Stage Data Corrections for Gage Subsidence and Sea Level Rise in the Sacramento-San Joaquin River Delta

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PETERSON . BRUSTAD . INC
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RECLAMATION DISTRICT NO. 800
BYRON TRACT
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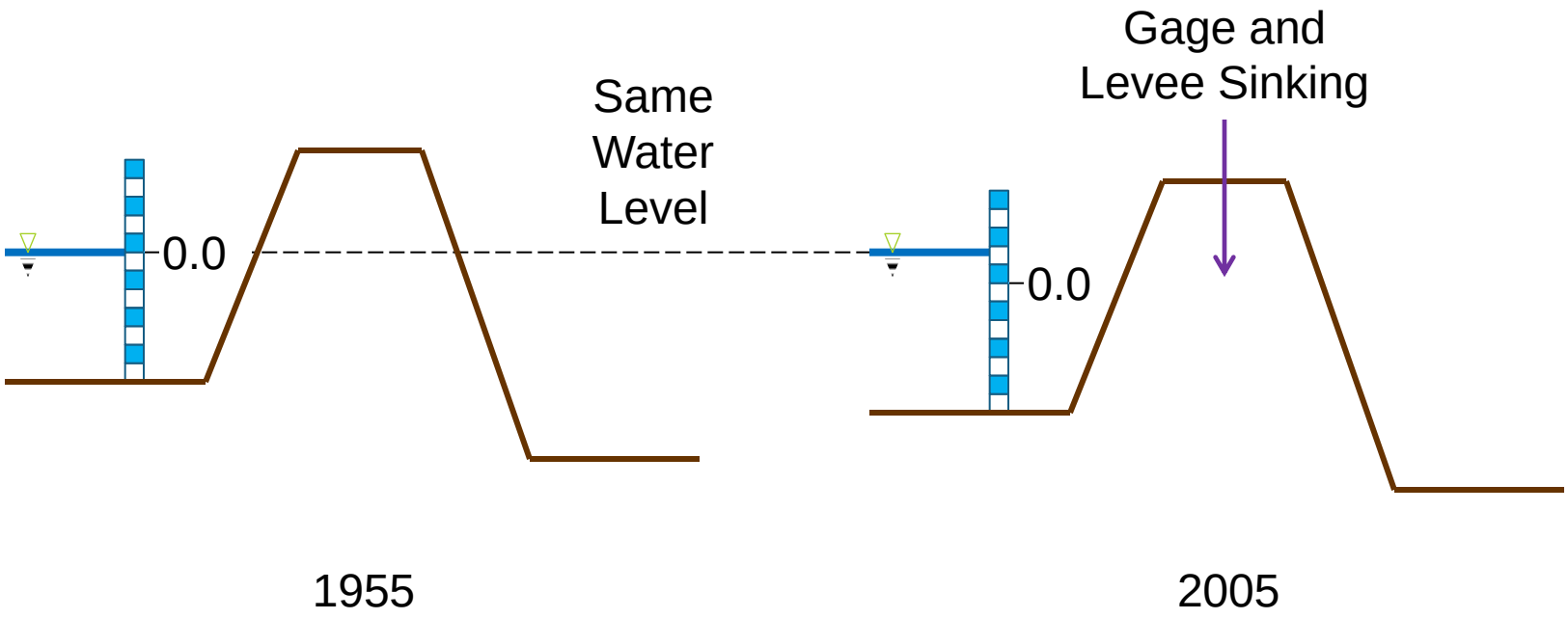
Purpose of Stage Data Corrections

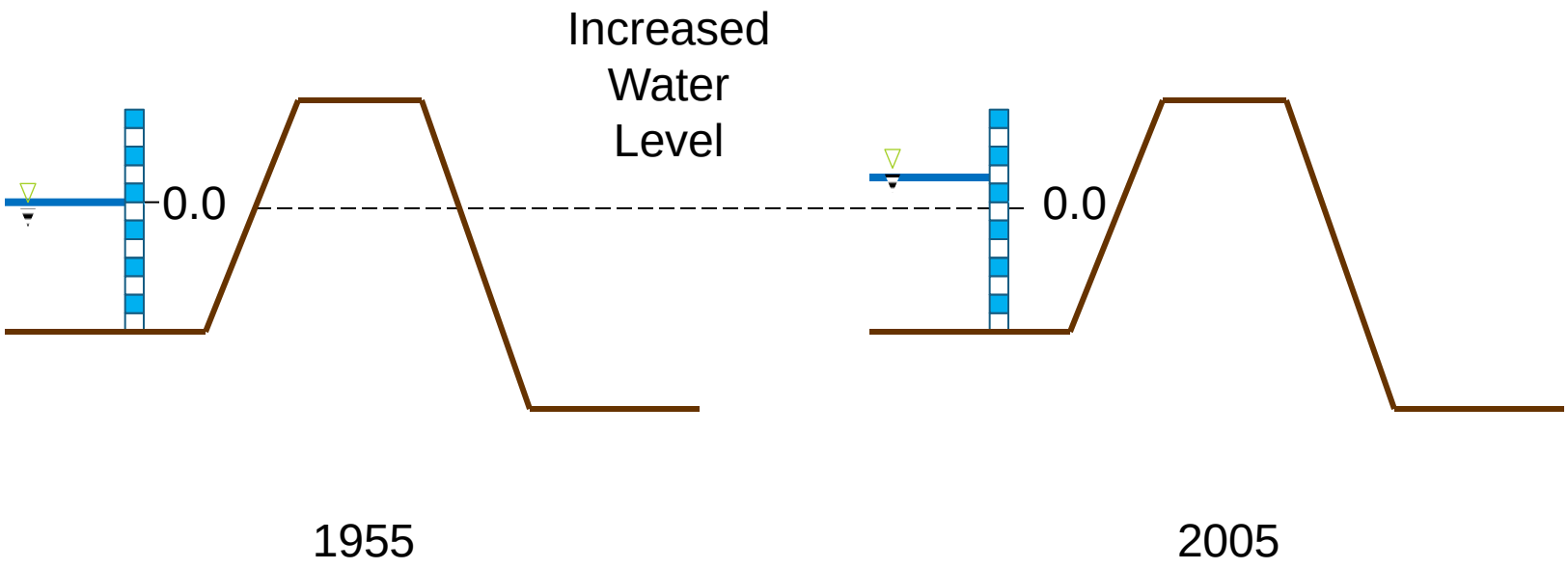
* Update 50 and 100 Year Flood Elevations
  * Currently based on USACE 1978 Stage Frequency Analysis (32 yr period of record)
  * Extend to 57 Year period of record (1953-2009)
* Generate 200 Year Flood Elevations
* Estimate Future Impact of Climate Change

Gage Subsidence



Effect of Gage Subsidence is to Raise Gage Readings Over Time

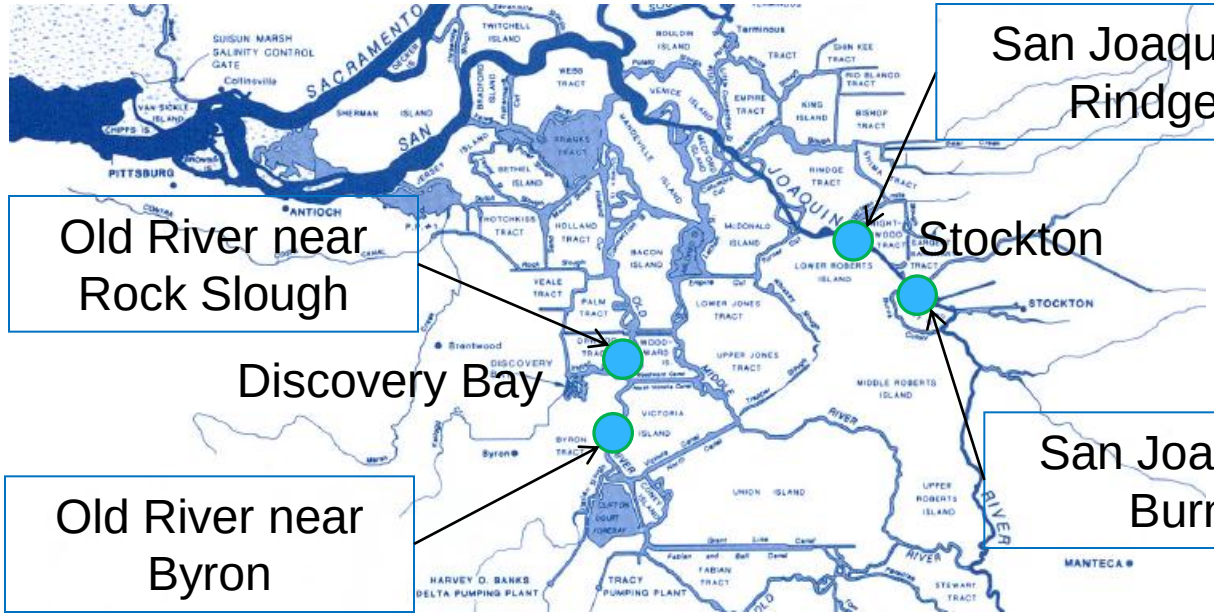
Sea Level Rise



Effect of Sea Level Rise is to Raise Gage Readings Over Time

Gage Locations

Sacramento-San Joaquin Delta



Data Manipulation

* Tide Cycles
* “Zero on Gage” Corrections
* Datum

Tide Cycles

* 19-Year Lunar Cycle
  * Creates 19-year tide cycles
  * Known as “Epoch Periods”
* Evaluation of complete 19-year periods eliminates affects of the tide cycles
* WY 1953 through WY 2009

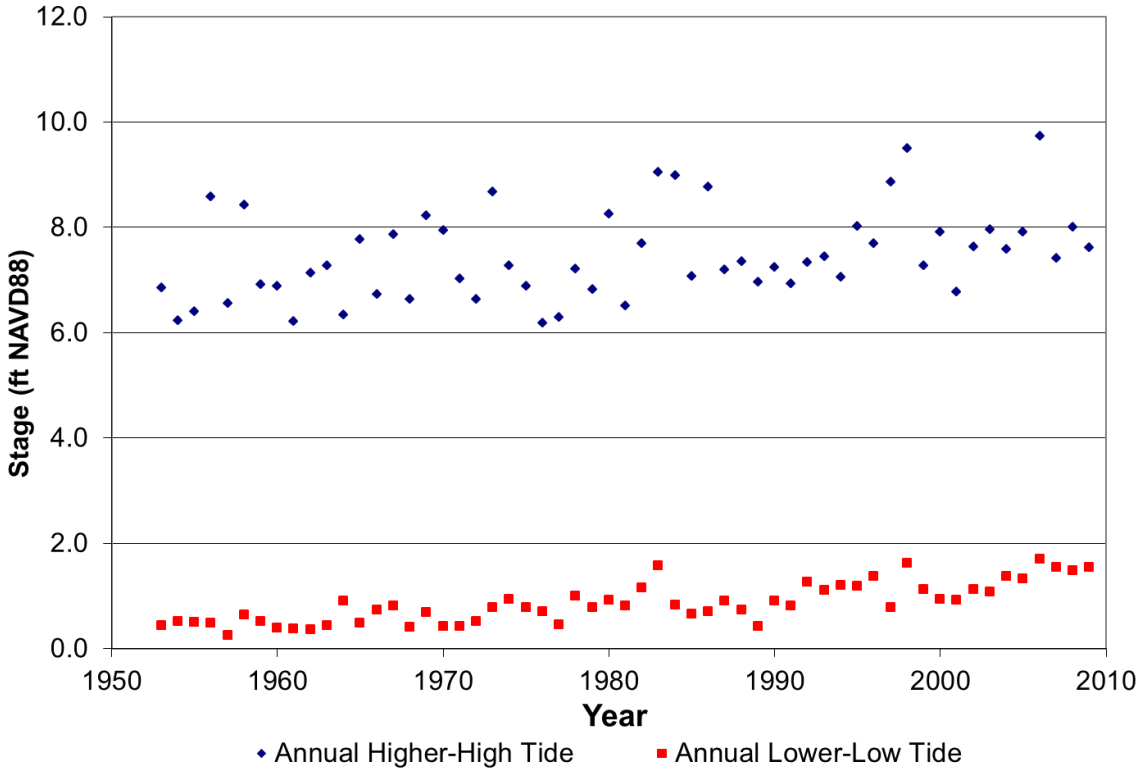
"Zero on Gage" Adjustments

* Stage Data Summaries include "zero on gage" adjustments
  * Prior to WY 1965 only
  * Appear to correct for subsidence
* Stockton gage stations:
  * About 0.5 ft correction between 1951 and 1964
* Discovery Bay gage stations:
  * About 0.6 ft correction between 1945 and 1964

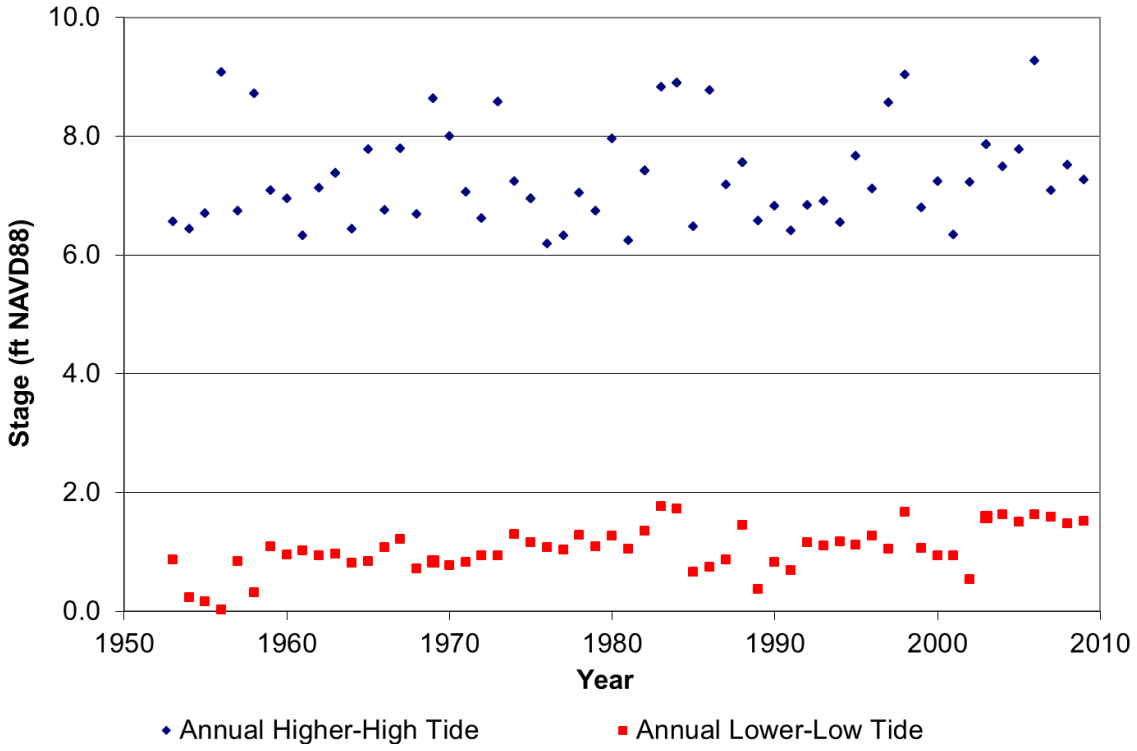
Datum Conversion

* USED/USCGS/NGVD29/NGVD29+3ft
  * Prior to WY 2006
  * Per Stage Data Summaries
* NAVD88
  * VERTCON Conversion
  * Site specific conversion based on 2002 DWR/NGS survey
* Datum Conversion per Site Specific Conversion

Rindge Pump Gage Station Data Adjusted



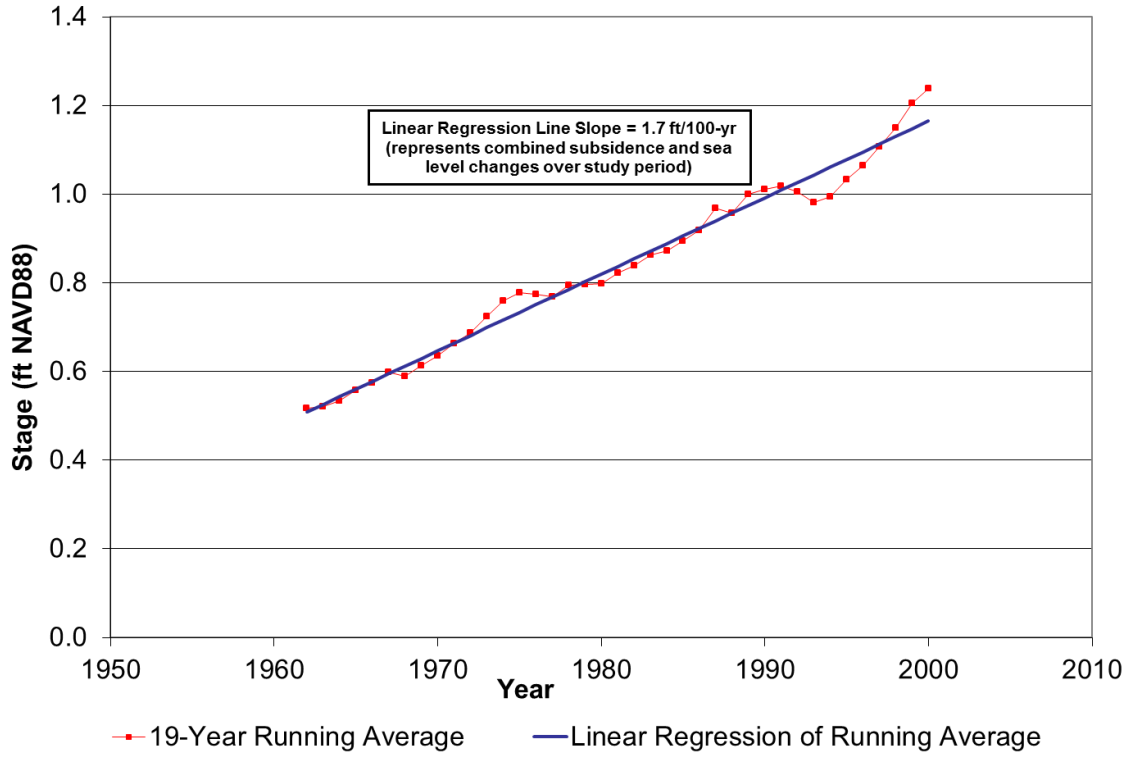
Rock Slough Gage Station Data Adjusted



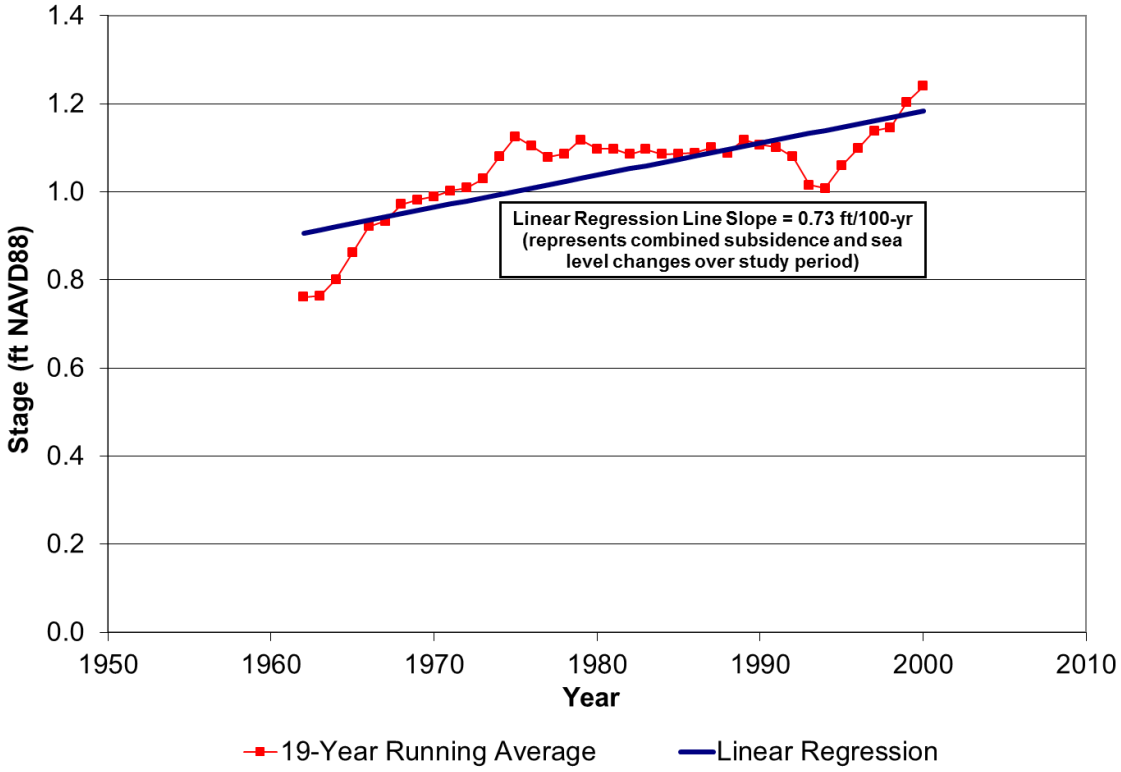
Lower-Low Tide Analysis

* Minimal hydraulic effects at lower-low tide
* Evaluate over 19-year periods to eliminate tide cycle impacts (3 full cycles = 57 year period of record)
* Plot 19-Year Running Average

Rindge Pump Gage Station 19-Year Running Average of Annual Lower-Low Tides



Rock Slough Gage Station 19-Year Running Average of Annual Lower-Low Tides



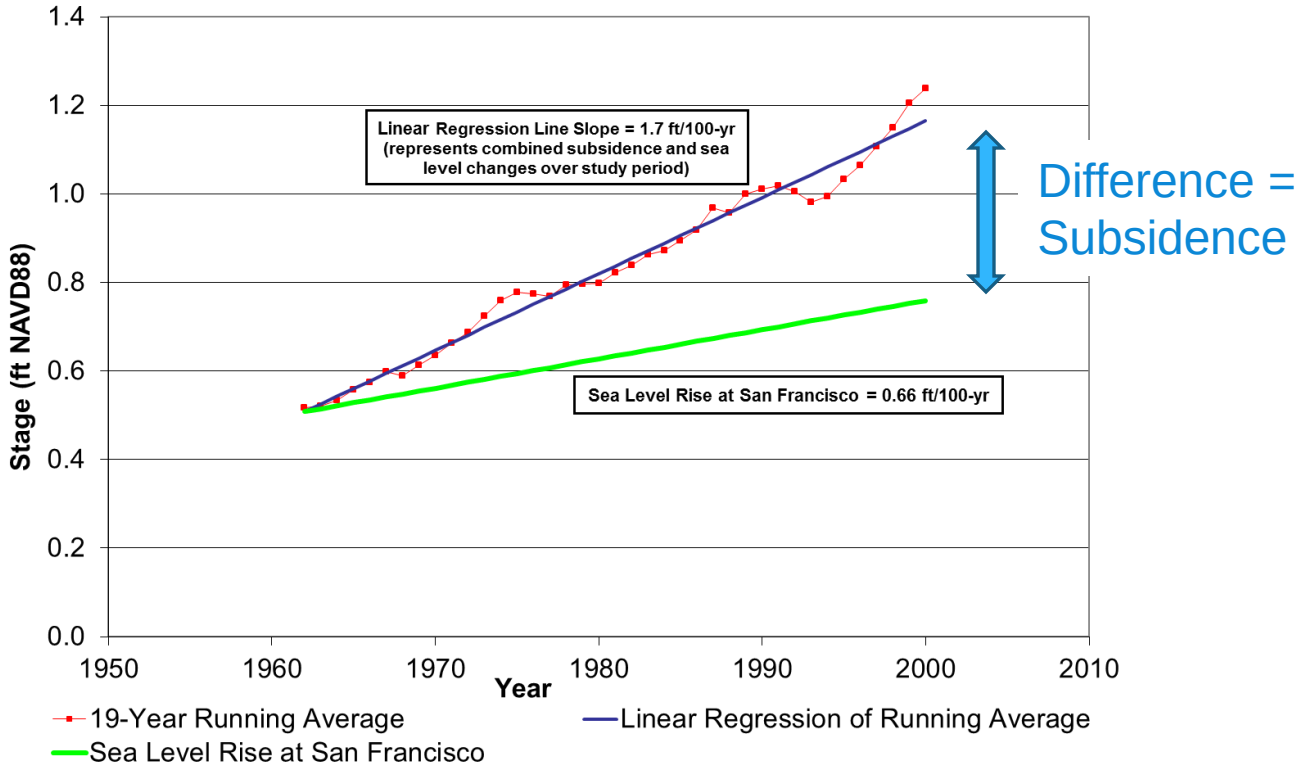
Lower-Low Tide Analysis

* Increases over time due to combined subsidence and sea level rise impacts
* Stockton Gages:
  * Rindge Pump: 1.7 ft/100-yr
  * Burns Cutoff: 2.3 ft/100-yr
* Discovery Bay Gages:
  * Rock Slough: 0.73 ft/100-yr
  * Byron: 0.70 ft/100-yr

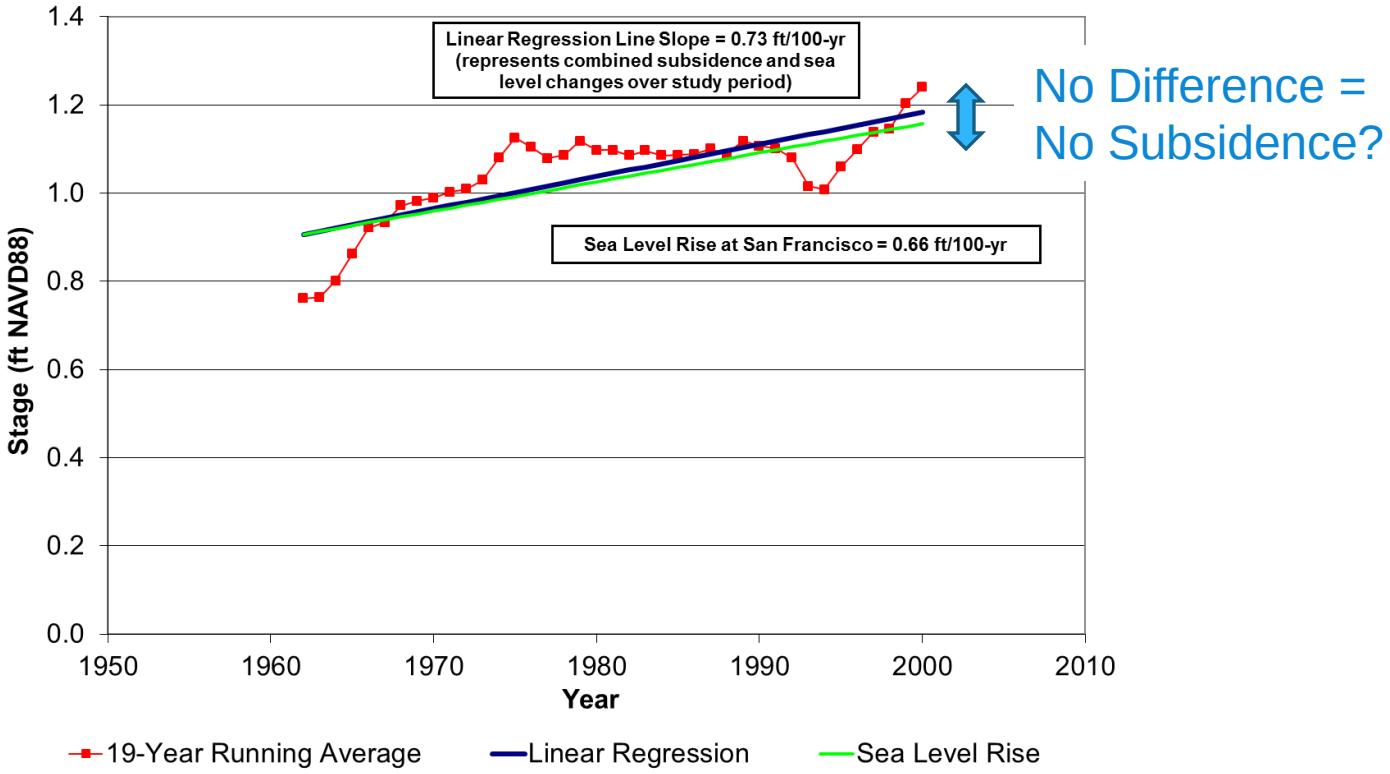
Subsidence Correction

* No survey data for corrections after WY 1964
* Know combined impact of subsidence and sea level rise
* Assume sea level rise matches San Francisco (0.66 ft/100-yr)
* Subsidence = Lower-low tide stage trend analysis minus 0.66 ft/100-yr

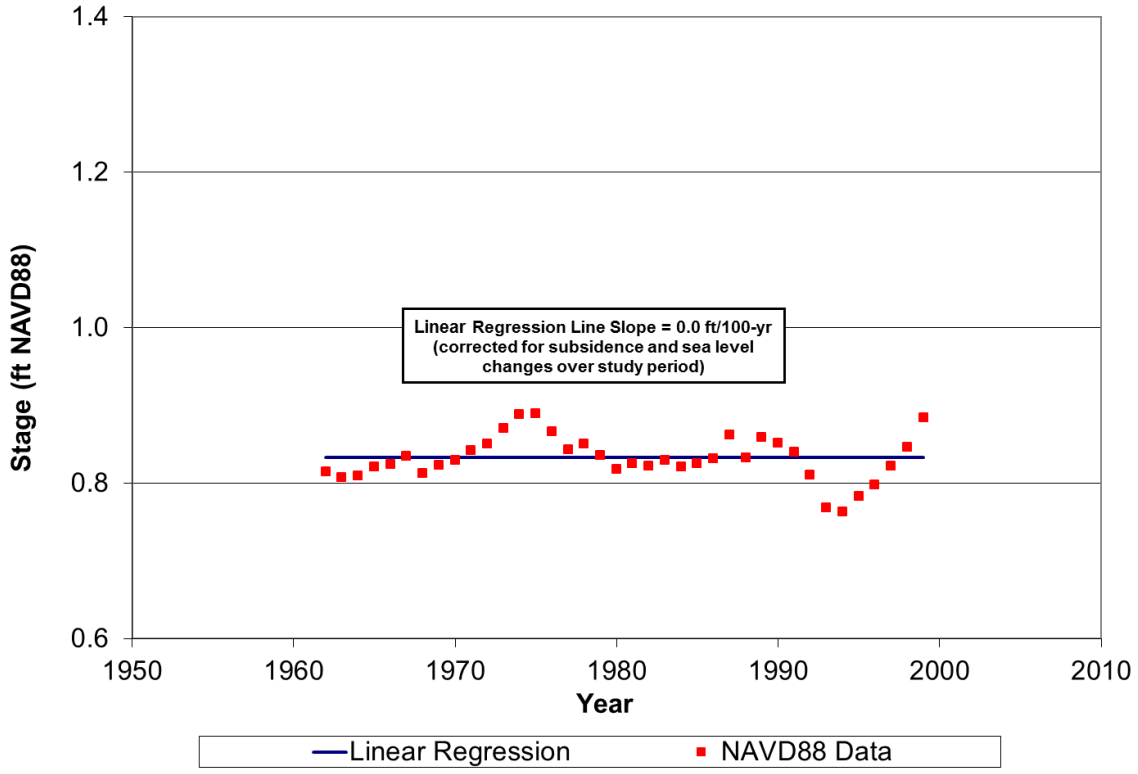
Rindge Pump Gage Station 19-Year Running Average of Annual Lower-Low Tides



Rock Slough Gage Station 19-Year Running Average of Annual Lower-Low Tides

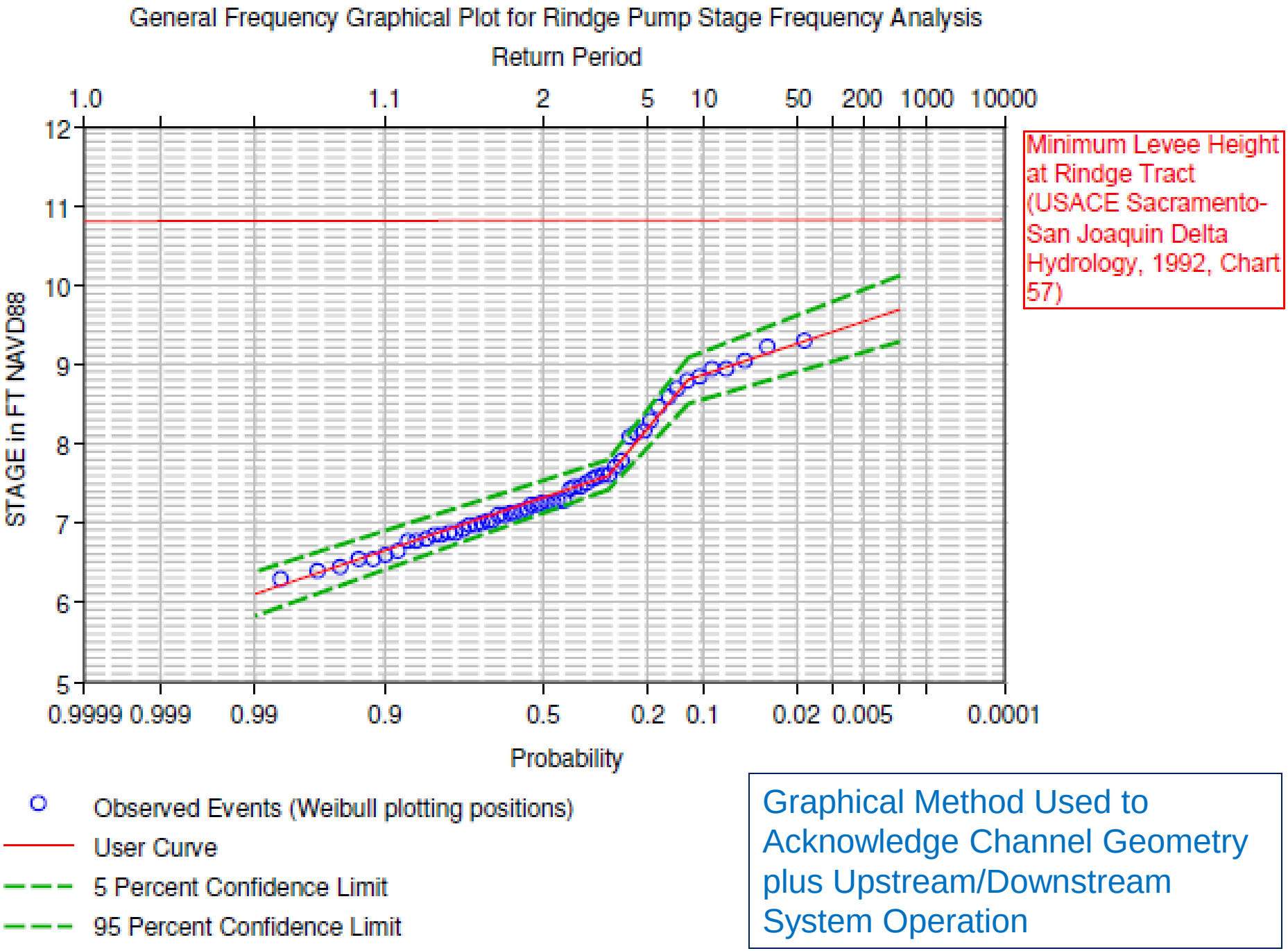


Corrected Data
Lower-Low Tide



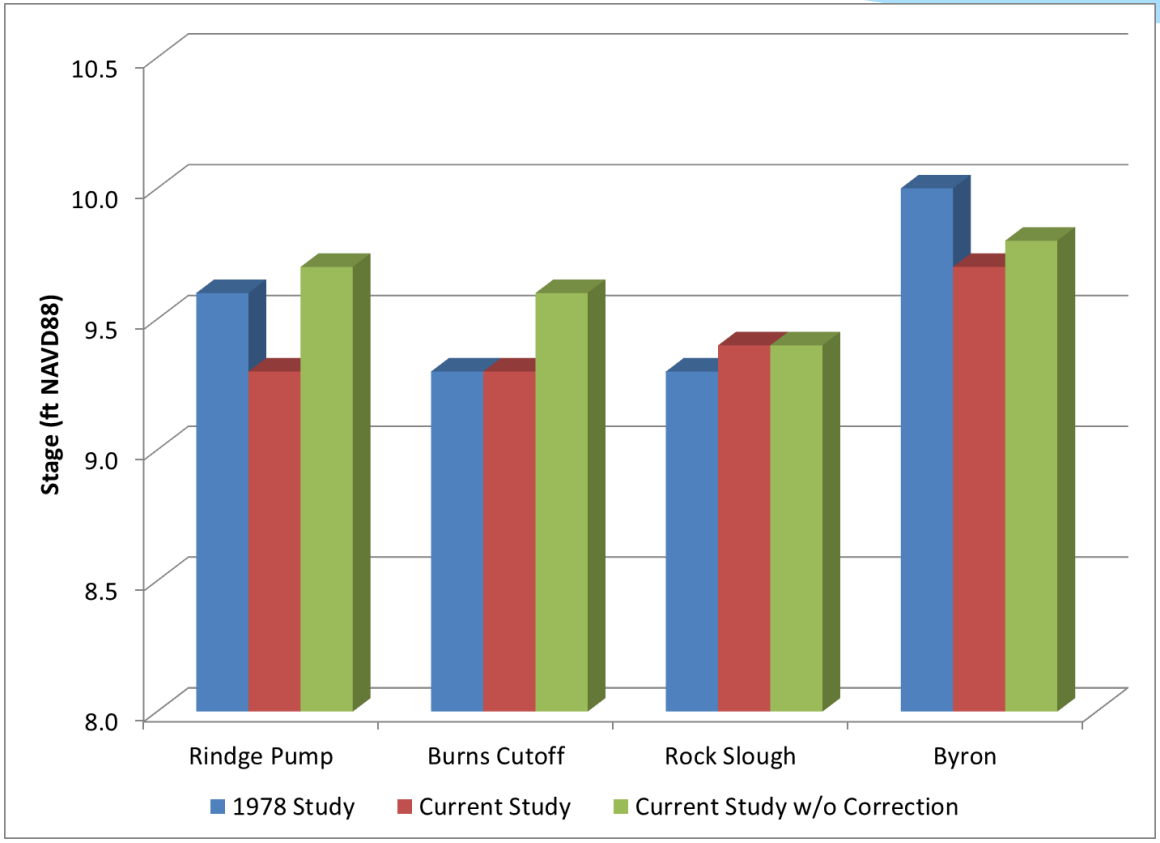
Stage Frequency Analysis

* Higher-High data manipulation
  * Three 19-year Tide Cycles
  * “Zero on Gage” Adjustments
  * NAVD88 Datum
* Higher-High Stage Data Corrections
  * Based on Lower-Low Tide Analysis
    * Subsidence/Sea Level Rise
* Analyzed Using HEC-SSP



Graphical Method Used to Acknowledge Channel Geometry plus Upstream/Downstream System Operation

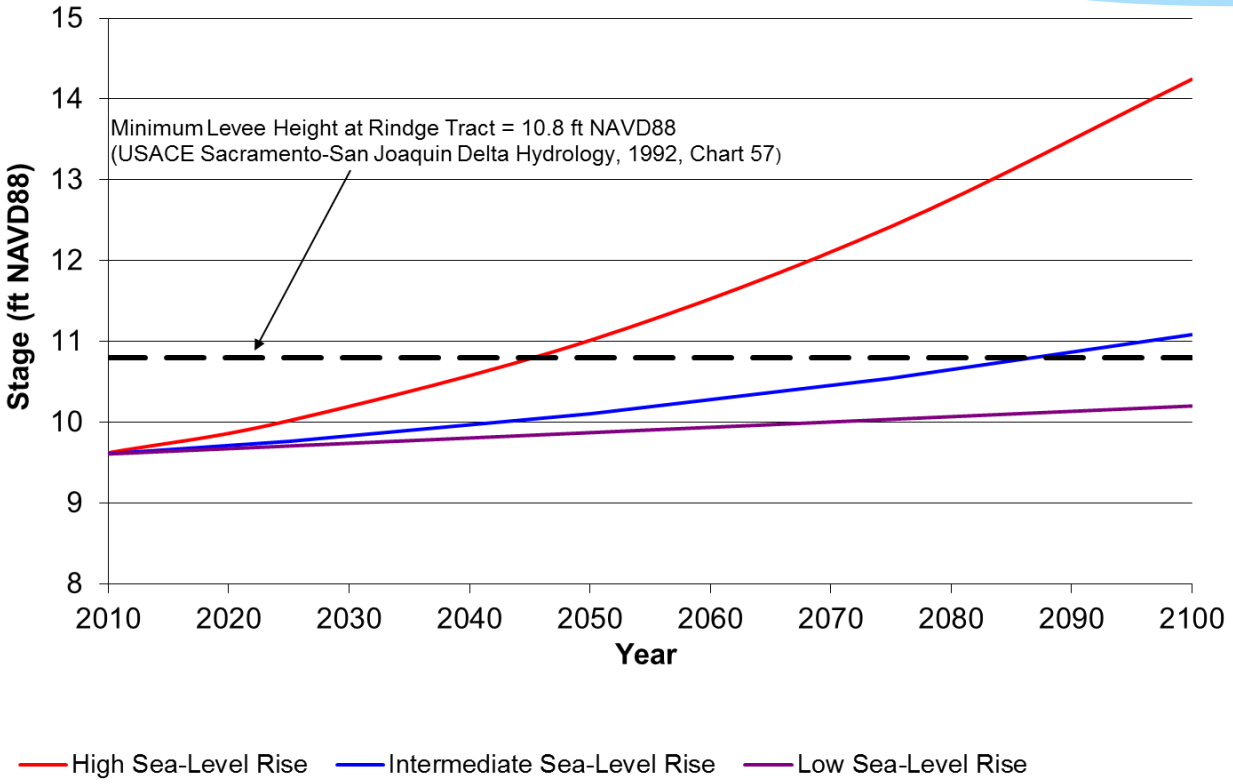
Comparison to 1978 Stage Frequency Analysis



Climate Change Impacts

* Future Sea Level Rise Impacts on WY 2009 Stage Frequency Results
* USACE recommends planning based on:
  * Low - based on historic levels
  * Intermediate - based on NRC (National Resource Council) Curve I
  * High - based on NRC Curve III

Rindge Pump Gage Station Estimated Stage with 1/200 Annual Exceedance Probability, 2010 through 2100



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