diskornia@prs3.com.

Very truly yours,
PICKETT, RAY & SILVER, INC.



David F. Skornia, P.L.S.
Director of Survey
aan

22 Richmond Center Court
St. Peters, Missouri 63376
Phone: 636-397-1211 Fax: 636-397-1104
Web: www.prs3.com

WATER MODELING PROJECT for the COE

1. Old Waste Water Treatment Facility

527146.146 (N)

1102632.220 (E)

348.780 (Elev. of the bottom of the wall)

Elevation of the mark denoting the **1993 Flood=351.72**

2. Broadway Gate

537536.141 (N)

1105979.456 (E)

342.630 (Elev. of the bottom of the wall)

Elevation of the mark denoting the **1993 Flood=352.530**

3. Intake at the Water Treatment Facility

546445.924 (N)

1112488.306 (E)

347.162 (Elev. of the bottom of the wall)

Elevation of the mark denoting the **1993 Flood=354.562**

NOTES:

1. Basis of Survey Datum-NAD 83, 11M.S.P.C. Zone 2401 East, determined by GPS observations using the MoDot GPS RTK Network

2. All coordinates shown are in US Survey Feet

3. Geoid Model used=Geoid 09

NEIGHBORS OF THE MISSISSIPPI - HIGH WATER MARKS ALONG THE MISSISSIPPI RIVER - North to South along river. Surveyed in Oct and Nov 2017.

	County	Nearest town	Contact	Phone Nos.	HWM Address	HWM type	Flood year	Northing NAD83	Easting NAD83	Elevation NAVD88
1	Pike MO	Ashburn MO	Ted Shanks	Site 573-754-6171 Offsite 573-248-2530				Not surveyed	Not surveyed	Not surveyed
2	Pike MO	Annada MO	Nancy and Harris Guyton	Cell 573-754-2218 Home 573-847-2207		Equipment shed wall	1993 2008	1249813.607 1249813.634	727789.120 727789.583	453.055 452.623
3	Pike MO	Riverport MO (Across from Hamburg)	Mickey Cornelius	573-898-2883	39270 Pile 202 Annada MO	Step on stairs	2008	1240087.180	753660.709	451.156
4	Calhoun IL	Hamburg IL	Edwin Williams Mayor	Cell 618-232-1025 Bzstar1968@hotmail.com	Mayor to escort to HWM	Overhead door	2008, 2013 or 2014	Not surveyed	Not surveyed	Not surveyed
5	Calhoun IL	Hamburg IL	Edwin Williams Mayor	Cell 618-232-1025	Mayor to escort to HWM	Overhead door jamb	2008, 2013 or 2014	Not surveyed	Not surveyed	Not surveyed
6	Calhoun IL	Hamburg IL	Edwin Williams Mayor	Cell 618-232-1025	Mayor to escort to HWM	Block building exterior	2008, 2013 or 2014	Not surveyed	Not surveyed	Not surveyed
7	Calhoun IL	Hamburg IL	Edwin Williams Mayor	Cell 618-232-1025	Mayor to escort to HWM	Metal building exterior	2008, 2013 or 2014	Not surveyed	Not surveyed	Not surveyed
8	Lincoln MO	Elsberry MO	Craig Koch	636-384-1952	595 Hatfield Ro Elsberry MO	Mark on metal building	2008	1216032.276	750354.666	446.620
9	Lincoln MO	Foley MO	Rob Youngerman	M 314-575-0064 O 636-366-9439	190 Highway 79 Winfield MO	Metal building painted aluminum. North shed is open. Inside marks better.	2008	1163383.642	753929.908	446.452
10	Lincoln MO	Winfield MO	Rob Youngerman son	M 314-575-0064 O 636-366-9439	1219 Keeteman Winfield MO	Hip roof barn - Hay loft floor	1993	1141262.553	757866.844	444.503
11	St. Charles MO	Northwest of Kampville MO	Chuck Williamson	314-581-7996		Gary Shleef house. Marks on deck and stairs.	1993 2008 2017	1103293.008 1103292.915 1103300.761	793670.461 793671.312 793671.255	443.035 440.269 435.840
12	St. Charles MO	Northeast of Kampville MO	Chuck Williamson	314-581-7996	1121 Harbor Grove, South Shore, MO	Marks on exterior of Chuck Williamson house.	1993 2008 2011 2013 May/2015 Dec/2015 2017	1103822.232 1103823.577 1103821.367 1103819.759 1103819.742 1103819.739 1103825.328	814570.659 814569.047 814576.261 814575.001 814574.984 814574.982 814580.155	442.707 436.973 435.720 435.889 436.018 436.183 434.768
13	St. Charles MO		Chuck Williamson	314-581-7996		Kerry Allen house. Marks on exterior.	1993 2008 2015	1109712.696 1109716.855 1109710.479	816151.597 816151.717 816156.545	442.531 437.159 436.412
14	St. Charles MO		Chuck Williamson	314-581-7996		Marks on outside wall of Lee Crockett house and outside steps.	1993 2015 2017	1120900.739 1120905.929 1120907.429	821962.601 821943.460 821940.088	442.702 436.313 434.289
15	St. Charles MO	5 miles NW of Portage Des Sioux	Chuck Williamson	314-581-7996	7125 Grafton Ferry Road	Outside steps and steel column. Owner name to be determined.	2015	1137832.148 1137788.040	838759.327 838780.390	424.768 423.548
16	St. Charles MO	Portage Des Sioux	Chuck Williamson	314-581-7996		Dallwitz marina shop. Marks on steel columns inside metal building.	1993 2015 2015 2017	1127476.418 1127414.317 1127414.318 1127414.318	864823.022 864825.922 864825.921 864825.922	440.047 432.926 432.571 432.767

Appendix E

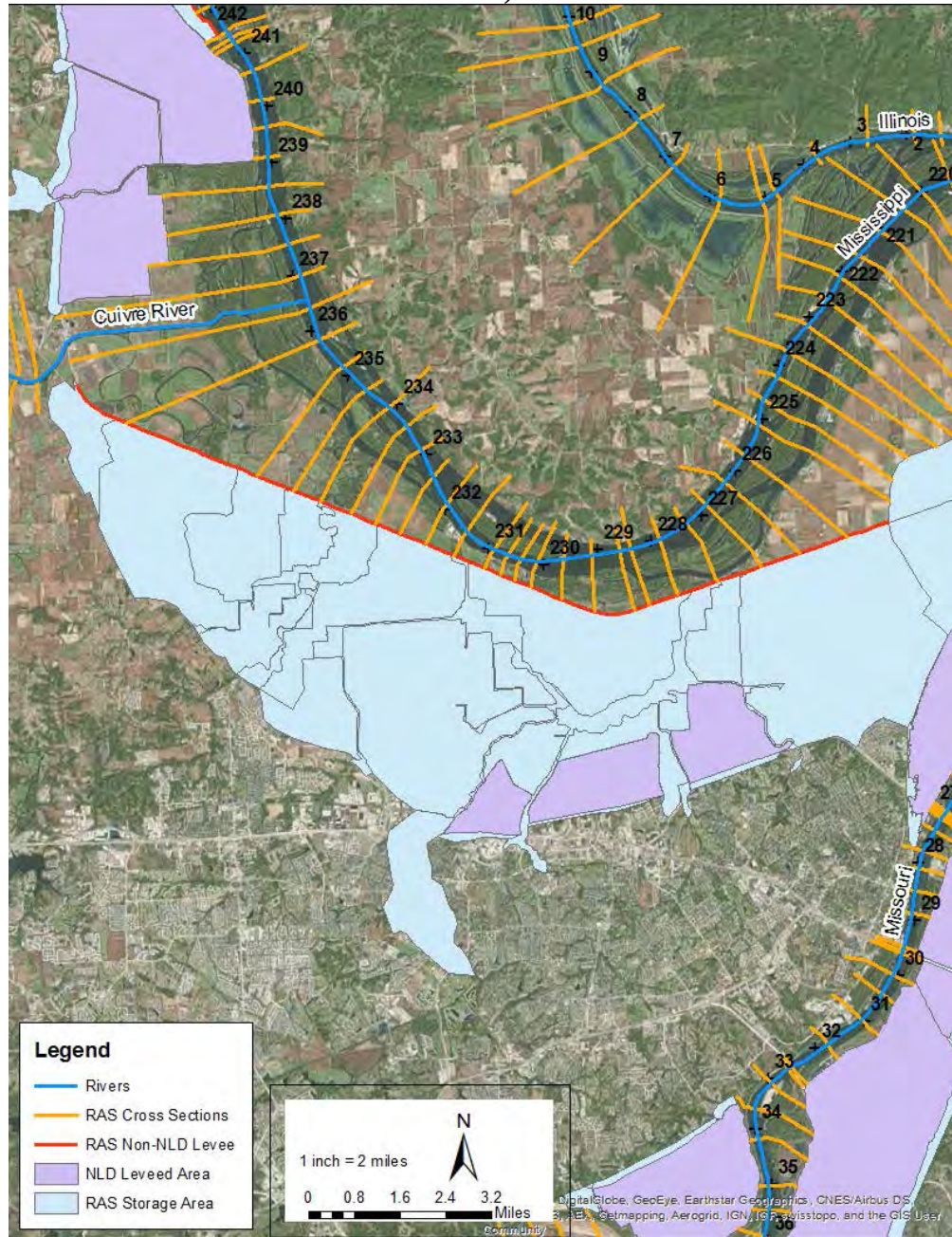
Maps of Non-NLD Leveed Areas

Appendix F – Non-NLD Levee Systems

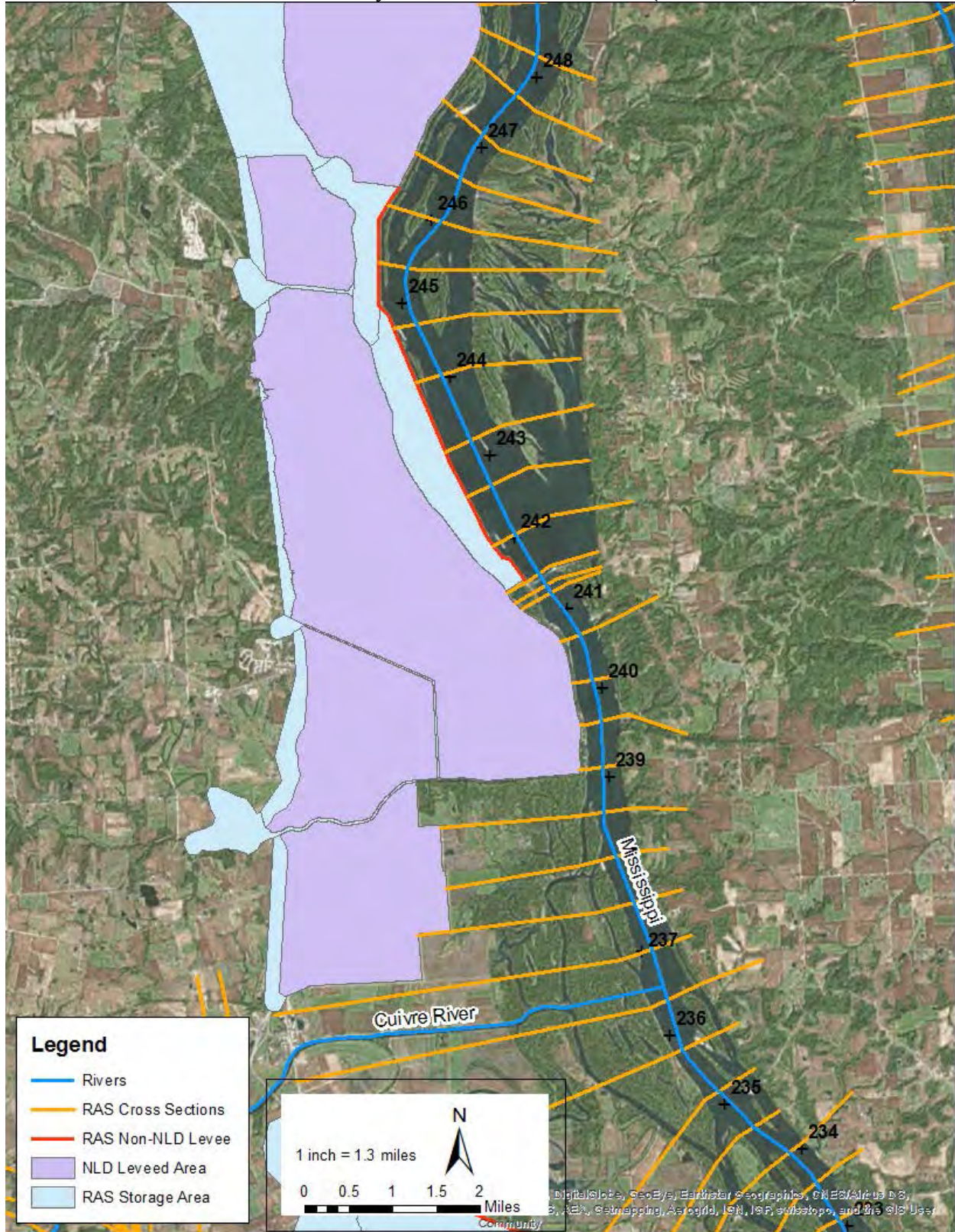
Non-federally constructed, not in the PL84-99 system

Terrain data used to determine levee elevations

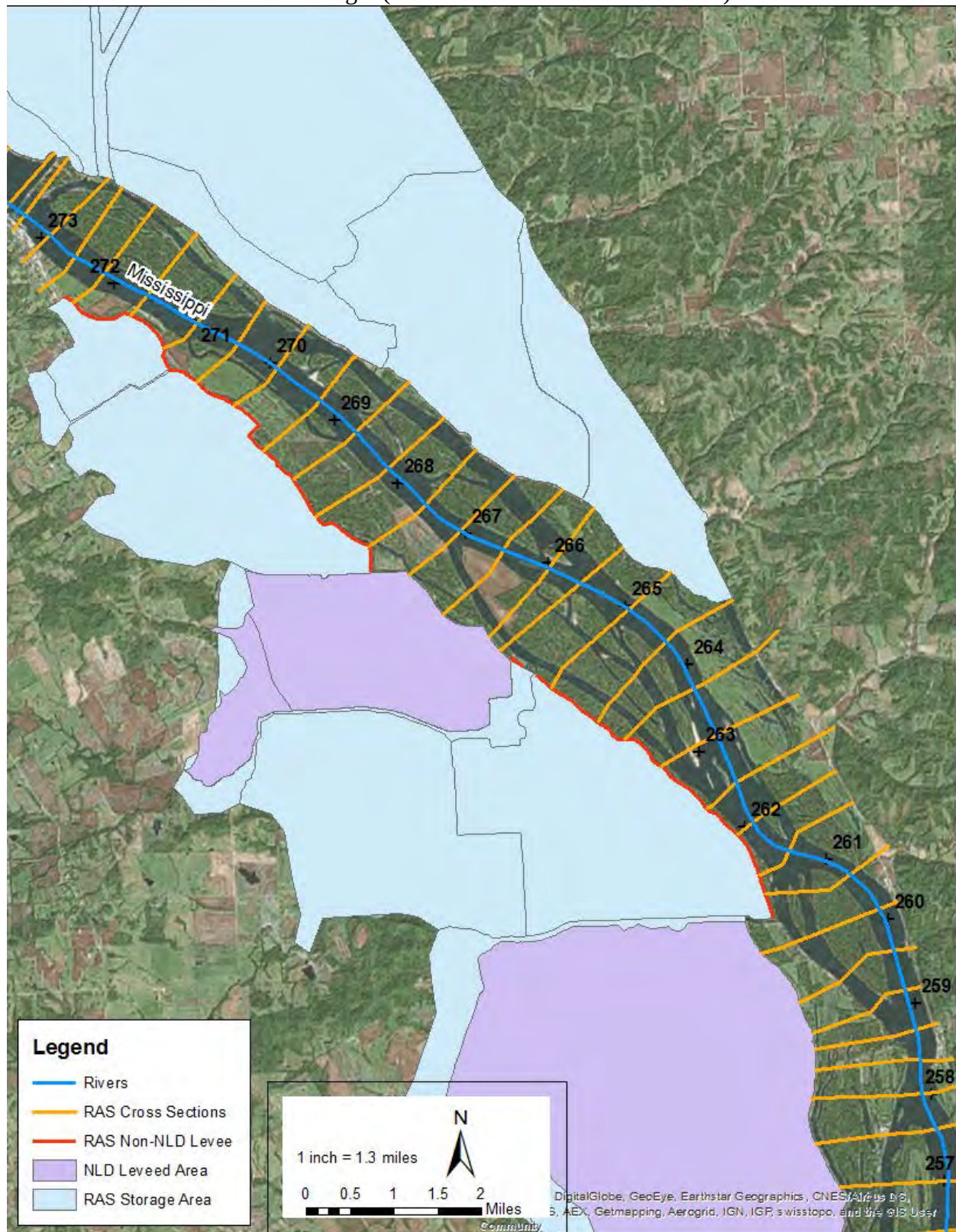
Non-PL84-99 levee systems behind Burlington Northern – Santa Fe Railroad (River Mile 225-236)



Non-PL84-99 levee at Sandy Island Conservation Area (River Mile 242-246)



Non-PL84-99 levees – Clarence Cannon, Busch-Goose Pasture, Clarksville, and Pettus-Burns-Prewitt-Jaeger (River Miles 261-266 and 268-272)



Non-PL84-99 Riverland levees (River Miles 286-293)

