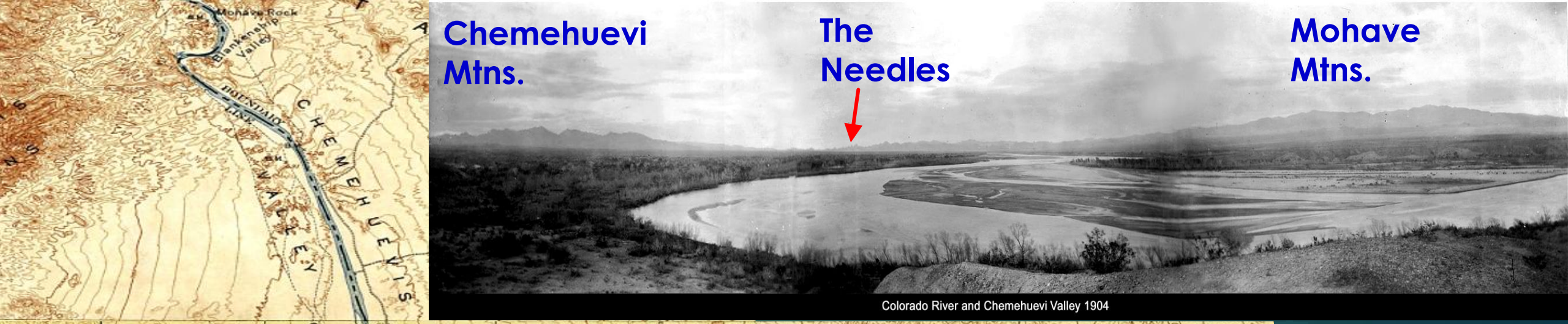
Lake Havasu Mapping and Stormwater Runoff Impacts From Lake Havasu City

Clean Colorado River Sustainability Coalition

Projects funded through Bureau of Reclamation and Bureau of Land Management



Colorado River and Chemehuevi Valley 1904

Lower Colorado River Prior to Lake Havasu

ca. 1903-1911

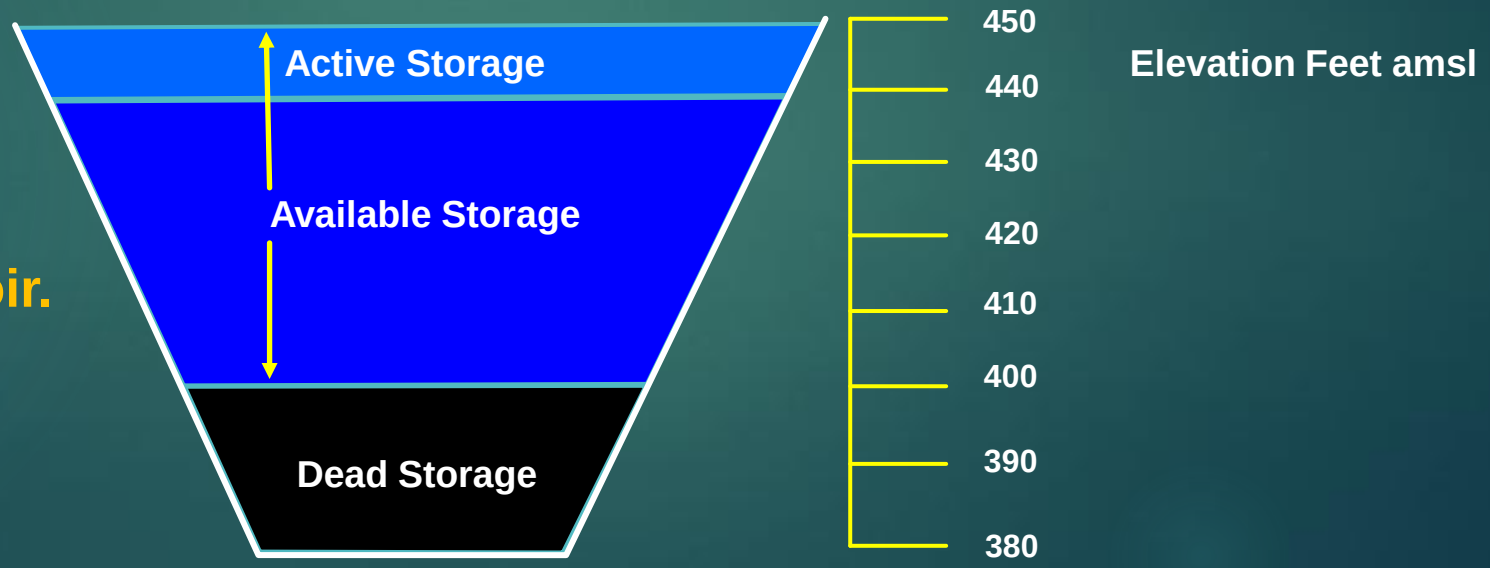
Capacity of Lake Havasu

Bureau of Reclamation recognizes 619,400 ac-ft of available storage, which was calculated from a 1957 survey, between 400’ to 450’ amsl.

Active storage is 180,000 ac-ft, which is from 440’- 450’ amsl, the limiting operations elevation range per contract with MWD.

Dead storage of 28,600 ac-ft is below 400’ amsl, the lowest elevation outlet from the reservoir.

450’ elevation is considered full reservoir.



Project Goals

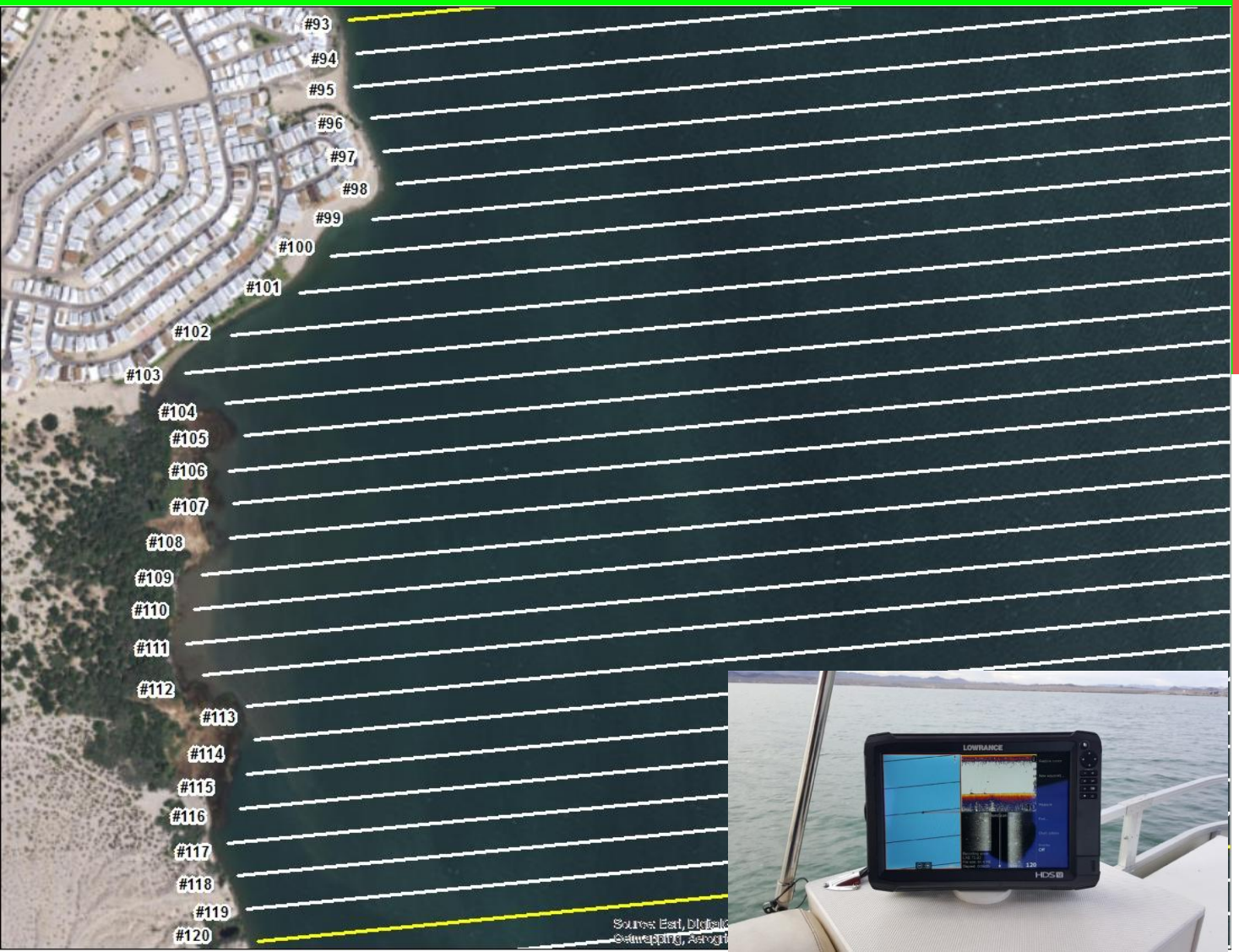
1) Generate geometry of the reservoir for future inclusion in Lower Colorado River (LCR) numerical water flow models.

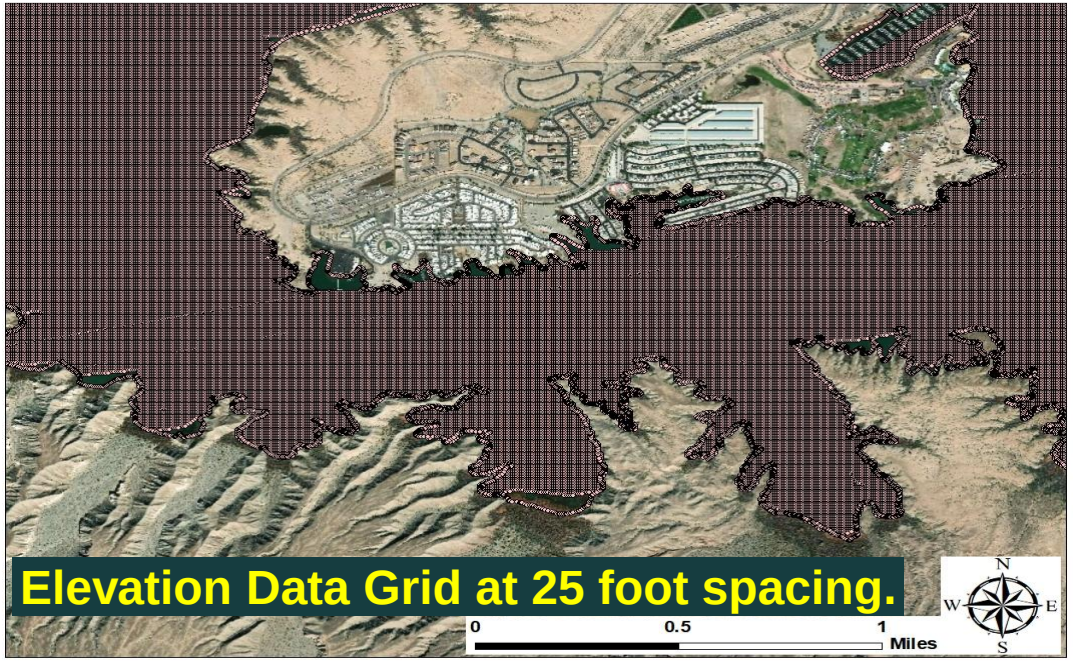
2) Document sedimentation styles and reservoir in-filling, and refine reservoir water supply capacity to increase water flow regulation efficiency in the LCR.

3) Subordinate benefits include application for search and rescue, water craft navigation, sport fishing, fish habitat cataloging, and define former riparian (forest) corridor.

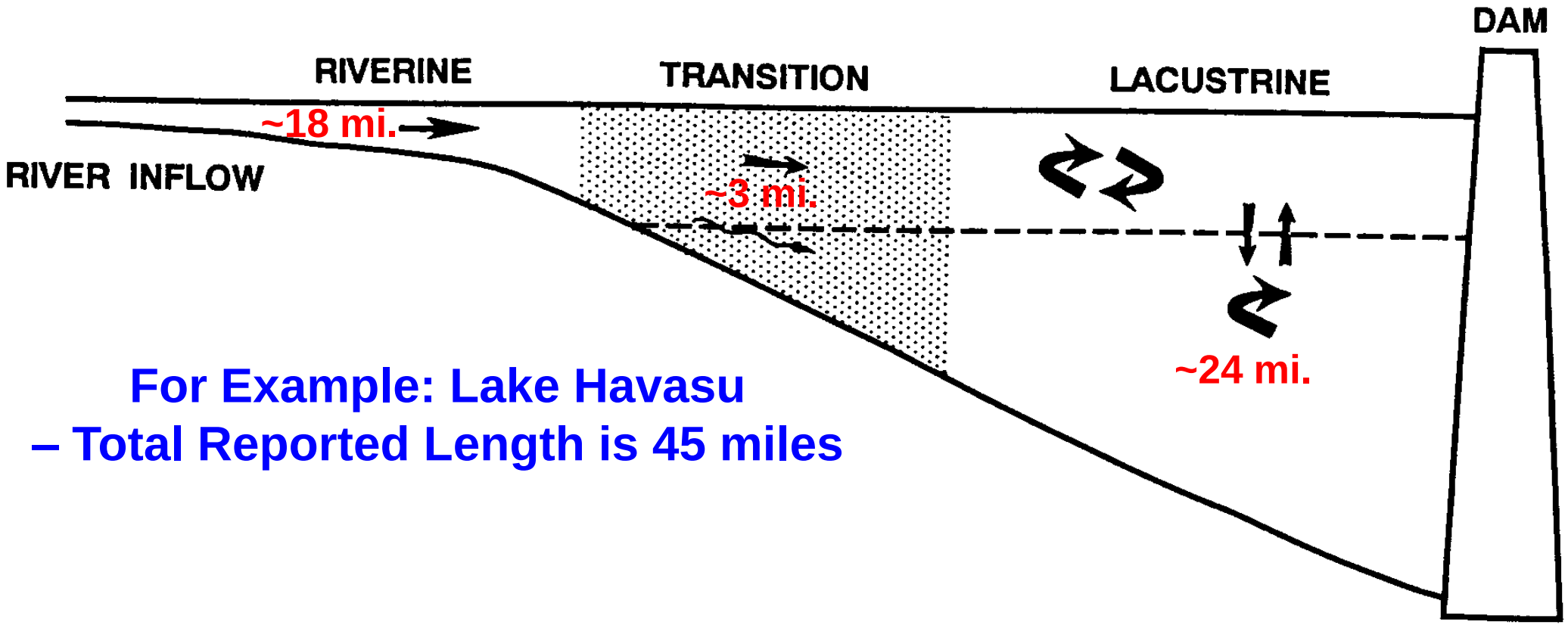
Example of Transect Lines

Transect Spacing = 200 Feet

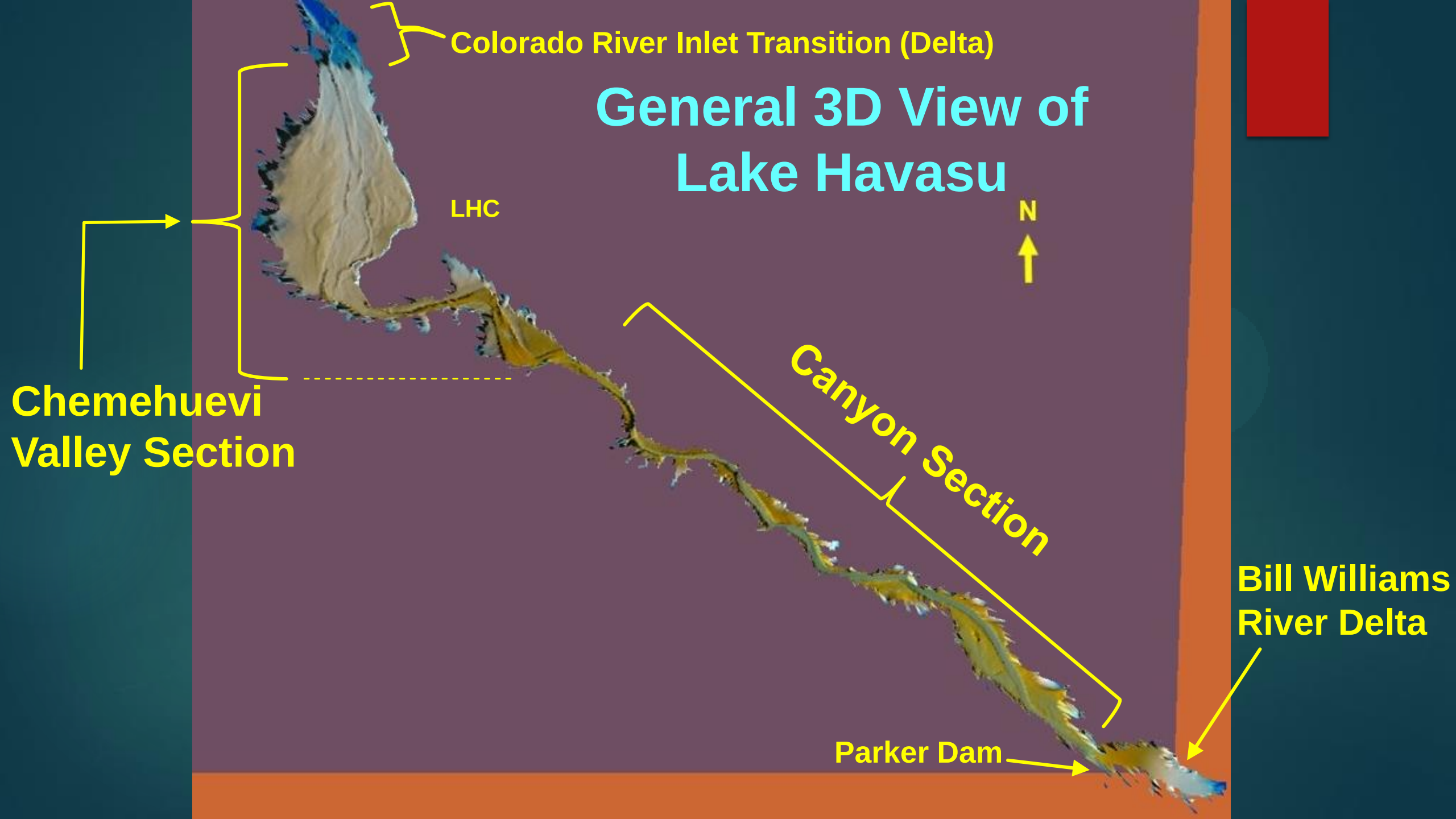




Generalized Zones Along Longitudinal Gradient in Reservoirs

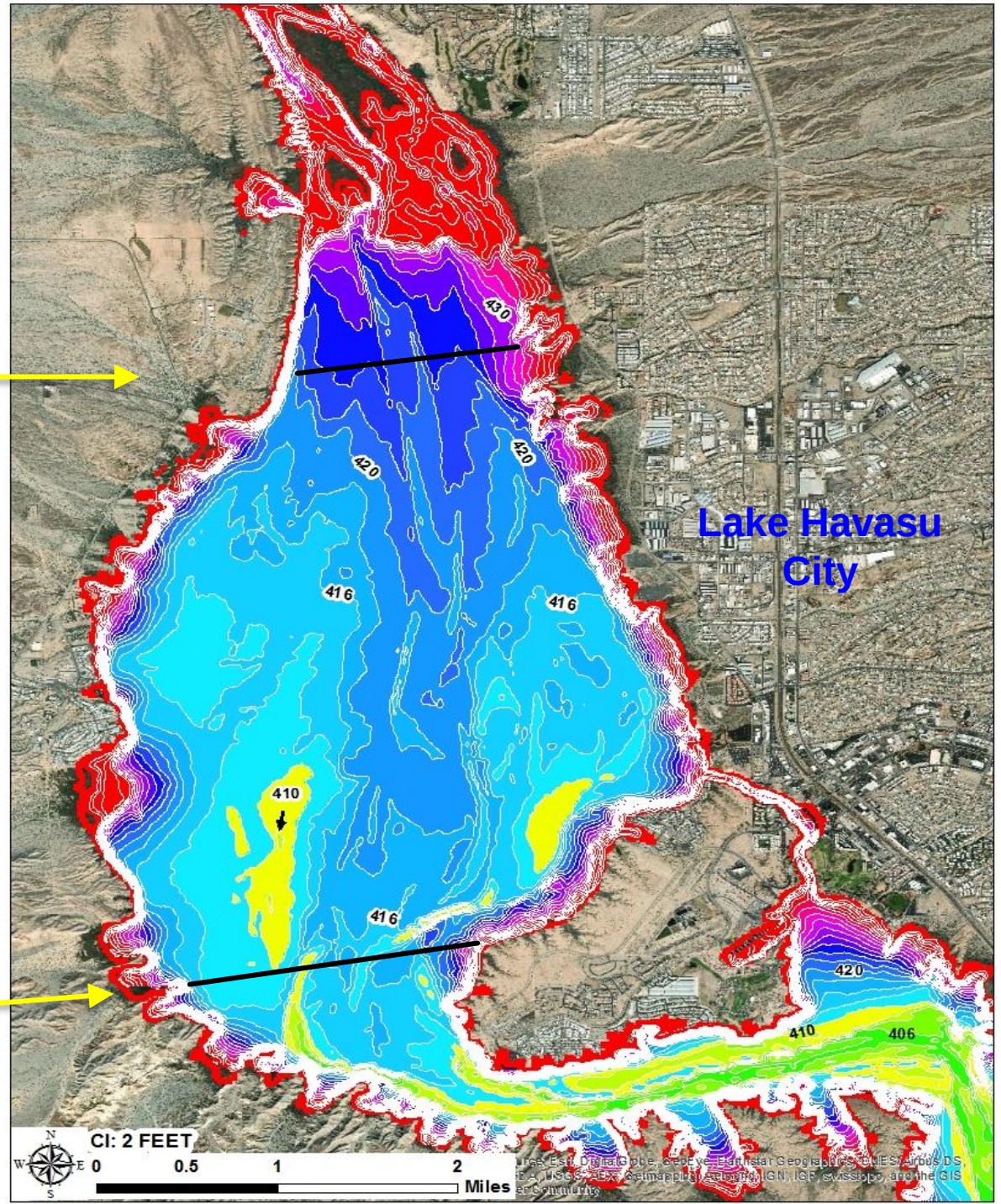


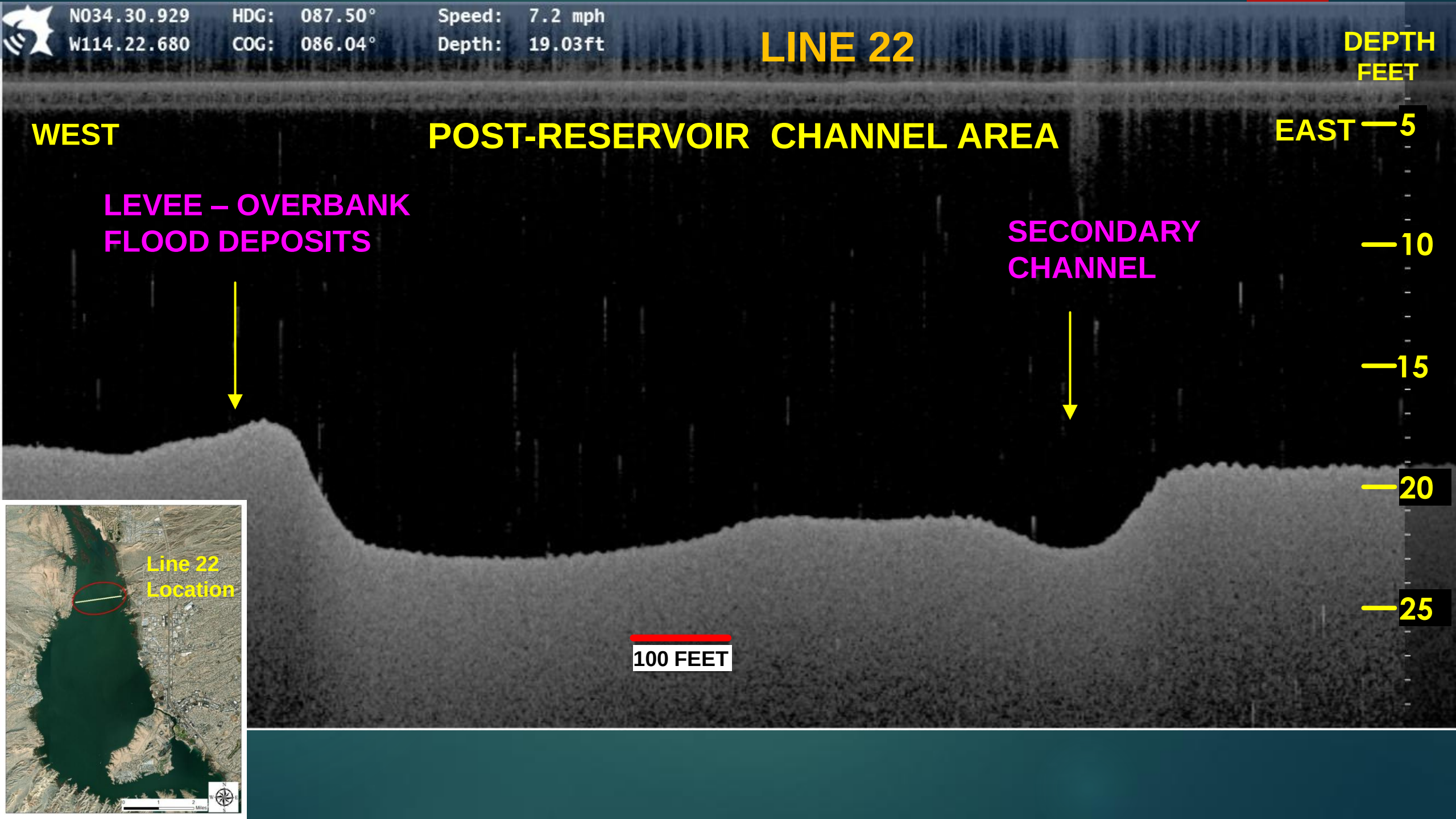
For Example: Lake Havasu
– Total Reported Length is 45 miles


Colorado River Inlet Transition (Delta)
General 3D View of Lake Havasu
LHC
N
Chemehuevi Valley Section
Canyon Section
Bill Williams River Delta
Parker Dam

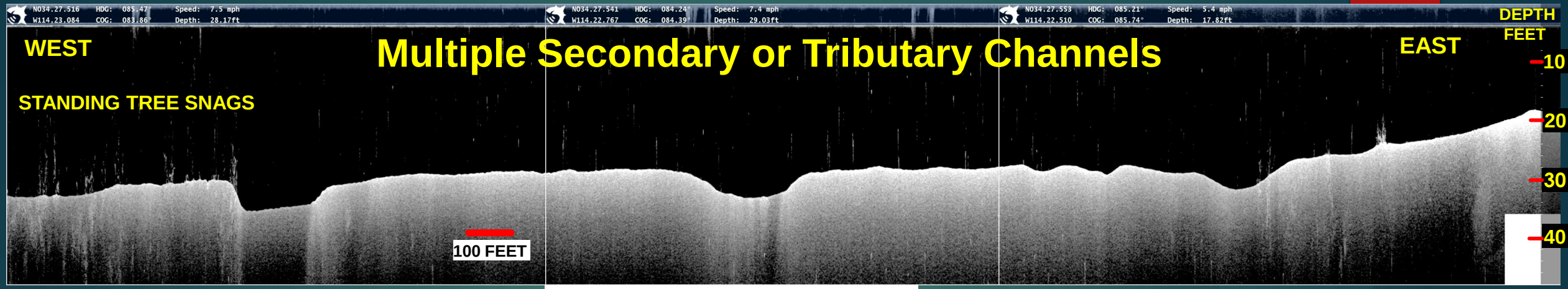
Lake Havasu Bathymetric Elevations – in Chemehuevi Valley Section

Datum: 450 Feet Above Mean Sea Level – Full Lake

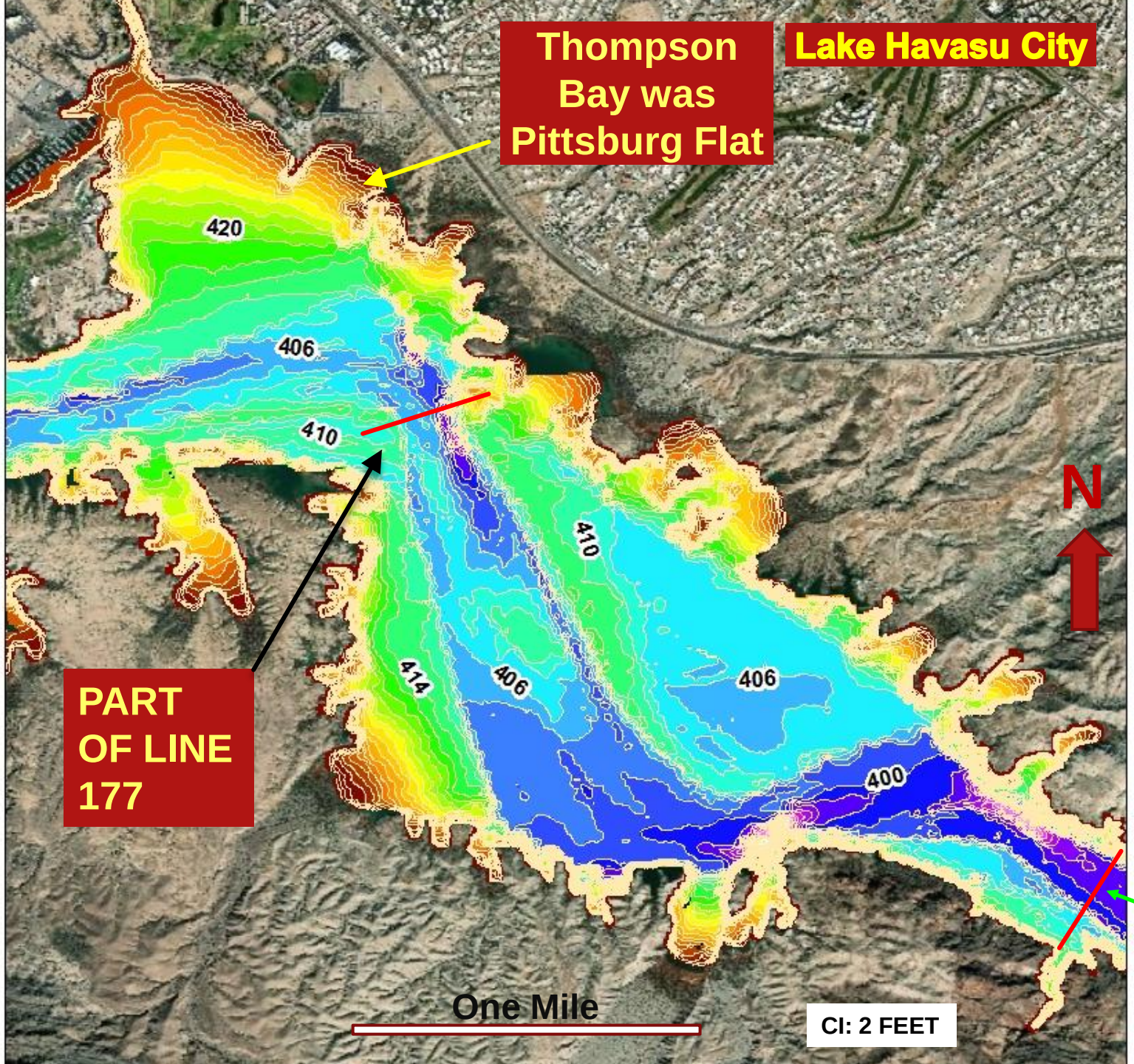



N034.30.929
W114.22.680
HDG: 087.50°
COG: 086.04°
Speed: 7.2 mph
Depth: 19.03ft
LINE 22
DEPTH
FEET
WEST
POST-RESERVOIR CHANNEL AREA
EAST
5
10
15
20
25
LEVEE – OVERBANK
FLOOD DEPOSITS
SECONDARY
CHANNEL
100 FEET
Line 22
Location

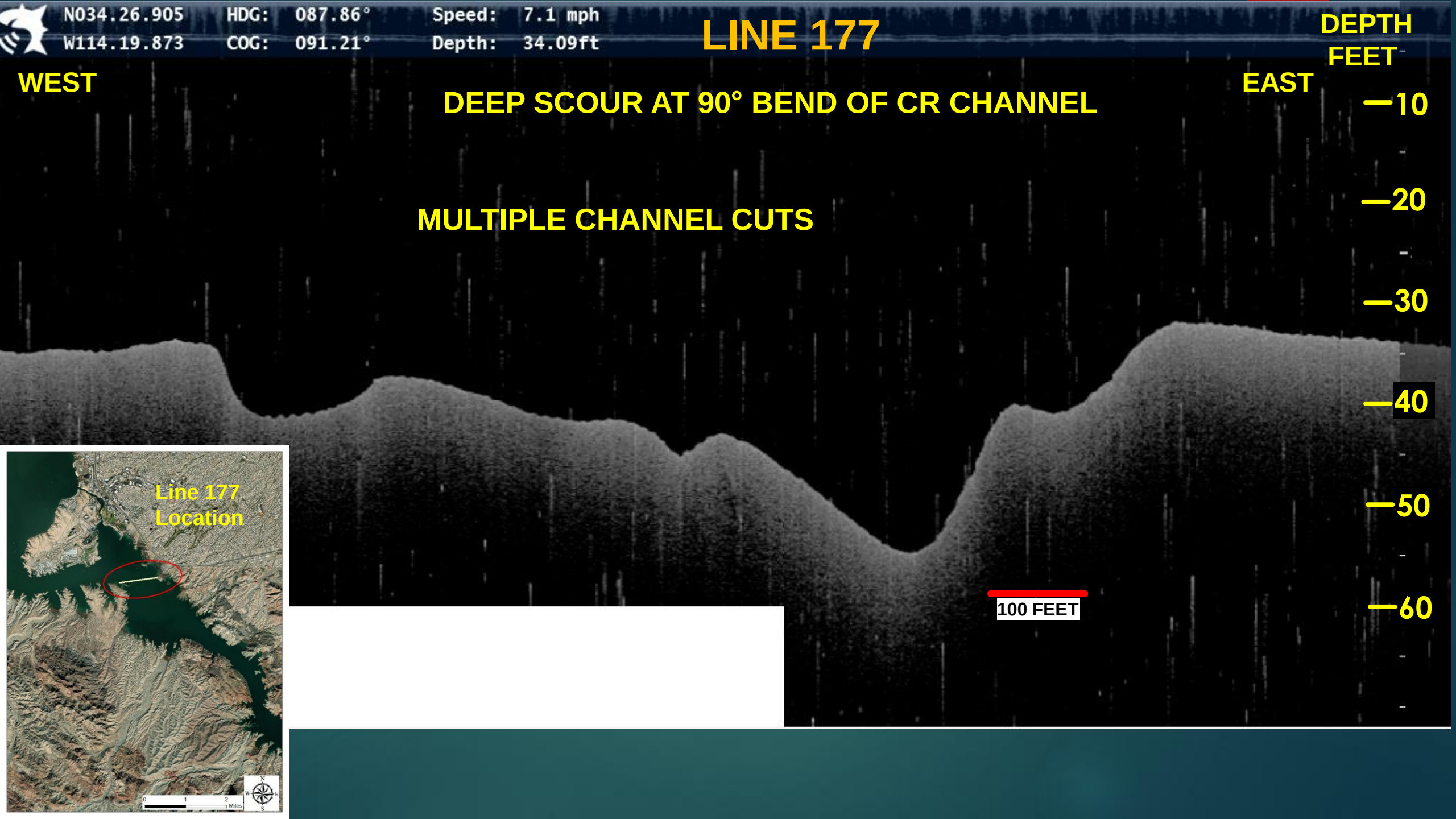
LINE 145

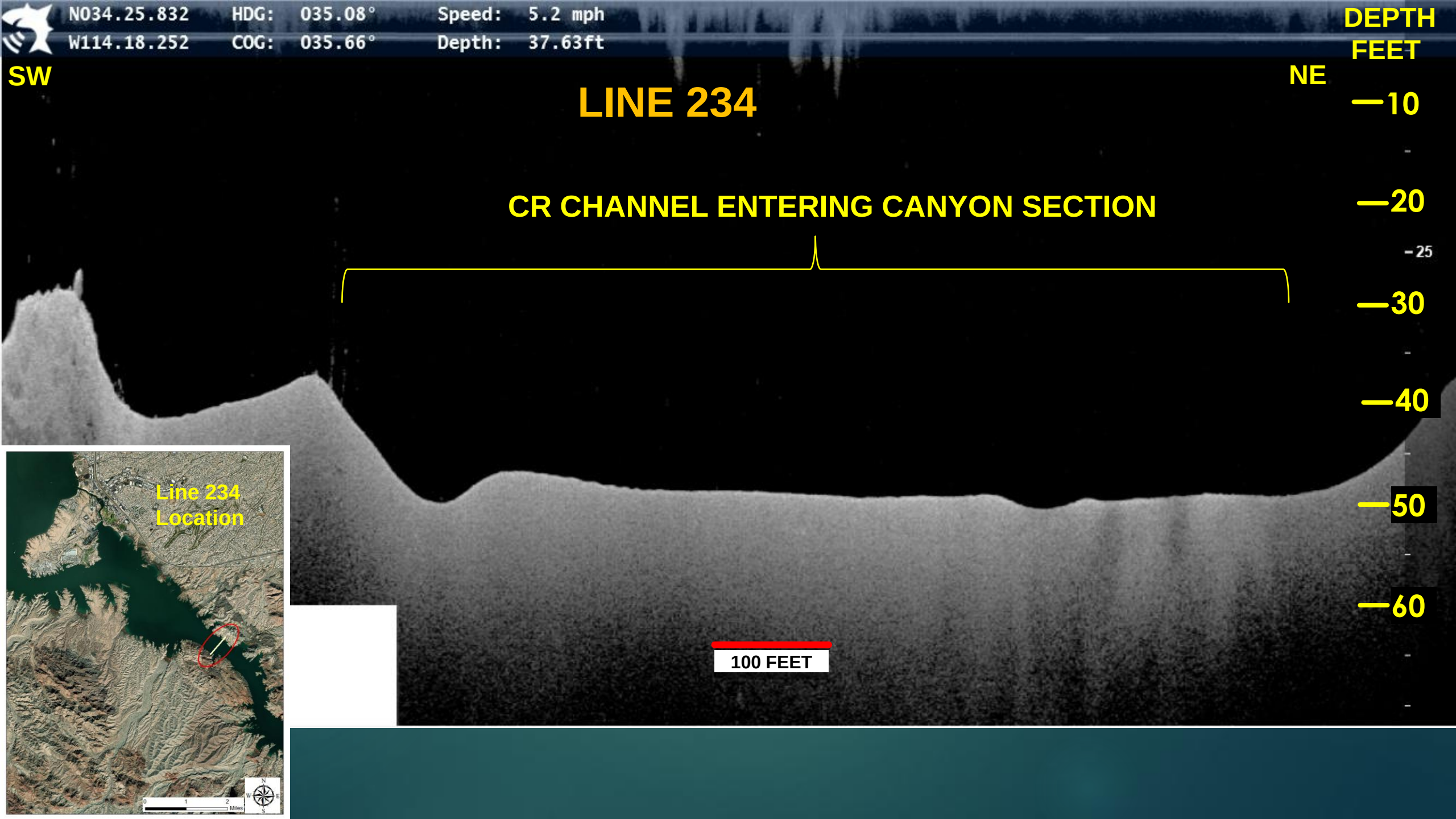

N034.27.516 HDG: 085.47° Speed: 7.5 mph
W114.23.084 COG: 083.86° Depth: 28.17ft
N034.27.541 HDG: 084.24° Speed: 7.4 mph
W114.22.767 COG: 084.39° Depth: 29.03ft
N034.27.553 HDG: 085.21° Speed: 5.4 mph
W114.22.510 COG: 085.74° Depth: 17.82ft
WEST
Multiple Secondary or Tributary Channels
EAST
DEPTH
FEET
10
20
30
40
STANDING TREE SNAGS
100 FEET

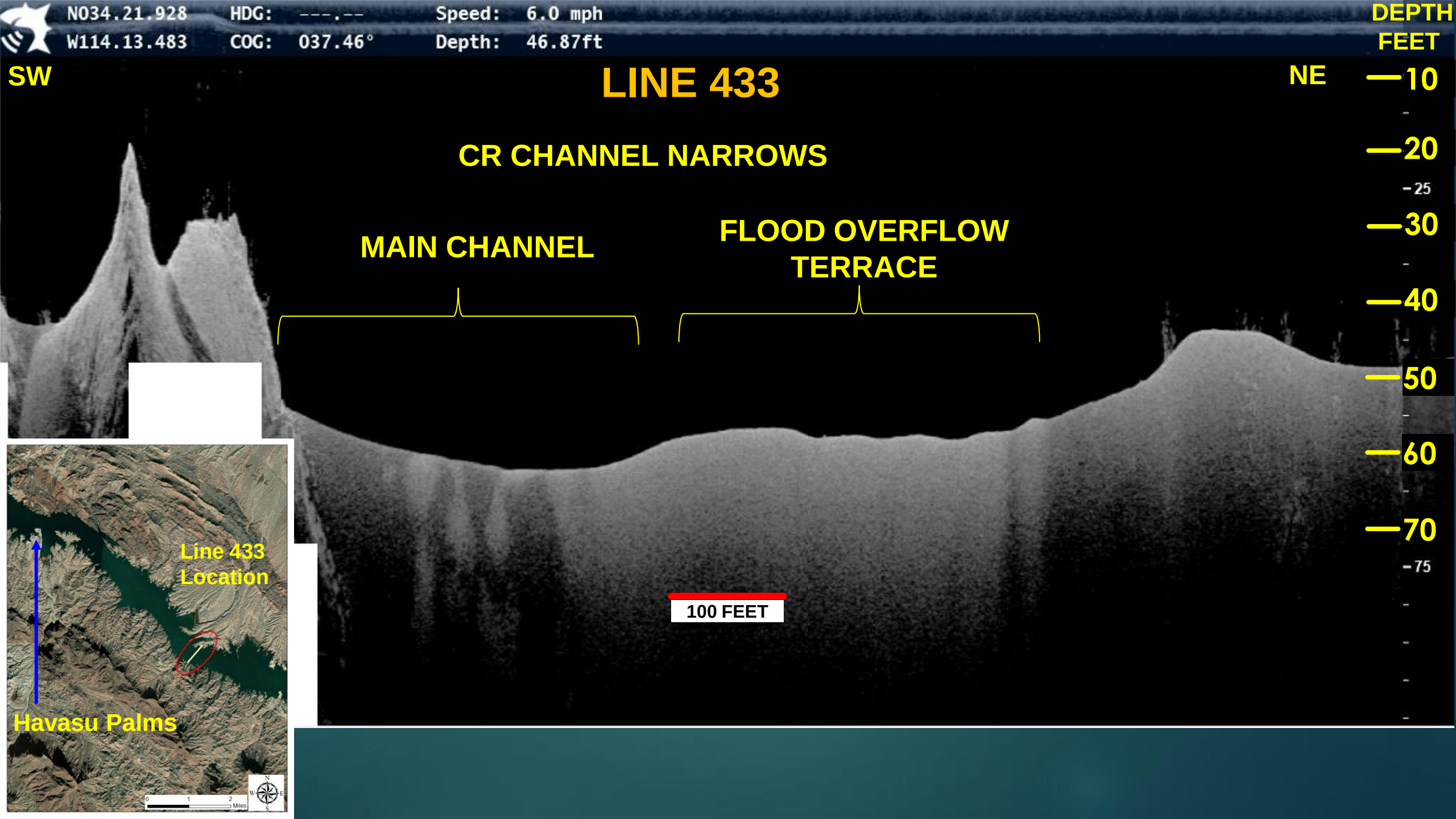

Line 145
Location
0
1
2
Miles
N
W
E
S



Lake Havasu Bathymetric Elevations - South of Island and Thompson Bay - also From Valley to Canyon Section


N034.26.905
W114.19.873
HDG: 087.86°
COG: 091.21°
Speed: 7.1 mph
Depth: 34.09ft
LINE 177
DEPTH FEET
WEST
EAST
DEEP SCOUR AT 90° BEND OF CR CHANNEL
MULTIPLE CHANNEL CUTS
10
20
30
40
50
60
100 FEET
Line 177 Location
0
1
2
Miles
N
W
E
S

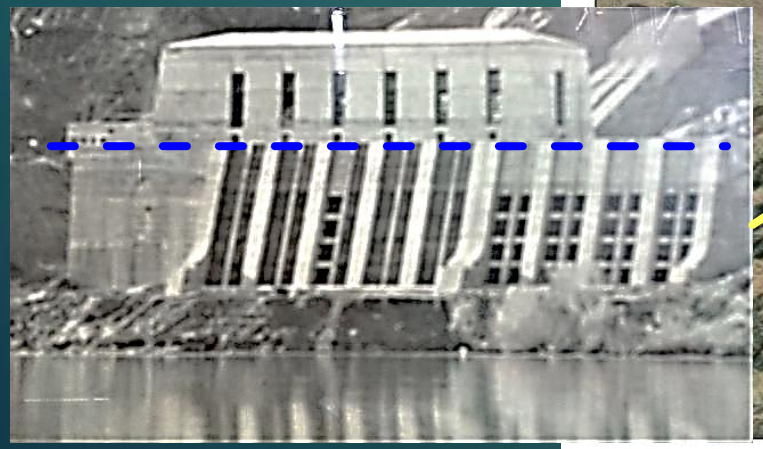

N034.25.832
W114.18.252
HDG: 035.08°
COG: 035.66°
Speed: 5.2 mph
Depth: 37.63ft
DEPTH FEET
SW
NE
LINE 234
CR CHANNEL ENTERING CANYON SECTION
10
20
25
30
40
50
60
100 FEET
Line 234 Location
0
1
2
Miles
N
W
E
S

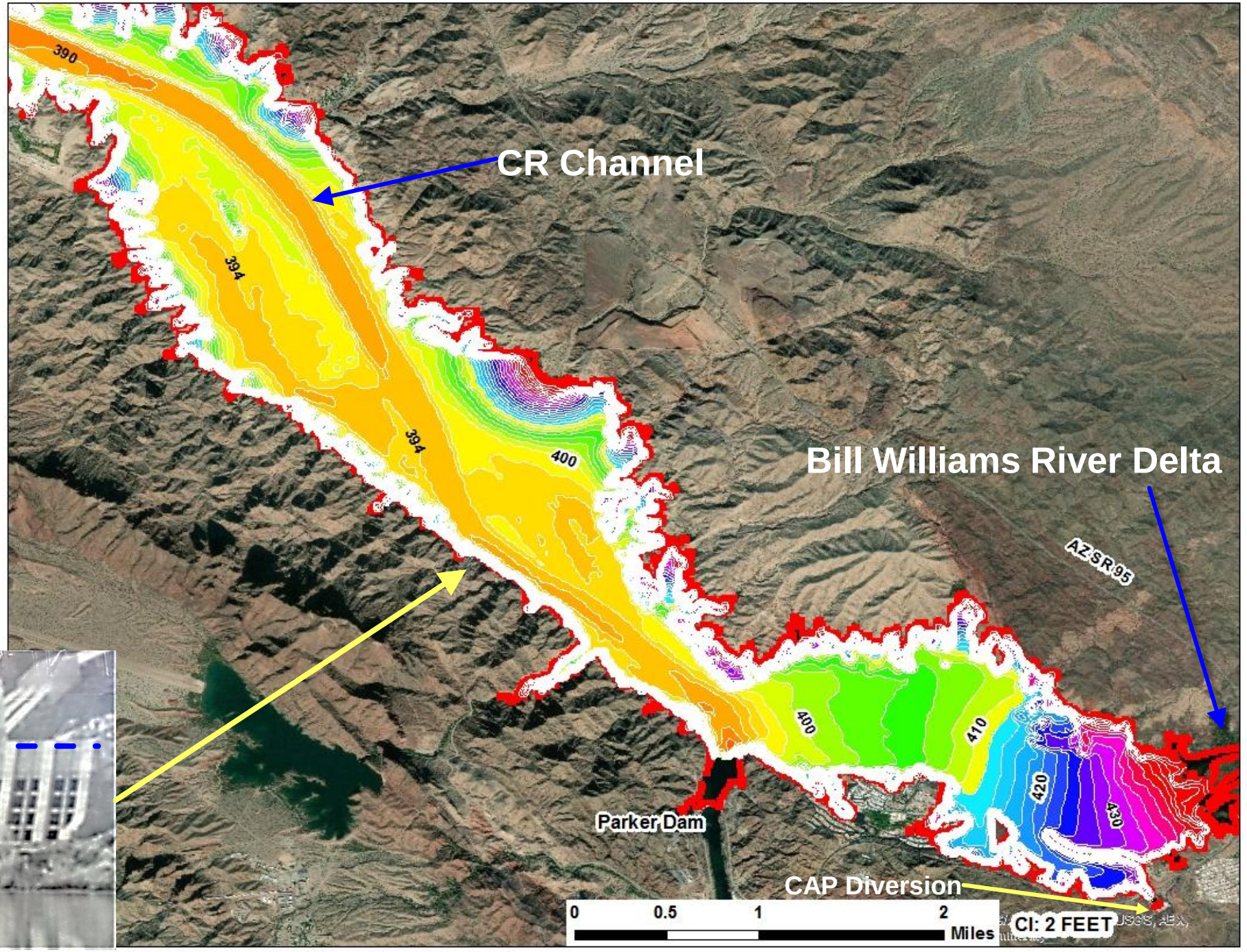

N034.21.928
W114.13.483
HDG: ---.--
COG: 037.46°
Speed: 6.0 mph
Depth: 46.87ft
DEPTH
FEET
SW
NE
LINE 433
CR CHANNEL NARROWS
MAIN CHANNEL
FLOOD OVERFLOW
TERRACE
10
20
25
30
40
50
60
70
75
100 FEET
Line 433
Location
Havasu Palms
0
1
2
Miles
N
W
E
S

South End of Lake Havasu

Normal Lake Havasu Level

Whitsett Pumping Plant - ca. 1938



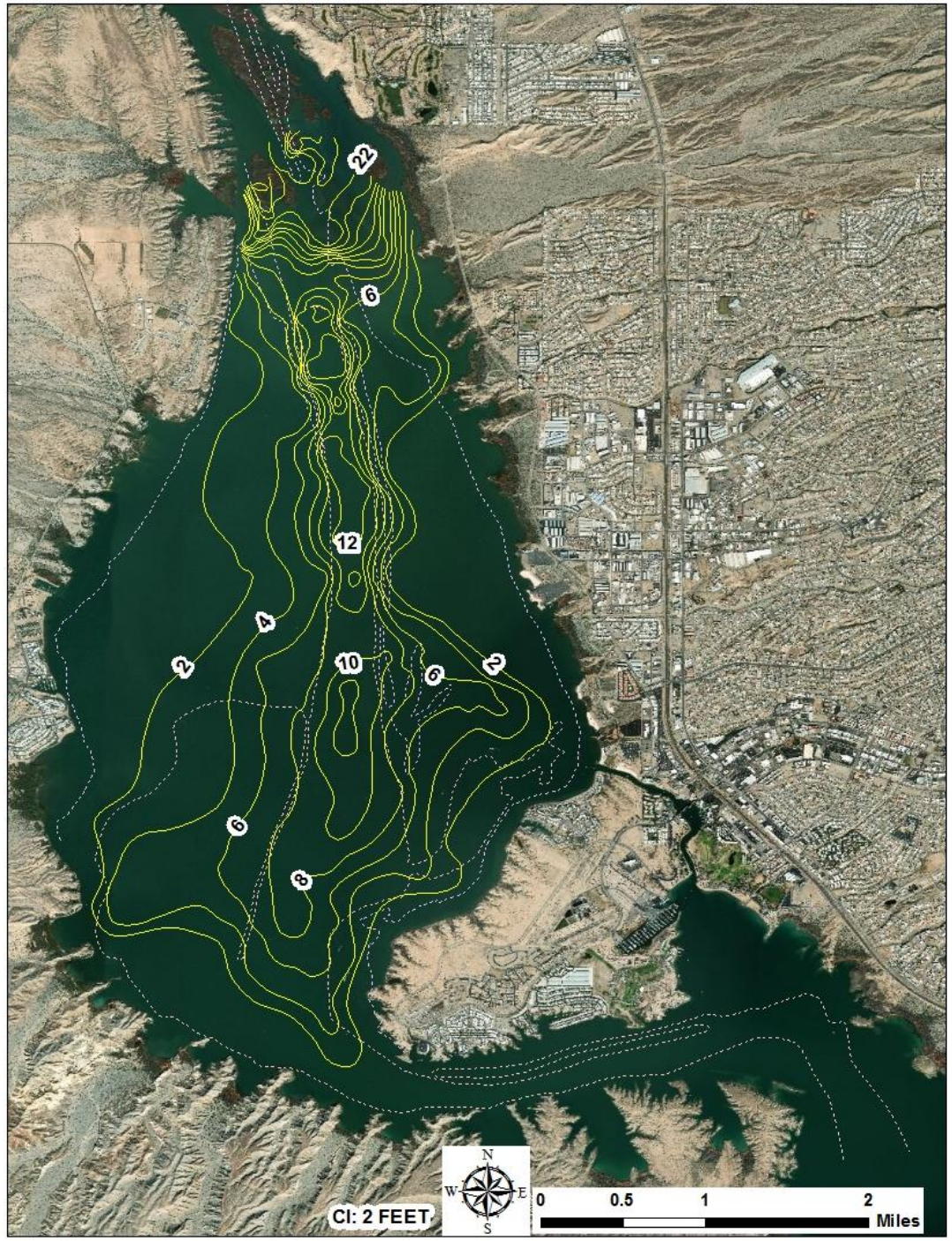


1931 Topography of the Colorado River Floodplain in the Chemehuevi Valley

Current Topography of Lake Havasu

Sediment Thickness on Top of the 1931 Surface

Davis Dam Construction completed in 1950 – Impounding Lake Mohave



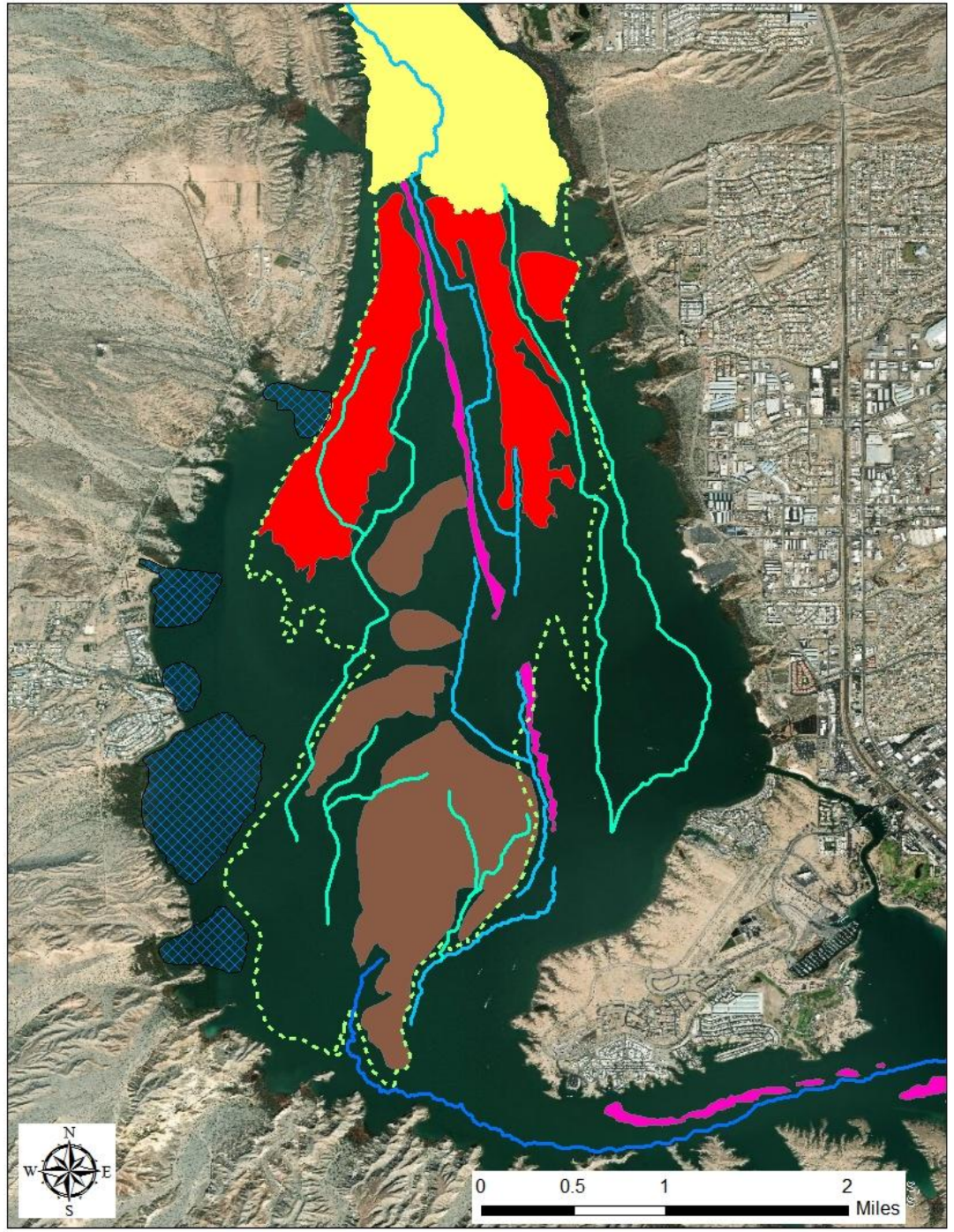
Lake Bottom Hardness Map and Sediment Sand percent in the Chemehuevi Valley

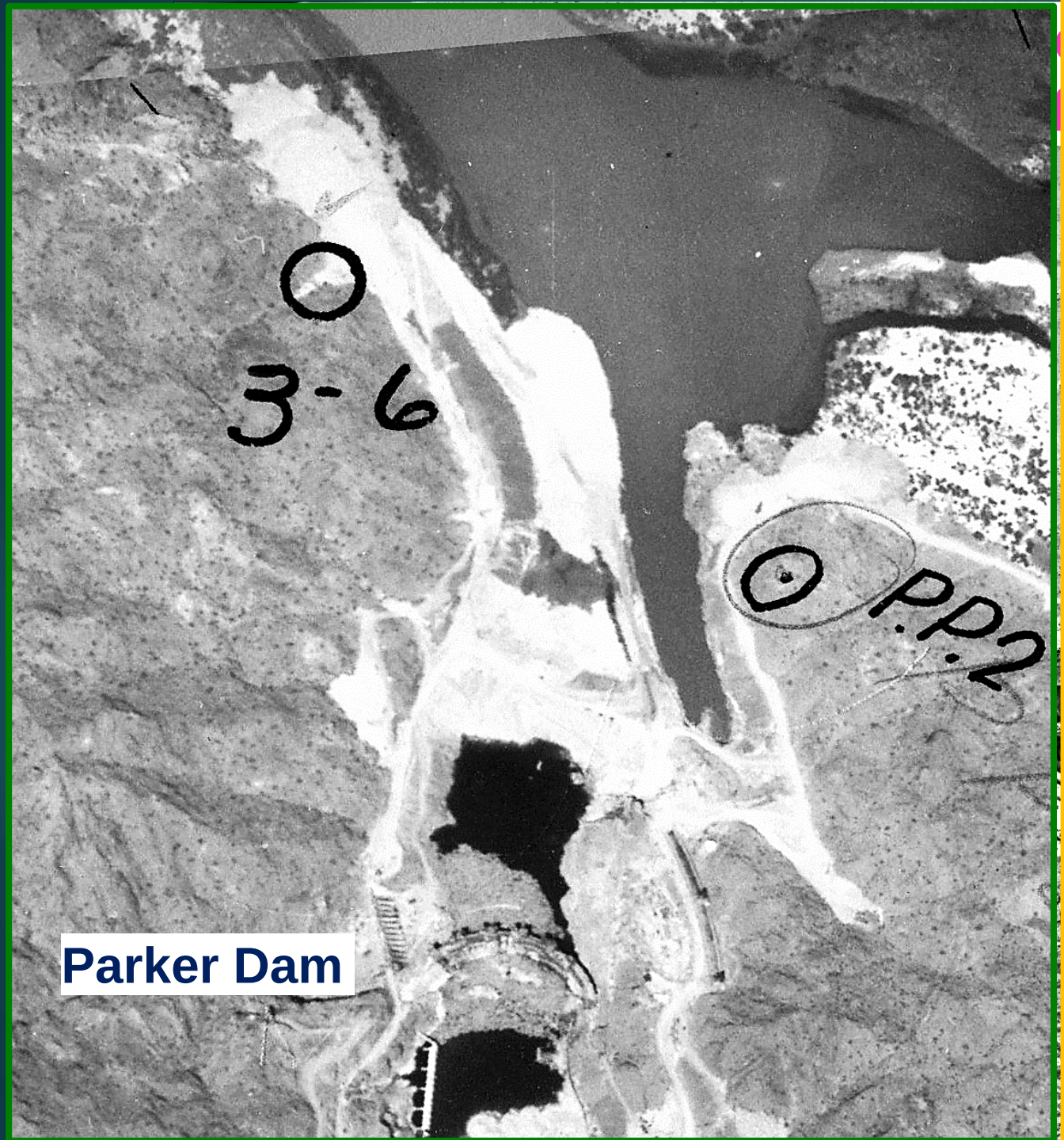
1931 Contours

Sediment Deposits and Post-Lake Channels

- Delta Sands
- Sediment Lobes
- Overbank Deposits
- Alluvial Fans
- Levees

- Colorado River Channel
- Main Secondary Channel
- Secondary Channel
- ~Sediment In-Fill Limit

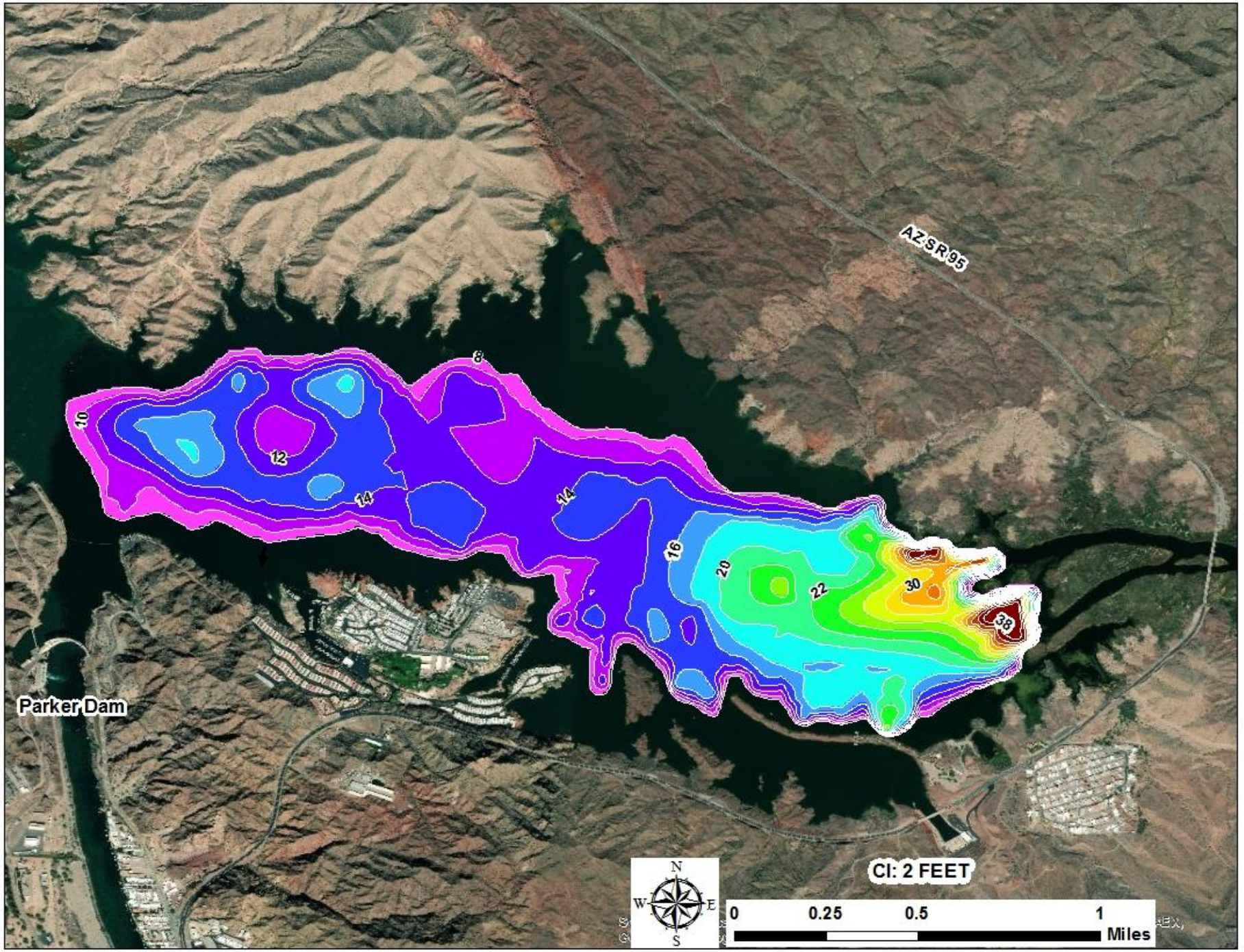



O
3-6
O P.P.2
Parker Dam

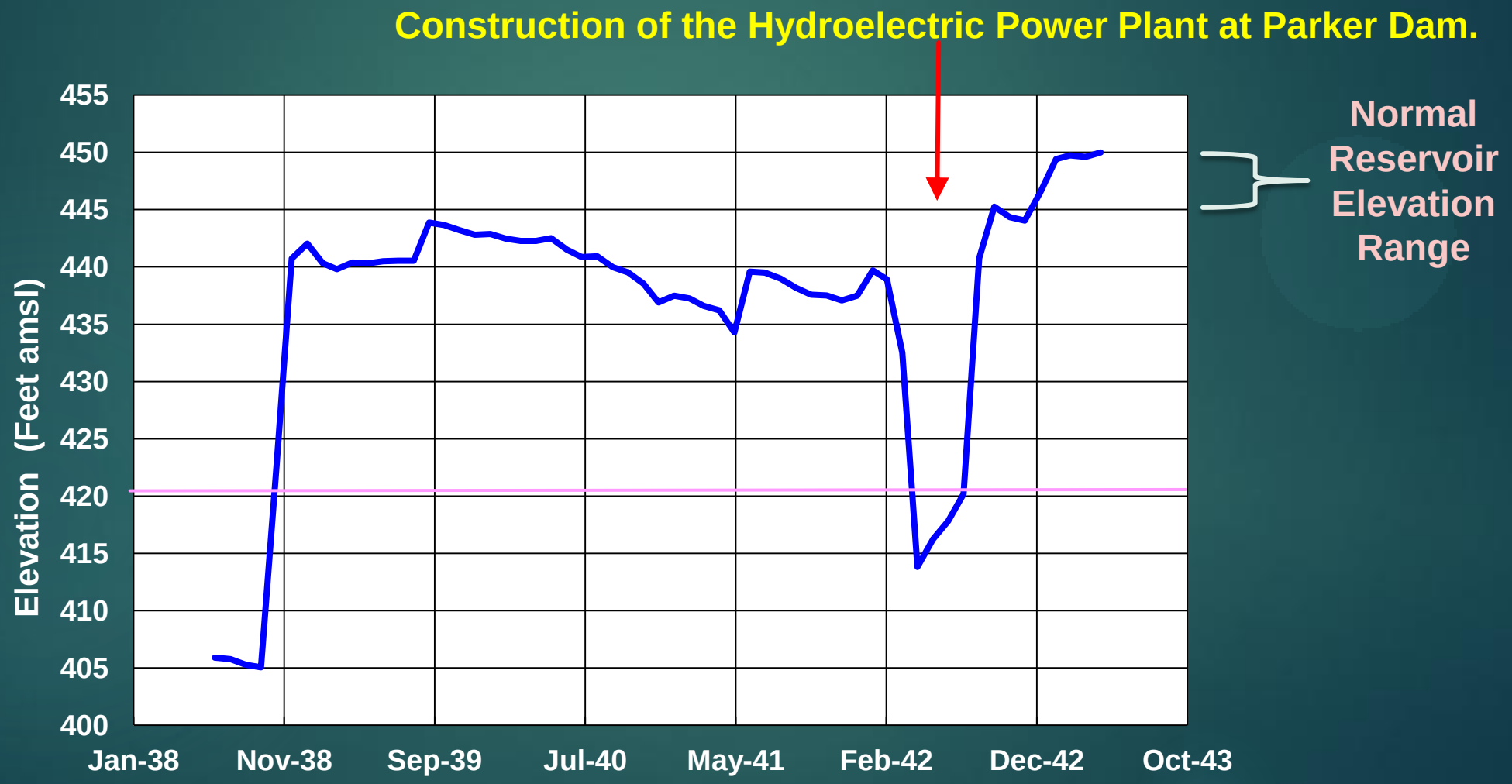

MWD Whitsett
Pumping Plant

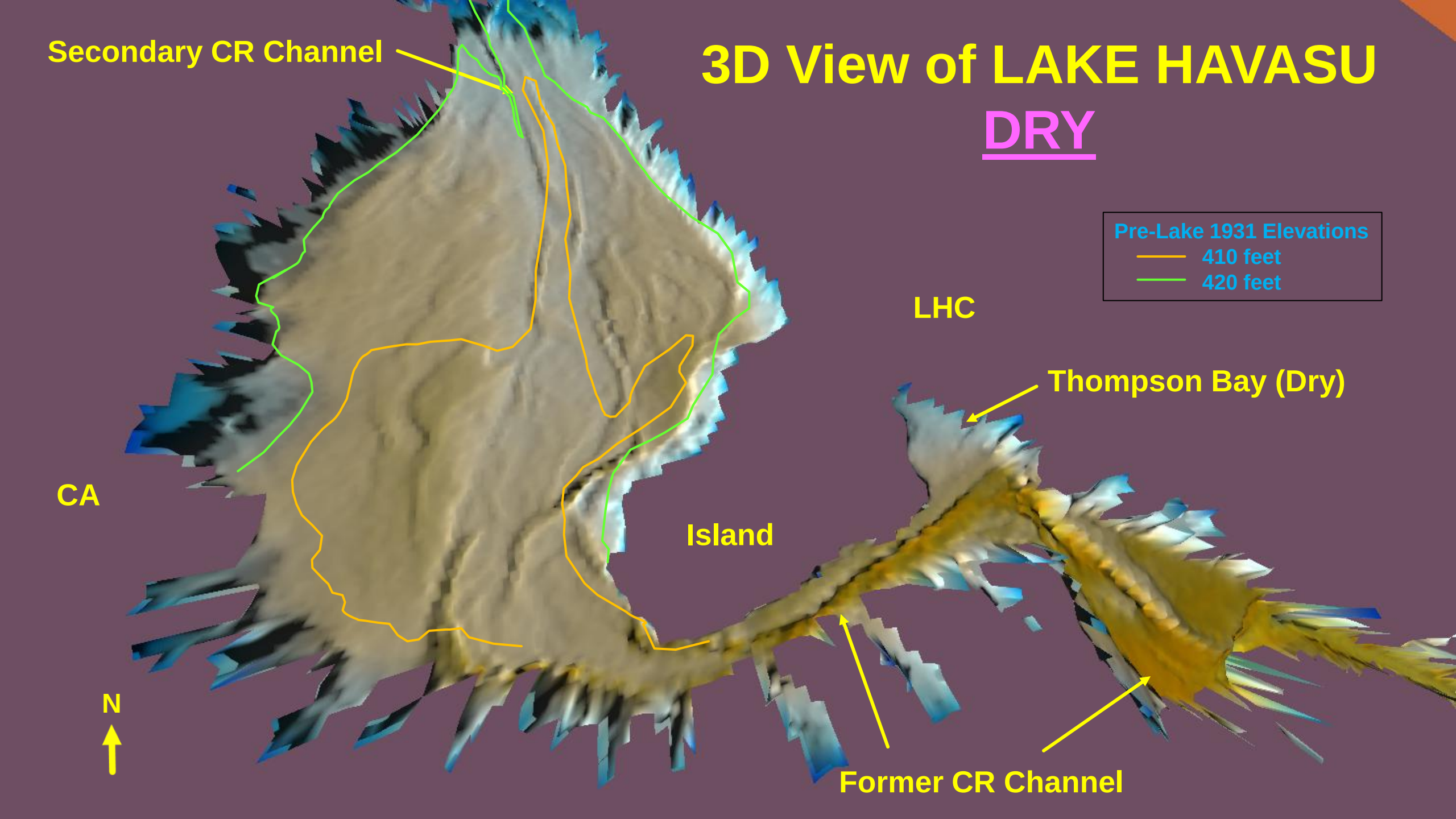
1931 Topography of Bill Williams River Area

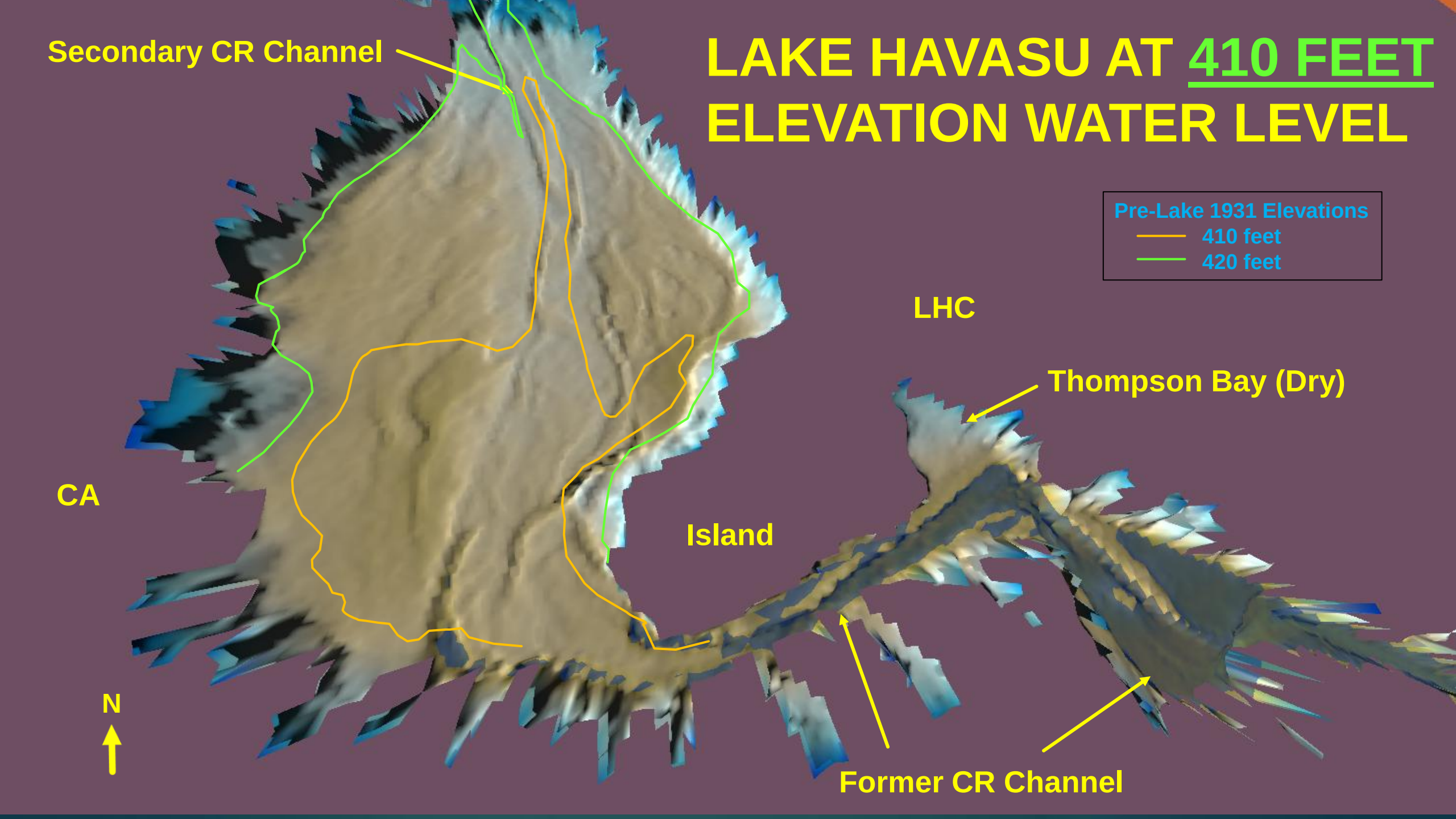
Sediment Thickness on top of the 1931 Surface

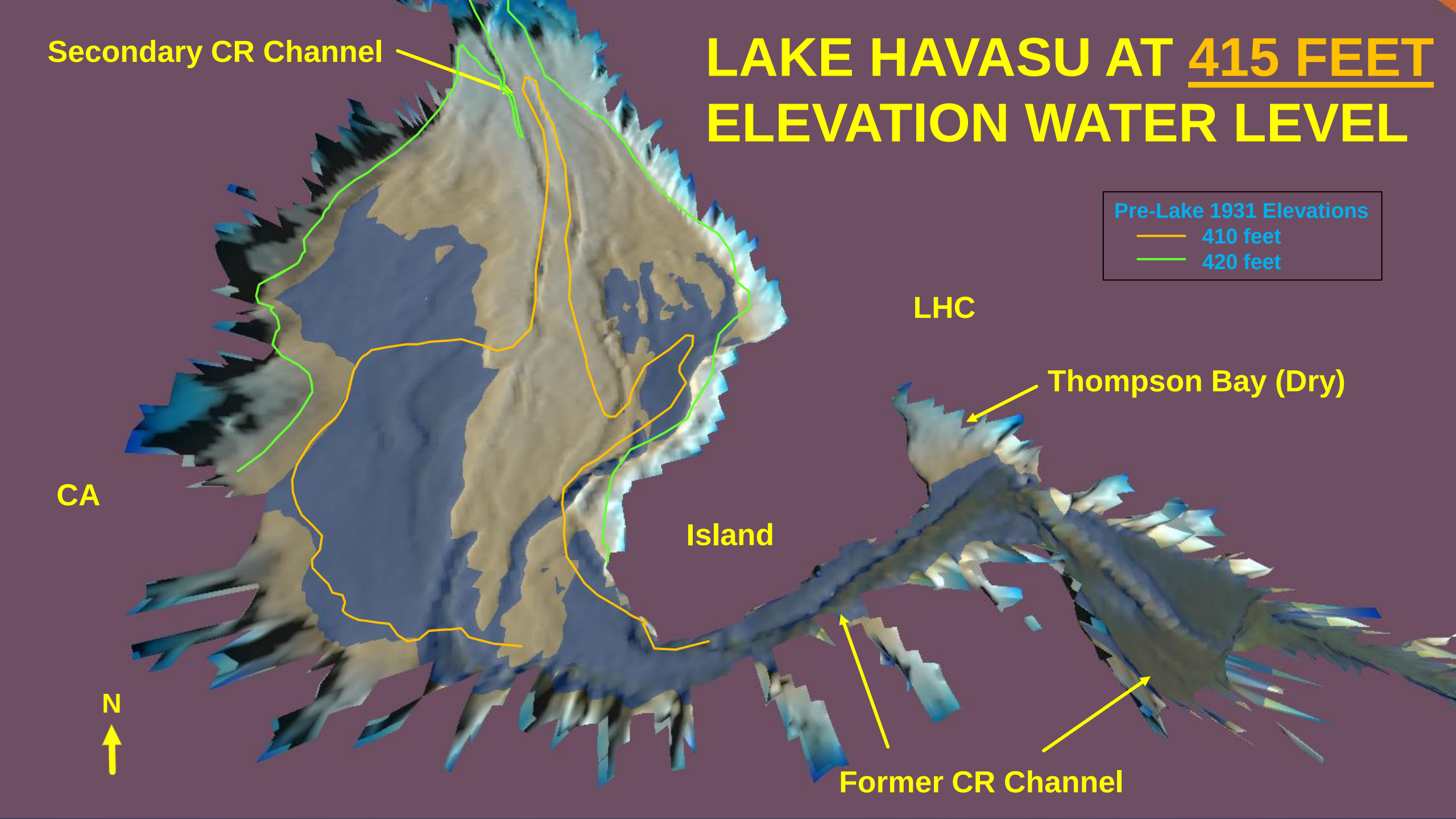


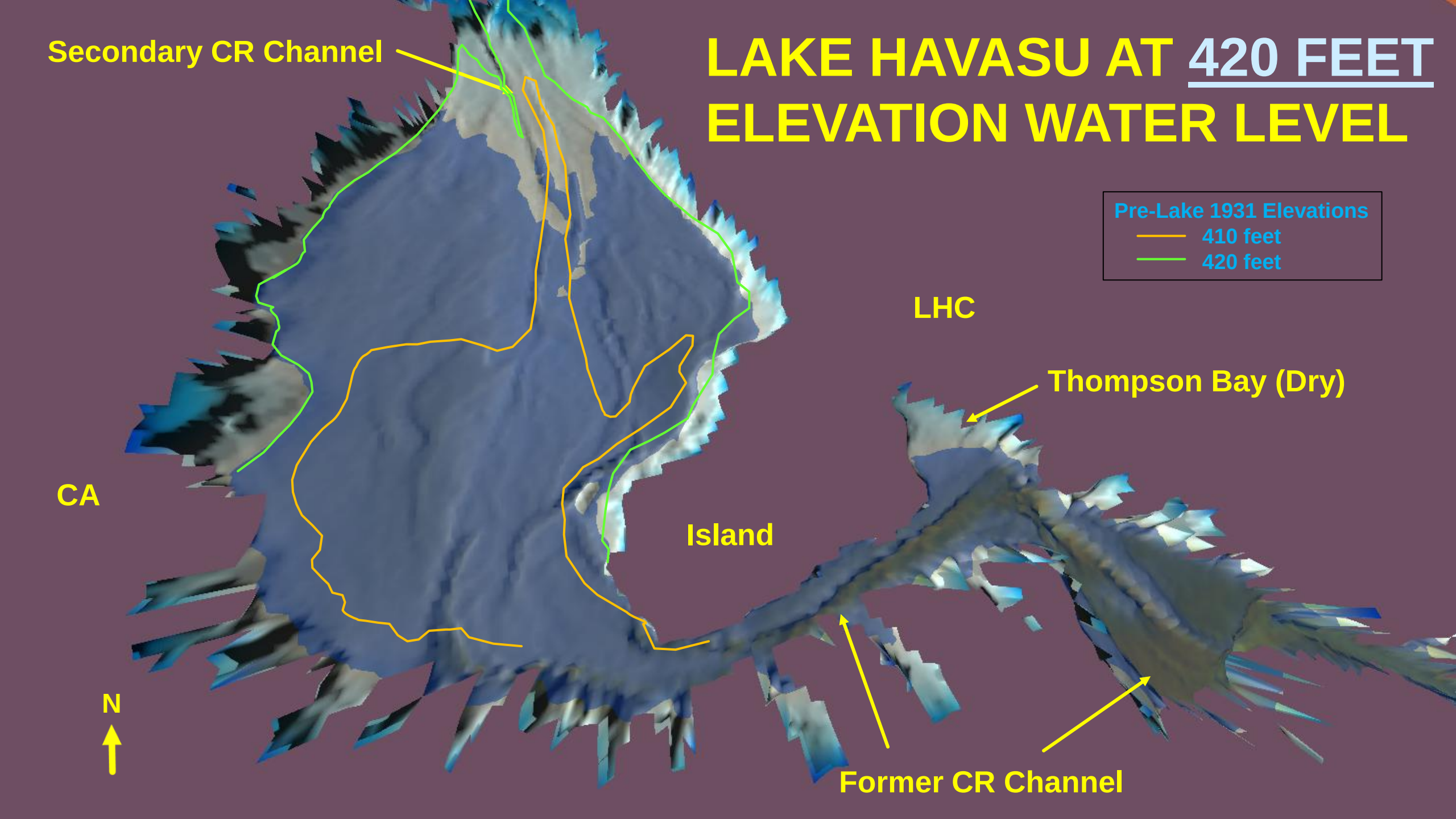
Initial Lake Havasu Impoundment History

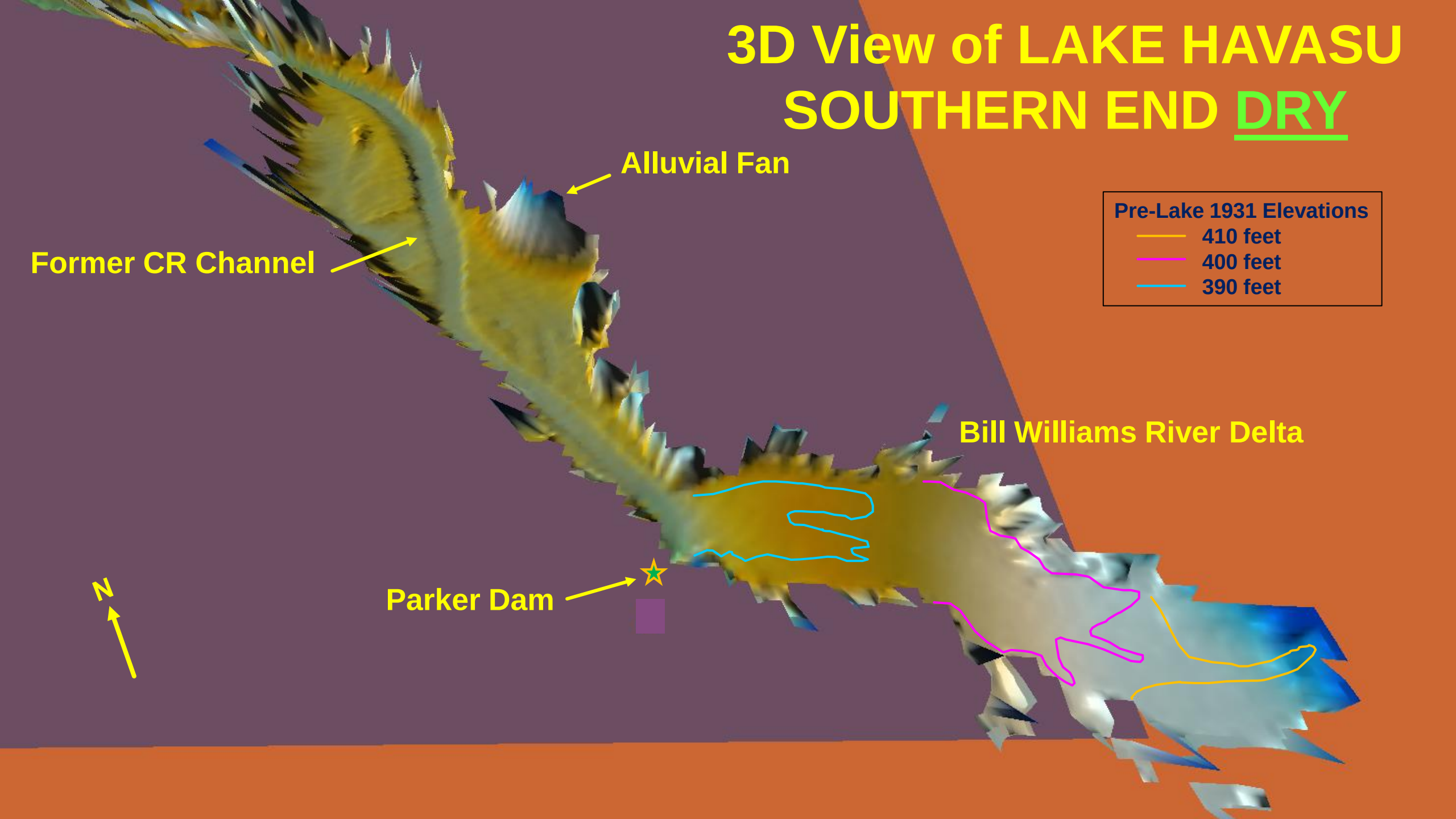



Secondary CR Channel
3D View of LAKE HAVASU
DRY
Pre-Lake 1931 Elevations
410 feet
420 feet
LHC
Thompson Bay (Dry)
CA
Island
N
Former CR Channel

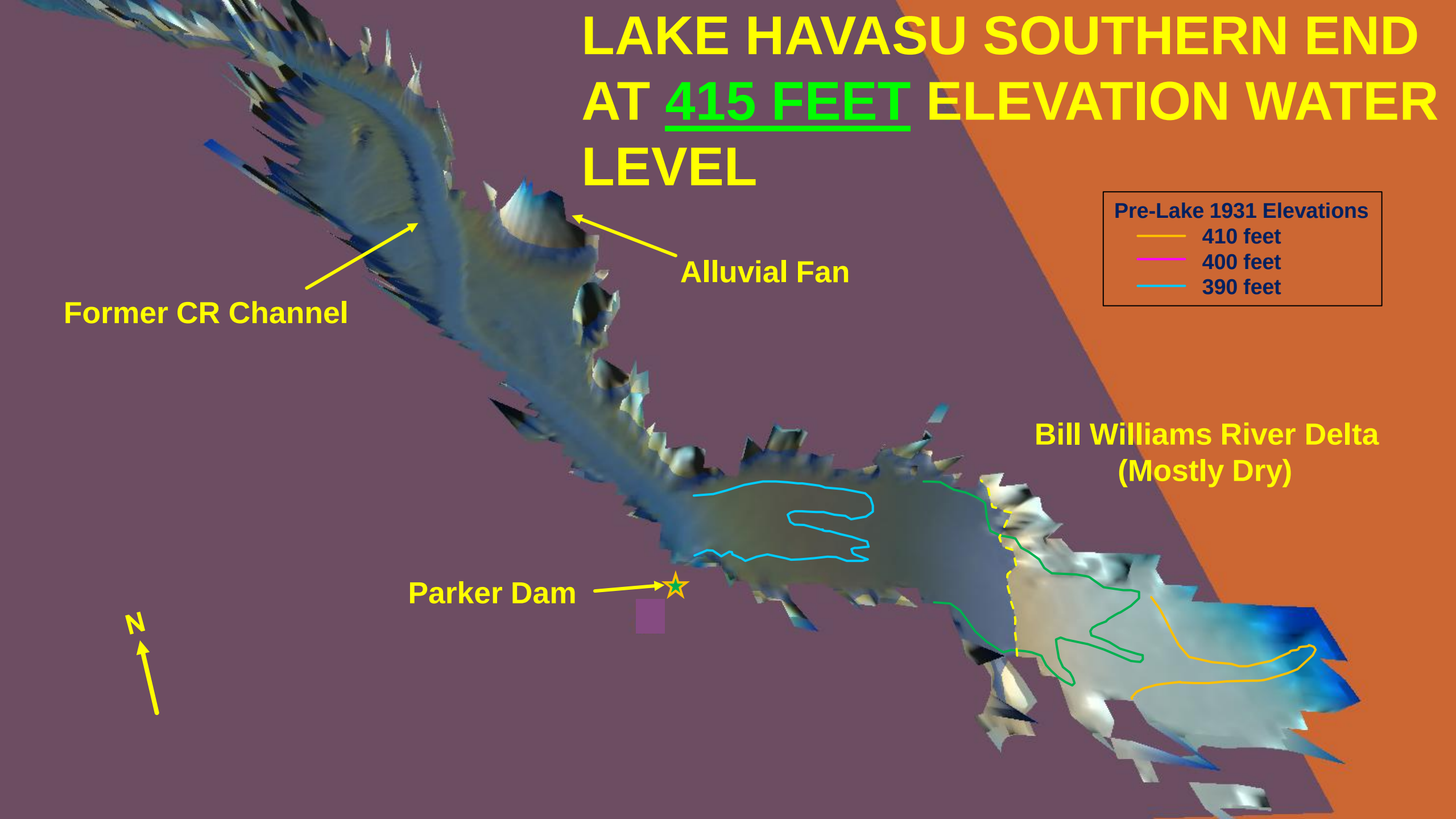

LAKE HAVASU AT 410 FEET
ELEVATION WATER LEVEL
Pre-Lake 1931 Elevations
410 feet
420 feet
Secondary CR Channel
LHC
Thompson Bay (Dry)
CA
Island
N
Former CR Channel


LAKE HAVASU AT 415 FEET
ELEVATION WATER LEVEL
Pre-Lake 1931 Elevations
410 feet
420 feet
Secondary CR Channel
LHC
Thompson Bay (Dry)
CA
Island
N
Former CR Channel


LAKE HAVASU AT 420 FEET
ELEVATION WATER LEVEL
Pre-Lake 1931 Elevations
410 feet
420 feet
Secondary CR Channel
LHC
Thompson Bay (Dry)
CA
Island
N
Former CR Channel


3D View of LAKE HAVASU
SOUTHERN END DRY
Alluvial Fan
Former CR Channel
Pre-Lake 1931 Elevations
410 feet
400 feet
390 feet
Bill Williams River Delta
Parker Dam
N

LAKE HAVASU SOUTHERN END AT 415 FEET ELEVATION WATER LEVEL



CALCULATION OF POST-IMPOUNDMENT SEDIMENT DEPOSITION

Two main sediment inputs:

- Colorado River Inlet Area – ~43-46 million m^3 (34,745 – 37,418 ac-ft)
  - Base Elevation 416’ amsl - 432’ amsl to 444’ amsl going north for lake bottom surface
  - – this does not include the Colorado River north of the main body of the lake.
- Bill Williams Delta - ~11 million m^3 (9,140 ac-ft)
  - Base Elevation 400’ amsl - 405’ amsl to 425’ amsl going east to the Bill Williams River mouth for lake bottom surface

Combined volume = 7.5% of the reservoir available storage calculated by USBOR.

- Their calculations are based on water volume between 400’- 450’ amsl
  - – available capacity of 619,400 ac-ft

Adjusted estimate of available capacity between 575,515ac-ft and 572,842 ac-ft

Stormwater Runoff Impacts to Lake Havasu

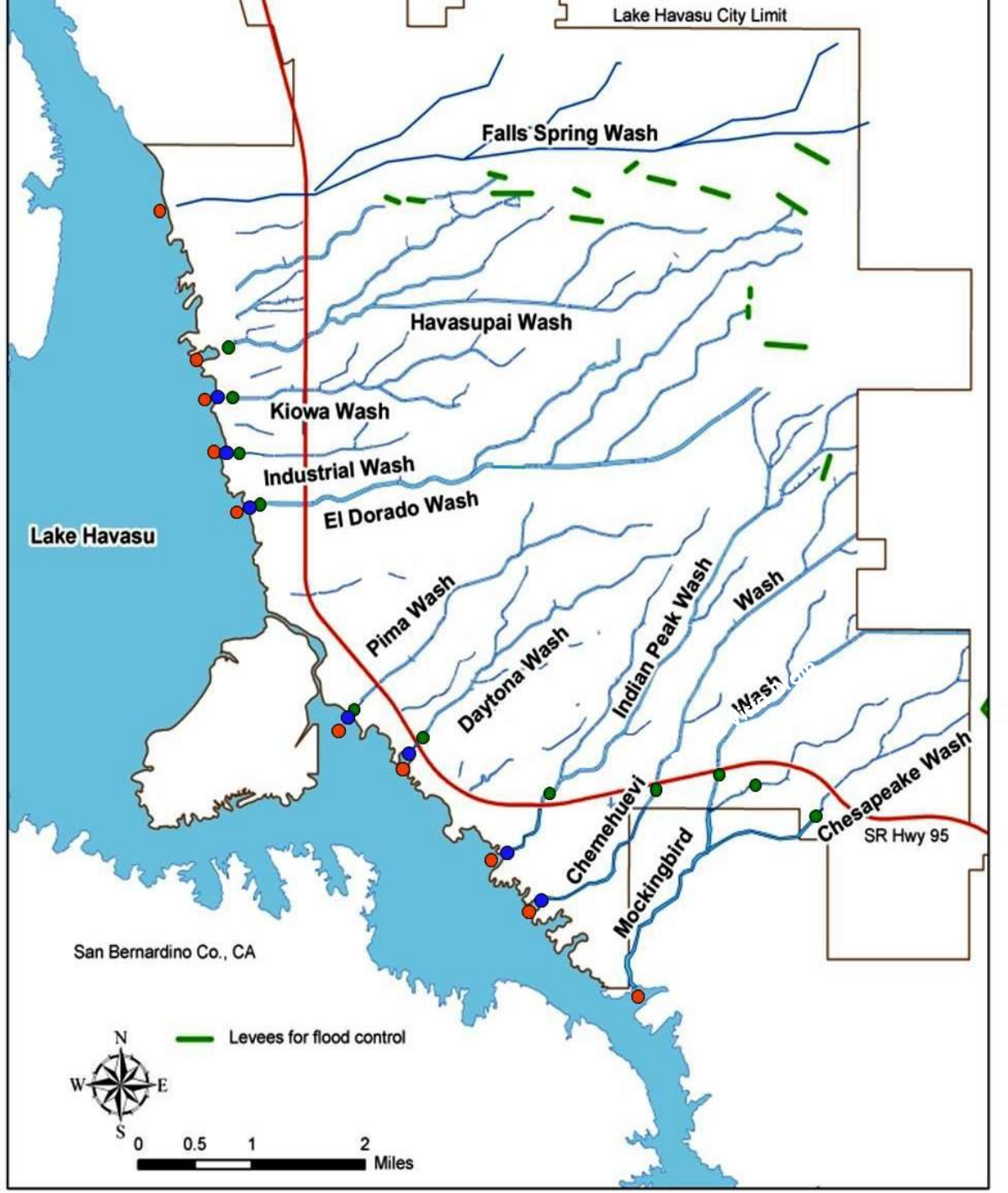
Runoff Events Large and Small

Drainages in Lake Havasu City flow over a dissected, highly disturbed, coalescing alluvial fan system carrying runoff mostly from within the city. Drainage area = 112 km^2

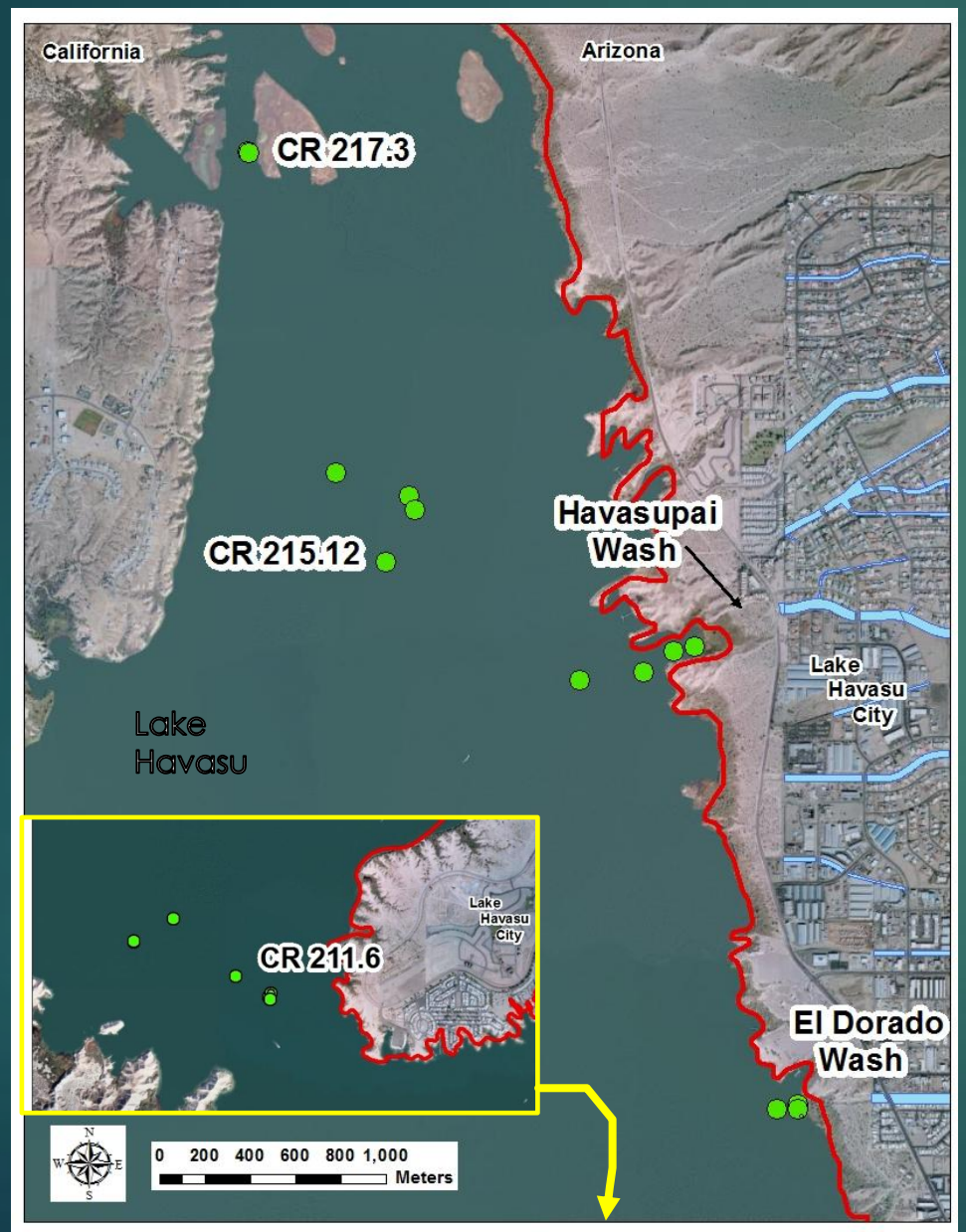
Lake Havasu City Population: ~55,000, swelling to ~80,000 during the winter months.

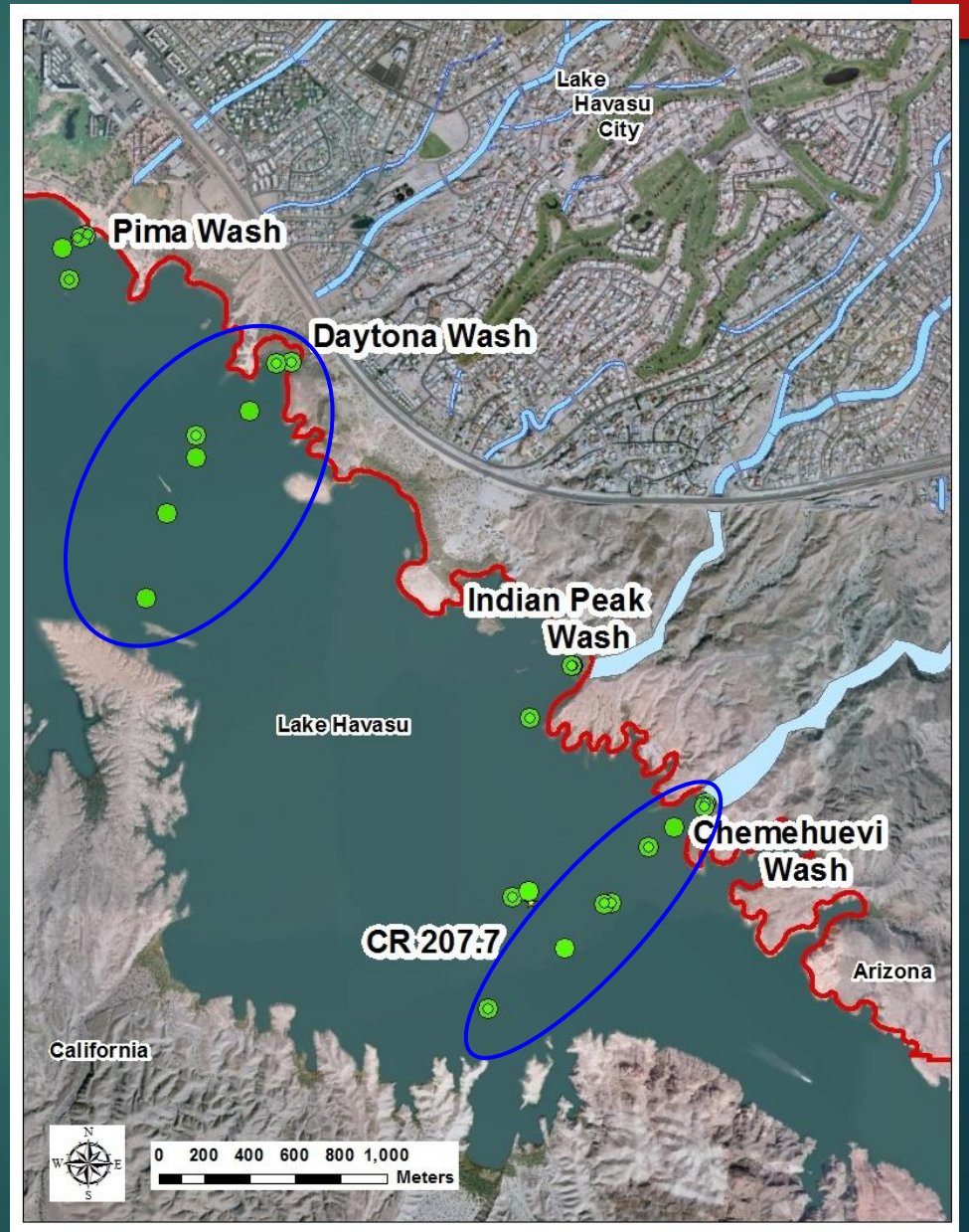
Selected Sample Locations for Stormwater Runoff Study

- Stormwater Runoff Sample
- Groundwater and Sediment Samples
- Lake Sample



Lake Havasu Sediment Sample Sites





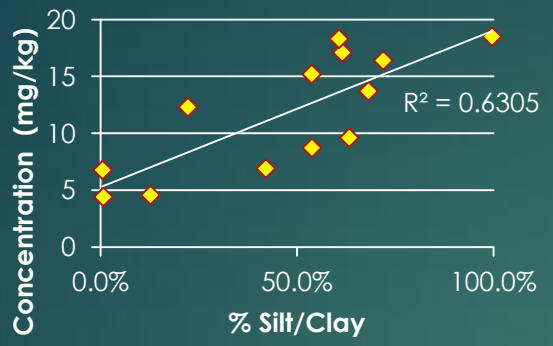
Overall Average Concentrations for all Sample Types

	Detection Limits for Water	EPA Drinking Water MCL	Average Lake	Average Groundwater	Average Stormwater Runoff	Average Sediment
Selected Total Metals	µg/L	µg/L	µg/L	µg/L	µg/L	µg/kg
Arsenic	2.0	10.0	*2.5*	24.0	6.0	3,980
Barium	2.0	2000	118	1,130	215	66,000
Cadmium	1.0	5.0	<1.0	2.3	1.9	55.0
Chromium	3.0	100	<3.0	52.0	19.4	9,694
Cobalt	5.0		<5.0	27.2	14.4	3,423
Copper	2.0	1300 AL	<2.0	64.9	40.4	6,889
Lead	2.0	15 AL	<2.0	61.4	15.6	5,586
Manganese	3.0	50	24.2	2,200	431	129,310
Molybdenum	2.0		*4.5*	7.8	4.9	<909.0
Nickel	5.0		<5.0	52.3	21.4	8,063
Selenium	2.0	50	*3.0*	23.1	5.1	<2,730
Anions	mg/L	mg/L	mg/L	mg/L	mg/L	mg/kg
Nitrate-N	0.1	10.0	0.49	0.92	1.14	2.58
Total Phosphate	0.02		<0.02	1.89	0.66	247
Ortho-phosphate	0.05		<0.05	0.19	0.37	0.64

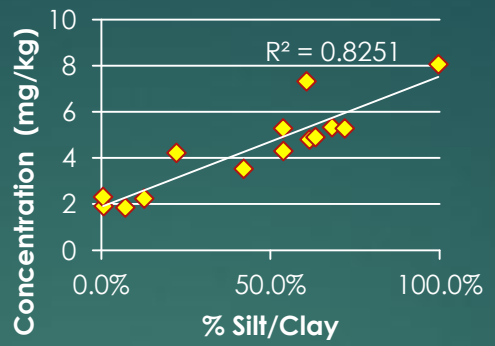
No Antimony or Mercury detected in any samples.

Lake and Wash Mouth Sediments Heavy Metal Concentrations vs Grain size Distribution

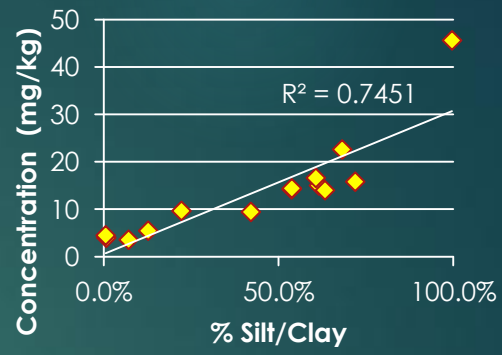
Chromium



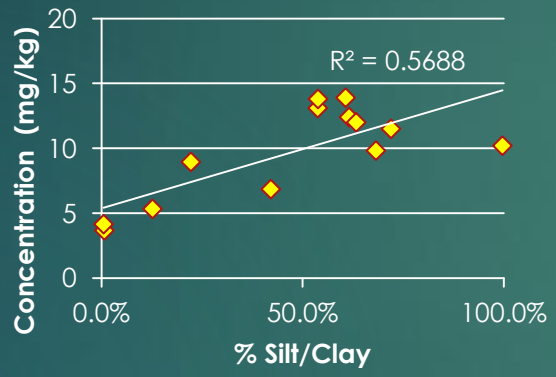
Cobalt



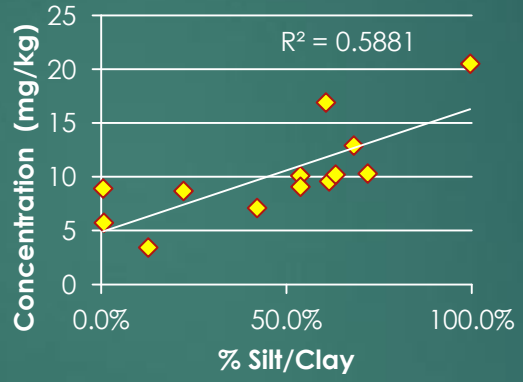
Copper



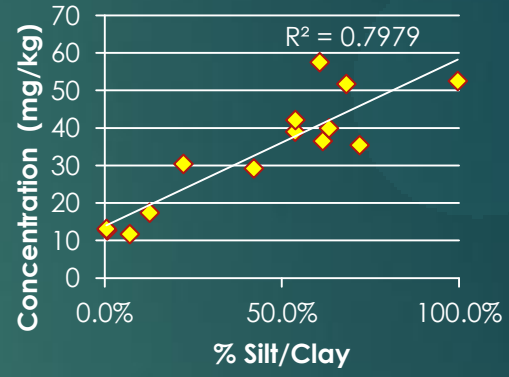
Lead



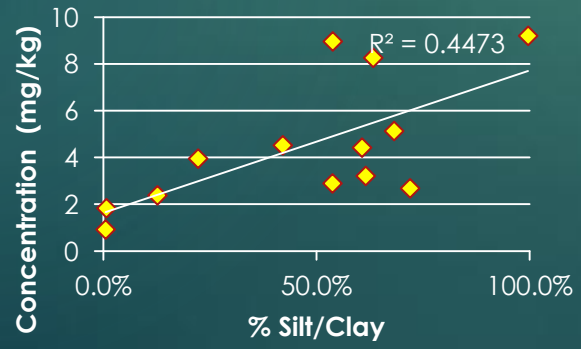
Nickel



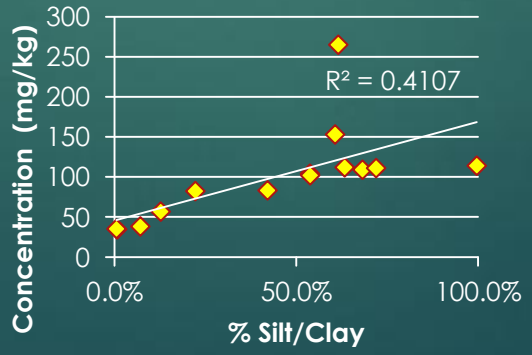
Zinc



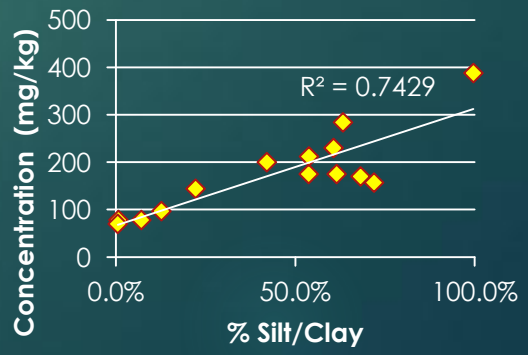
Arsenic



Barium



Manganese

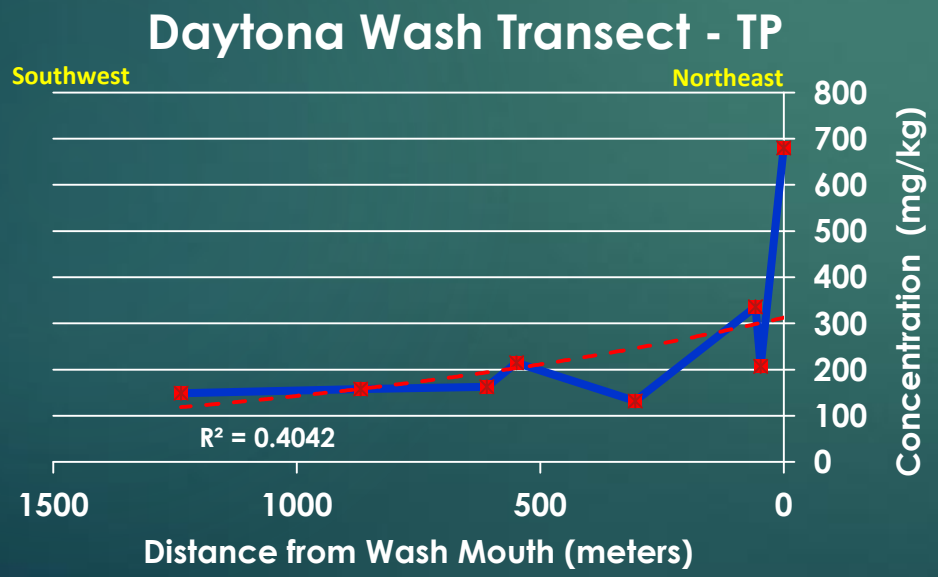


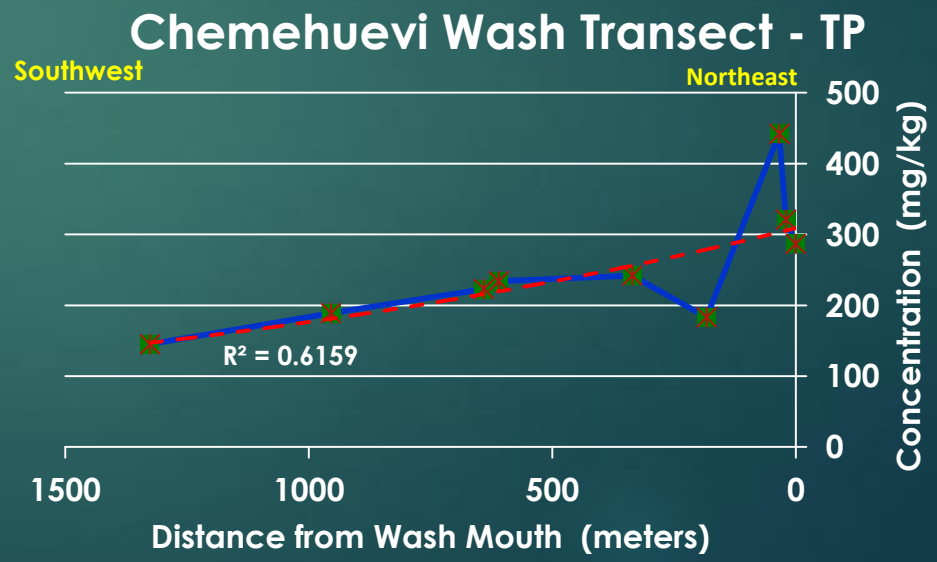
Lake Sediment Average Nutrient Concentrations

All Concentrations in mg/kg

Lake Sediment Averages	Total Phosphate	Ortho-phosphate	Nitrate-N	# Samples	% SAND	%SILT/CLAY
Havasupai	237	0.42	4.20	4	27.6	72.4
El Dorado	223	0.38	<0.4	4	45.9	54.1
Pima	150	0.26	4.96	4		
Daytona	194	0.30	3.82	7	38.2	61.8
Indian Peak	252	0.33	4.47	3	71.5	28.5
Chemehuevi	246	0.60	1.88	10	38.8	61.2
CR217.3	187	0.4	2.03	3	89.9	10.1
CR215.12	275	0.81	1.57	4	30.7	69.3
CR211.6	197	0.53	2.53	4	57.5	42.5
Average of All Samples	207	0.45	3.18	43		

Nutrients:
No Correlation With Grain Size
All R^2 <0.22





QUESTIONS ??