SOME HYDROLOGIC ASPECTS OF UTAH'S GREAT SALT LAKE

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by

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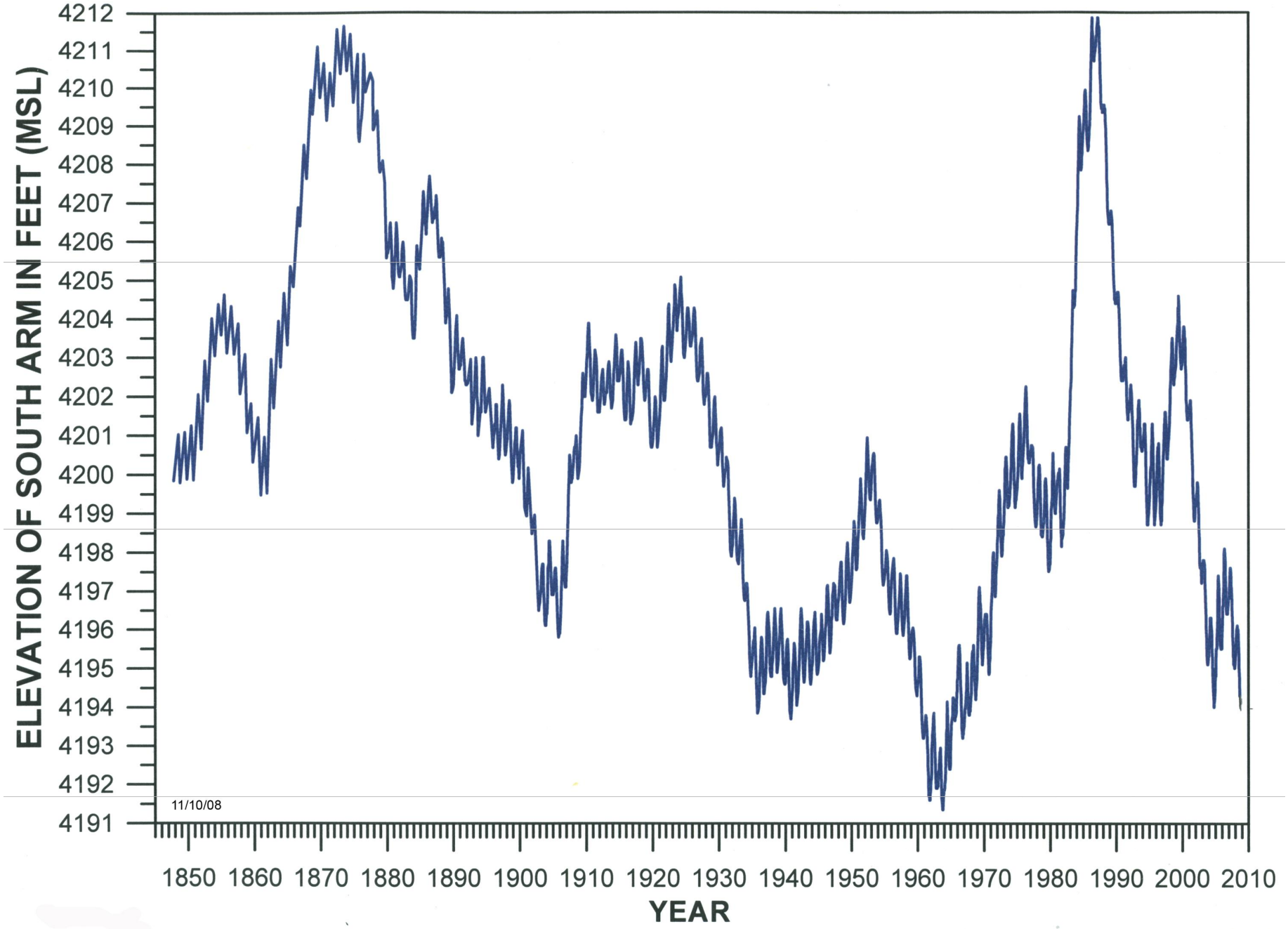
- Great Salt Lake is a terminal lake, that is, there are no rivers leaving the lake.

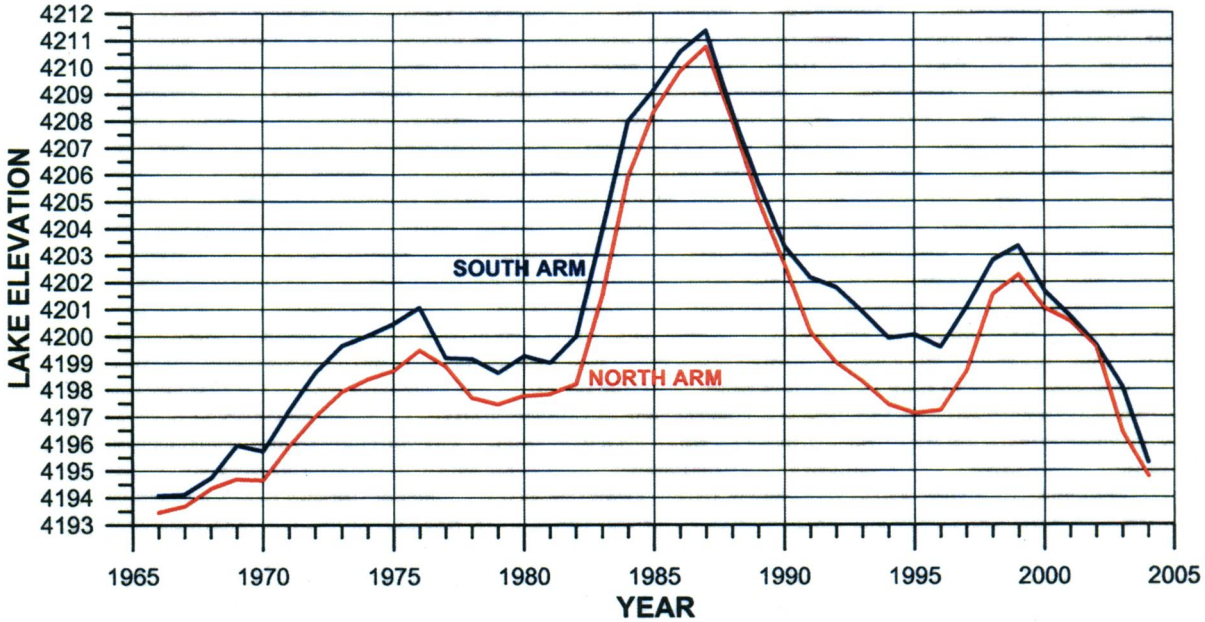
- The lake’s surface elevation depends on the balance between inflows (rivers, streams, precipitation, groundwater) and evaporation.

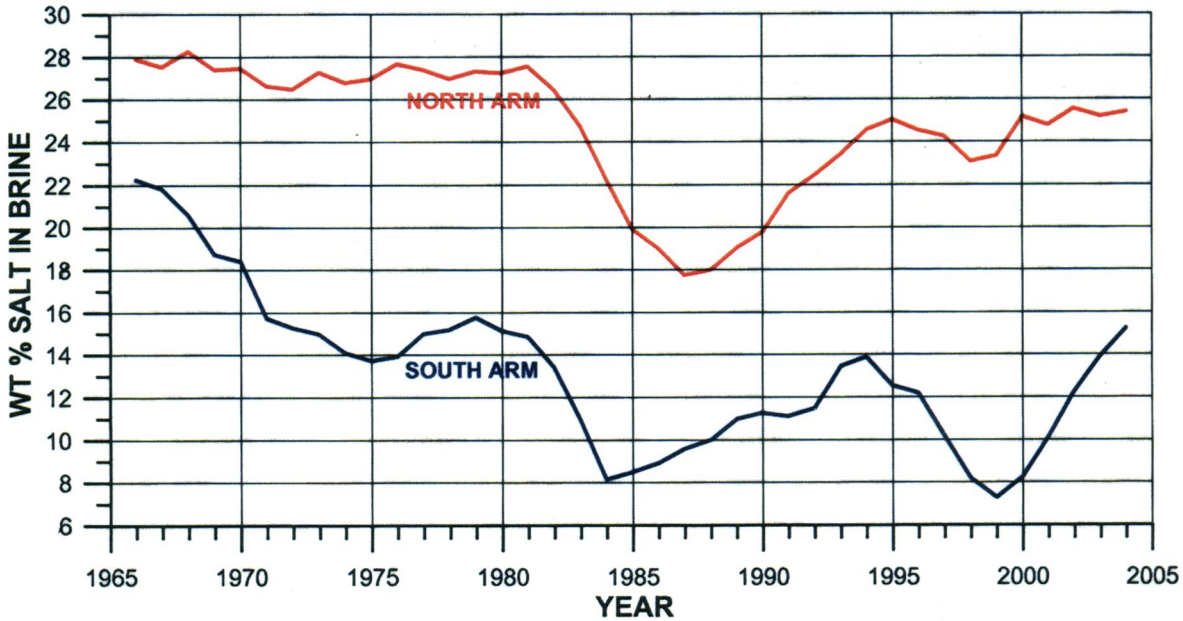
- The lake’s surface elevation has fluctuated between 4193.35 feet in 1963 to nearly 4212 feet in 1873 and again in 1986 and 1987, a range of nearly 19 feet.


ELEVATION OF SOUTH ARM IN FEET (MSL)
4212
4211
4210
4209
4208
4207
4206
4205
4204
4203
4202
4201
4200
4199
4198
4197
4196
4195
4194
4193
4192
4191
11/10/08
1850 1860 1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010
YEAR

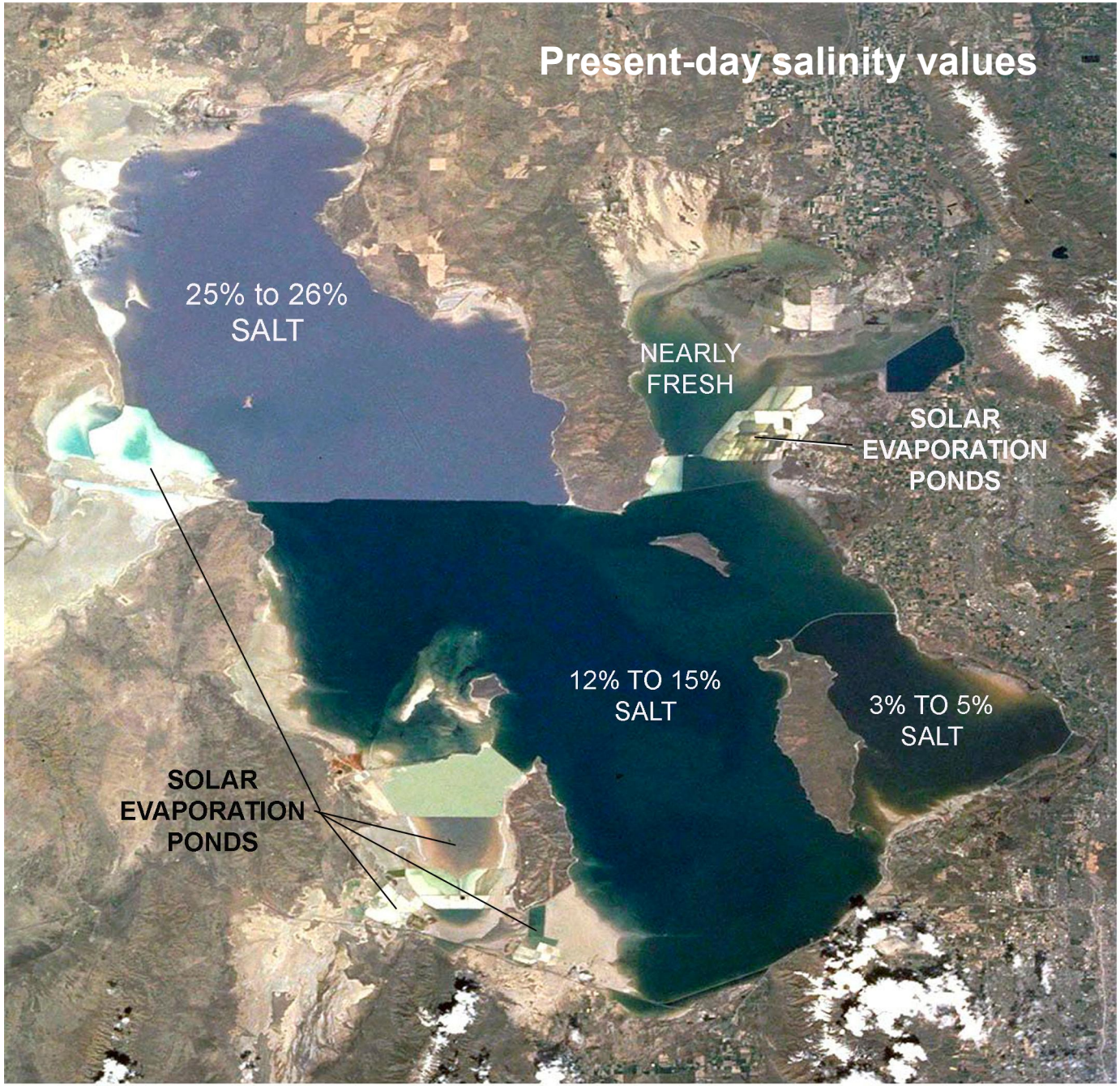
- The salinity of Great Salt Lake changes inversely with lake elevation, that is, as the lake rises, the salinity drops, and as the lake drops, the salinity rises.

- Because the south arm receives the majority of the fresh-water input, and the north arm receives mainly salty from the south arm, the north arm's salinity is not as responsive to lake-level changes as the south arm. Salt precipitates on the bottom of the north arm during low-water years.


LAKE ELEVATION
4212
4211
4210
4209
4208
4207
4206
4205
4204
4203
4202
4201
4200
4199
4198
4197
4196
4195
4194
4193
SOUTH ARM
NORTH ARM
1965
1970
1975
1980
1985
1990
1995
2000
2005
YEAR

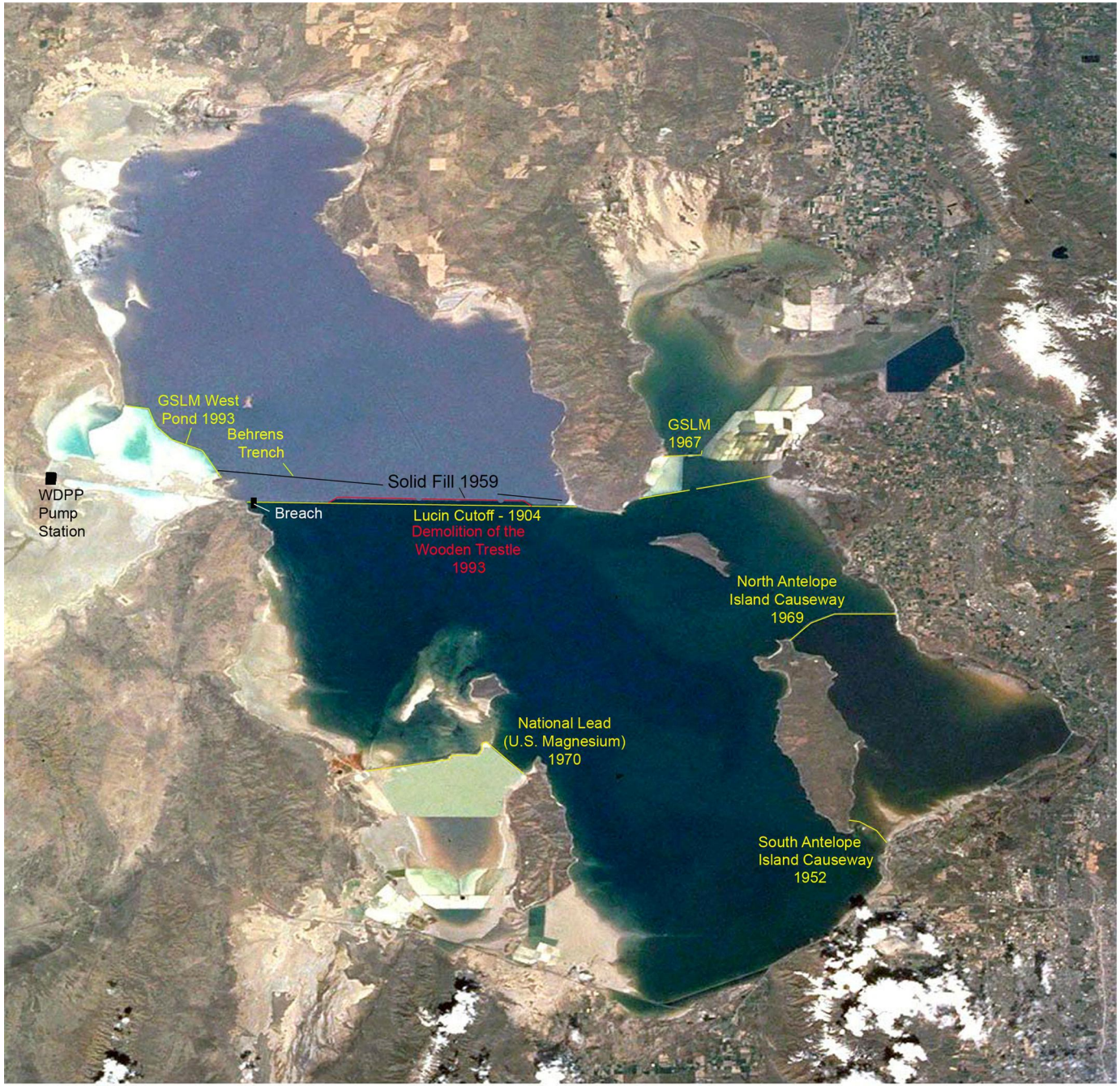

WT % SALT IN BRINE
30
28
26
24
22
20
18
16
14
12
10
8
6
NORTH ARM
SOUTH ARM
1965
1970
1975
1980
1985
1990
1995
2000
2005
YEAR

- The causeways and dikes that have been built within the lake have created different salinities in different parts of the lake.


Present-day salinity values
25% to 26%
SALT
NEARLY
FRESH
SOLAR
EVAPORATION
PONDS
12% TO 15%
SALT
3% TO 5%
SALT
SOLAR
EVAPORATION
PONDS

- Causeways have been built for the purpose of railroad or vehicle transportation.

- Dikes have been constructed to create solar evaporation ponds for the mineral extraction industries.

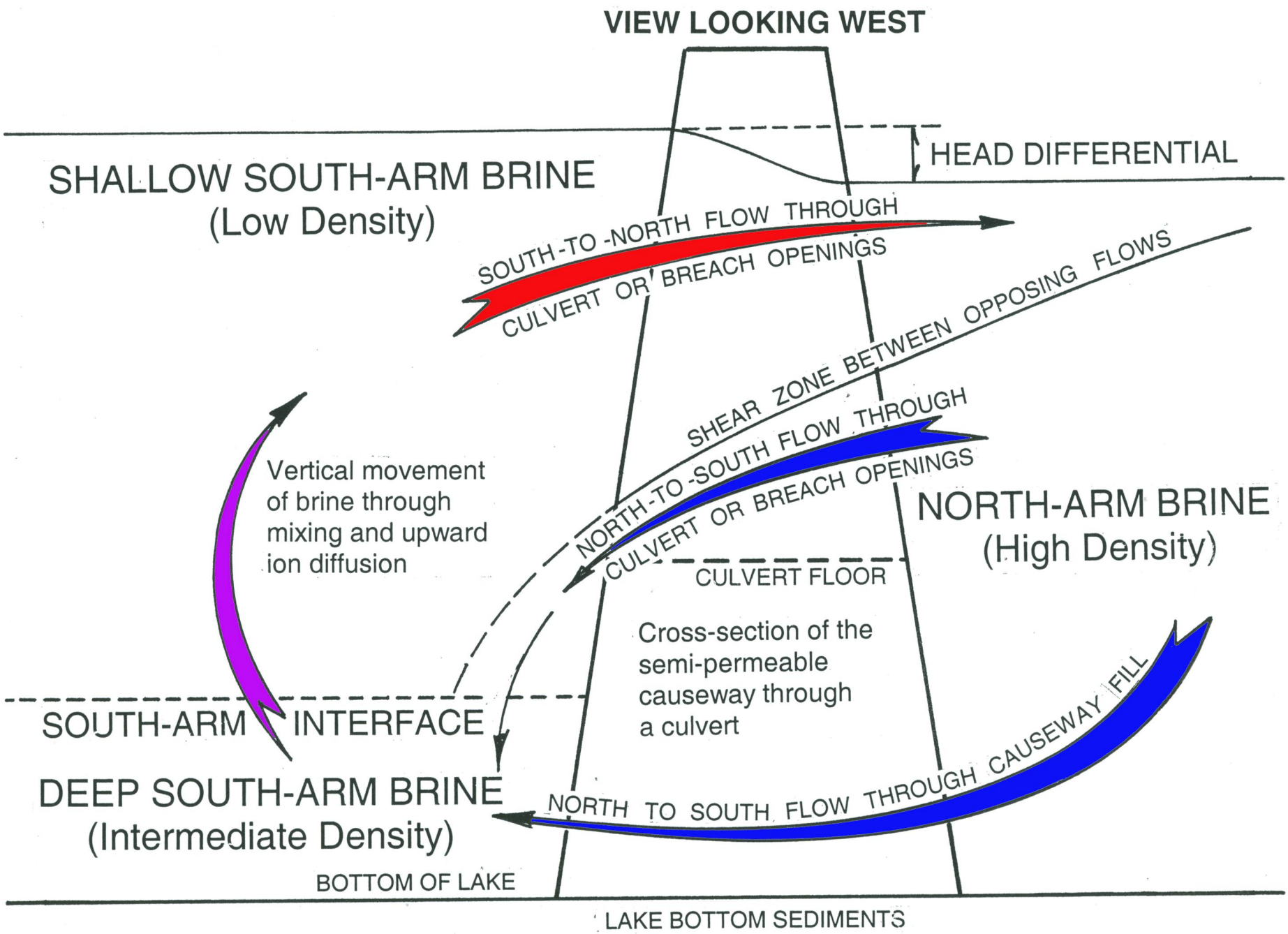

GSLM West
Pond 1993
Behrens
Trench
WDPP
Pump
Station
Solid Fill 1959
Breach
Lucin Cutoff - 1904
Demolition of the
Wooden Trestle
1993
GSLM
1967
North Antelope
Island Causeway
1969
National Lead
(U.S. Magnesium)
1970
South Antelope
Island Causeway
1952

- There is an exchange of brine between the south and north arms of the lake.

- South arm brine flows into the north arm as surficial flow, and north arm brine can flow into the south arm, at depth, under certain conditions.

- This movement of brine in two directions is called bi-directional flow.

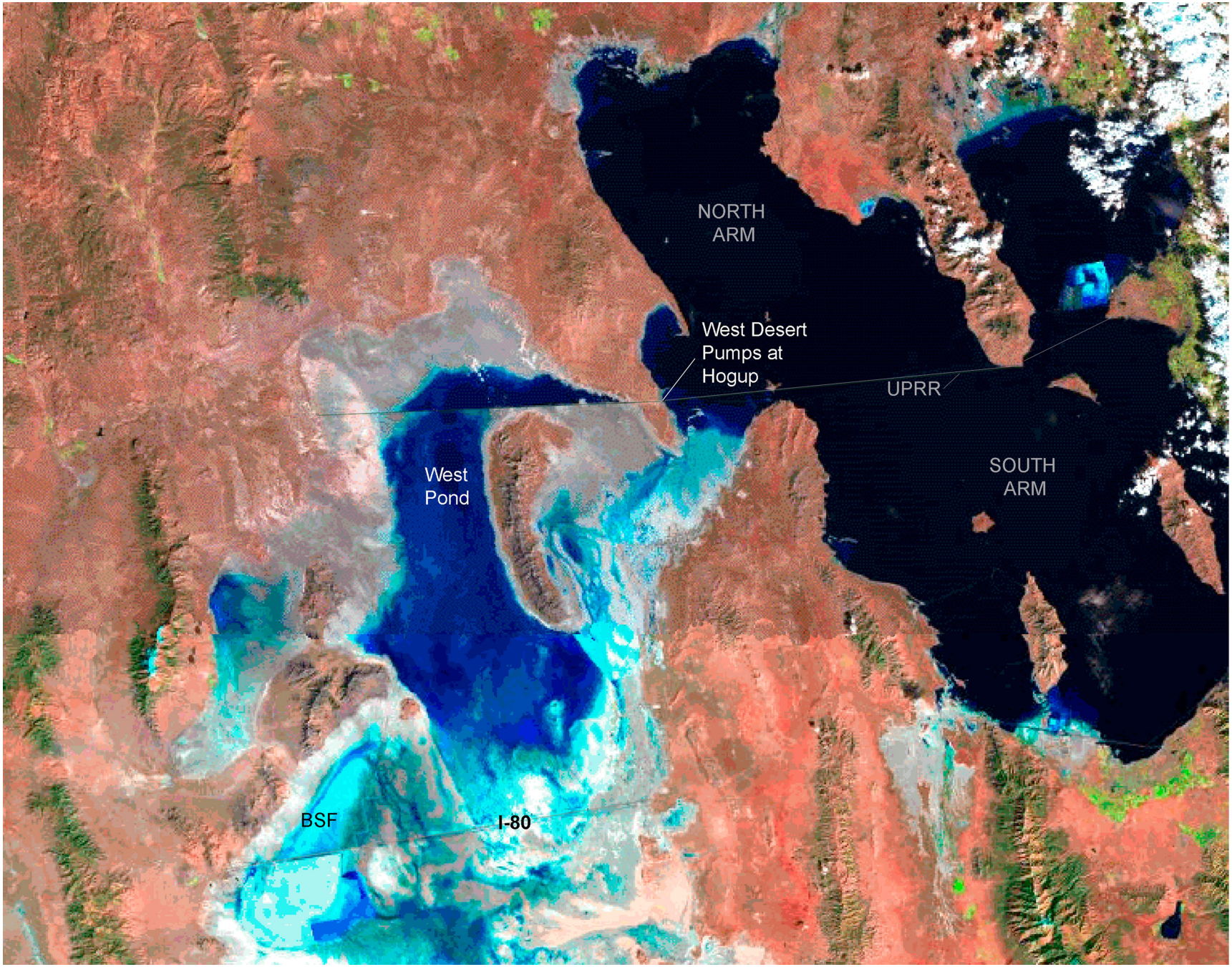
- Bi-directional flow is responsible for the creation and maintenance of a deep, dense, south arm brine.


VIEW LOOKING WEST
HEAD DIFFERENTIAL
SHALLOW SOUTH-ARM BRINE
(Low Density)
SOUTH-TO-NORTH FLOW THROUGH
CULVERT OR BREACH OPENINGS
SHEAR ZONE BETWEEN OPPOSING FLOWS
NORTH-TO-SOUTH FLOW THROUGH
CULVERT OR BREACH OPENINGS
Vertical movement
of brine through
mixing and upward
ion diffusion
NORTH-ARM BRINE
(High Density)
CULVERT FLOOR
Cross-section of the
semi-permeable
causeway through
a culvert
SOUTH-ARM INTERFACE
DEEP SOUTH-ARM BRINE
(Intermediate Density)
NORTH TO SOUTH FLOW THROUGH CAUSEWAY FILL
BOTTOM OF LAKE
LAKE BOTTOM SEDIMENTS

- Two major flood-control measures were been implemented on the lake during the mid to late 1980s. Both projects had major impacts on the lake.

- In 1984, the Southern Pacific Railroad causeway was breached to reduce the head differential of nearly 3.5 feet that had developed between the south and north arms of the lake. A great mixing of the lake brines followed the opening of the breach.

- In 1987, the West Desert Pumping project was implemented to add additional evaporation area to the lake and help to reduce its elevation. This project helped to reduce the lake's level by over two feet during the 26 months it operated. Nearly 12 to 14 percent of the total salt load of the lake was left our in the west pond after the pumping ceased.


NORTH
ARM
West Desert
Pumps at
Hogup
UPRR
SOUTH
ARM
West
Pond
BSF
I-80