

# East Coast Floridan Model

## Overview and Results

### Lower East Coast

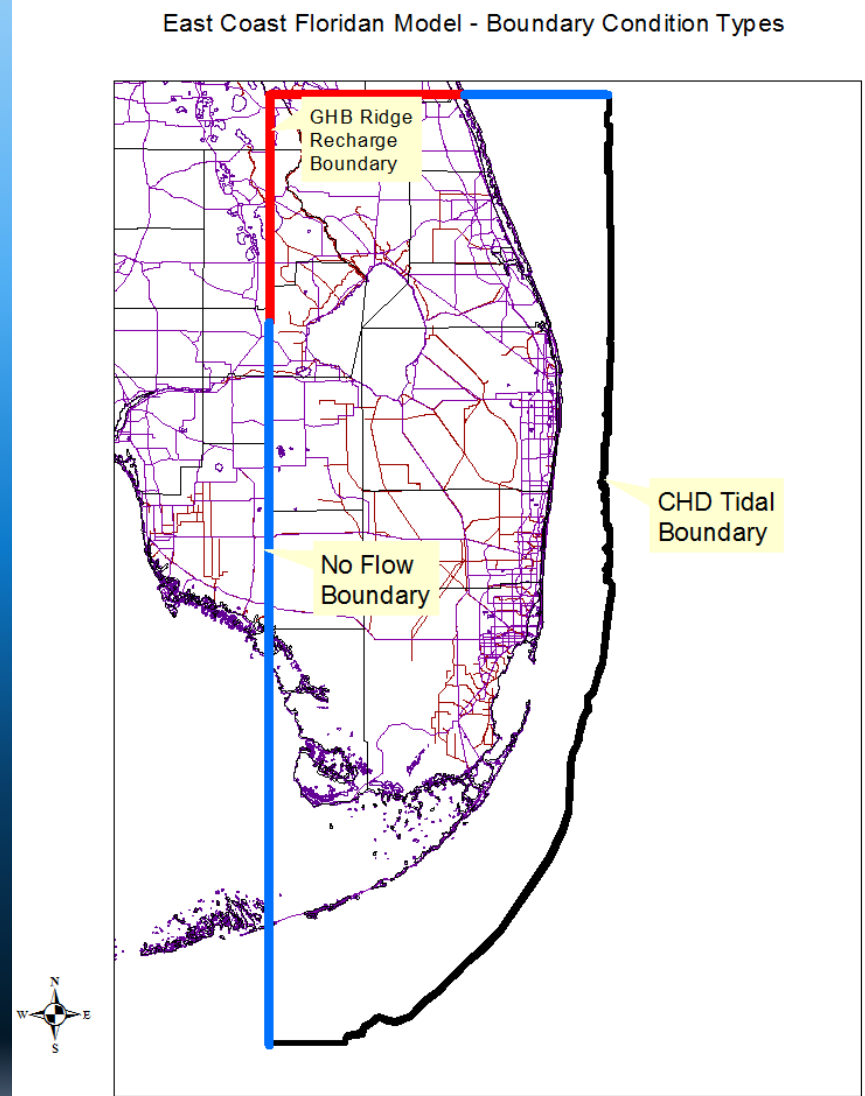
Peter J. Kwiatkowski, P.G.  
Section Administrator, Water Supply Bureau, SFWMD  
July 24, 2018

# LEC Floridan Aquifer System Modeling

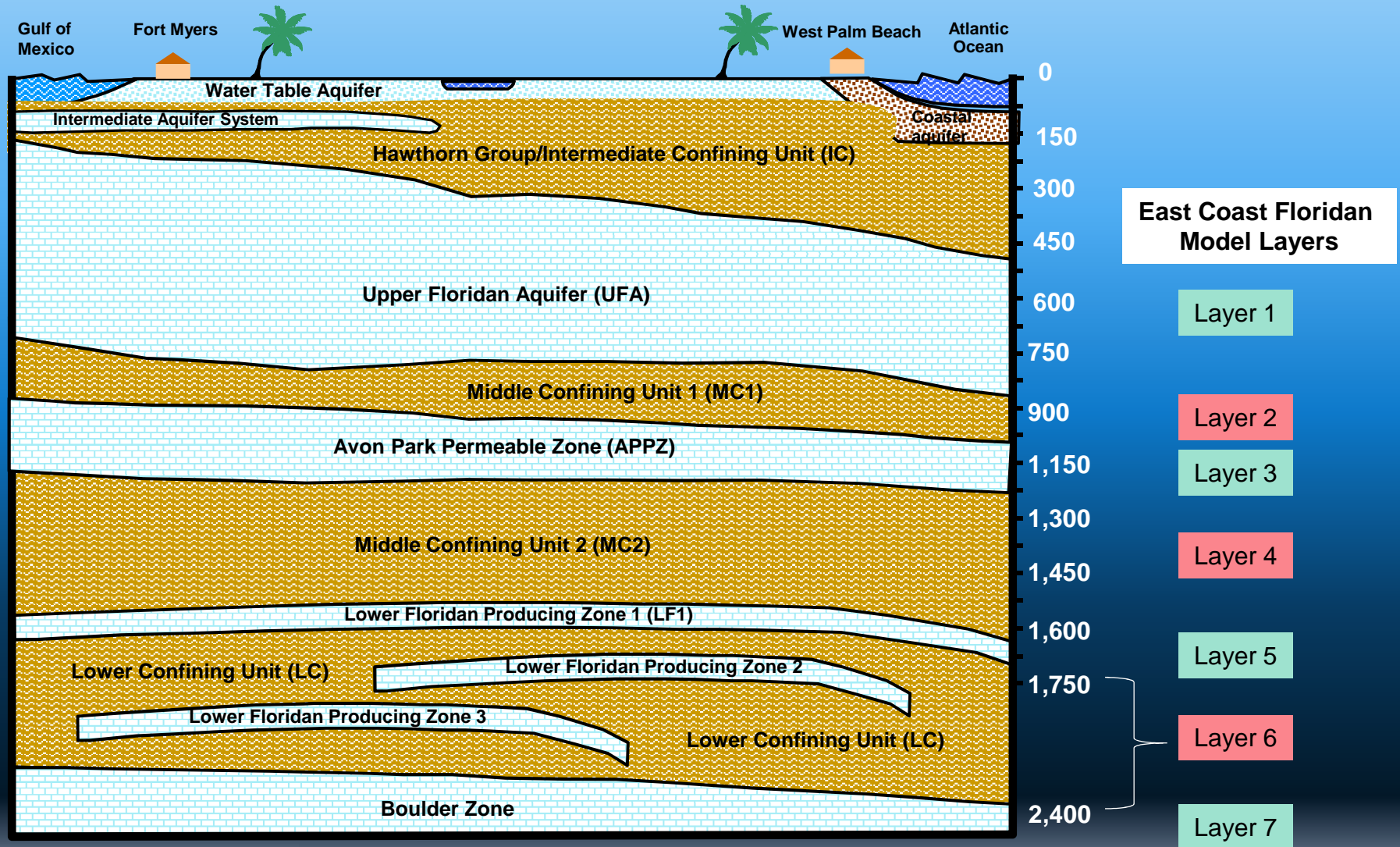
- Application of the East Coast Floridan Model (ECFM) in support of the 2018 Lower East Coast Water Supply Plan Update
- ECFM was used in 2016 Upper East Coast WSP Update
- ECFM was peer reviewed and comments incorporated
- Two simulations
  - 2016 Current Condition (using actual FAS withdrawals for 24 years)
  - 2040 Future Condition (using projected FAS withdrawals for 24 years)
- Key measurements: water levels, water quality, flows

# ECFM Overview

- Uses USGS' SEAWAT code – density-dependent
- Calibration period: 1989 through 2012
- Monthly stress periods
- 24-year period of record
- Cell size: 2,400 ft × 2,400 ft
- Vertical extent:
  - Upper Floridan aquifer (Layer 1)
  - Boulder Zone (Layer 7)



# ECFM Layers





# Key Assumptions

- 2016 Run used actual pumped volumes
- 2040 Run used projected demands
  - Typically less than permitted volumes
  - FAS used only after SAS use maximized
  - Existing FAS wells used first; proposed wells used if necessary
  - Historical use patterns were considered
  - Demands were activated in SP1, not incrementally
- ASR wells & specific wellfield operations were not simulated

# Limitations in Simulating Demands

- Each simulation is 24 years
  - Same as calibration period
  - Wide range of climatic conditions
- Can't simulate annual demand growth
- Simulated demands are "instant on"
- Results from the 2040 simulation are considered conservative



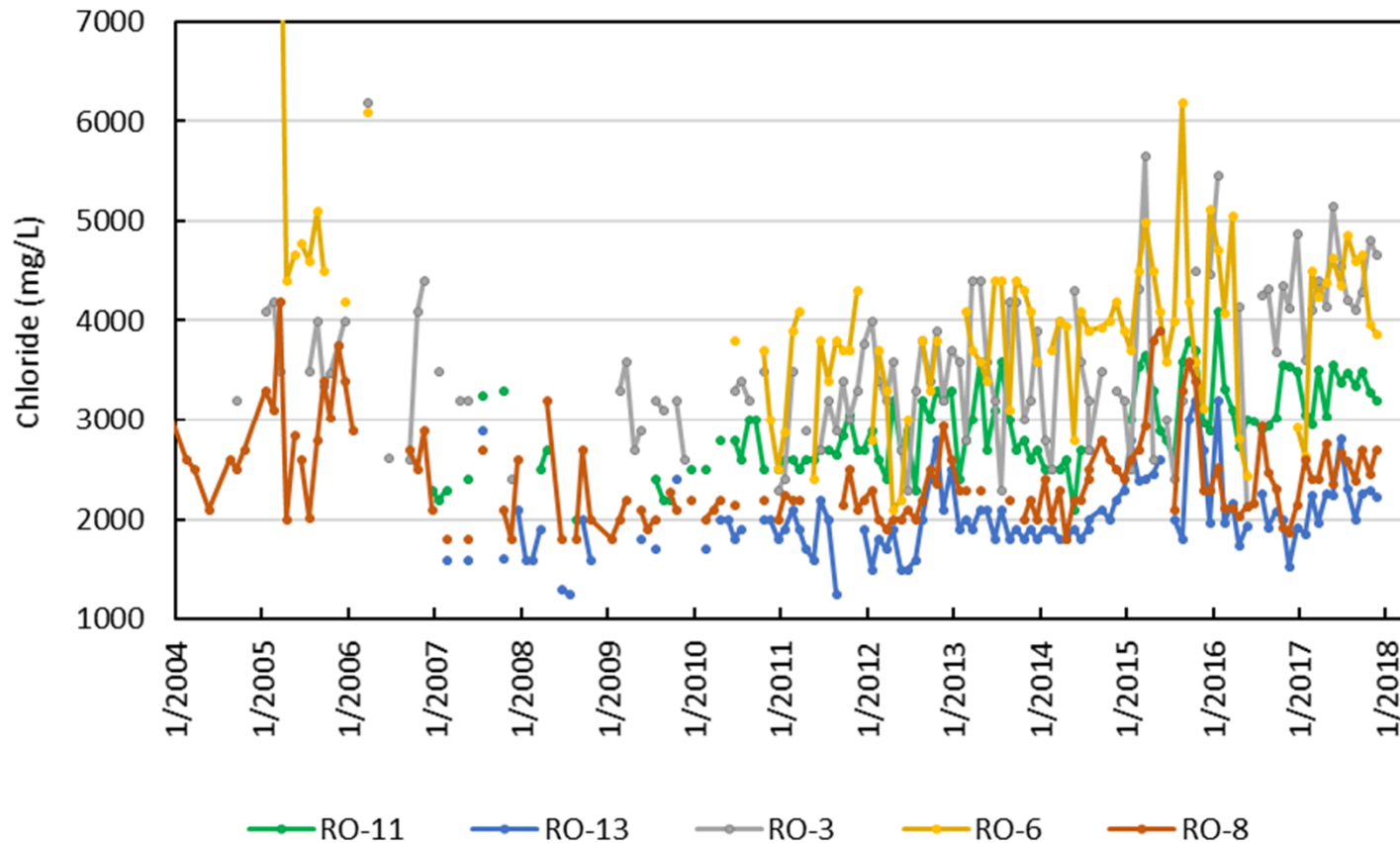


# LEC Floridan Aquifer System Demand Summary by County

County	FAS Allocation (mgd)	2016 FAS Modeled (mgd)	2040 FAS Modeled (mgd)
Palm Beach	48.81	29.48	34.92
Broward	56.54	12.74	29.02
Miami-Dade	102.34	22.26	81.66
Monroe*	3.82	0.36	0.38
<b>Total</b>	<b>211.51</b>	<b>64.84</b>	<b>145.98</b>

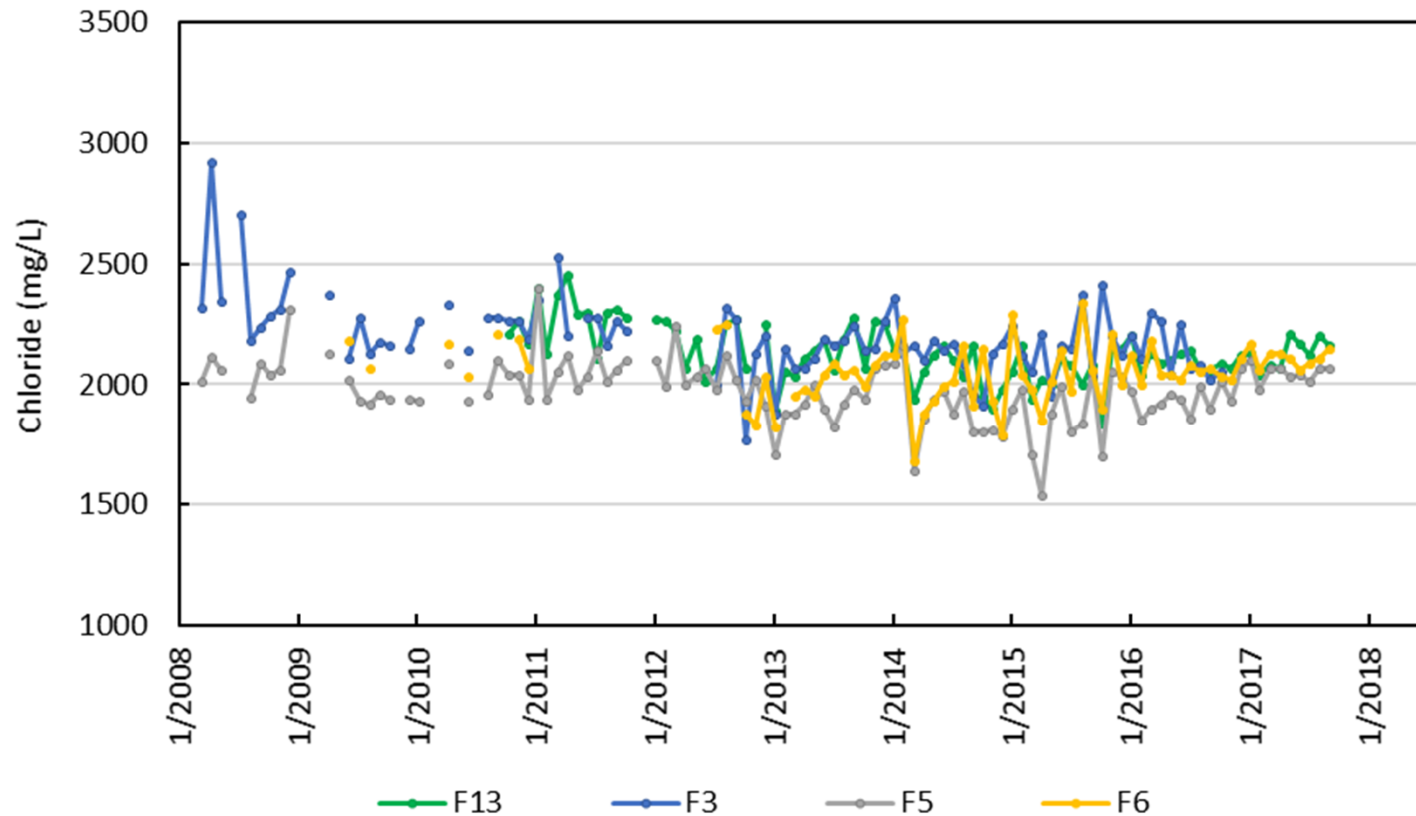
\* Wells for FCAA, the primary water supplier in Monroe County, are located in Miami-Dade County.

# Town of Jupiter



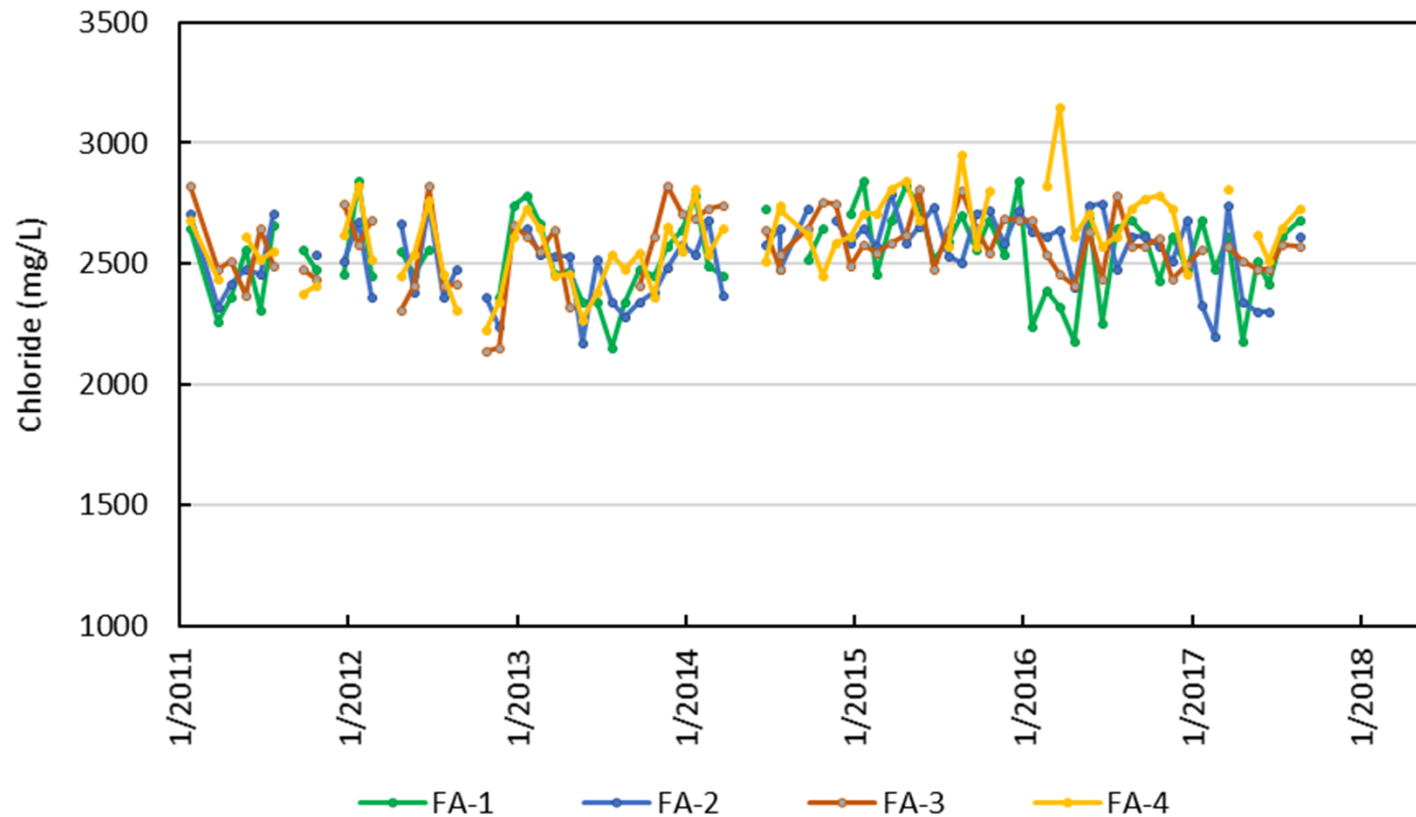
2016 – 9.95 mgd FAS actual pumpage

# City of Hollywood



2016 – 3.85 mgd FAS actual pumpage

# Florida Keys Aqueduct Authority



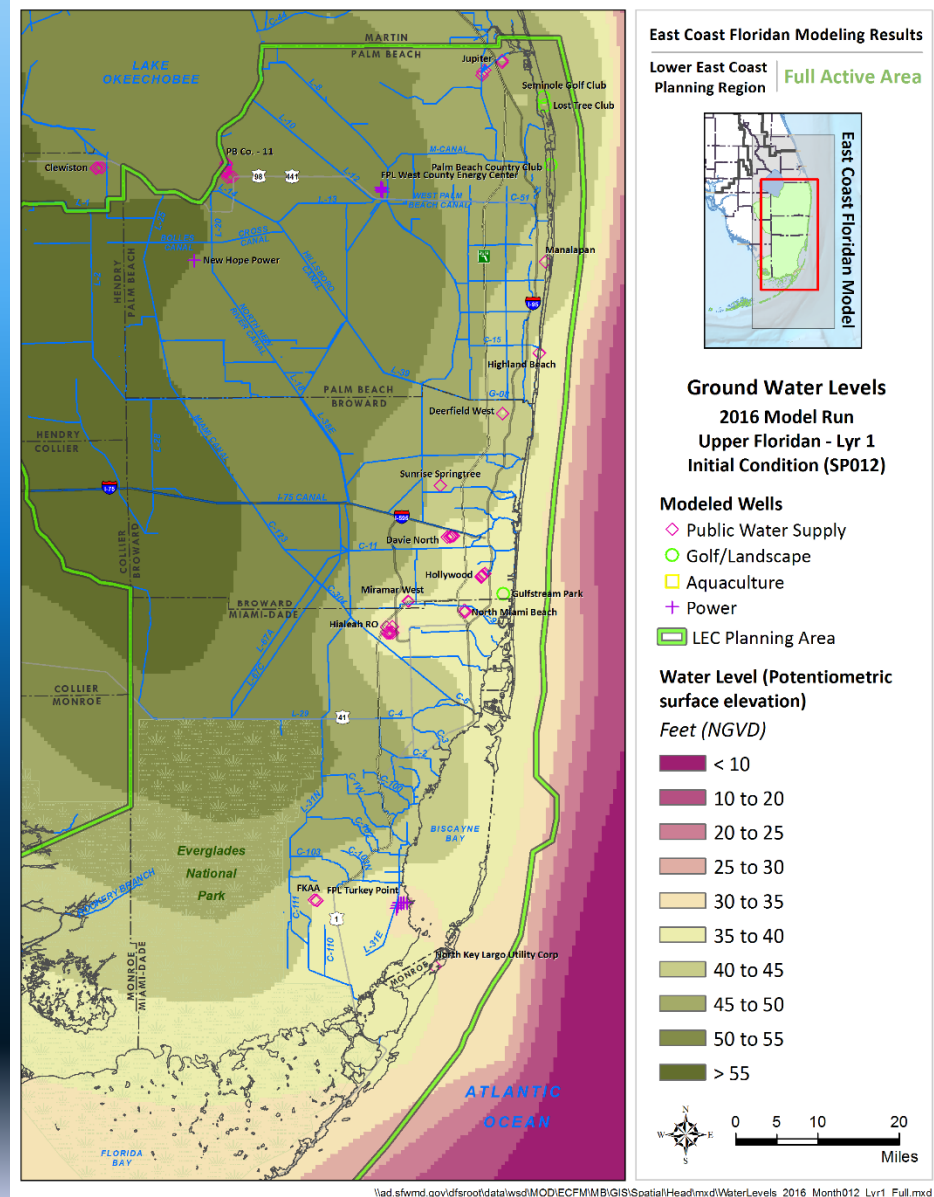
2016 – 0.53 mgd FAS actual pumpage

# How to Read the Results



## Legend

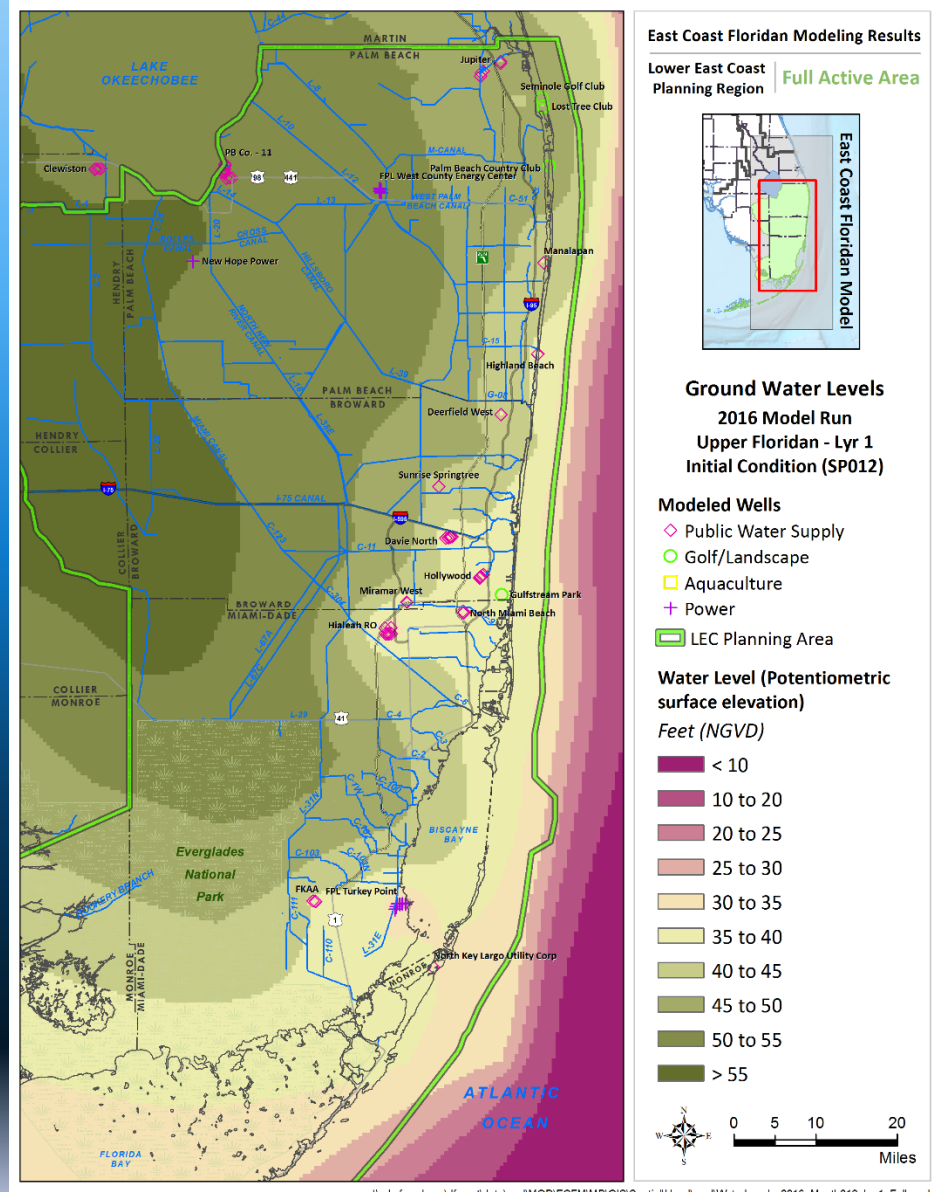
- Model run (2016, 2040, or difference)
- Layer (1 or 3)
- Stress period (month 12 or 288)
- Well symbols
- Planning area boundary
- Performance measurement
- Units and scale





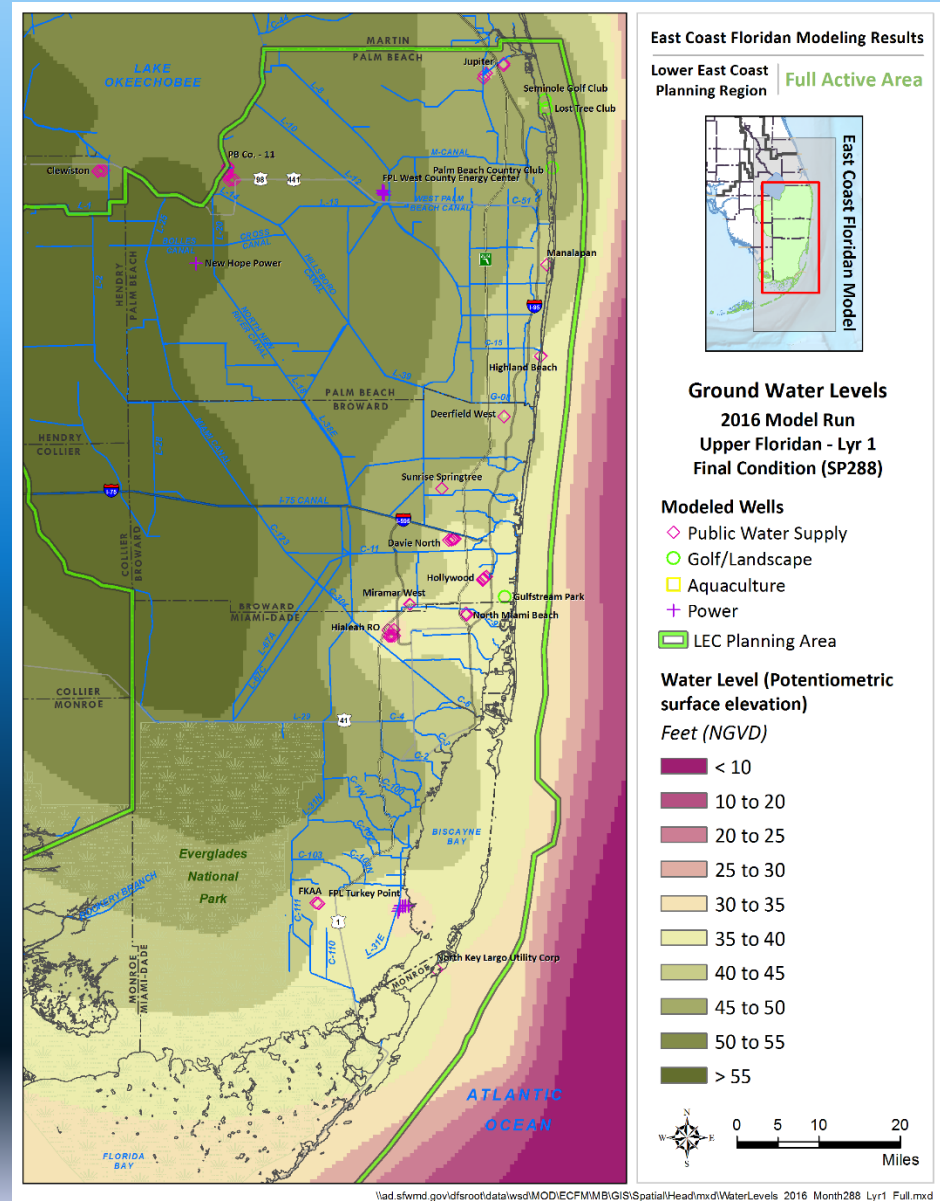
# Water Levels

- Model run: 2016
- Layer 1
- Stress period: 12
- Only existing wells shown
- Potentiometric surface
- In feet NGVD
- Range: below 10 ft to above 55 ft



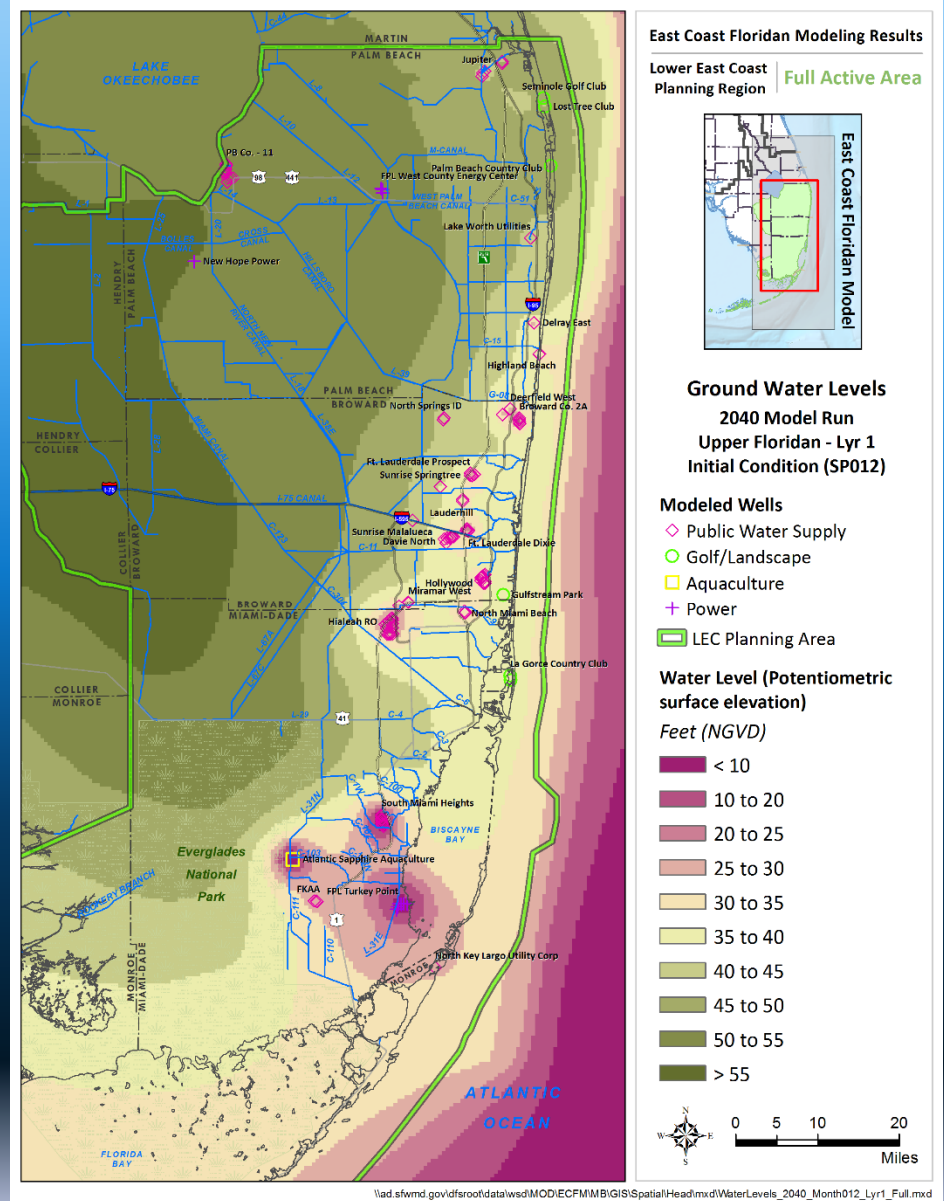
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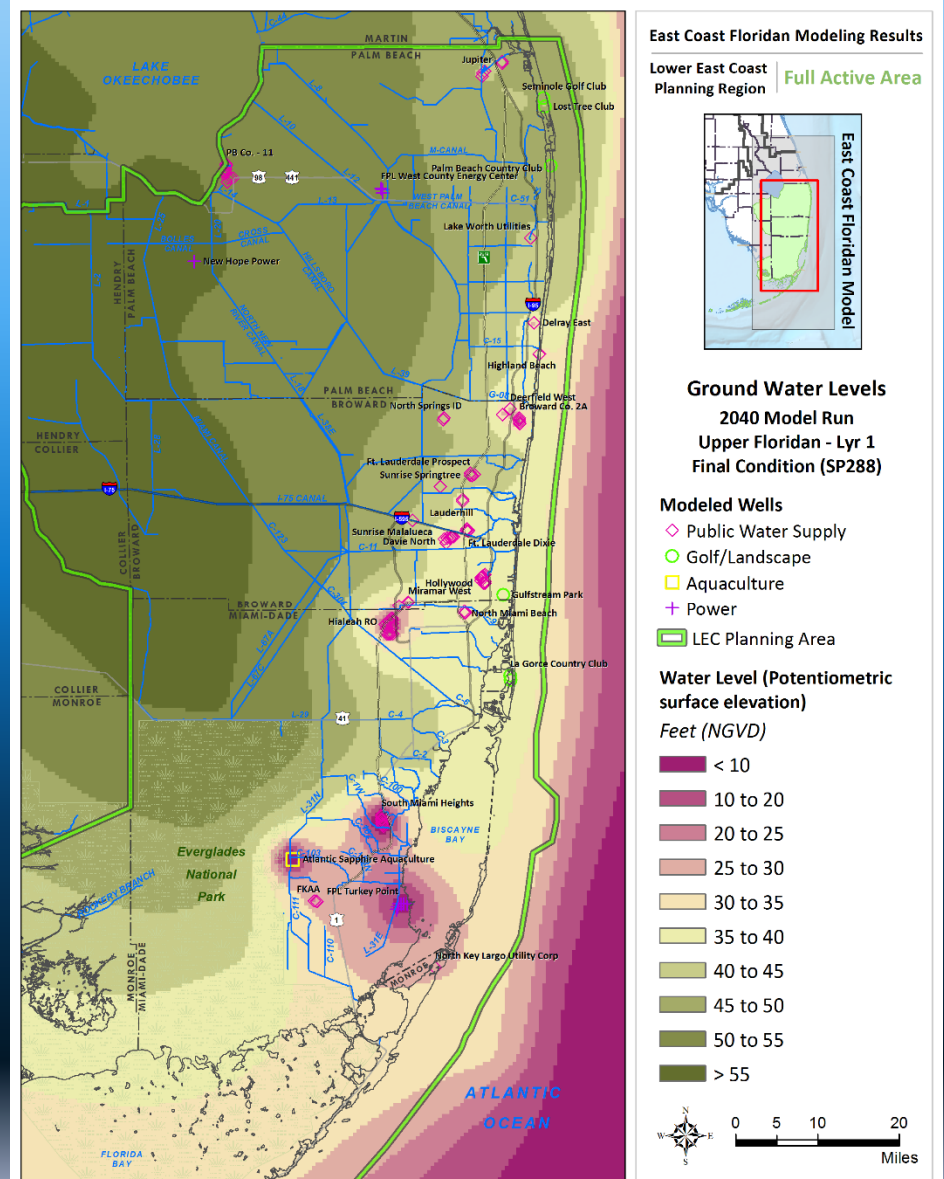
# Water Levels

- Model run: 2040
- Layer 1
- Stress period: 12
- Existing & proposed wells shown
- Potentiometric surface
- In feet NGVD
- Range: below 10 ft to above 55 ft
- Total FAS demand increased by 81 mgd



# Water Levels

- Model run: 2040
- Layer 1
- Stress period: 288
- Existing & proposed wells shown
- Potentiometric surface
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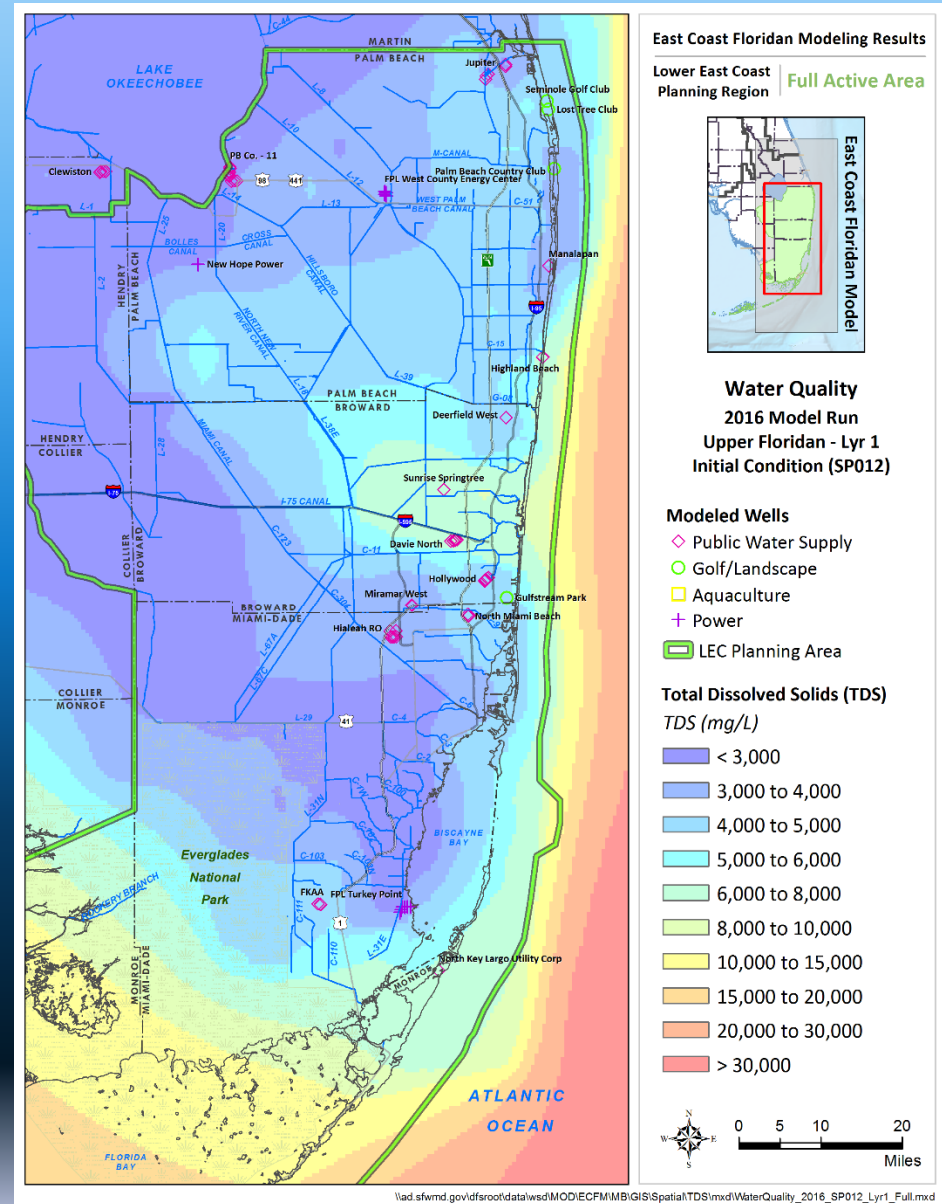


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- East Coast Floridan Modeling Results**
- Lower East Coast Planning Region** **Full Active Area**
- East Coast Floridan Model**
- Ground Water Level Difference**  
(2016 - 2040) Model Run  
Upper Floridan - Lyr 1  
Final Condition (SP288)
- Modeled Wells**
- Public Water Supply
  - Golf/Landscape
  - Aquaculture
  - Power
  - LEC Planning Area
- Water Level Difference Feet (NGVD)**
- < -10
  - 9.9 to -5
  - 4.9 to -1
  - 0.9 to 1
  - 1.1 to 5
  - 5.1 to 10
  - 10.1 to 25
  - 25.1 to 50
  - > 50
- Map Labels:** LAKE OKEECHOBEE, MARTIN, PALM BEACH, Jupiter, Seminole Golf Club, Lost Tree Club, M-CANAL, Palm Beach Country Club, PFL West County Energy Center, Lake Worth Utilities, Manalapan, Delray East, Highland Beach, Deerfield West Broward Co. 2A, Ft. Lauderdale Prospect Sunrise Springtree, Lauderdale Hills, Sunrise Ocala/Dade North, Ft. Lauderdale Dade, Hollywood Miramar West, Sulfstream Park, North Miami Beach, La Gore Country Club, Biscayne Bay, South Miami Heights, Atlantic Sapphire Aquaculture, FKA A, FPL Turkey Point, North Key Largo Utility Corp, Broward MIAMI-DADE, Collier BROWARD, Collier MONROE, Everglades National Park, FLORIDA BAY, ATLANTIC OCEAN.



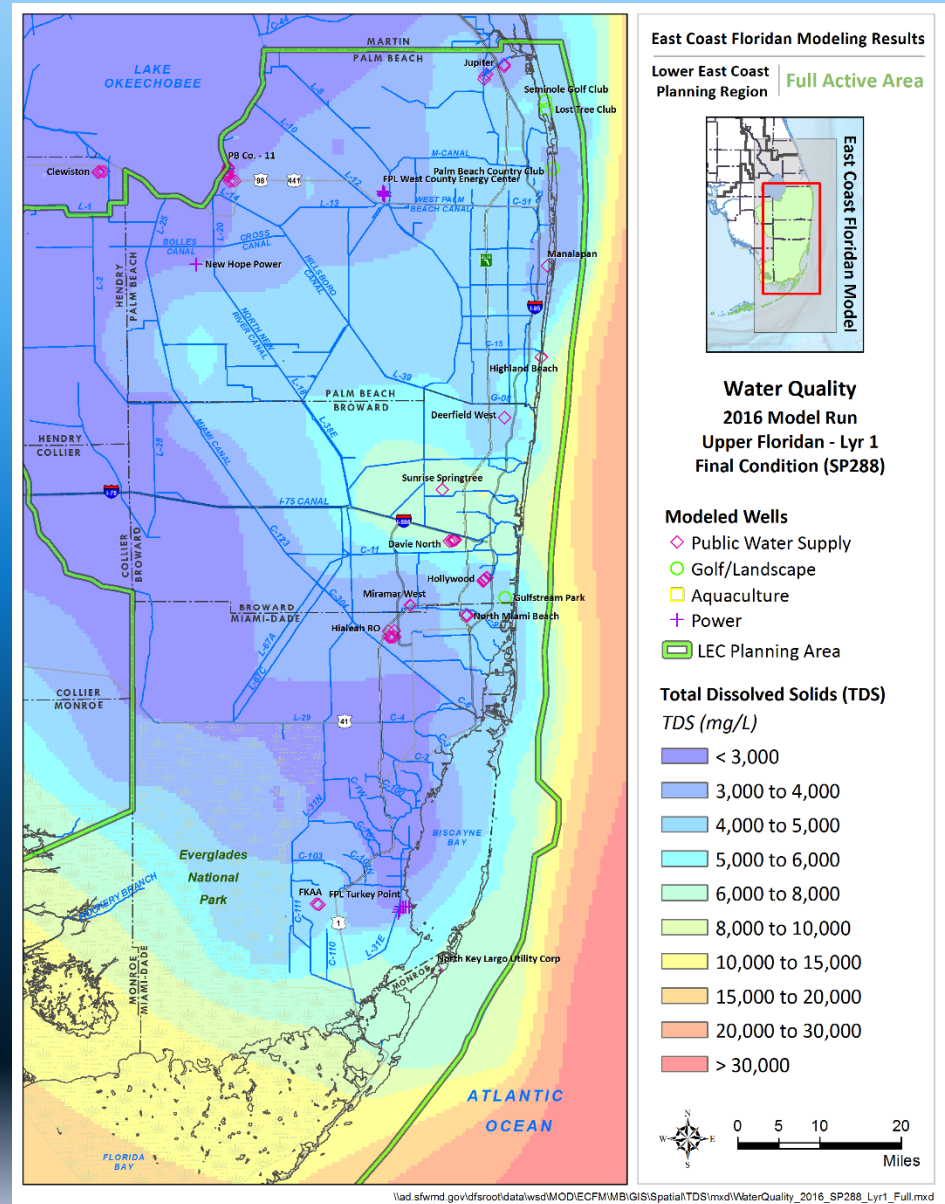
# Water Quality

- Model run: 2016
- Layer 1
- Stress period: 12
- Only existing wells shown
- TDS in mg/L
- Range: <3,000 to >30,000



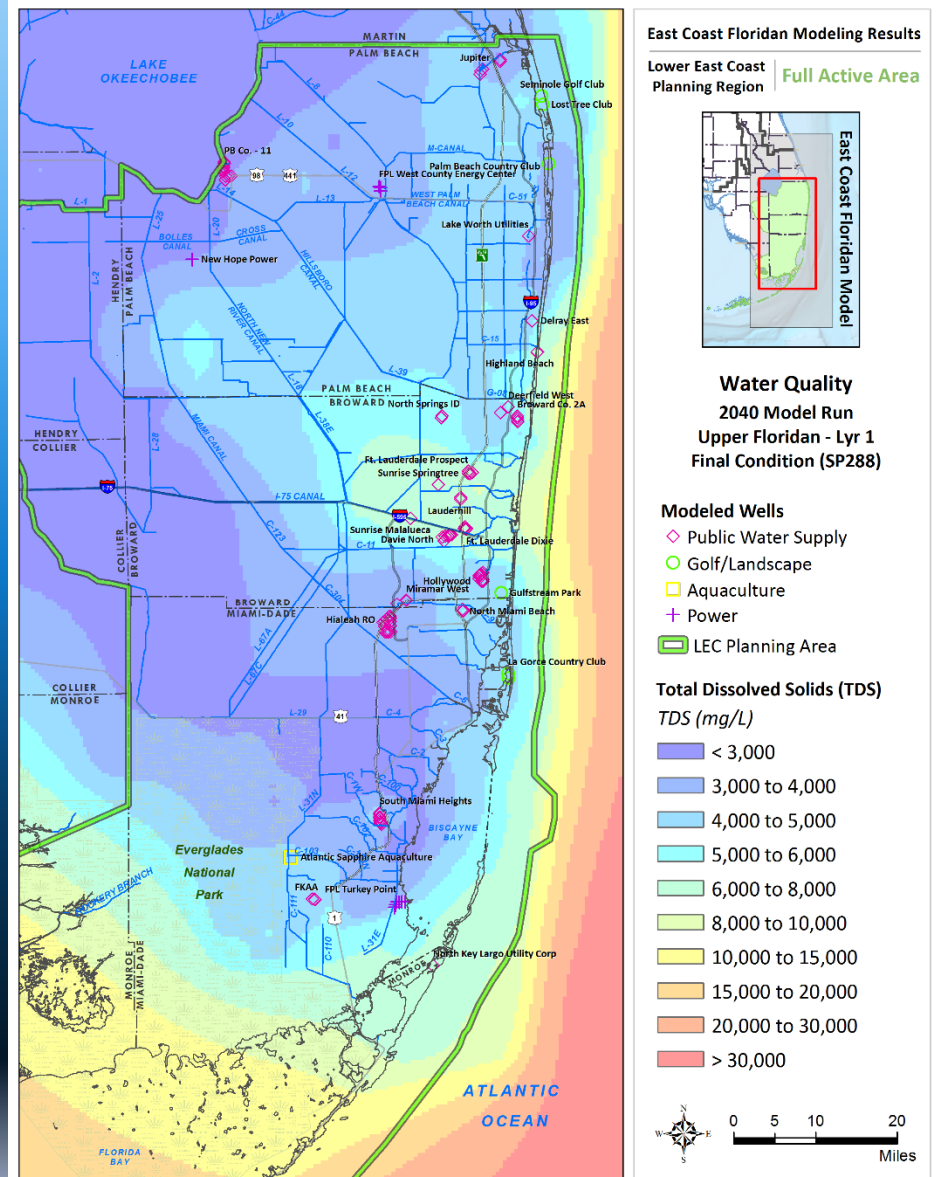
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# Water Quality

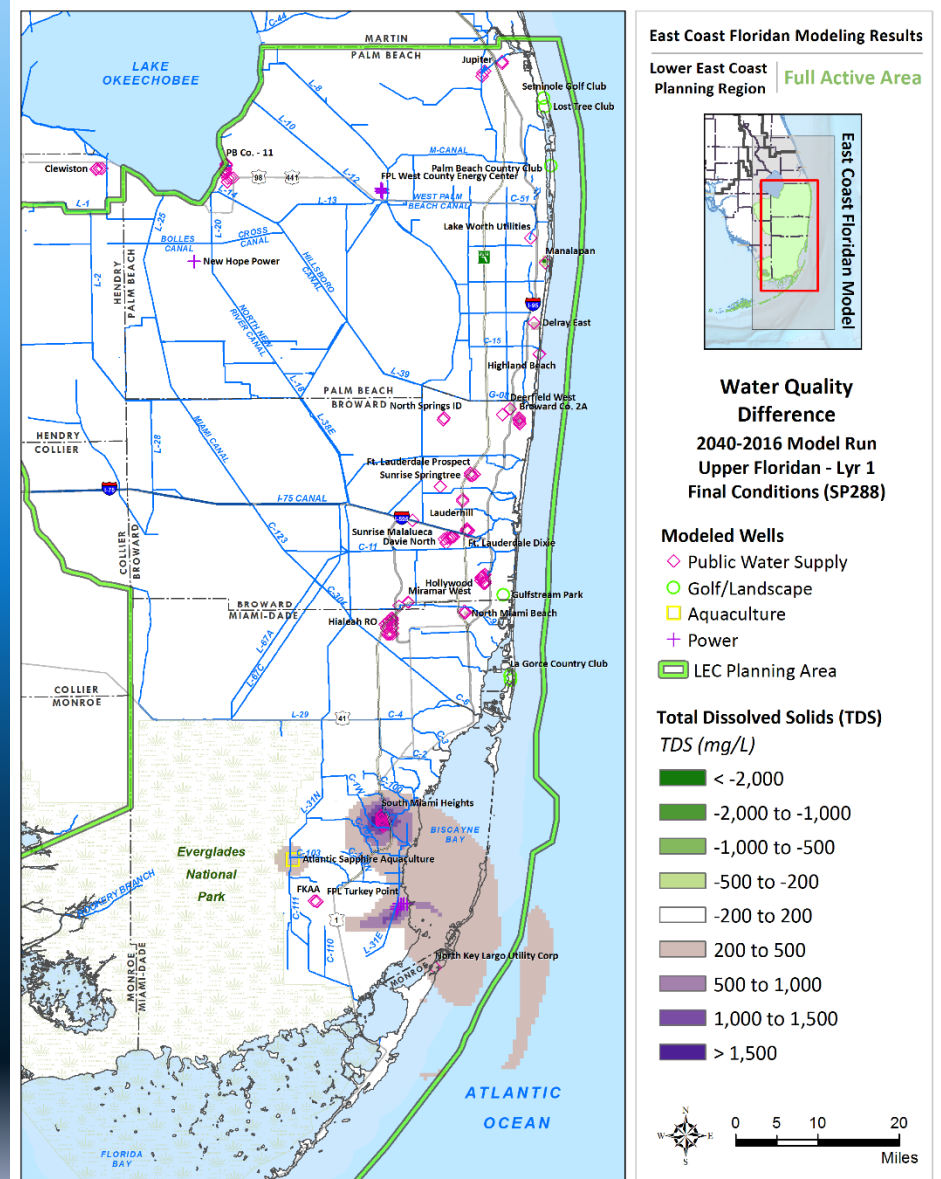
- Model run: 2040
- Layer 1
- Stress period: 288
- Existing & proposed wells shown
- TDS in mg/L
- Range: <3,000 to >30,000





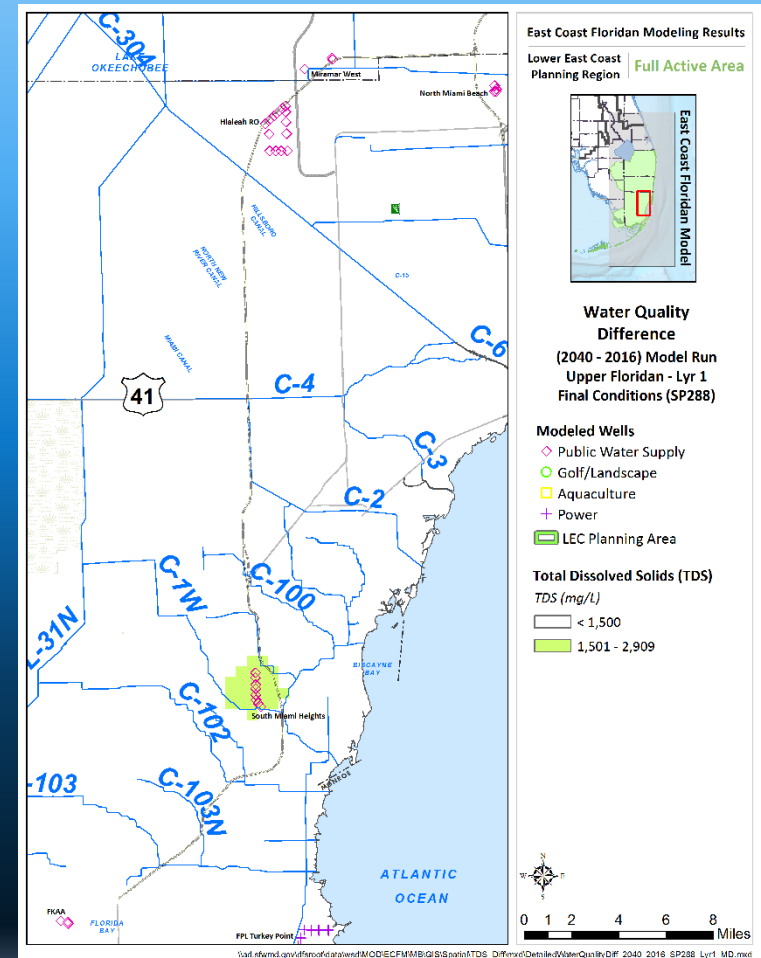
# Water Quality Differences

- Model run: 2040-2016
- Layer 1
- Stress period: 288
- Existing & proposed wells shown
- TDS in mg/L
- Range: >-2,000 to >1,500



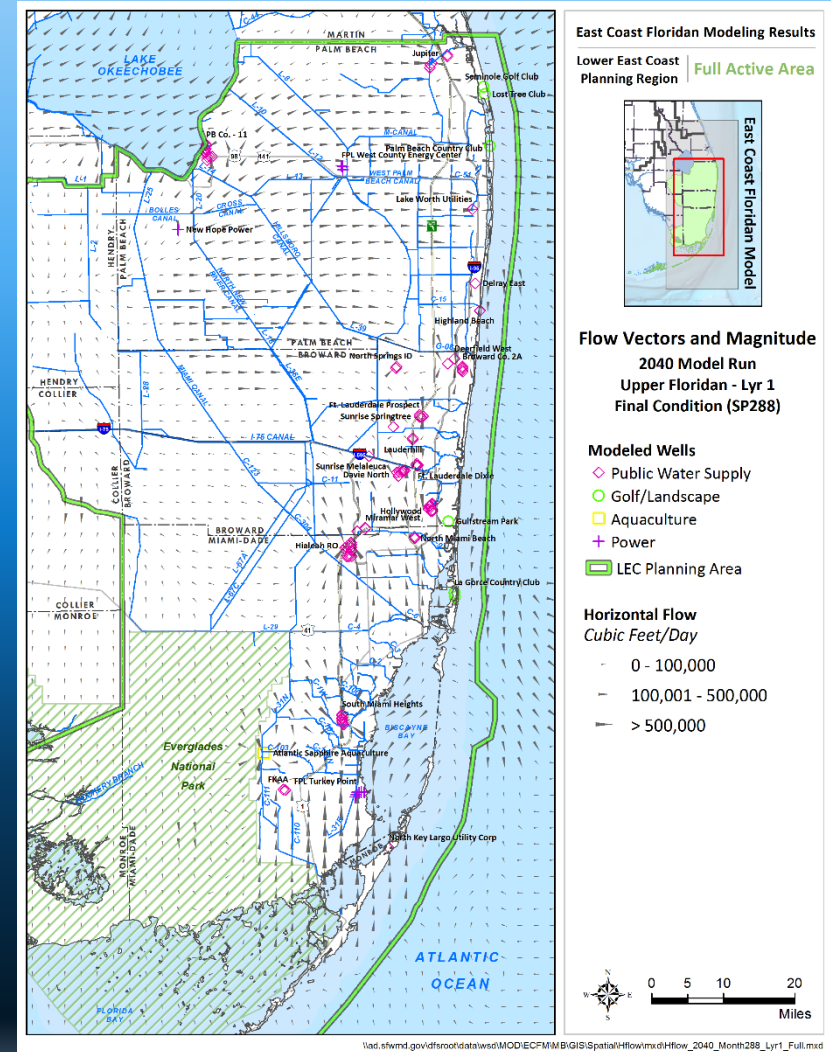
# Water Quality Differences Miami-Dade Close Up

- Model run: 2040-2016
- **Layer 1**
- Stress period: 288
- Existing & proposed wells shown
- TDS in mg/L
- Range: 1,500 to 2,900



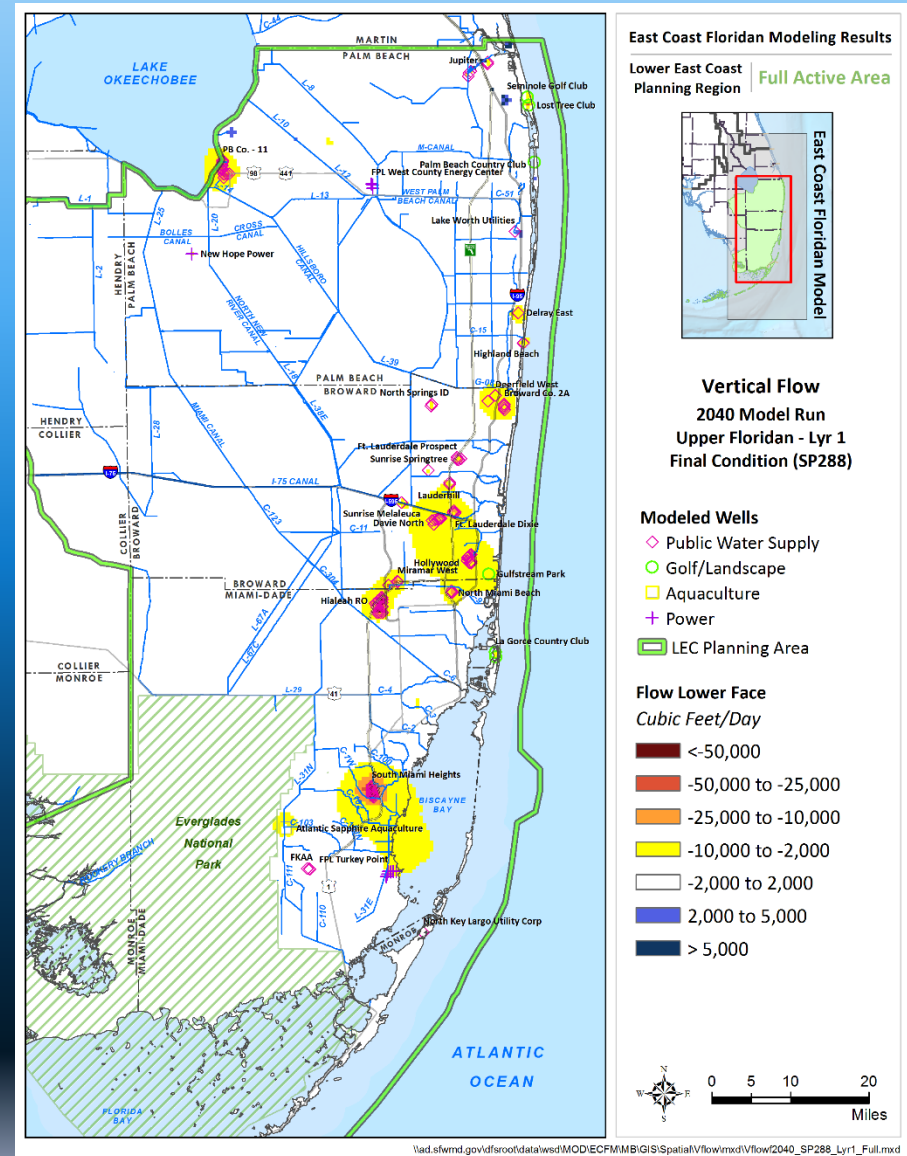
# Horizontal Flow Vectors

- Model run: 2040
- Layer 1
- Stress period: 288
- Performance measurement
- Cubic feet per day



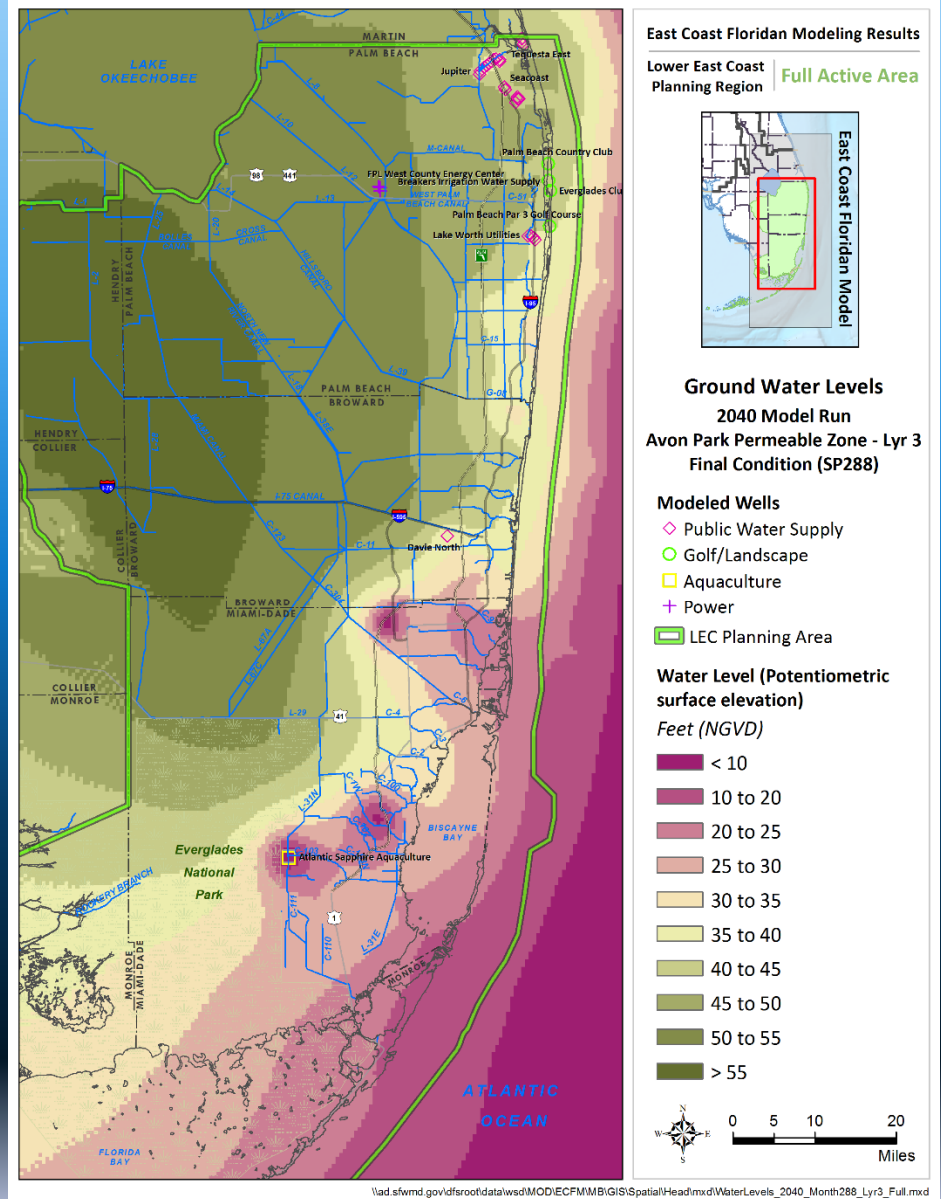
# Vertical Flow Vectors

- Model run: 2040
- Layer 1
- Stress period: 288
- Performance measurement
- Cubic feet per day



# Water Levels

- Model run: 2040
- Layer 3
- Stress period: 288
- Existing & proposed wells shown
- Potentiometric surface
- In feet NGVD
- Range: below 10 ft to above 55 ft

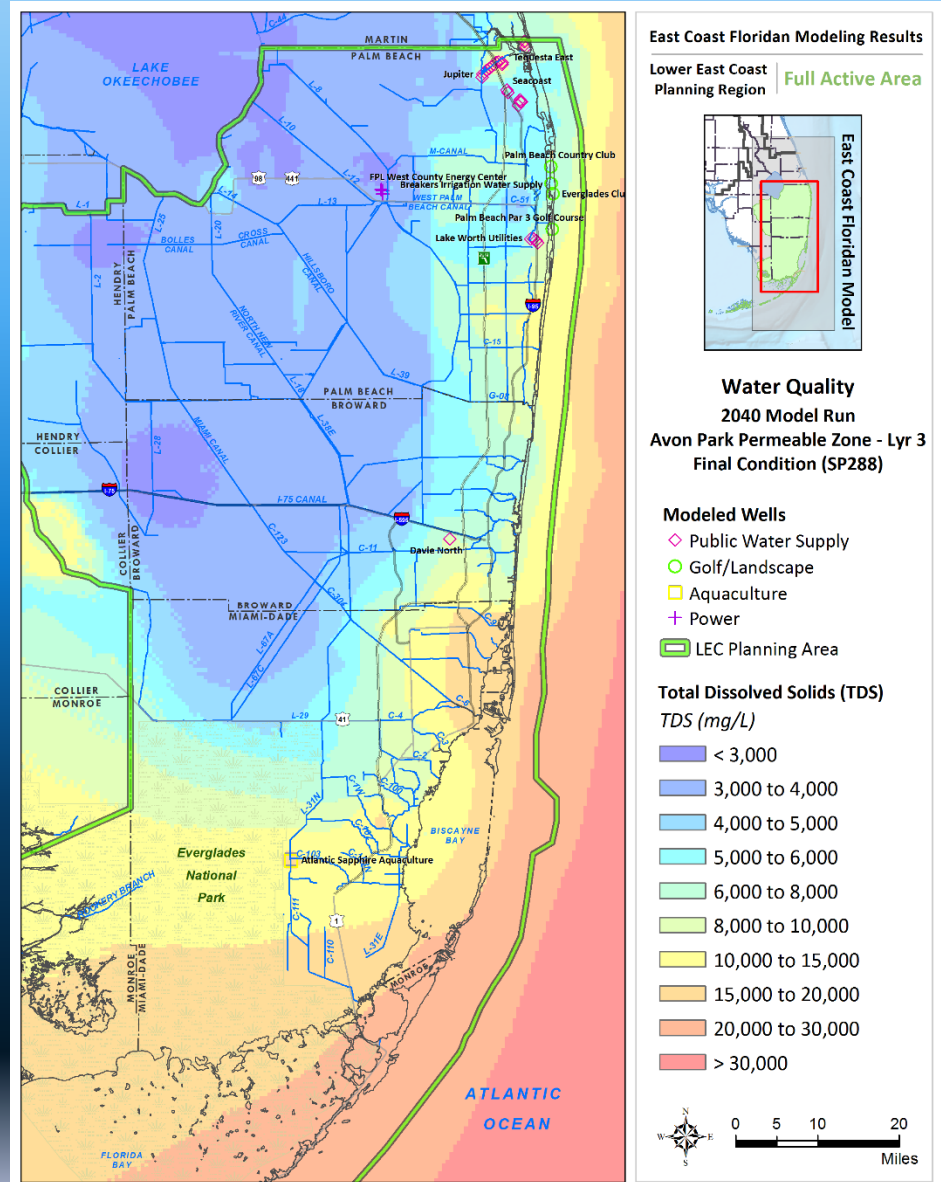




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- Ground Water Level Difference**  
(2016 - 2040) Model Run  
Avon Park Permeable Zone - Lyr 3  
Final Condition (SP288)
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- Map Labels:** LAKE OKEECHOBEE, MARTIN, PALM BEACH, JUPITER, SEACREST, M-CANAL, PALM BEACH COUNTRY CLUB, FPL WEST PALM BEACH WATER SUPPLY, WEST PALM BEACH CANAL, PALM BEACH BROWARD, PALM BEACH BROWARD, L-39, L-38, L-37, L-36, L-35, L-34, L-33, L-32, L-31, L-30, L-29, L-28, L-27, L-26, L-25, L-24, L-23, L-22, L-21, L-20, L-19, L-18, L-17, L-16, L-15, L-14, L-13, L-12, L-11, L-10, L-9, L-8, L-7, L-6, L-5, L-4, L-3, L-2, L-1, L-0, L-1, L-2, L-3, L-4, L-5, L-6, L-7, L-8, L-9, L-10, L-11, L-12, L-13, L-14, L-15, L-16, L-17, L-18, L-19, L-20, L-21, L-22, L-23, L-24, L-25, L-26, L-27, L-28, L-29, L-30, L-31, L-32, L-33, L-34, L-35, L-36, L-37, L-38, L-39, L-40, L-41, L-42, L-43, L-44, L-45, L-46, L-47, L-48, L-49, L-50, L-51, L-52, L-53, L-54, L-55, L-56, L-57, L-58, L-59, L-60, L-61, L-62, L-63, L-64, L-65, L-66, L-67, L-68, L-69, L-70, L-71, L-72, L-73, L-74, L-75, L-76, L-77, L-78, L-79, L-80, L-81, L-82, L-83, L-84, L-85, L-86, L-87, L-88, L-89, L-90, L-91, L-92, L-93, L-94, L-95, L-96, L-97, L-98, L-99, L-100, L-101, L-102, L-103, L-104, L-105, L-106, L-107, L-108, L-109, L-110, L-111, L-112, L-113, L-114, L-115, L-116, L-117, L-118, L-119, L-120, L-121, L-122, L-123, L-124, L-125, L-126, L-127, L-128, L-129, L-130, L-131, L-132, L-133, L-134, L-135, L-136, L-137, L-138, L-139, L-140, L-141, L-142, L-143, L-144, L-145, L-146, L-147, L-148, L-149, L-150, L-151, L-152, L-153, L-154, L-155, L-156, L-157, L-158, L-159, L-160, L-161, L-162, L-163, L-164, L-165, L-166, L-167, L-168, L-169, L-170, L-171, L-172, L-173, L-174, L-175, L-176, L-177, L-178, L-179, L-180, L-181, L-182, L-183, L-184, L-185, L-186, L-187, L-188, L-189, L-190, L-191, L-192, L-193, L-194, L-195, L-196, L-197, L-198, L-199, L-200, L-201, L-202, L-203, L-204, L-205, L-206, L-207, L-208, L-209, L-210, L-211, L-212, L-213, L-214, L-215, L-216, L-217, L-218, L-219, L-220, L-221, L-222, L-223, L-224, L-225, L-226, L-227, L-228, L-229, L-230, L-231, L-232, L-233, L-234, L-235, L-236, L-237, L-238, L-239, L-240, L-241, L-242, L-243, L-244, L-245, L-246, L-247, L-248, L-249, L-250, L-251, L-252, L-253, L-254, L-255, L-256, L-257, L-258, L-259, L-260, L-261, L-262, L-263, L-264, L-265, L-266, L-267, L-268, L-269, L-270, L-271, L-272, L-273, L-274, L-275, L-276, L-277, L-278, L-279, L-280, L-281, L-282, L-283, L-284, L-285, L-286, L-287, L-288, L-289, L-290, L-291, L-292, L-293, L-294, L-295, L-296, L-297, L-298, L-299, L-300, L-301, L-302, L-303, L-304, L-305, L-306, L-307, L-308, L-309, L-310, L-311, L-312, L-313, L-314, L-315, L-316, L-317, L-318, L-319, L-320, L-321, L-322, L-323, L-324, L-325, L-326, L-327, L-328, L-329, L-330, L-331, L-332, L-333, L-334, L-335, L-336, L-337, L-338, L-339, L-340, L-341, L-342, L-343, L-344, L-345, L-346, L-347, L-348, L-349, L-350, L-351, L-352, L-353, L-354, L-355, L-356, L-357, L-358, L-359, L-360, L-361, L-362, L-363, L-364, L-365, L-366, L-367, L-368, L-369, L-370, L-371, L-372, L-373, L-374, L-375, L-376, L-377, L-378, L-379, L-380, L-381, L-382, L-383, L-384, L-385, L-386, L-387, L-388, L-389, L-390, L-391, L-392, L-393, L-394, L-395, L-396, L-397, L-398, L-399, L-400, L-401, L-402, L-403, L-404, L-405, L-406, L-407, L-408, L-409, L-410, L-411, L-412, L-413, L-414, L-415, L-416, L-417, L-418, L-419, L-420, L-421, L-422, L-423, L-424, L-425, L-426, L-427, L-428, L-429, L-430, L-431, L-432, L-433, L-434, L-435, L-436, L-437, L-438, L-439, L-440, L-441, L-442, L-443, L-444, L-445, L-446, L-447, L-448, L-449, L-450, L-451, L-452, L-453, L-454, L-455, L-456, L-457, L-458, L-459, L-460, L-461, L-462, L-463, L-464, L-465, L-466, L-467, L-468, L-469, L-470, L-471, L-472, L-473, L-474, L-475, L-476, L-477, L-478, L-479, L-480, L-481, L-482, L-483, L-484, L-485, L-486, L-487, L-488, L-489, L-490, L-491, L-492, L-493, L-494, L-495, L-496, L-497, L-498, L-499, L-500, L-501, L-502, L-503, L-504, L-505, L-506, L-507, L-508, L-509, L-510, L-511, L-512, L-513, L-514, L-515, L-516, L-517, L-518, L-519, L-520, L-521, L-522, L-523, L-524, L-525, L-526, L-527, L-528, L-529, L-530, L-531, L-532, L-533, L-534, L-535, L-536, L-537, L-538, L-539, L-540, L-541, L-542, L-543, L-544, L-545, L-546, L-547, L-548, L-549, L-550, L-551, L-552, L-553, L-554, L-555, L-556, L-557, L-558, L-559, L-560, L-561, L-562, L-563, L-564, L-565, L-566, L-567, L-568, L-569, L-570, L-571, L-572, L-573, L-574, L-575, L-576, L-577, L-578, L-579, L-580, L-581, L-582, L-583, L-584, L-585, L-586, L-587

# Water Quality

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- Layer 3
- Stress period: 288
- Existing & proposed wells shown
- TDS in mg/L
- Range: <3,000 to >30,000



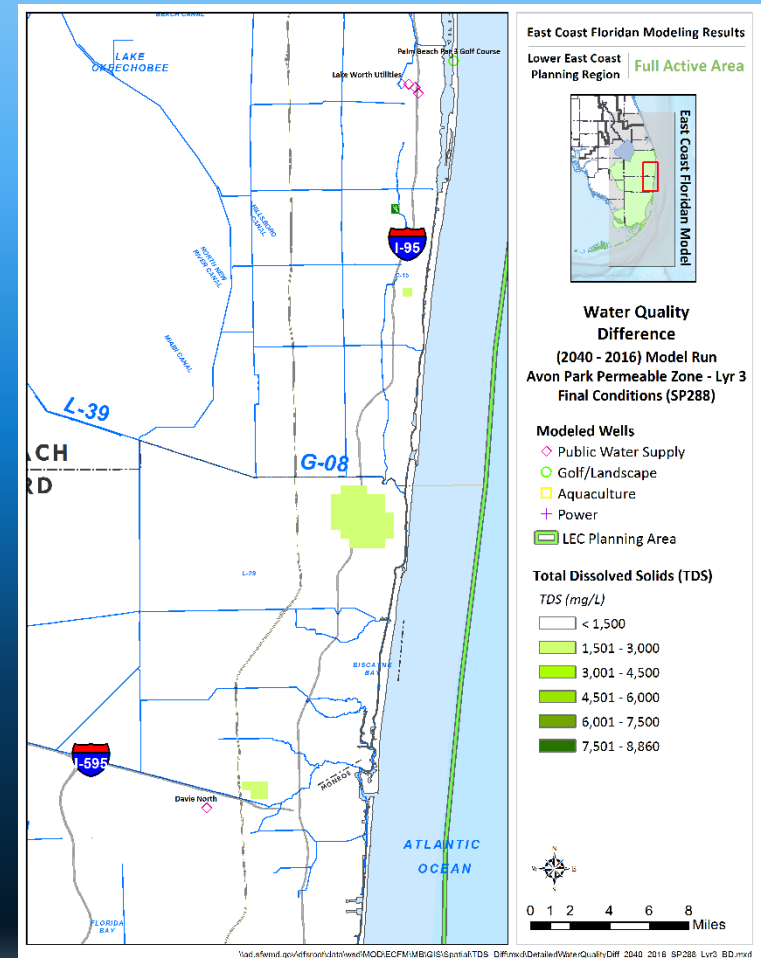
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- East Coast Floridan Model**
- Water Quality Difference**  
**2040-2016 Model Run**  
**Avon Park Permeable Zone - Lyr 3**  
**Final Conditions (SP288)**
- Modeled Wells**
- Public Water Supply
  - Golf/Landscape
  - Aquaculture
  - Power
  - LEC Planning Area
- Total Dissolved Solids (TDS)**  
**TDS (mg/L)**
- < -2,000
  - 2,000 to -1,000
  - 1,000 to -500
  - 500 to -200
  - 200 to 200
  - 200 to 500
  - 500 to 1,000
  - 1,000 to 1,500
  - > 1,500
- Map Labels:** LAKE OKEECHOBEE, MARTIN, PALM BEACH, Jupiter, Seacoast, M-CANAL, Palm Beach Country Club, FPL West Palm Beach Water Supply, WEST PALM BEACH CANAL, C-51, Everglades Club, Palm Beach Park Golf Course, Lake Worth Utilities, Manalapan, S-10, G-10, G-11, G-12, G-13, G-14, G-15, G-16, G-17, G-18, G-19, G-20, G-21, G-22, G-23, G-24, G-25, G-26, G-27, G-28, G-29, G-30, G-31, G-32, G-33, G-34, G-35, G-36, G-37, G-38, G-39, G-40, G-41, G-42, G-43, G-44, G-45, G-46, G-47, G-48, G-49, G-50, G-51, G-52, G-53, G-54, G-55, G-56, G-57, G-58, G-59, G-60, G-61, G-62, G-63, G-64, G-65, G-66, G-67, G-68, G-69, G-70, G-71, G-72, G-73, G-74, G-75, G-76, G-77, G-78, G-79, G-80, G-81, G-82, G-83, G-84, G-85, G-86, G-87, G-88, G-89, G-90, G-91, G-92, G-93, G-94, G-95, G-96, G-97, G-98, G-99, G-100, G-101, G-102, G-103, G-104, G-105, G-106, G-107, G-108, G-109, G-110, G-111, G-112, G-113, G-114, G-115, G-116, G-117, G-118, G-119, G-120, G-121, G-122, G-123, G-124, G-125, G-126, G-127, G-128, G-129, G-130, G-131, G-132, G-133, G-134, G-135, G-136, G-137, G-138, G-139, G-140, G-141, G-142, G-143, G-144, G-145, G-146, G-147, G-148, G-149, G-150, G-151, G-152, G-153, G-154, G-155, G-156, G-157, G-158, G-159, G-160, G-161, G-162, G-163, G-164, G-165, G-166, G-167, G-168, G-169, G-170, G-171, G-172, G-173, G-174, G-175, G-176, G-177, G-178, G-179, G-180, G-181, G-182, G-183, G-184, G-185, G-186, G-187, G-188, G-189, G-190, G-191, G-192, G-193, G-194, G-195, G-196, G-197, G-198, G-199, G-200, G-201, G-202, G-203, G-204, G-205, G-206, G-207, G-208, G-209, G-210, G-211, G-212, G-213, G-214, G-215, G-216, G-217, G-218, G-219, G-220, G-221, G-222, G-223, G-224, G-225, G-226, G-227, G-228, G-229, G-230, G-231, G-232, G-233, G-234, G-235, G-236, G-237, G-238, G-239, G-240, G-241, G-242, G-243, G-244, G-245, G-246, G-247, G-248, G-249, G-250, G-251, G-252, G-253, G-254, G-255, G-256, G-257, G-258, G-259, G-260, G-261, G-262, G-263, G-264, G-265, G-266, G-267, G-268, G-269, G-270, G-271, G-272, G-273, G-274, G-275, G-276, G-277, G-278, G-279, G-280, G-281, G-282, G-283, G-284, G-285, G-286, G-287, G-288, G-289, G-290, G-291, G-292, G-293, G-294, G-295, G-296, G-297, G-298, G-299, G-300, G-301, G-302, G-303, G-304, G-305, G-306, G-307, G-308, G-309, G-310, G-311, G-312, G-313, G-314, G-315, G-316, G-317, G-318, G-319, G-320, G-321, G-322, G-323, G-324, G-325, G-326, G-327, G-328, G-329, G-330, G-331, G-332, G-333, G-334, G-335, G-336, G-337, G-338, G-339, G-340, G-341, G-342, G-343, G-344, G-345, G-346, G-347, G-348, G-349, G-350, G-351, G-352, G-353, G-354, G-355, G-356, G-357, G-358, G-359, G-360, G-361, G-362, G-363, G-364, G-365, G-366, G-367, G-368, G-369, G-370, G-371, G-372, G-373, G-374, G-375, G-376, G-377, G-378, G-379, G-380, G-381, G-382, G-383, G-384, G-385, G-386, G-387, G-388, G-389, G-390, G-391, G-392, G-393, G-394, G-395, G-396, G-397, G-398, G-399, G-400, G-401, G-402, G-403, G-404, G-405, G-406, G-407, G-408, G-409, G-410, G-411, G-412, G-413, G-414, G-415, G-416, G-417, G-418, G-419, G-420, G-421, G-422, G-423, G-424, G-425, G-426, G-427, G-428, G-429, G-430, G-431, G-432, G-433, G-434, G-435, G-436, G-437, G-438, G-439, G-440, G-441, G-442, G-443, G-444, G-445, G-446, G-447, G-448, G-449, G-450, G-451, G-452, G-453, G-454, G-455, G-456, G-457, G-458, G-459, G-460, G-461, G-462, G-463, G-464, G-465, G-466, G-467, G-468, G-469, G-470, G-471, G-472, G-473, G-474, G-475, G-476, G-477, G-478, G-479, G-480, G-481, G-482, G-483, G-484, G-485, G-486, G-487, G-488, G-489, G-490, G-491, G-492, G-493, G-494, G-495, G-496, G-497, G-498, G-499, G-500, G-501, G-502, G-503, G-504, G-505, G-506, G-507, G-508, G-509, G-510, G-511, G-512, G-513, G-514, G-515, G-516, G-517, G-518, G-519, G-520, G-521, G-522, G-523, G-524, G-525, G-526, G-527, G-528, G-529, G-530, G-531, G-532, G-533, G-534, G-535, G-536, G-537, G-538, G-539, G-540, G-541, G-542, G-543, G-544, G-545, G-546, G-547, G-548, G-549, G-550, G-551, G-552, G-553, G-554, G-555, G-556, G-557, G-558, G-559, G-560, G-561, G-562, G-563, G-564, G-565, G-566, G-567, G-568, G-569, G-570, G-571, G-572, G-573, G-574, G-575, G-576, G-577, G-578, G-579, G-580, G-581, G-582, G-583, G-584, G-585, G-586, G-587, G-588, G-589, G-590, G-591, G-592, G-593, G-594, G-595, G-596, G-597, G-598, G-599, G-600, G-601, G-602, G-603, G-604, G-605, G-606, G-607, G-608, G-609, G-610, G-61



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- East Coast Florida Modeling Results**
- Lower East Coast Planning Region **Full Active Area**
- Water Quality Difference**  
(2040 - 2016) Model Run  
Avon Park Permeable Zone - Lyr 3  
Final Conditions (SP288)
- Modeled Wells**
- Public Water Supply
  - Golf/Landscape
  - Aquaculture
  - Power
  - LEC Planning Area
- Total Dissolved Solids (TDS)**  
TDS (mg/L)
- < 1,500
  - 1,501 - 3,000
  - 3,001 - 4,500
  - 4,501 - 6,000
  - 6,001 - 7,500
  - 7,501 - 8,860
- 0 1 2 4 6 8 Miles
- Source: [http://doh.fl.gov/water/infocentralandMODECFMAMB/GIS/parts/TDS\\_DifferenceDetailedWaterQualityDiff\\_2040\\_2016\\_SP288\\_Lyr3\\_MD.mxd](http://doh.fl.gov/water/infocentralandMODECFMAMB/GIS/parts/TDS_DifferenceDetailedWaterQualityDiff_2040_2016_SP288_Lyr3_MD.mxd)

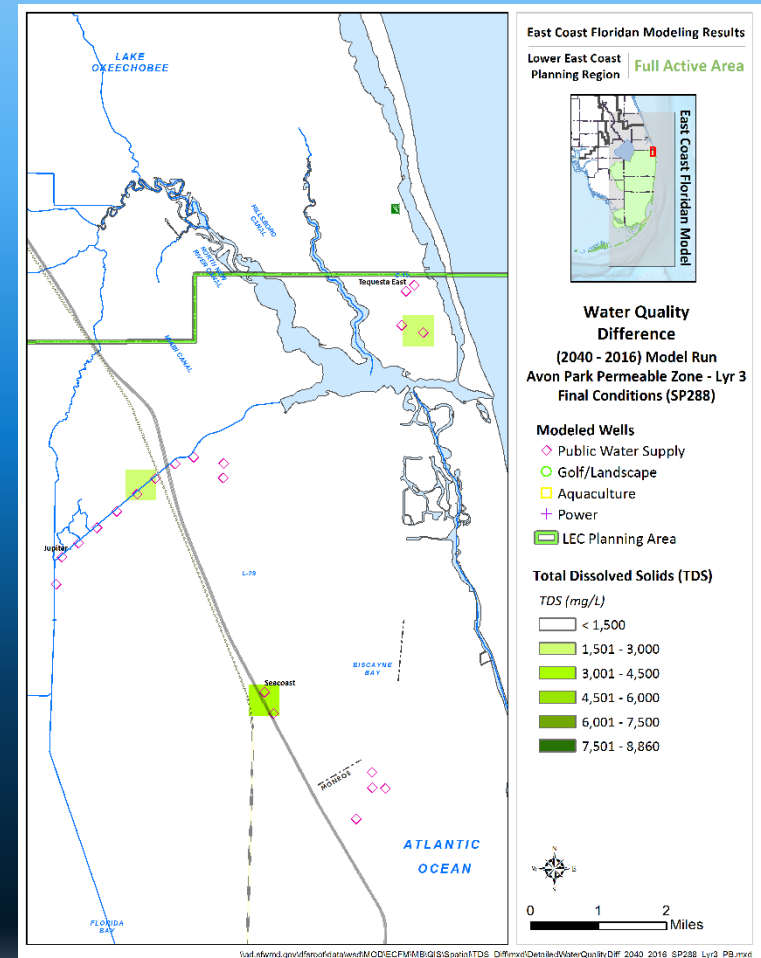
# Water Quality Differences Broward Close Up

- Model run: 2040-2016
- Layer 3
- Stress period: 288
- Existing & proposed wells shown
- TDS in mg/L
- Range: 1,500 to 3,000

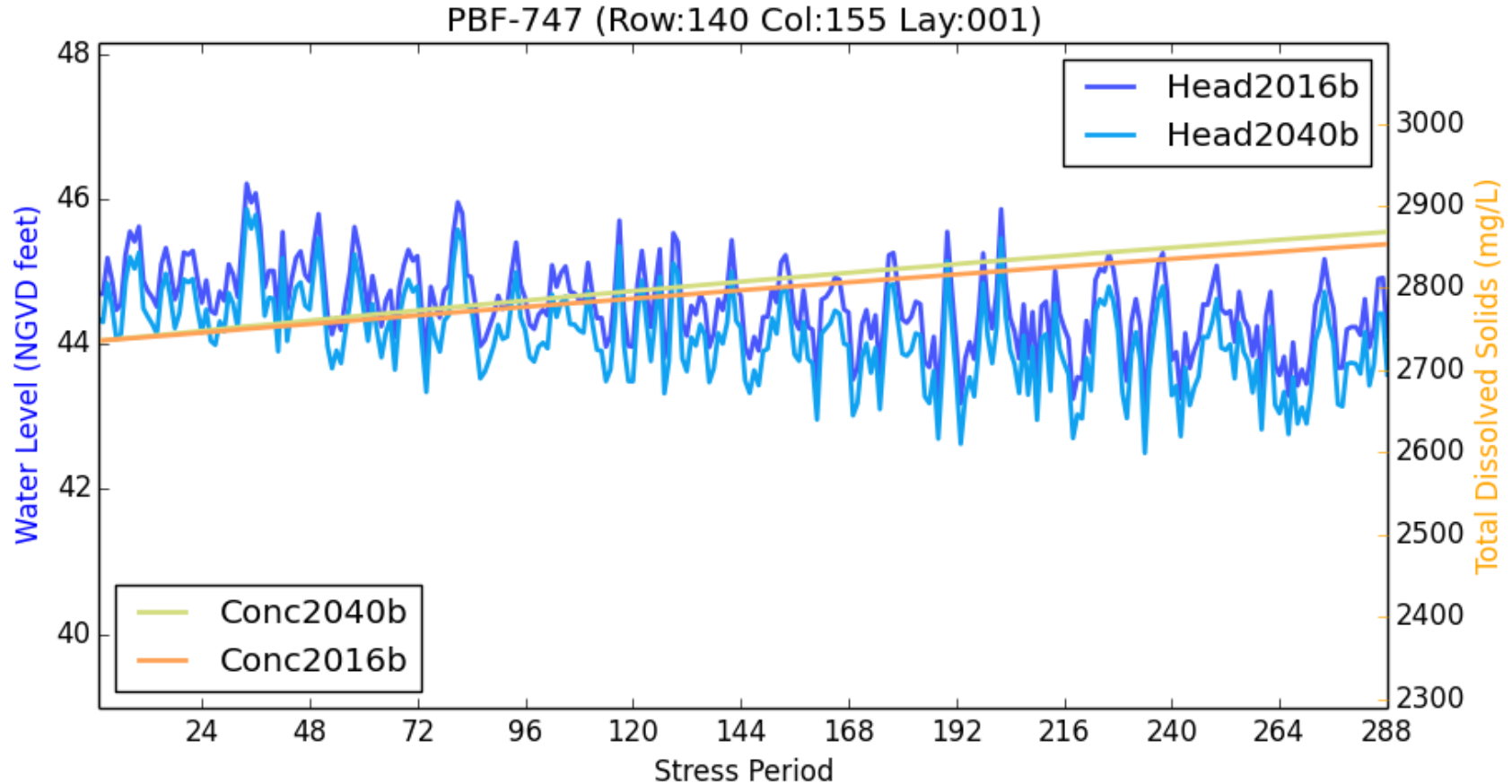


# Water Quality Differences Palm Beach Close Up

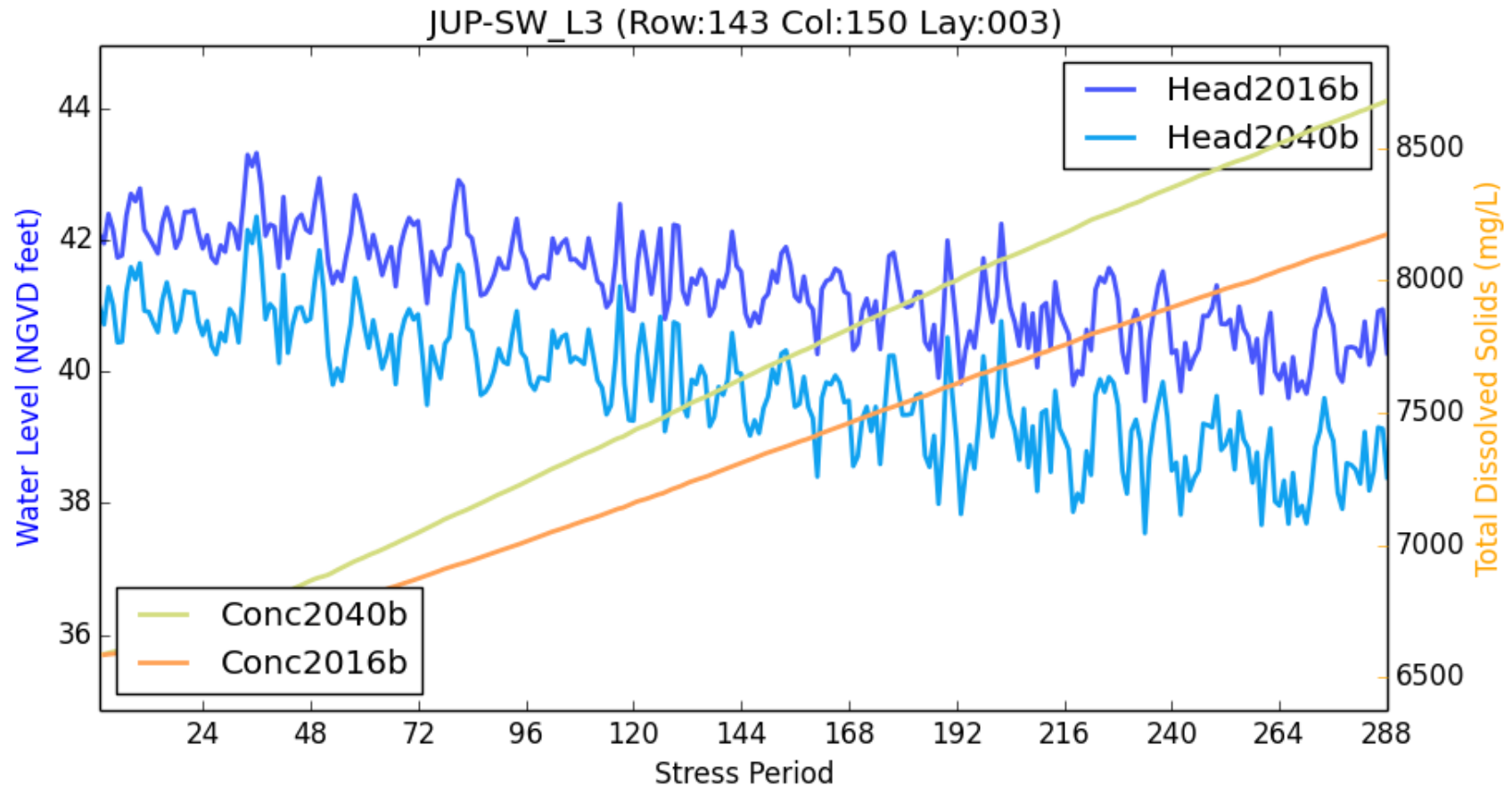
- Model run: 2040-2016
- **Layer 3**
- Stress period: 288
- Existing & proposed wells shown
- TDS in mg/L
- Range: 1,500 to 3,000



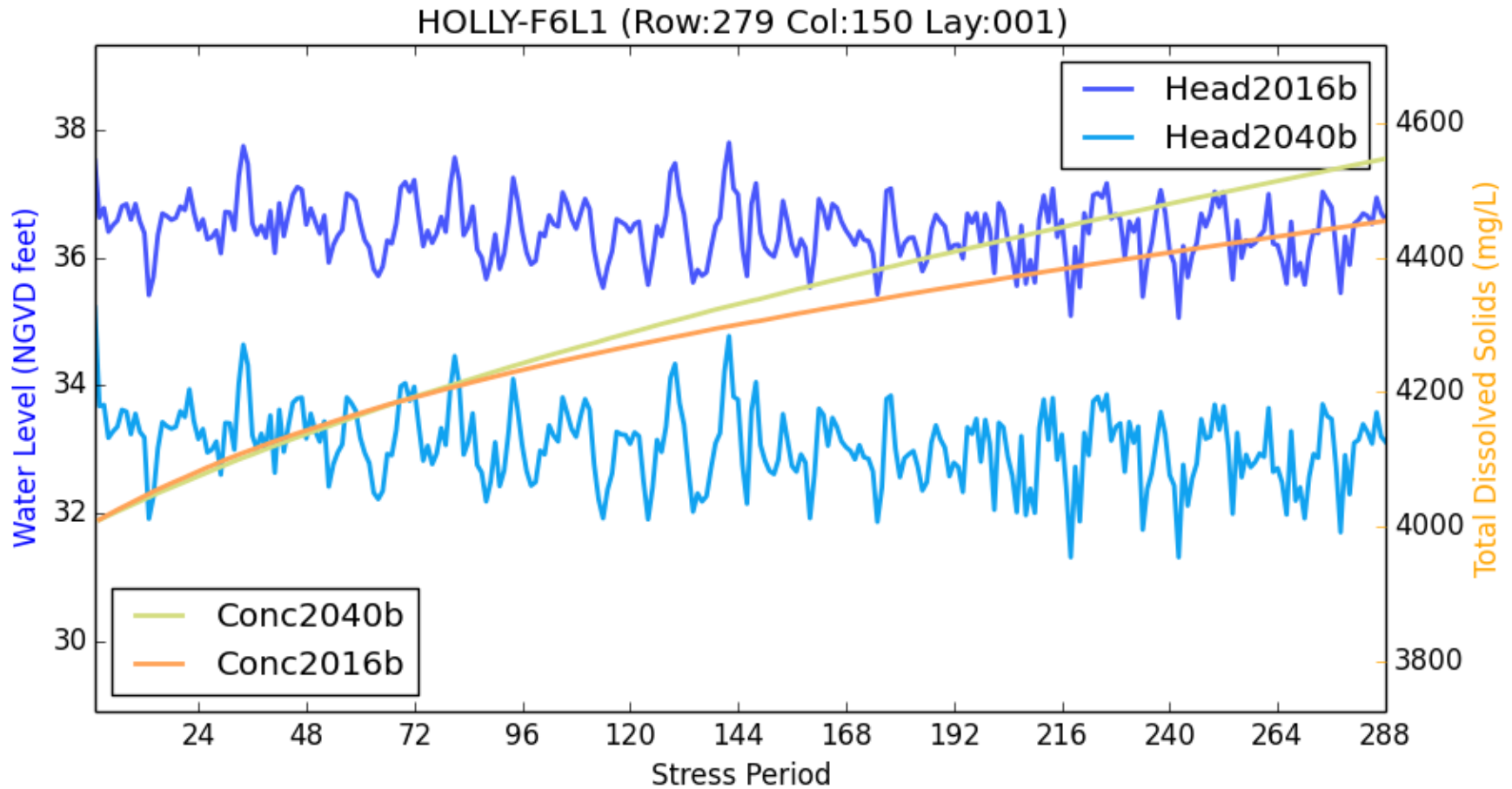
# Simulated Hydrograph Town of Jupiter



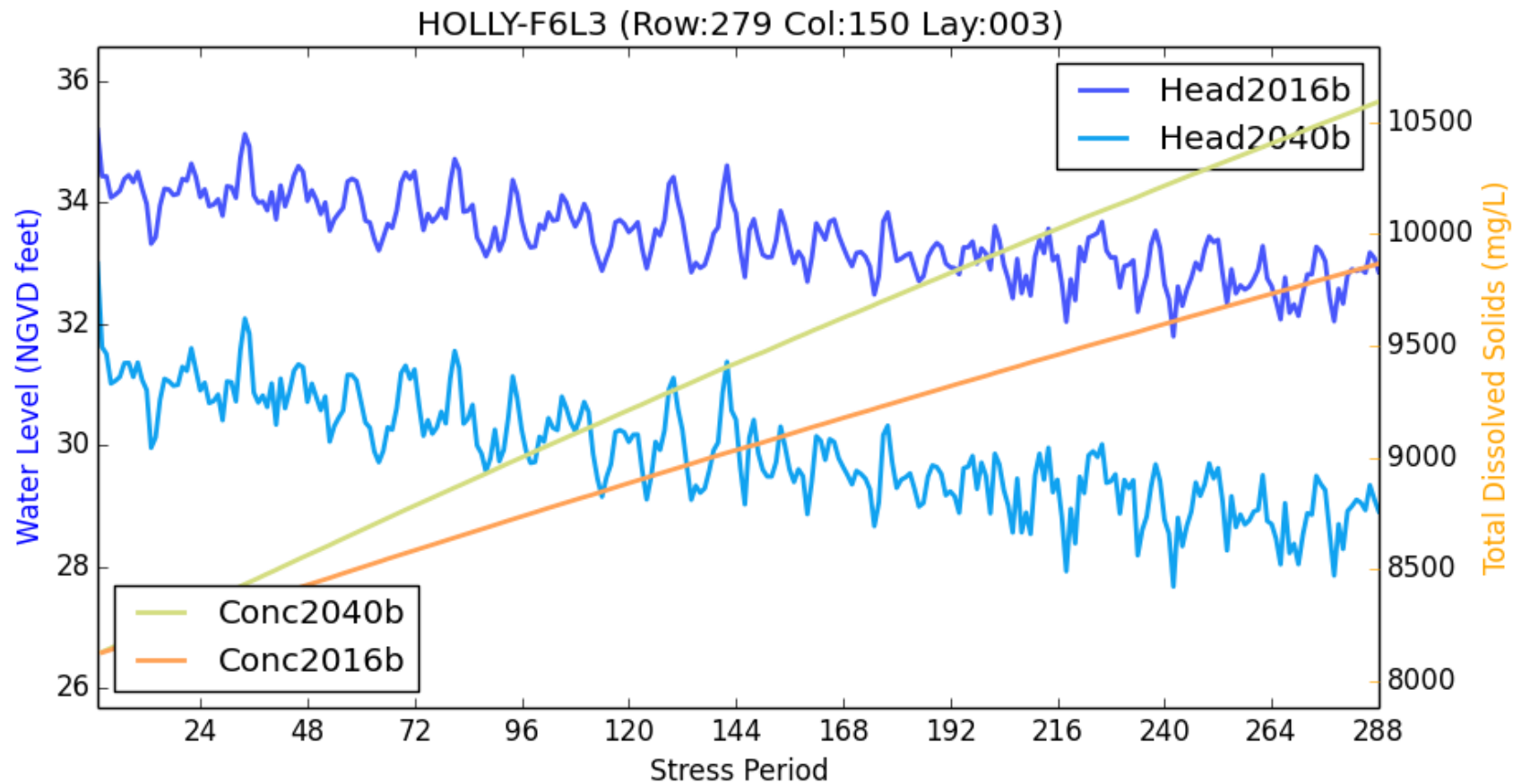
# Simulated Hydrograph Town of Jupiter



# Simulated Hydrograph City of Hollywood

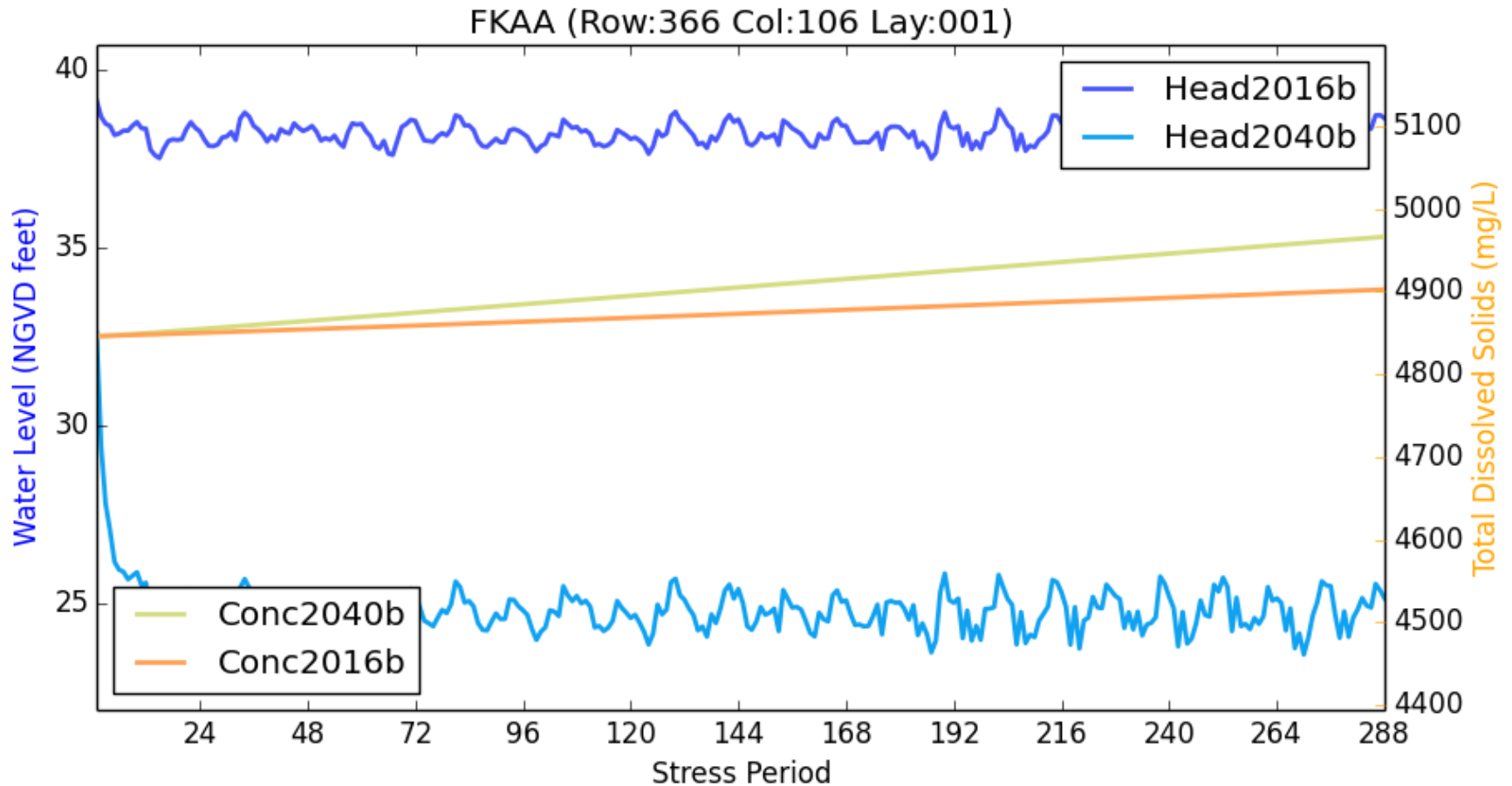


# Simulated Hydrograph City of Hollywood



# Simulated Hydrograph

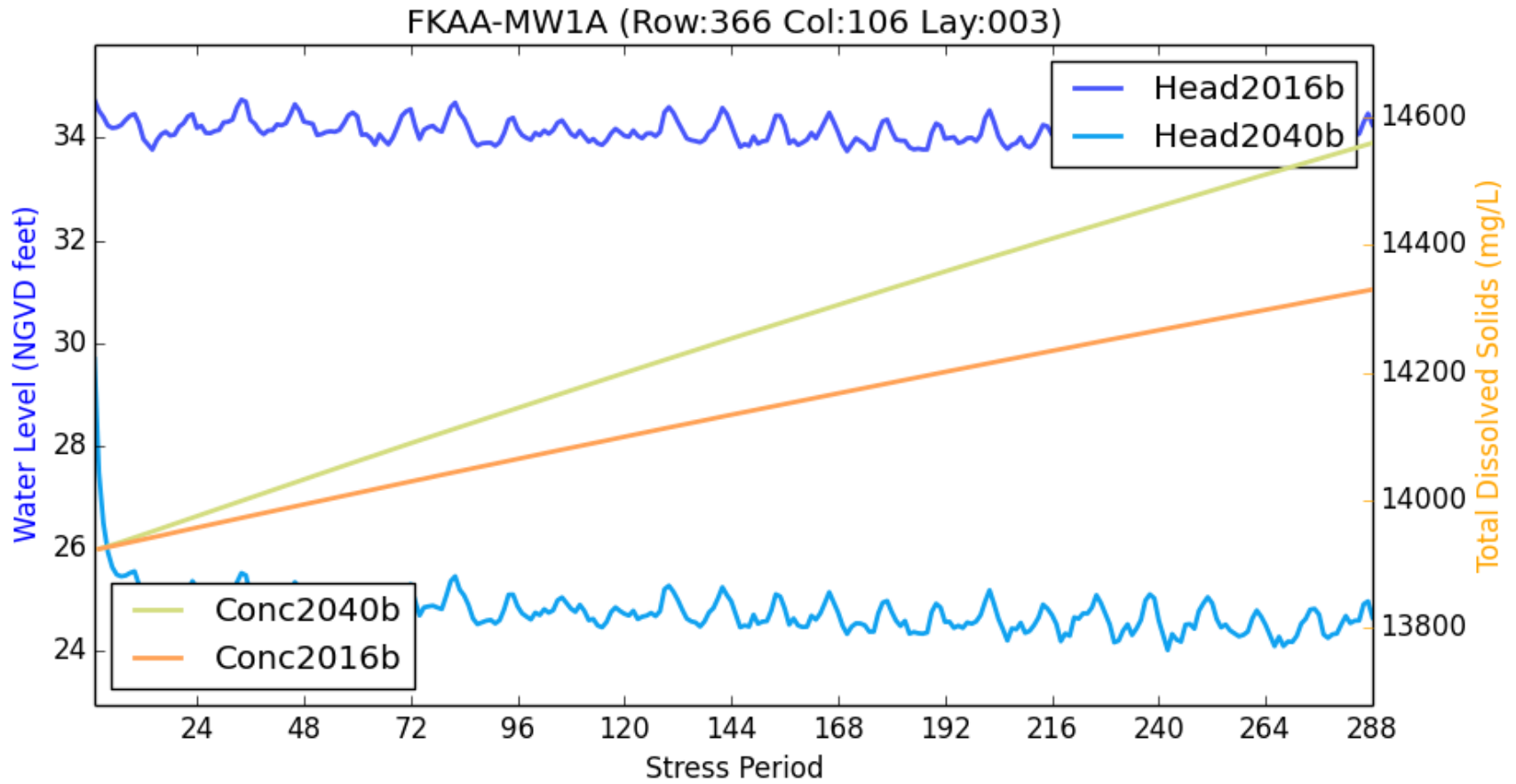
## Florida Keys Aqueduct Authority





# Simulated Hydrograph

## Florida Keys Aqueduct Authority



# Observations

- Water Level
  - Stages in APPZ (Layer 3) decline in vicinity of some Upper Floridan aquifer (Layer 1) withdrawals, suggesting upward movement of water
- Water Quality
  - Some degradation occurs, although much of the change is <1,500 mg/L TDS over 24 years
  - Potential upward movement of APPZ water into Upper Floridan aquifer may degrade water quality
- Regional Model
  - May not be able to simulate response at individual wells
- FAS appears to be capable of meeting projected demands of all users as simulated through 2040

# Discussion

# Next Steps

- August 2 Overview of draft 2018 LECWSP Update to WRAC\*
- August 17 Post draft documents for stakeholder review
- Late August Stakeholder Meeting #3
- September 13 Presentation to Governing Board
- September 21 Deadline for stakeholder comments
- November 1 Post final documents
- November 8 Final Plan to Governing Board for approval

\* SFWMD Water Resources Analysis Coalition

