PMTurkeyCOLPEm Resource

From: Franzone, Steve <Steve.Franzone@fpl.com>
Sent: Monday, August 22, 2016 2:05 PM
To: Comar, Manny
Cc: TurkeyCOL Resource; Wen, Peter; Maher, William; Orthen, Richard; Burski, Raymond
Subject: [External_Sender] PTN 6 & 7 Sea Level Rise
Attachments: L-2011-125 dated 04-06-2011 RAI Ltr 10 eRAI5233 Response to RAI-02.04.05....pdf; L-2011-474 signed 11-04-2011 Response to NRC RAI Letter No. 036 (eRAI 58....pdf

Manny
The development of our sea level rise prediction is briefly discussed in the following FSAR Sub-sections:
2.4.5.2.2.1 Antecedent Water Level
2.4.5.2.2.3 Sensitivity of PMH Parameters on Storm Surge Elevation
2.4.5.2.2.5 Uncertainties in SLOSH Model Results

RAIs 02.04.05-3 & 02.04.05-5 discussed Sea Level rise in more detail and are attached.

Thanks
Steve Franzone
NNP Licensing Manager - COLA
"Even if you're on the right track, you'll get run over if you just sit there." ~ Will Rogers
561.904.3793 (office)
754.204.5996 (cell)
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Subject: [External_Sender] PTN 6 & 7 Sea Level Rise
Sent Date: 8/22/2016 2:04:33 PM
Received Date: 8/22/2016 2:04:47 PM
From: Franzone, Steve

Created By: Steve.Franzone@fpl.com

Recipients:
"TurkeyCOL Resource" <TurkeyCOL.Resource@nrc.gov>
Tracking Status: None
"Wen, Peter" <Peter.Wen@nrc.gov>
Tracking Status: None
"Maher, William" <William.Maher@fpl.com>
Tracking Status: None
"Orthen, Richard" <Richard.Orthen@fpl.com>
Tracking Status: None
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Tracking Status: None
"Comar, Manny" <Manny.Comar@nrc.gov>
Tracking Status: None

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Files	**Size**	**Date & Time**
MESSAGE	1192	8/22/2016 2:04:47 PM
L-2011-125 dated 04-06-2011 RAI Ltr 10 eRAI5233 Response to RAI-02.04.05....pdf	325670	
L-2011-474 signed 11-04-2011 Response to NRC RAI Letter No. 036 (eRAI 58....pdf	244538	

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Recipients Received:

L-2011-125
10 CFR 52.3

April 6, 2011

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

Re: Florida Power & Light Company
Proposed Turkey Point Units 6 and 7
Docket Nos. 52-040 and 52-041
Response to Request for Additional Information 02.04.05-3, Letter No. 010 (eRAI 5233) Standard Review Plan Section 02.04.05 - Probable Maximum Surge and Seiche Flooding

Reference:

1. NRC Letter to FPL dated December 2, 2010, Request for Additional Information Letter No. 010 Related to SRP Section 02.04.05 - Probable Maximum Surge and Seiche Flooding for the Turkey Point Nuclear Plant Units 6 and 7 Combined License Application

FPL provides, as an attachment to this letter, its response to the Nuclear Regulatory Commission's (NRC) request for additional information RAI 02.04.05-3 (Reference 1). The attachment identifies changes that will be made in a future revision of the Turkey Point Units 6 and 7 Combined License Application (if applicable).

If you have any questions, or need additional information, please contact me at 561-691-7490.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on April 6, 2011

Sincerely,

William Maher
Senior Licensing Director – New Nuclear Projects

WDM/RFB

Attachment: FPL Response to NRC RAI No. 02.04.05-3 (eRAI 5233)

cc:
PTN 6 & 7 Project Manager, AP1000 Projects Branch 1, USNRC DNRL/NRO
Regional Administrator, Region II, USNRC
Senior Resident Inspector, USNRC, Turkey Point Plant 3 & 4

NRC RAI Letter No. PTN-RAI-LTR-010

SRP Section: 02.04.05 - Probable Maximum Surge and Seiche Flooding

QUESTIONS from Hydrologic Engineering Branch (RHEB)

NRC RAI Number: 02.04.05-3 (eRAI 5233)

The Applicant's analysis of long-term sea-level rise is based on a linear extrapolation of historical sea-level changes measured at Miami Beach, Florida. Please explain whether a linear extrapolation of sea-level records is conservative compared to a nonlinear model extrapolation approach (e.g., Walton, 2007, etc.). Provide analysis of the effect of a nonlinear model of the future rate of sea-level rise on PMF water levels at Units 6 and 7 resulting from PMH-related storm surge.

References

Walton, Todd L, Jr. 2007. Projected sea level rise in Florida. *Ocean Engineering* 34:1832-1840. doi: 10.1 016/j.oceaneng.2007.02.003.

FPL RESPONSE:

As indicated in FSAR Subsection 2.4.5, Revision 2, the long-term sea-level rise for the Turkey Point Units 6 & 7 site is established at 1.0 ft. This rise in sea-level is conservatively estimated based on the rate of 0.78 ft (Figure 1) in 100 years determined for the Miami Beach area by the National Oceanic and Atmospheric Administration (NOAA) (FSAR Subsection 2.4.5, Reference 206). NOAA's analysis is based on a linear trend model using sea-level data at Miami Beach, Florida tide gage station (Station 8723170) (Reference 1). In developing the sea-level rise model, NOAA removed the seasonal fluctuation (long-term average monthly values) from the monthly mean sea level data. Located approximately 27 miles northeast of Turkey Point Units 6 & 7 site, Miami Beach is the closest tide gage station to the site that has a substantially long record of approximately 50 years and is therefore expected to provide a reasonable representation of the sea-level characteristics at the site.

Additional sea-level trend analyses were performed to demonstrate that the 1.0 ft long-term sea-level rise adopted in the FSAR, Revision 2 is conservative for the site. In addition to the linear trend model using Miami Beach data, five different trend models have been applied to the sea-level data at Miami Beach and Key West, as described below. In the trend models, seasonal fluctuations were removed from the monthly mean sea levels, consistent with NOAA's methodology adopted in developing a linear trend model.

The five additional trend models are as follows:

(a) Nonlinear second order polynomial trend model on the historical monthly mean sea levels from June 1931 to June 1981 at the Miami Beach tide gage station. Walton 2007 (Reference 2) uses a second order polynomial for projecting sea-level rise in Florida. Using data at Miami Beach, the current model projects a sea-level decline of 2.79 ft in 100 years starting from November 2010, as shown in Figure 1. This decline in sea-level is very unlikely and therefore a second order trend model is not appropriate for Miami Beach data from 1931 to 1981.

(b) Linear trend model on the historical monthly mean sea levels from January 1941 to November 2010 at Key West, Florida tide gage station (Station 8724580) (Reference 3). The linear trend leads to a projected increase of 0.69 ft in 100 years (Figure 2). Using the linear trend model and data from 1941 to 2005, Walton 2007 (Reference 2) forecasts a sea-level rise of 0.49 ft in 75 years at Key West, which is consistent with the current analysis. It should be noted that the Key West station is approximately 110 miles southwest of the site. Because of its long distance from the site, the data from this tide gage station are not considered to be directly representative of the sea-level characteristics at the site.

(c) Nonlinear second order polynomial trend model on the historical monthly mean sea levels from January 1941 to November 2010 at Key West station. With the seasonal fluctuations removed, the second order trend projects a 1.54 ft rise in 100 years starting from November 2010 (Figure 2). Using the second order polynomial trend model and data from 1941 to 2005, Walton 2007 (Reference 2) forecasts a sea-level rise of 1.02 ft in 75 years at Key West which is consistent with the current analysis. However, because of its long distance from the site, the data from this tide gage station are not considered to be directly representative of the sea-level characteristics at the site.

(d) Linear trend model on an extended monthly mean sea level series from June 1931 to November 2010 at the Miami Beach station. As sea-level measurement at Miami Beach station terminated in 1981, a statistical technique was derived to extend the data from 1981 to 2010 using the historical sea-level record from the Key West station. A regression relationship was established between the historical data from the Key West station and from the Miami Beach station for the overlapping period between 1931 and 1981, as illustrated below and shown in Figure 3.

$$MonthlyMeanSeaLevel_{MiamiBeach}(ft, NAVD88) = 1.0352 * MonthlyMeanSeaLevel_{KeyWest}(ft, NAVD88) - 0.0487\,ft$$

Using the regression relationship presented above, a new data series was generated for Miami Beach to extend the sea-level data from 1981 to 2010 and to fill in a few data gaps from 1931 to 1981. The linear trend model derived using the extended sea-level data from 1931 to 2010 projects a 0.77 ft rise in 100 years, as shown in Figure 4.

(e) Nonlinear second order polynomial trend model on the extended monthly mean sea level series from June 1931 to November 2010 at the Miami Beach station. The second order polynomial trend on the 80-year period of sea-level data series at Miami Beach station projects a 0.50 ft rise in 100 years starting from November 2010 (Figure 4).

The projected 100 year sea-level rises for the linear and nonlinear models and the corresponding coefficients of determination, which measure the goodness of fit of the trend lines, are summarized in Table 1. With the exception of the second order trend derived from the sea-level record of the Key West station, all models project a 100 year sea-level rise of 0.78 ft or less. Key West station is far away from the site with approximately 110 mile distance in between. In addition, as evident from the regression shown in Figure 3 between the two monthly mean sea level data sets, the sea-level at the Key West station is not equal to the sea-level at the Miami Beach station. Consequently, the long-term trend at Key West is not considered to be directly applicable to the Turkey Point Units 6 & 7 site. Therefore, the nominal long-term sea-level rise of 1.0 ft adopted in FSAR Subsection 2.4.5.2.2.1, Revision 2 remains valid and conservative based on the sea-level rise trend models applicable for the site.

Based on the sea-level data that is applicable for the site, linear extrapolation of the sea-level records is more conservative compared to nonlinear extrapolation. Moreover, there is conservatively an additional 1.2 ft margin between the design grade elevation of 26.0 ft NAVD 88 for safety-related facilities and the probable maximum hurricane flood elevation of 24.8 ft NAVD 88, which includes a long-term sea-level rise of 1.0 ft. Hence, at design grade elevation the safety-related facilities can accommodate a long-term sea-level rise of more than 1.0 ft.

This response is PLANT SPECIFIC.

Table 1: 100-Year Sea-Level Trend near the Turkey Point Units 6 & 7 Site.

	Linear Extrapolation	**Nonlinear (2nd order) Extrapolation**
Key West (1941-2010)	0.69 ft	1.54 ft
	R^2 = 0.45 (*)	R^2 = 0.46
Miami Beach (1931-1981)	0.78 ft (**)	-2.79 ft (***)
	R^2 = 0.32	R^2 = 0.35
Miami Beach (1931-2010) Missing data estimated from Key West using linear regression imputation	0.77 ft	0.50 ft
	R^2 = 0.53	R^2 = 0.53

(*) R^2 is the coefficient of determination
(**) Same as NOAA's analysis in FSAR Subsection 2.4.5, Reference 206
(***)The decline in sea-level is very unlikely and therefore second order extrapolation is not appropriate for Miami Beach data from 1931 to 1981.

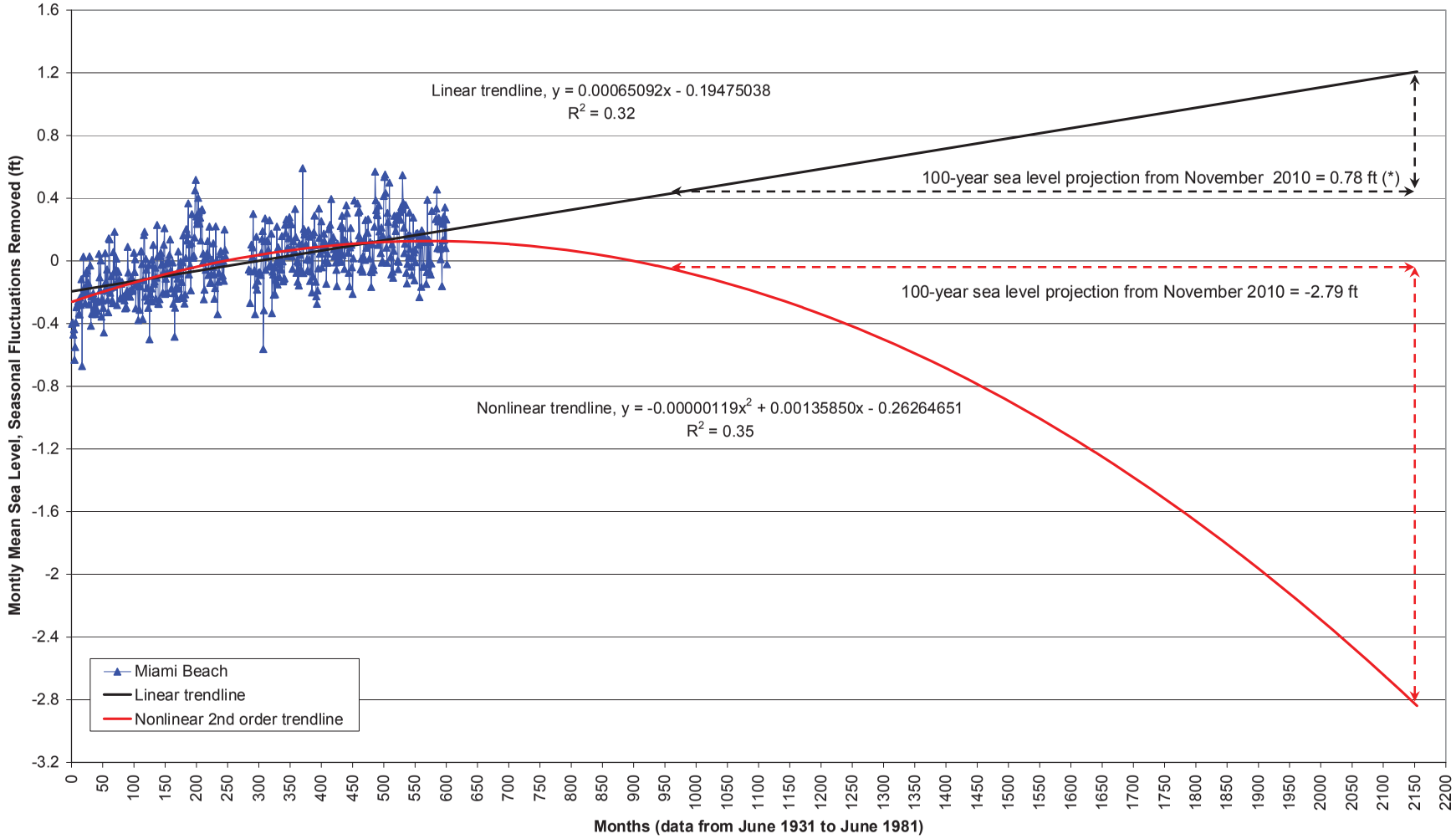

Figure 1: Monthly Mean Sea Level Trend at Miami Beach with Seasonal Fluctuations Removed.

(*) Same as NOAA's analysis in FSAR Subsection 2.4.5, Reference 20

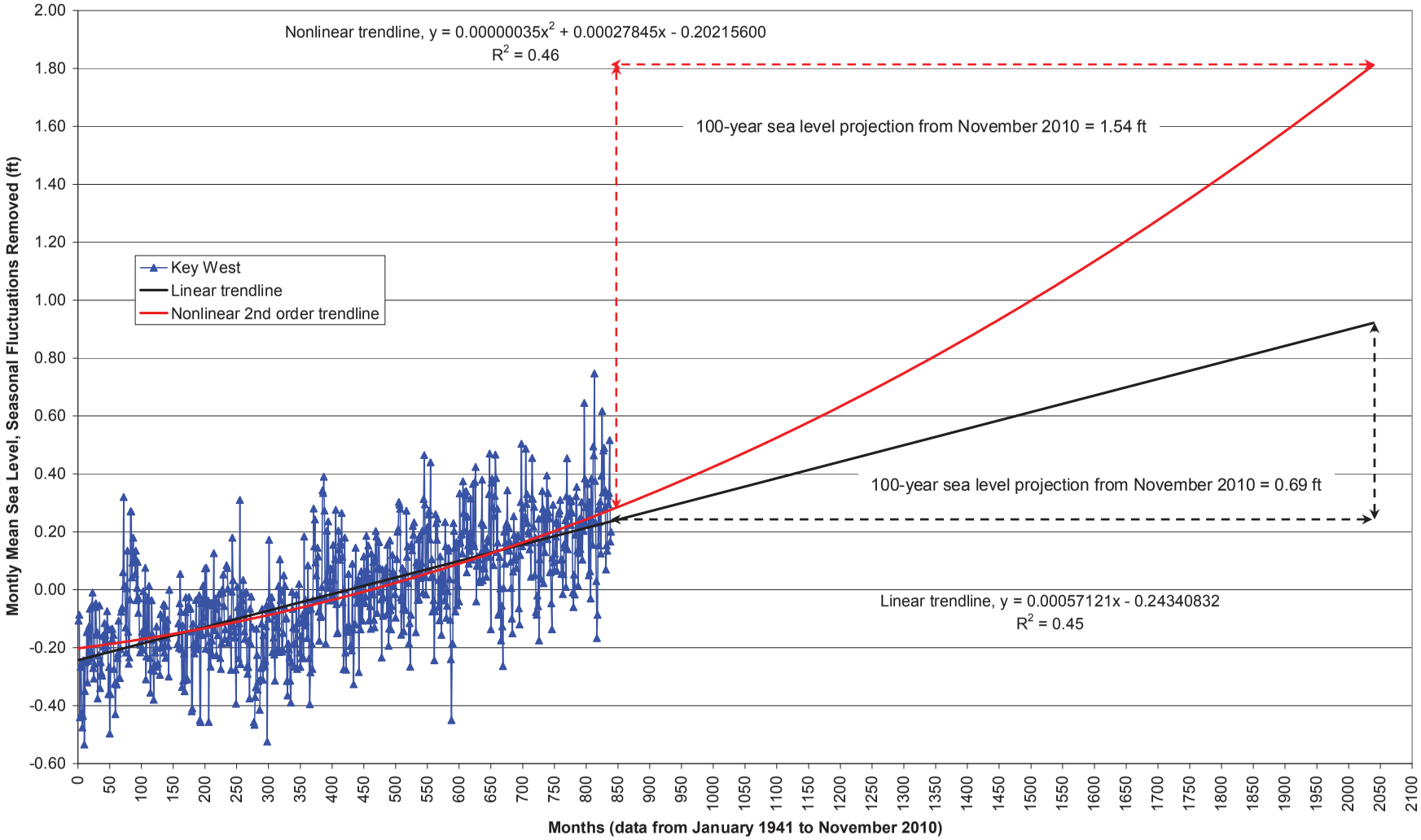

Figure 2: Monthly Mean Sea Level Trend at Key West with Seasonal Fluctuations Removed.

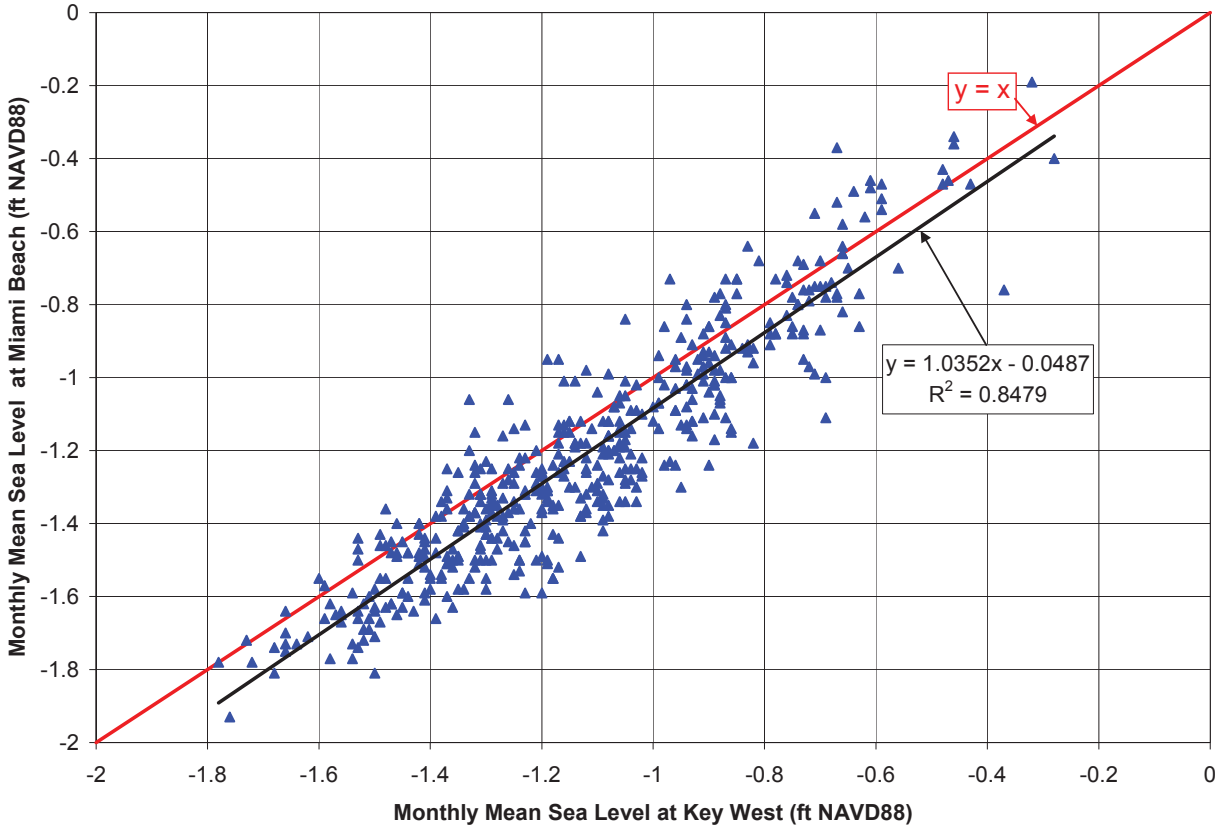

Figure 3: Monthly Mean Sea Level, Miami Beach vs Key West from 1931 to 1981

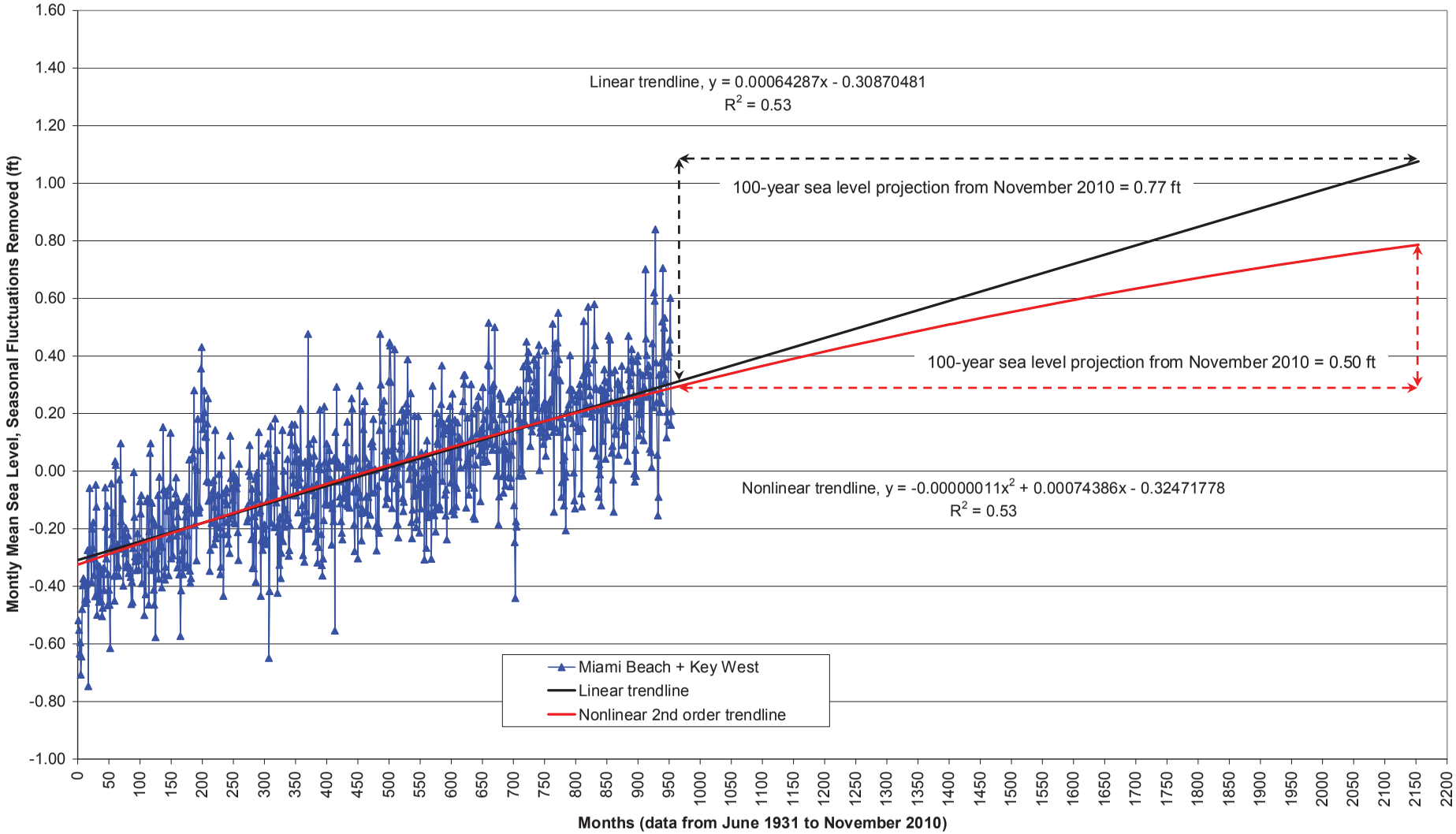

Figure 4: Monthly Mean Sea Level Trend for Miami Beach from 1931 to 2010 with Seasonal Fluctuations Removed. Missing Data Estimated from Key West Using Linear Regression Imputation.

References:

1. NOAA Miami Beach Tide Station Historic Tide Data, available at: http://tidesandcurrents.noaa.gov/data_menu.shtml?bdate=19001013&edate=20101214&wl_sensor_hist=W5&relative=&datum=7&unit=1&shift=g&stn=8723170+Miami+Beach%2C+FL&type=Historic+Tide+Data&format=View+Data, accessed 12-13-2010.

2. Walton, Todd L, Jr. 2007. Projected sea level rise in Florida. *Ocean Engineering* 34:1832-1840. doi:10.1016/j.oceaneng.2007.02.003.

3. NOAA Key West Tide Station Historic Tide Data, available at: http://tidesandcurrents.noaa.gov/data_menu.shtml?bdate=19001013&edate=20101214&wl_sensor_hist=W5&relative=&datum=7&unit=1&shift=g&stn=8724580+Key+West%2C+FL&type=Historic+Tide+Data&format=View+Data, accessed 12-13-2010

ASSOCIATED COLA REVISIONS:

No COLA changes have been identified as a result of this response.

ASSOCIATED ENCLOSURES:

None

L-2011-474
10 CFR 52.3

November 4, 2011

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

Re: Florida Power & Light Company
Proposed Turkey Point Units 6 and 7
Docket Nos. 52-040 and 52-041
Response to NRC Request for Additional Information Letter No. 036 (eRAI 5860)
SRP Section: 02.04.05 Probable Maximum Surge and Seiche Flooding

Reference:

1. NRC Letter to FPL dated September 21, 2011, Request for Additional Information Letter No.036 Related to SRP Section 02.04.05 - Probable Maximum Surge and Seiche Flooding for the Turkey Point Nuclear Plant Units 6 and 7 Combined License Application
2. FPL Letter to NRC dated October 21, 2011, Response and Response Schedule to NRC Request for Additional Information Letter No. 036 (eRAI 5860) SRP Section: 02.04.05 Probable Maximum Surge and Seiche Flooding

Florida Power & Light Company (FPL) provides, as an attachment to this letter, its response to the Nuclear Regulatory Commission's (NRC) Request for Additional Information (RAI) 02.04.05-5 provided in Reference 1. FPL provided a schedule for the response to RAI 02.04.05-5 in Reference 2. The attachment identifies changes that will be made in a future revision of the Turkey Point Units 6 and 7 Combined License Application (if applicable).

If you have any questions, or need additional information, please contact me at 561-691-7490.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on November 4, 2011

Sincerely,

William Maher
Senior Licensing Director – New Nuclear Projects

WDM/RFB

Attachment: FPL Response to NRC RAI No. 02.04.05-5 (eRAI 5860)

cc:
PTN 6 & 7 Project Manager, AP1000 Projects Branch 1, USNRC DNRL/NRO
Regional Administrator, Region II, USNRC
Senior Resident Inspector, USNRC, Turkey Point Plant 3 & 4

NRC RAI Letter No. PTN-RAI-LTR-036

SRP Section: 02.04.05 - Probable Maximum Surge and Seiche Flooding

Question from Hydrologic Engineering Branch (RHEB)

NRC RAI Number: 02.04.05-5 (eRAI 5860)

The new analysis that the Miami Beach data set appears to have some shortcomings. The most recent measurements are 20 years old, so the data set may not represent recent trends, and there are gaps in the record from earlier years. A data set exists for Key West that covers a longer period, continuing to the present time, and does not have gaps. R-squared values for both linear and nonlinear trend analyses of the Miami Beach data are much lower than those for trend analyses for Key West data (values of 0.32 to 0.35 for Miami Beach data (versus values of 0.45 and 0.46 for Key West data). Also, the applicant's attempt to fit a second-order trend to the Miami Beach data yields apparently counterintuitive results, in that it predicts a large drop in sea level, which suggests problems with the data set. The applicant's linear regression analysis of the Miami Beach and Key West data sets did, however, find a close correlation between sea level measurements at the two locations (R-squared of 0.85).
Provide reasoning and analysis sufficient to demonstrate that reliance on the Miami Beach sea-level data is a valid and sufficient basis for predicting potential future sea-level rise, when a longer and more recent data set for the region is available from Key West.

FPL RESPONSE:

The 100-year linear and nonlinear projections of the sea-level data from Miami Beach (Reference 1) and Key West (Reference 2) tide gage stations were provided in response to NRC RAI No. 02.04.05-3 (Reference 3), in which FPL was requested to explain whether a linear extrapolation of sea-level records is conservative compared to a nonlinear model extrapolation approach. The results of the analyses are summarized in Table 1. In response to the current RAI question, a sea-level rise trend analysis on the Key West station data for the period of 1931 to 1981 (same period of record available at the Miami Beach station) is also included in Table 1.

As shown in Table 1 and Figure 1, the linear trend model on the historical monthly sea-level data from the Key West station for the period of 1931 to 1981 projects an increase of 0.66 ft in 100 years. The nonlinear model projects a sea-level decline of -0.97 ft in 100 years, which is not considered to be a plausible outcome. Similar trends and projections are exhibited in the Miami Beach data of the same time period. Rather than indicating unsuitability of the Miami Beach data, these trends suggest that the nonlinear trend model is not appropriate for the sea-level data period of 1931 to 1981, as previously indicated in the response to NRC RAI No. 02.04.05-3.

Figure 2 (Figure 3 of Reference 3) shows a regression relationship between the historical sea-level data from the Key West and the Miami Beach stations for the overlapping period between 1931 and 1981. Although the two data sets indicate a general correlation, as evident from the regression between the two data sets, the sea-level at the Key West station is not a direct substitute of the sea-level at the Miami Beach station. As the Key West station is further from the Turkey Point Units 6 & 7 site than the Miami Beach station

(110 miles southwest versus 27 miles northeast), the data from the Key West station cannot be considered to be more representative of the sea-level characteristic at the site.

As expressed in the response to NRC RAI No. 02.04.05-3 (Reference 3), the regression relationship between the historical data from the Key West and the Miami Beach stations was used to extend the Miami Beach sea-level data from 1981 to 2010 and to fill in a few data gaps from 1931 to 1981. The linear trend model on this extended data set projects a 0.77 ft rise in 100 years, whereas the nonlinear model projects a 0.50 ft rise in 100 years (See Table 1). The coefficients of determinations (R-squared values) are 0.53 for both linear and nonlinear models and are the highest among the data sets analyzed.

Based on the evaluation of the sea-level data that is applicable for the site, linear projection is more conservative compared to nonlinear projection and is a valid and sufficient basis for predicting potential future sea-level rise. It is therefore concluded that the nominal long-term sea-level rise of 1.0 ft adopted in FSAR Subsection 2.4.5 remains valid and conservative.

Table 1: 100-Year Sea-Level Trend near the Turkey Point Units 6 & 7 Site.

Data Set	Linear Extrapolation	Nonlinear (2nd order) Extrapolation
Key West (1941-2010)	0.69 ft	1.54 ft
	R^2 = 0.45 *	R^2 = 0.46
Key West (1931-1981)	0.66 ft	-0.97 ft ***
	R^2 = 0.28	R^2 = 0.29
Miami Beach (1931-1981)	0.78 ft **	-2.79 ft ***
	R^2 = 0.32	R^2 = 0.35
Miami Beach (1931-2010) Missing data estimated from Key West using linear regression imputation	0.77 ft	0.50 ft
	R^2 = 0.53	R^2 = 0.53

* R^2 is the coefficient of determination
** Same as NOAA's analysis in FSAR Subsection 2.4.5, Reference 206
***The decline in sea-level is not considered to be a plausible outcome and therefore second order extrapolation is not appropriate for the sea-level data from 1931 to 1981.

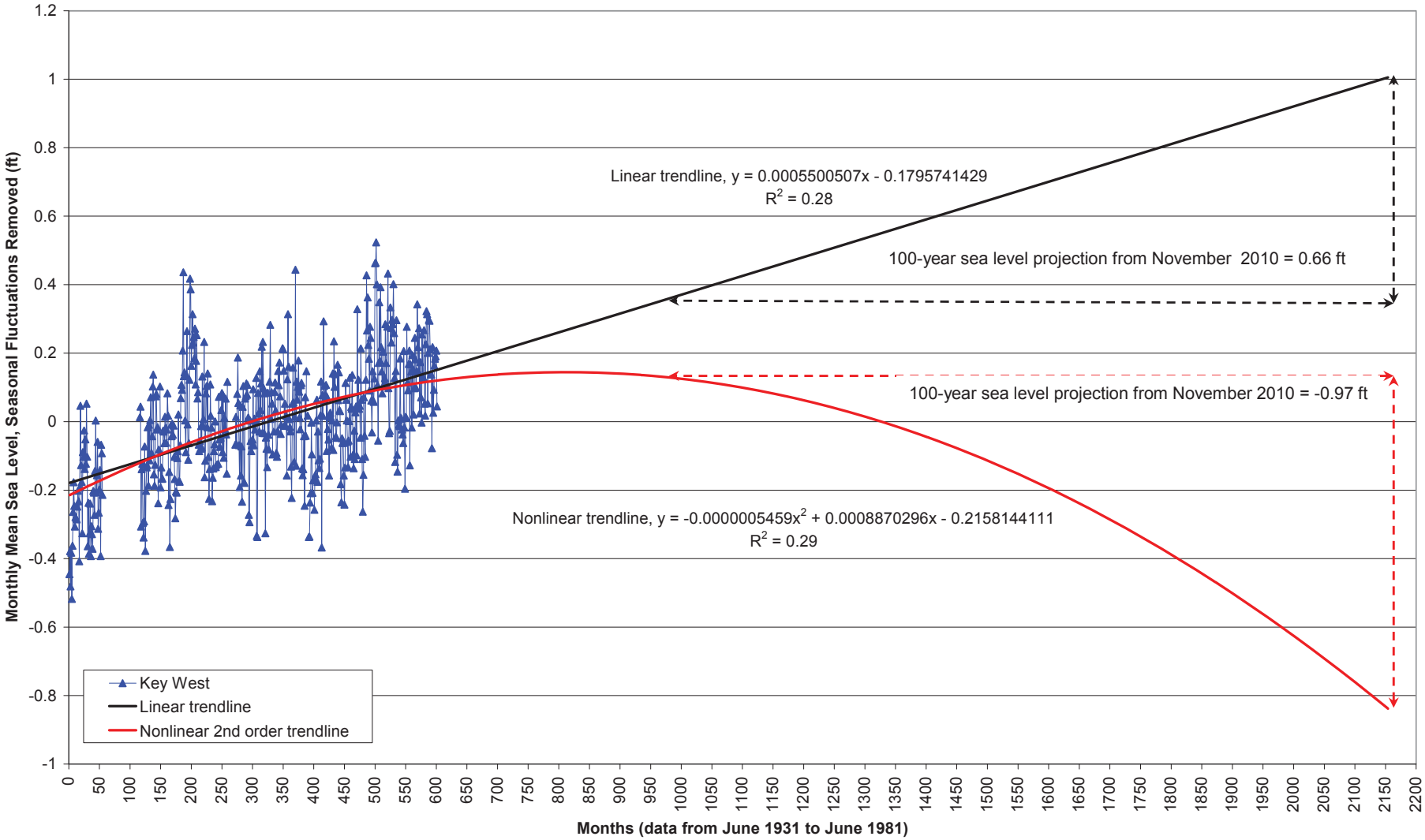

Figure 1: Monthly Mean Sea Level Trend at Key West with Seasonal Fluctuations Removed.

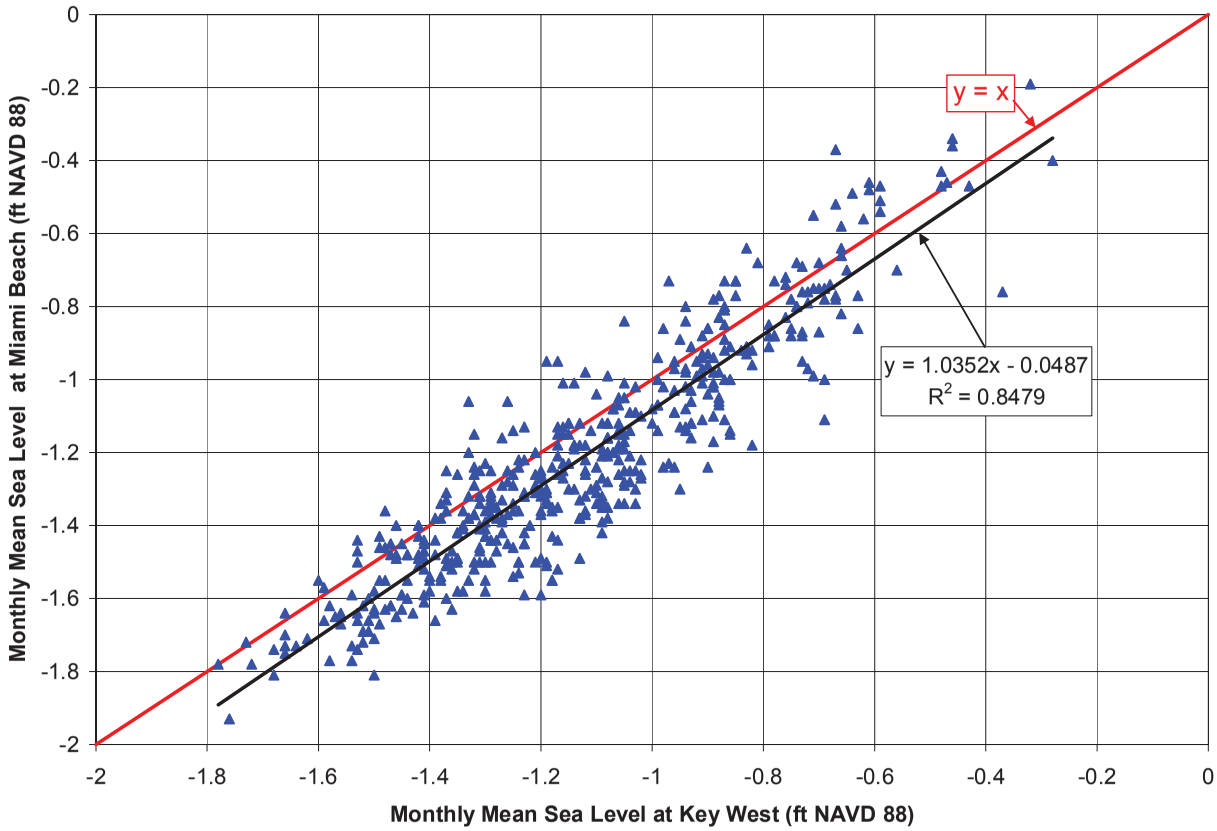

Figure 2: Monthly Mean Sea Level, Miami Beach vs Key West from 1931 to 1981 (Source: Figure 3 of Reference 3).

This response is PLANT SPECIFIC.

References:

1. NOAA Miami Beach Tide Station Historic Tide Data, available at: http://tidesandcurrents.noaa.gov/data_menu.shtml?bdate=19001013&edate=20101214&wl_sensor_hist=W5&relative=&datum=7&unit=1&shift=g&stn=8723170+Miami+Beach%2C+FL&type=Historic+Tide+Data&format=View+Data , accessed 12-13-2010.

2. NOAA Key West Tide Station Historic Tide Data, available at: http://tidesandcurrents.noaa.gov/data_menu.shtml?bdate=19001013&edate=20101214&wl_sensor_hist=W5&relative=&datum=7&unit=1&shift=g&stn=8724580+Key+West%2C+FL&type=Historic+Tide+Data&format=View+Data , accessed 12-13-2010.

3. FPL Letter L-2011-125 to NRC dated April 6, 2011, Response to Request for Additional Information 02.04.05-3, Letter No. 010 (eRAI 5233) Standard Review Plan Section 02.04.05 - Probable Maximum Surge and Seiche Flooding

ASSOCIATED COLA REVISIONS:

None

ASSOCIATED ENCLOSURES:

None