Appendix H

Boundary Conditions

CONTENTS

FIGURES

TABLES

H.1 TIDAL BOUNDARY CONDITIONS

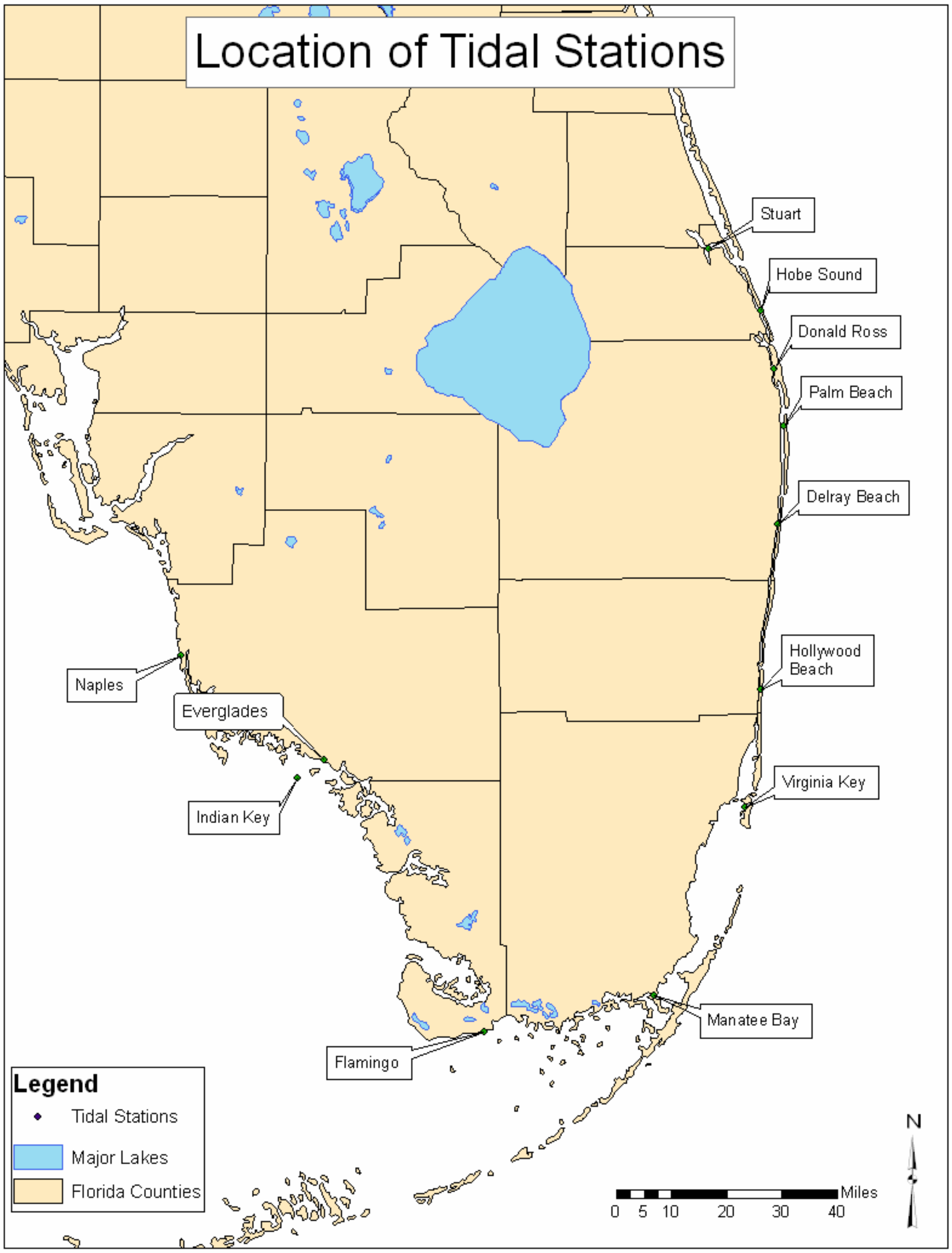

Figure H.1-1. Tidal Stations Used to Define Coastal Boundary Conditions for the NSRSM

Table H.1-1. Constants from the National Oceanic Service Products and Services Division used to Compute Water Level for the Secondary Stations

Tidal station	Time		Constant
	High Water	Low Water	
Naples Primary Station			
Manatee Bay, FL	1 hr 14 min	2 hr 3 min	0.163
Flamingo Bay, FL	3 hr 5 min	4 hr 28 min	0.837
Indian Key, FL	47 min	1 hr 2 min	1.486
Everglades City, FL	2 hr 23 min	3 hr 25 min	0.983
Virginia Key Primary Station			
Stuart	1 hr 44 min	2 hr 41 min	0.483
Hobe Sound	59 min	1 hr 35 min	0.778
Donald Ross	-8 min	1 min	1.148
Palm Beach	-41 min	-35 min	1.365
Delray Beach	53 min	1 hr 16 min	1.243
Hollywood Beach	8 min	15 min	1.017

Datum Conversion from MLLW to NGVD29

The following figures and formula describe the conversion process from MLLW to NGVD29 via NAVD88 when the difference between MLLW and NGVD 29 is unknown and the shift values from MLLW to NAVD88 and NAVD88 to NGVD29 are known.

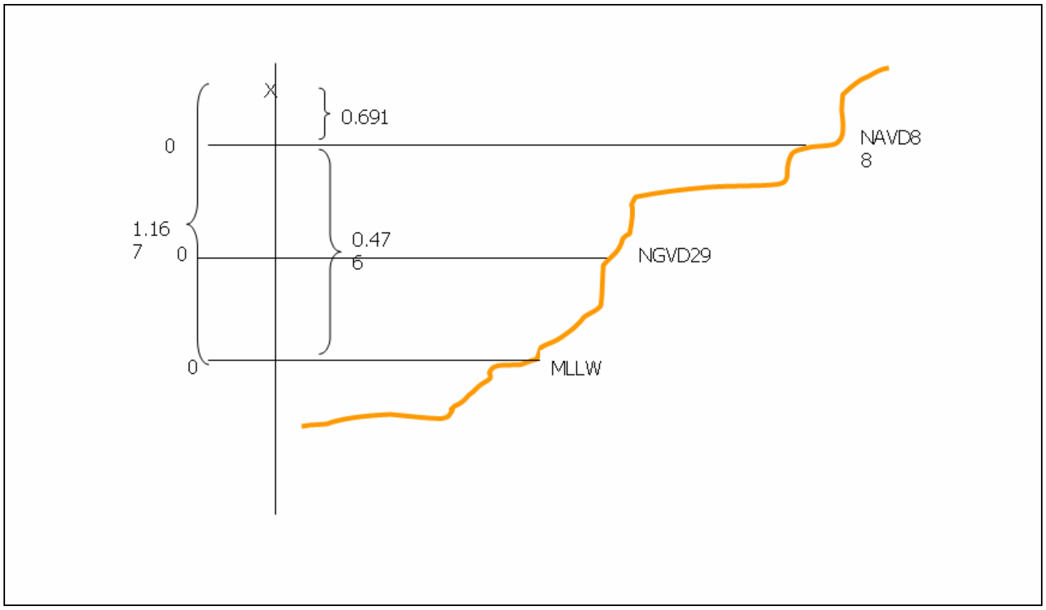

Figure H.1-2. Case 1 - Conversion process from MLLW to NGVD29 via NAVD88.

For this particular case:

NGVD29 = NAVD 88 + [Δ NAVD88 and NGVD29] (4.1)

NAVD88 = NGVD29 – [Δ NAVD88 and NGVD29] (4.2)

MLLW = NAVD88 + [Δ MLLW and NAVD88] (4.3)

NAVD88 = MLLW – [Δ MLLW and NAVD88] (4.4)

By replacing the value of NAVD88 from equation (4.4) in equation (4.1) we have:

NGVD29 = (MLLW - / Δ MLLW and NAVD88/)
+ [Δ NAVD88 and NGVD29] (4.5)

(Δ MLLW and NAVD88) is a given value for the reference stations in NOAA/NOS web site, (Δ NAVD88 and NGVD29) can be computed with **VERTCON**[1], and raw data are already referenced to the MLLW datum. VERTCON is a North American vertical datum conversion utility provided by the National Geodetic Survey.

[1] http://www.ngs.noaa.gov/TOOLS/Vertcon/vertcon.html

Example:

For Virginia Key (Δ MLLW and NAVD88)[2] is 0.608 m (see NOAA/NOS web site listed below) and datum shift from NAVD88 to NGVD29 or (Δ NAVD88 and NGVD29) computed with **VERTCON** is (-0.476).

To convert a water level referenced in MLLW for Virginia Key to NGVD29 we can just replace the value referenced in MLLW in Equation 4.5, by using the datum shift value from NAVD88 to NGVD29 and (Δ MLLW and NAVD88) for Virginia Key.

For a water level = -0.037m referenced in MLLW datum we have:

$\text{NGVD29} = -0.037 - 0.608 + 0.476 \Rightarrow \text{NGVD29} = -0.169\text{m}$

VERTCON output for Virginia Key.

Latitude: 25 43.9

Longitude: 80 09.7

NGVD29 Height: 1.008

Datum shift (NAVD88 minus NGVD 29): -0.476 meters

Converted to NAVD88 height: 0.532 meters

Latitude: 25 43.9

Longitude: 80 09.7

NAVD88 Height: 1.008

Datum shift (NAVD88 minus NGVD 29): -0.476 meters

Converted to NGVD29 height: 1.484 meters

The shift value remains the same from NAVD88 to NGVD29 or From NGVD29 to NAVD88 for the same coordinates or the same tidal station. The calculations of tides at the secondary stations are provided in Table 4.x2 below. In some cases, the shift value from MLLW to NGVD29 is known and a direct conversion can be made.

[2] http://www.co-ops.nos.noaa.gov/benchmarks/8723214.html
http://www.co-ops.nos.noaa.gov/bench.html

Table H.1-2. Calculation of tides for the coastal NSRSM boundary conditions. Tidal benchmarks (PID) that the adjustments are based on are listed in red.

Tidal station	NOAA constant	Δ(MLLW and NAVD88)	Δ(NAVD88 and NGVD29	Δ(MLLW and NGVD29)
Naples	1	-	-	0.305
Equation	NGVD29 ft =(Naples MLLW-0.305)*3.28083 PID AD5731			
Virginia Key	1	0.608	0.476	-
Equation	NGVD29 ft =(Virginia MLLW-0.608+0.476)*3.28083 PID AC2154			
Secondary Stations using Naples Coast as reference				
Manatee Bay	0.163	-	-	0.07
Equation	NGVD29 ft =(0.163*Naples MLLW+0.07)*3.28083 PID AC3299			
Flamingo Bay	0.837	0.64	0.447	-
Equation	NGVD29 ft =(0.837*Naples MLLW-0.64+0.447)*3.28083			
Indian Key	1.486	-	-	0.216
Equation	NGVD29 ft =(1.486*Naples MLLW-0.216)*3.28 PID AC0625			
Everglades City	0.983	0.632	0.419	-
Equation	NGVD29 ft =(0.983*Naples MLLW-0.632+0.419)*3.28083 PID AC0625			
Secondary Stations using Virginia Key as reference				
Stuart	0.483	0.418	0.445	-
Equation	NGVD29 ft =(0.483*Virginia MLLW-0.418+0.445)*3.28083 PID AF3145			
Hobe Sound	0.778	0.592	0.455	-
Equation	NGVD29 ft =(0.778*Virginia MLLW-0.592+0.455)*3.28083 PID AF6989			
Donald Ross	1.148	0.722	0.460	
Equation	NGVD29 ft =(1.148*Virginia MLLW-0.722+0.460)*3.28083 PID AD2897 and PID AD6273			
Palm Beach	1.365	0.805	0.465	-
Equation	NGVD29 ft =(1.365*Virginia MLLW-0.805+0.465)*3.28083 PID AD0670			
Delray Beach	1.243	0.691	0.469	
Equation	NGVD29 ft =(1.243*Virginia MLLW-0.691+0.469)*3.28083 PID AD5817			
Hollywood Beach	1.017	-	-	0.152
Equation	NGVD29 ft =(1.017* Virginia MLLW-0.152)*3.28083 PID AD5895			

Processing diagram

An overview of the process from tidal raw data collection to the final data set is given in the diagram shown below.

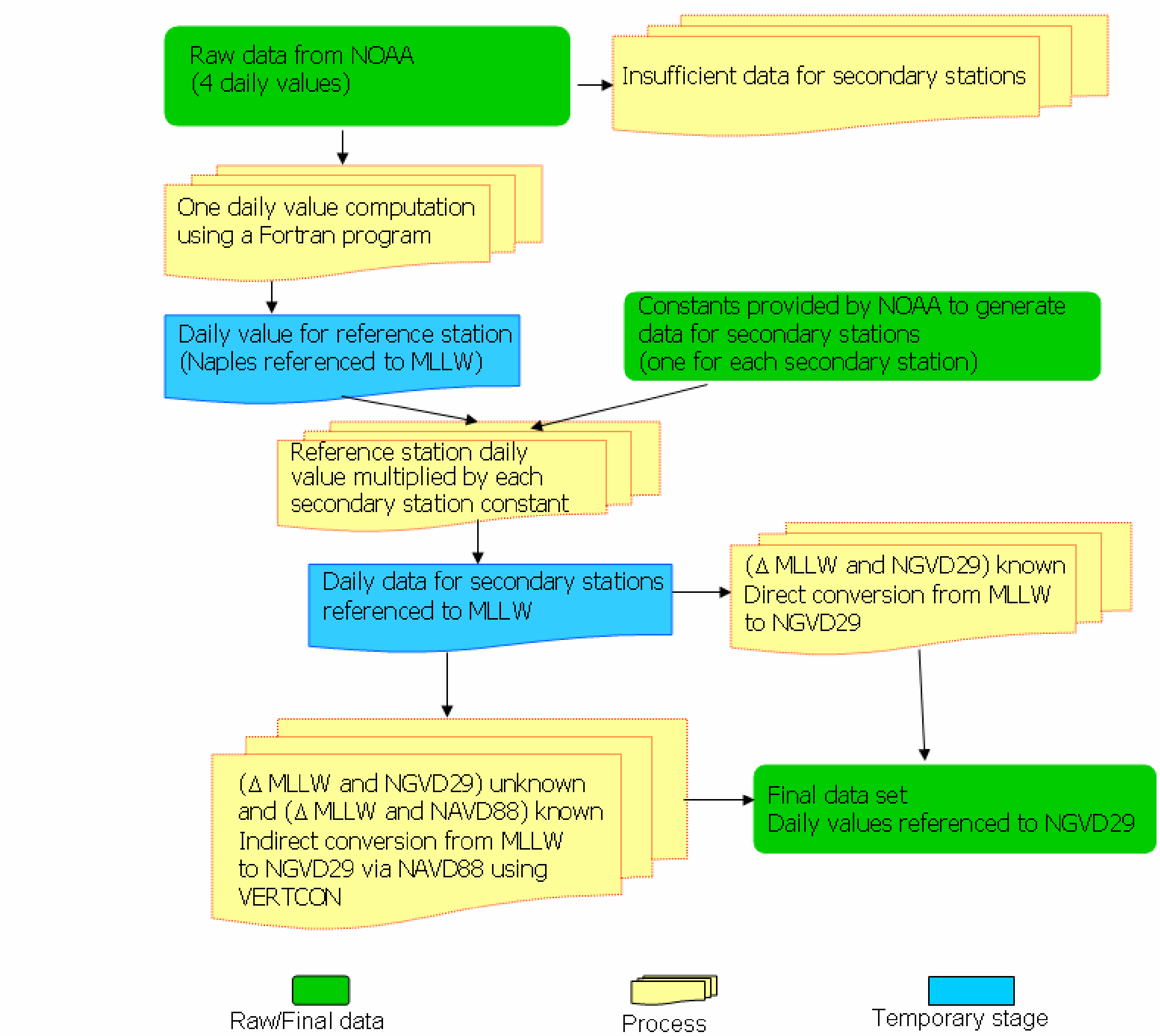

Figure H.1-3. Process Diagram

H.2 SEALINK MODEL

The upper extent of the Kissimmee River provides the NSRSM with flows from outside the model domain. Under pre-drainage conditions all overland flow from the Kissimmee Upper Basin (KUB) are assumed to collect in Lake Kissimmee and flow naturally into the Kissimmee River and into the Lower Kissimmee Basin (LKB).

The Sealink model was used to simulate the runoff from the KUB that is assumed to drain through Lake Kissimmee and into the LKB. This flow input boundary condition was used for the NSRSM northern most boundary into the Kissimmee River and the LKB. The period of record for which Sealink was calibrated for the KUB was 1965 to 2000. This calibration was done using both Kissimmee basins and using historical flows from structures S65E and S65 where available. Only the KUB portion of this calibrated model is being used in the NSRSM.

Sealink was designed to simulate the movement of water within basins that are nearly level, poorly drained, and subject to frequent flooding. It is a field scale, root zone model using a daily time step. Sealink models the rainfall-runoff, infiltration, evapotranspiration (ET), irrigation, and seepage processes. It uses a variation of the Interactive Water Balance Model (ISWAB) developed at the SFWMD to simulate regional movement of water. The ISWAB conceptualizes a basin as an array of storage tanks. Each column of tanks represents a sub-basin. Within a sub-basin, water moves vertically between a column of three tanks, surface storage, soil storage and ground water storage. The vertical movement of water represents infiltration, ET and deep percolation processes of the hydrologic cycle. Flow between columns represents surface runoff, ground water flow, and base flow between sub-basins. Equations with calibrated coefficients act as valves to control flow between storage tanks.

Although the concepts from the ISWAB model are used, Sealink replaces the soil storage tank in the ISWAB model with a series of field scale root zone models. Each "land use" within a sub-basin is represented by a root zone similar to those in the CRAMS-WT model (Heatwole et al, 1984). The root zone model uses daily rainfall, pan evaporation, soil and land use parameters, to simulate runoff, ET seepage, base flow, soil water content and water table depth for each land use in each sub-basin. The volume of runoff and base flow simulated by each root zone model is added to the respective sub-basin surface storage. Similarly the volume of deep seepage is added to the respective sub-basin groundwater storage.

Irrigation options can be added to any land use. Water will be withdrawn from the sub-basin surface and groundwater storage. Irrigation efficiency losses are apportioned between surface runoff, seepage and evaporation. Secondary sources can be specified.

Wetland areas can be designated within a sub-basin. Sealink maintains water table levels in a wetland using base flow contributions from the other land use areas in the sub-basin. The quantity of flow between the wetland and other land uses is a function of a hydraulic conductivity coefficient.

A drainage option is also available to all land uses. This option triggers pumps when the water table reaches a specific depth. The pumps remove water at a specified rate and discharge to sub-basin surface storage until the water table drops to a specified shutoff depth.

In addition to NSRSM base condition simulation1(965 to 2000) a run was made for a 100 year boundary condition input to NSRSM which has a POR of 1885 to 1993. For this, 100 year POR, the model was not calibrated. The runoff output from Sealink was compared to flow data at S65 which exists from 1933 forward. The computed Sealink flows did approximate the measured flows observed at S65 reasonably well for the period 1933 to 1993. It should be noted that from 1965 to 1993 the flows do not match as well as actual measured flows begin to exhibit operational management trends and not the natural flow regime. **Figure H.2-1**.

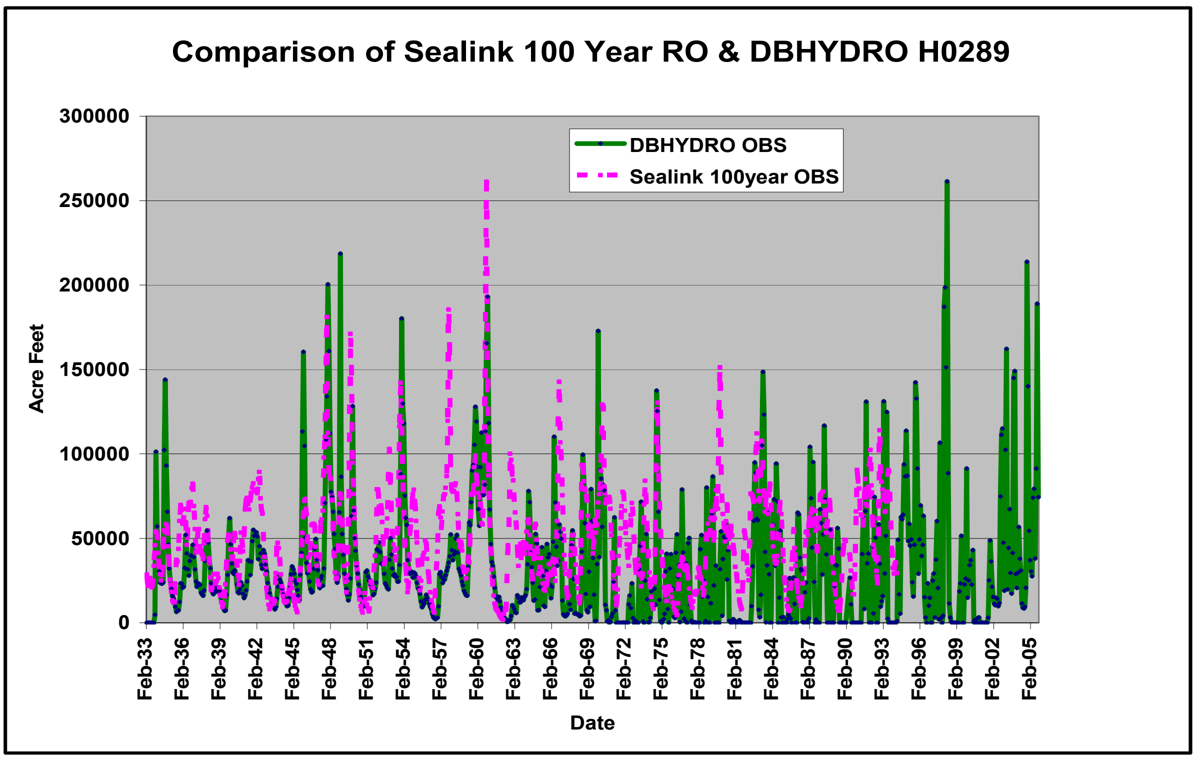

Figure H.2-1. Comparison of Sealink data.