UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	Docket No. 72-22-ISFSI
PRIVATE FUEL STORAGE, LLC (Independent Spent Fuel Storage Installation)	)	ASLBP No. 97-732-02-ISFSI
	)	May 21, 1999

STATE OF UTAH'S FOURTH SUPPLEMENTAL RESPONSE TO APPLICANT'S FIRST SET OF FORMAL DISCOVERY REQUESTS

The State of Utah supplements its April 14, 1999, April 29, 1999, May 12, 1999, and May 20, 1999 responses to the Applicant's First Set of Formal Discovery Requests ("Applicant's Discovery Requests"). This response supplements the State's responses to Applicant's Discovery Requests for Utah Contention N (flooding) and is supported by the Declarations of David B. Cole and Barry J. Solomon, attached hereto.

BOARD CONTENTION 10 (UTAH N) FLOODING

A. Interrogatories - Utah N

INTERROGATORY NO. 2 – UTAH N. Specify the height of the "water waves generated by wind" and the resulting "swamping" by such water waves of the ITP at its new location that the State claims could result "in very wet years."

STATE'S SUPPLEMENTAL RESPONSE TO INTERROGATORY NO. 2 - UTAH N:

The State was faced with severe flooding of the Great Salt Lake in the 1980s.

During that time, the State conducted feasibility and design diking studies in order to consider alternative mitigation measures to address the critical problems associated with historic high lake levels and the resulting damage and threat to shoreline structures. The studies included calculations of wind tides, or seiche, and wave height associated with the high lake level in order to assure adequate height of the proposed dikes. *See* documents listed in State's Response to Document Request No. 3 below. Based on its review of these feasibility and design diking studies, the State calculates that at least two feet of seiche combined with seven feet of wave height could result during storms in very wet years along the lake shores. However, until the Applicant supplies the exact location and elevation for the new intermodal transfer facility (ITF), the State is not in a position to evaluate seiche and wave height effects on the new ITF location.

INTERROGATORY NO. 3 - UTAH N. Specify the height of flooding and/or "water waves . . . generated by earthquake or landslide events," and the resulting swamping by such water waves, of the ITP at its new location that the State claims could result from earthquake or landslide events.

STATE'S SUPPLEMENTAL RESPONSE TO INTERROGATORY NO. 3 - UTAH N:

Based on review of relevant articles relating to the effect of earthquake-induced flooding by the Great Salt Lake, the State estimates that a seiche generated by an earthquake may be more than 12 feet in height. Lowe, 1993; Black and Solomon,

1995.[1] The State also estimates that tectonic subsidence may be as much as 20 feet. Smith and Richins, 1984; Atwood and Mabey, 1995; Chang and Smith, 1998. However, until the Applicant supplies the exact location and elevation for the new ITF, the State is not in a position to complete its analysis of the effects of seiche and subsidence on the new ITF location.

INTERROGATORY NO. 4 – UTAH N. Identify and fully explain the scientific, technical, statistical and any other bases for the flooding and/or swamping by water waves of the ITP, as set forth in response to interrogatories 1, 2 and 3 above, fully accounting for any difference between the elevation of the ITP and the Great Salt Lake's historic high.

STATE'S SUPPLEMENTAL RESPONSE TO INTERROGATORY NO. 4 - UTAH N:

During very wet years, the water level of the Great Salt Lake, a closed basin, rises due to drainage into it from three major rivers and other surrounding drainages. Historically, the lake has reached an elevation of about 4,212 feet, as measured by the United States Geological Survey in June 1986. Arnow and Stephens, 1990. Between 1982 and 1986, the lake level increased by 13 million acre feet, with six million of those acre feet added during the water year of 1982-1983, in which the lake rose 5.2 feet, a record seasonal rise. Atwood and Mabey, 1995. Documented lake levels earlier than the last 120 years are not available. However, the study of beach records can supply

[1] Complete citations to references are found in State's Responses to Document Requests below.

data showing lake levels reached by wind setup and wave runup,[2] which can be considerably higher than the static lake level or highstand level occurring at the same time. On Antelope Island, for example, located in the Great Salt Lake about 26 miles east northeast of Rowley Junction, shoreline features for the 1980s indicate that storms resulted in flooding above the gauged highstand, and ranged in elevation from 4,212.4 to 4,218 feet. Atwood and Mabey, 1995.

Additionally, other disciplines, such as stratigraphy, geochemistry, paleontology and radiometric dating of sediment cores, can supplement shoreline evidence. Studies of the Holocene epoch have found lake elevation levels of approximately 4,221 feet occurring about 2,000 years ago, using radiocarbon dates of lagoon sediments correlated with sediment cores from the lake bed. Murchison, 1989. Archaeological studies indicates a high lake level of 4,217 feet occurring approximately 400 years ago. Atwood and Mabey, 1995.

Seiche and wave hydraulics were extensively evaluated for the Great Salt Lake in diking feasibility studies prepared for the Utah Department of Natural Resources

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[2] As explained by Atwood and Mabey, 1995 (at 488),

> The height of storm-related flooding on a beach is determined by three wind driven processes: wind setup, wave setup, and wave runup. Wind setup (storm surge) is the super-elevation of the water level of the lake generated by wind blowing over the water and stacking water against the downwind shore. Wave setup is the super-elevation of the water surface due to on-shore transport of water by wave action alone. Runup is the up-rushing of waves onto the beach that deposits the debris line and gravel berm that become the geomorphic evidence of flooding.

Division of Water Resources for the purpose of providing an additional or alternative means of protecting shoreline developments in specific areas around the Great Salt Lake. Montgomery, 1984; Montgomery, 1985; Horrocks Carrolo and Chen, 1985.

With respect to flooding events associated with earthquakes, tectonic subsidence can cause inundation along lake shores, and ponding of water in areas with a shallow water table. Keaton, 1987; Black, 1995. Subsidence associated with the 20-foot maximum displacement caused by the 1959 Hebgen Lake, Montana earthquake (magnitude 7.5) extended over an area about 20 miles long and 15 miles wide. Smith and Richins, 1984; Atwood and Mabey, 1995; Chang and Smith, 1998. Should similar subsidence occur along an active fault in Skull Valley, large areas adjacent to the shore of Great Salt Lake may be inundated. Seiches may also be generated by earthquake or landslide events. Seiches occurring along the southern shoreline of Great Salt Lake at the Saltair and the Lucin trestle during the 1909 Hansel Valley earthquake (magnitude 6) were reported at more than 12 feet high. In 1909 the lake elevation was 4,202.0 feet. The seiche generated by the Hansel Valley earthquake overtopped the Lucin cutoff railroad trestle at an elevation of 4,214.85 feet. Black and Solomon, 1995; Atwood and Mabey, 1995; Lowe, 1993.

As explained in State's Response to Interrogatory No. 2 above, at this time the State is not in a position to account for the difference between the ITF elevation and the effects of the lake's historic high until the Applicant provides the exact location

and elevation of the new ITF.

INTERROGATORY NO. 5 – UTAH N. Identify and fully explain any adverse impacts and/or safety consequences that the State claims would occur with respect to the ITP as a result of the flooding and/or swamping by water waves of the ITP site, as set forth in response to interrogatories 1, 2 and 3 above, fully accounting for any difference between the elevation of the ITP and the Great Salt Lake's historic high.

STATE'S SUPPLEMENTAL RESPONSE TO INTERROGATORY NO. 5 - UTAH N:

At historic lake elevations, structures in the vicinity of the lake in the past have been, and in the future could be, damaged or threatened by lake flooding. Moreover, during storms when strong winds affect the lake, wind setup and waves cause additional damage from lake water surges above the high lake level. During the high water years of the 1980s, flooding and wave action caused extensive damage to structures along the lake shore, such as the Saltair resort, approximately 24 miles east of Rowley Junction, and the public marina on the south shore of the lake, and breached the dikes that protected the AMAX evaporation ponds (now operated by Magnesium Corporation), about three miles east northeast from Rowley Junction. Atwood and Mabey, 1995; Montgomery, 1984. Damage to structures and costs associated with attempts to protect structures amounted to hundreds of millions of dollars. Other critical facilities constructed in the vicinity of the Great Salt Lake shoreline are exposed to inundation by lake flooding, and include such structures as the Salt Lake City International Airport, Interstate Highways I-80 and I-15, the mainlines

of the Union Pacific railroads, sewage treatment plants, and electrical transmission lines. Atwood and Mabey, 1995.

Other effects during wet hydrologic cycles which cause flooding of the Great Salt Lake include the backing up of surface drainage into the lake and rising water tables, both of which can impact structures located at elevations significantly above the lake level. For example, some areas impacted during the 1980s wet cycle included residential and agricultural areas along the lower reaches of the Jordan River (backed up and slow drainage), Wasatch Front communities (activities to protect sewage treatment plants), the Salt Lake International Airport (pumping shallow groundwater beneath the runways), and septic tanks systems along the lake which ceased to function. Atwood and Mabey, 1995.

As explained in Response to Interrogatory No. 2 above, the State is not in a position to account for the difference between the ITF elevation and the effects of the lake's historic high until the Applicant provides the exact location and elevation of the new ITF.

INTERROGATORY NO. 6 – UTAH N. Identify and fully explain the scientific, technical, engineering and any other bases for the adverse impacts and/or safety consequences set forth in response to interrogatory 5 above, fully accounting for any difference between the elevation of the ITP and the Great Salt Lake's historic high.

STATE'S SUPPLEMENTAL RESPONSE TO INTERROGATORY NO. 6 - UTAH N:

Based on the State's review of the diking feasibility and design reports referred

to in the State's Response to Interrogatory No.2 above, and using the historical gauged elevation of 4,211.60 feet, the State's calculations show that wave damage may occur to structures up to an elevation of 4,221 feet. Furthermore, areas up to 4,220 feet in elevation may be affected by earthquake-induced seiches during high lake levels. Lowe, 1993; Black and Solomon, 1995. Additionally, the Utah Division of Comprehensive Management recommends a Beneficial Development Area around the Great Salt Lake extending no lower than 4,217 feet in elevation; however, if the lake reaches that level, wind waves will likely increase the lake fluctuation surface yet higher. Atwood and Mabey, 1995. *See also* responses to Interrogatories Nos. 1-5.

As explained in Response to Interrogatory No. 2 above, the State is not in a position to account for any difference between the ITF elevation and the effects of the lake's historic high until the Applicant provides the exact location and elevation of the new ITF. However, if the new ITF is located north of I-80 in section 12 of Township 1 South, Range 8 West, the elevation appears to range from 4,219 feet south of that general location to 4,209 feet north of that general location. As explained above, structures built at those elevations may be at risk from inundation by lake flooding, wind setup and wave height during high lake levels, and may also be subject to earthquake-induced flooding during times of high lake levels.

B. Document Requests - Utah - Flooding

The Applicant requests the State of Utah to produce the following documents directly or indirectly within its possession, custody or control to the extent not

previously produced by the State during informal discovery:

DOCUMENT REQUEST NO. 1 – UTAH N. All documents related to the claims raised by the State in Utah N.

STATE'S RESPONSE TO DOCUMENT REQUEST NO. 1 - UTAH N:

The State has produced to PFS during informal discovery all relevant documents not privileged and will continue to identify all such documents not previously produced. Additionally, documents relied upon in answering these Interrogatories include the following listed in State's Response to Document Requests Nos. 2-7 and are available for inspection and copying at Ms. Nakahara's office, Utah Department of Environmental Quality.

DOCUMENT REQUEST NO. 2 – UTAH N. All documents and calculations relating to potential flooding at the ITP, including swamping by water waves generated by wind, earthquake or landslide.

STATE'S RESPONSE TO DOCUMENT REQUEST NO. 2 - UTAH N:

See Response to Document Request No. 1. State's expert David B. Cole's calculations[3] in response to this discovery request were reviewed, as well as the following specific articles and reports:

Arnow, Ted, and Stephens, Doyle, 1990, Hydrologic characteristics of the Great Salt Lake, Utah: 1847-1986: U.S. Geological Survey Water Supply Paper 2332, 32 p.

Atwood, Genevieve, and Mabey, D.R., 1995, Flooding Hazards Associated with Great Salt Lake, *in* Lund, W.R., editor, Environmental & Engineering Geology of the Wasatch Front Region: Utah Geological Association Publication 24, p. 483-493.

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[3] David B. Cole's calculations are available for inspection and copying at Ms. Nakahara's office, and as a convenience are also attached to this discovery response.

Black, B.D., and Solomon, B.J., 1995, Other Earthquake Hazards, *in* Solomon, B.J. and Black, B.D., editors, Geologic Hazards and Land-use Planning for Tooele Valley and the West Desert Hazardous Industry Area, Tooele County, Utah: Utah Geological Survey Open-File Report 318, p. F-1 through F.

Black, B.D., 1995, Tectonic Subsidence, *in* Solomon, B.J. and Black, B.D., editors, Geologic Hazards and Land-use Planning for Tooele Valley and the West Desert Hazardous Industry Area, Tooele County, Utah: Utah Geological Survey Open-File Report 318, p. D-1 through D-4.

Chang, Wu-Lung, and Smith, R.B., 1998, Potential for tectonically induced tilting and flooding by the Great Salt Lake, Utah, from large earthquakes on the Wasatch fault, in Lund, W.R., editor, Western States Seismic Policy Council Proceedings Volume, Basin and Range Province Seismic-Hazards Summit: Utah Geological Survey Miscellaneous Publication 98-2, p. 128-138.

Keaton, J.R., 1987, Potential Consequences of Earthquake-induced Regional Tectonic Deformation Along the Wasatch Front, North-central Utah, *in* McCalpin, James, editor, Proceedings of the 23rd Symposium on Engineering Geology and Soils Engineering: Boise, Idaho Department of Transportation, p. 19-34.

Lowe, Mike, 1993, Hazards from Earthquake-induced Ground Failure in Sensitive Clays, Vibratory Settlement, and Flooding due to Seiches, Surface-drainage Disruptions and Increased Ground-water Discharge, Davis County, Utah, *in* Gori, P.L., editor, Applications of Research from the U.S. Geological Survey Program, Assessment of Regional Earthquake Hazards and Risk Along the Wasatch Front, Utah: U.S. Geological Survey Professional Paper 1519, p. 163-166.

Murchison, S.B., 1989, Fluctuation History of Great Salt Lake, Utah, During the Last 13,000 years: Salt Lake City, University of Utah, Ph.D. dissertation, 137 p.

Smith, R.B., and Richins, W.D., 1984, Seismicity and Earthquake Hazard of Utah and the Wasatch Front: Paradigm and Paradox, *in* Hays, W.W., and Gori, P.L., editors, Evaluation of Regional and Urban Earthquake Hazards and Risk in Utah: U.S. Geological Survey Open-File Report 84-763, p. 73-112.

DOCUMENT REQUEST NO. 3 – UTAH N. All documents identifying or documenting the height of water waves generated by wind and the resulting flooding along the shores of the Great Salt Lake.

STATE'S RESPONSE TO DOCUMENT REQUEST NO. 3 - UTAH N:

See Response to Document Request Nos. 1 and 2. Additionally, the following specific reports and articles were reviewed:

James M. Montgomery Consulting Engineers, Inc., 1984, Great Salt Lake Diking Feasibility Study, Vol. 1, prepared for State of Utah, Department of Natural Resources, Division of Water Resources.

James M. Montgomery Consulting Engineers, Inc., 1985, Farmington Bay Area Perimeter Diking Alternative Final Design Report, Vol. 1, prepared for State of Utah, Department of Natural Resources, Division of Water Resources.

Horrocks Carollo Engineers and Chen & Associates Consulting Geotechnical Engineers, 1985, State of Utah Division of Water Resources West Desert Pumping Project, Bonneville Dike Design Report.

Lin, Anching, and Wang, Po, 1978, Wind Tides of the Great Salt Lake: Utah Geology, v. 5, no. 1, p. 17-25.

DOCUMENT REQUEST NO. 4 – UTAH N. All documents relied upon by the State to support the proposition that floods and water waves have been generated by earthquakes or landslide events along the shores of the Great Salt Lake.

STATE'S RESPONSE TO DOCUMENT REQUEST NO. 4 - UTAH N:

See Response to Document Request Nos. 1- 3.

DOCUMENT REQUEST NO. 5 – UTAH N. All documents identifying or documenting the height of water waves and resulting flooding along the shores of the Great Salt Lake generated by earthquakes or landslide events.

STATE'S RESPONSE TO DOCUMENT REQUEST NO. 5 - UTAH N:

See Response to Document Request Nos. 1- 3.

DOCUMENT REQUEST NO. 6 – UTAH N. All documents relied upon to support the assertion that Rowley Junction and/or the new location of the ITP has been impacted by extensive flooding events in the recent past due to the rise in

elevation of the Great Salt Lake.

STATE'S RESPONSE TO DOCUMENT REQUEST NO. 6 - UTAH N:

See Response to Document Request Nos. 1- 3.

DOCUMENT REQUEST NO. 7 – UTAH N. All documents, data or other information reviewed, considered or relied upon by Mr. Cole or any other expert or consultant assisting the State with respect to Contention N.

STATE'S RESPONSE TO DOCUMENT REQUEST NO. 7 - UTAH N:

See Response to Document Request Nos. 1- 3.

DATED this 21th day of May, 1999.

Respectfully submitted,

STATE OF UTAH

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CERTIFICATE OF SERVICE

I hereby certify that a copy of STATE OF UTAH'S FOURTH SUPPLEMENTAL RESPONSE TO APPLICANT'S FIRST SET OF FORMAL DISCOVERY REQUESTS was served on the persons listed below by electronic mail (unless otherwise noted) with conforming copies by United States mail first class, this 21st day of May, 1999:

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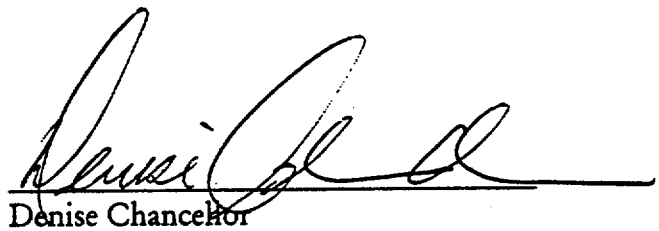

Denise Chancellor
Assistant Attorney General
State of Utah

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	Docket No. 72-22-ISFSI
PRIVATE FUEL STORAGE, LLC (Independent Spent Fuel Storage Installation)	)	ASLBP No. 97-732-02-ISFSI
	)	May 21, 1999

DECLARATION OF DAVID B. COLE

I, David B. Cole, hereby declare under penalty of perjury and pursuant to 28 U.S.C. § 1746, that the statements contained in State of Utah's May 21, 1999 Fourth Supplemental Response to Applicant's First Set of Formal Discovery Requests, with respect to Utah Contention N (flooding), limited to changes to the volume of the Great Salt Lake, calculations of seiche and wave height, and effects of lake and surface drainage flooding, are true and correct to the best of my knowledge, information and belief.

Executed this 21st day of May, 1999.

By: David B. Cole

David B. Cole
Senior Engineer
Utah Division of Water Resources
Utah Department of Natural Resources

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	Docket No. 72-22-ISFSI
PRIVATE FUEL STORAGE, LLC (Independent Spent Fuel Storage Installation)	)	ASLBP No. 97-732-02-ISFSI
	)	May 21, 1999

DECLARATION OF BARRY J. SOLOMON

I, Barry J. Solomon, hereby declare under penalty of perjury and pursuant to 28 U.S.C. § 1746, that the statements contained in State of Utah's May 21, 1999 Fourth Supplemental Response to Applicant's First Set of Formal Discovery Requests, with respect to Utah Contention N (flooding), limited to geologic and earthquake hazards, tectonic subsidence, and shoreline levels, are true and correct to the best of my knowledge, information and belief.

Executed this 21st day of May, 1999.

By: Barry J. Solomon

Barry J. Solomon
Senior Geologist
Utah Geological Survey
Utah Department of Natural Resources

DIVISION OF WATER RESOURCES
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MEMORANDUM

April 22, 1999

Attorney Work Product Attorney Client Privilege Confidential

TO: Connie Nakahara, Jean Braxton

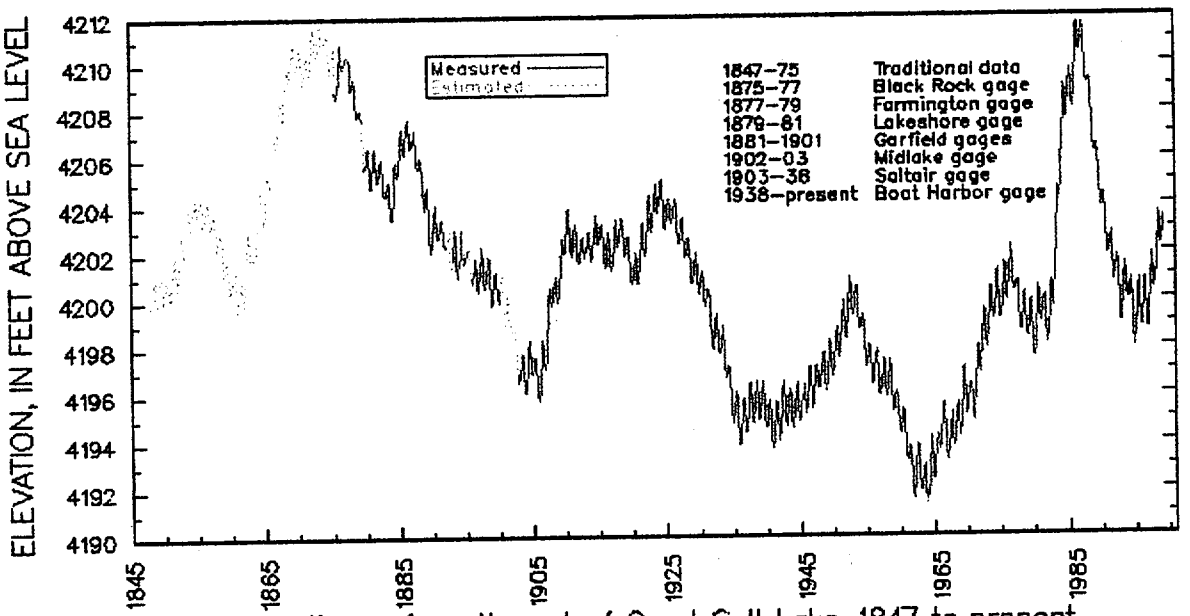
FROM: David B. Cole

SUBJECT: Flooding from Great Salt Lake of PFS Unloading Facility

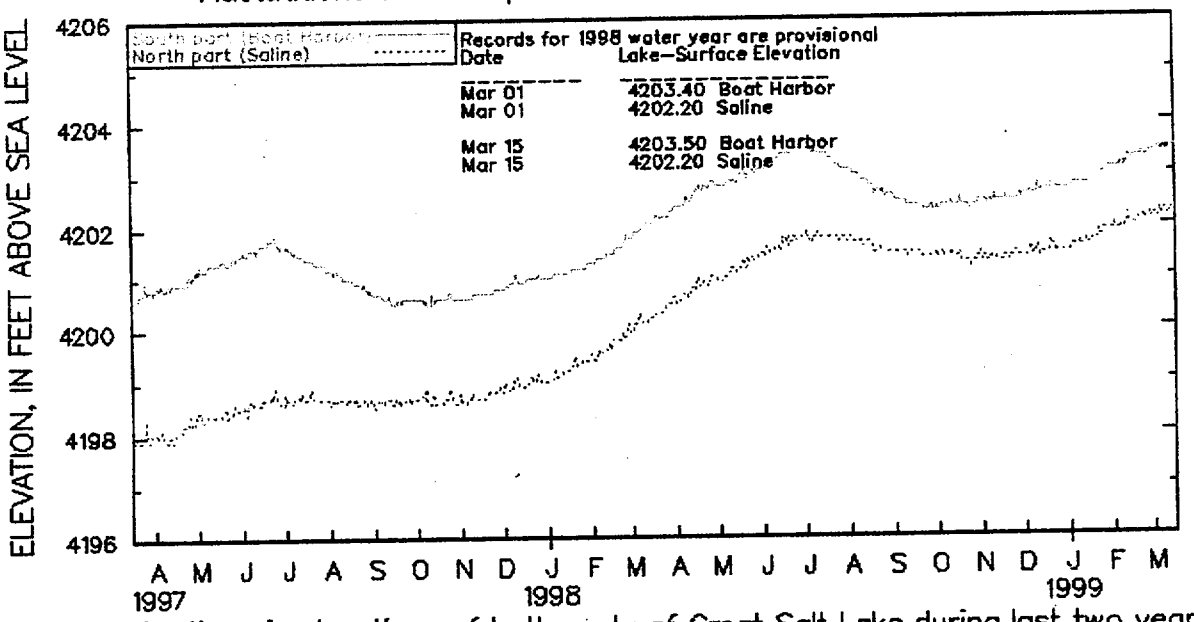
I reviewed feasibility and design reports prepared for the State of Utah showing Great Salt Lake wind setup and wave height calculations. These reports were prepared back in the 1980's when the lake was damaging and threatening shoreline structures.

The *Great Salt Lake Diking Feasibility Study prepared for the State of Utah Department of Natural Resources Division of Water Resources Feasibility Study Volume I, December 1984 by James M. Montgomery, Consulting Engineers, Inc.* contains seiche and wave hydraulics calculations for the Great Salt Lake. Two engineering design reports which have similar calculations are *State of Utah Division of Water Resources West Desert Pumping Project, Bonneville Dike, Design, Report June 1985 by Horrocks and Corollo plus Chen and Associates Engineers* and *Farmington Bay Area perimeter Diking Alternative final Design Report prepared for State of Utah, Department of Natural Resources, Division of Water Resources, Final Design Report Volume I, June 1985.*

Based on information from these reports and the historical gaged elevation of 4211.60 feet, measured by the United States Geological Survey in June 1986, I believe that wave damage may occur to structures up to an elevation of **4221** feet. This is a lake elevation of 4212 plus 2 feet of seiche and 7 feet of wave height. I have included a hydrograph showing the Fluctuations of the South Part of Great Salt Lake, 1847 to present. This is from a document on the internet at the address: http://wwwdutslc.wr.usgs/gsl.gif



Fluctuations of south part of Great Salt Lake, 1847 to present.



Fluctuations in elevations of both parts of Great Salt Lake during last two years.