DRAFT Implementation of the Turbidity Criterion for the Protection of Coral Reef and Hardbottom Communities

Division of Environmental Assessment and Restoration

Florida Department of Environmental Protection

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Section 1. Introduction

1.1 Purpose of Document

This document describes how the turbidity criterion for areas supporting coral reef and hardbottom communities will be implemented in Department permits and 303(d) assessments (Impaired Waters Rule, IWR). The criterion does not allow increases in turbidity above background levels but takes into account the variability in background levels. Key topics addressed in this document include how background levels will be established for both permitted activities and 303(d) assessments, how variability of background levels will be quantified, and how the variability will be used to assess compliance with the criterion.

1.2 Background Information

Florida is the only state in the continental United States with extensive shallow coral reef formations near its coasts. Coral reefs create specialized habitats that provide shelter, food, and breeding sites for numerous plants and animals. This includes ones important to fishing like spiny lobster, snapper, and grouper. Coral reefs lay the foundation of a dynamic ecosystem with tremendous biodiversity. The Florida Reef Tract stretches approximately 360 linear miles from Dry Tortugas National Park west of the Florida Keys to the St. Lucie Inlet in Martin County. Roughly two-thirds of the Florida Reef Tract lies within Biscayne National Park and the Florida Keys National Marine Sanctuary, a marine protected area that surrounds the Florida Keys island chain. The northern third of the Florida Reef Tract (Miami-Dade to Martin County) was recently designated as the Southeast Florida Coral Reef Ecosystem Conservation Area (Coral ECA). Additionally, the state has extensive hardbottom and worm rock reef habitats along its southeastern and southwestern coasts. Protection of these marine resources is critically important for preserving the State's marine biodiversity, protection of endangered or threatened species protection of fisheries, tourism, and coastal resiliency including protection against the effects of sea level rise.

The implementation procedures presented in this document are intended to provide necessary protections to these critically important marine communities and help ensure that man-induced turbidity is not a limiting factor in the recovery of Florida's coral reefs. It is intended to help implement Executive Order

19-12 (Achieving More Now for Florida's Environment) by helping to ensure that Florida's valuable and vulnerable coastlines and natural resources are protected.

1.3 Proposed Rule Language and Area Covered

Paragraph 62-302.530(70)(b), Florida Administrative Code (F.A.C.), states:

b. Turbidity shall not be increased above background conditions within the Southeast Florida Coral Reef Ecosystem Conservation Area, Biscayne National Park, Biscayne Bay Aquatic Preserve, Florida Keys National Marine Sanctuary excluding canals, and Dry Tortugas National Park, as shown on the map titled "Florida Reef Tract", July 2019, which is incorporated by reference herein, or other areas of the state where coral reef or hardbottom communities, are currently found. For the purposes of evaluating this criterion, background conditions shall take into account the natural variability of turbidity levels and shall be established following the methods described in the document *Implementation of the Turbidity Criterion for the Protection of Coral Reef and Hardbottom Communities*, dated September 2019, which is incorporated by reference.

The Florida Reef Tract (FRT, **Figure 1**) is specifically listed and identified in the criterion because it contains waters, including marine sanctuary, state parks, national parks, and conservation area known to currently or historically[1] support extensive coral reefs. Consideration of the historical presence of coral is of critical importance because the FRT has experienced significant due to bleaching event and disease. Coral and hardbottom organisms have a potential to colonize and grow throughout the FRT; the turbidity criterion is intended to ensure that turbidity is not a limiting factor to their survival, recruitment, growth, or recovery from disease or bleaching events, regardless of whether these species currently occur within an area. Additionally, most of the FRT has been designated as critical habitat for the threatened coral species *Acropora cervicornis* (staghorn coral) and *Acropora palmata* (elkhorn coral) by the National Oceanographic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS),

[1]The term "historical" can be interpreted to mean a range of time periods; however, in the context used in this document, it relates to the establishment of an "Existing Use," which means that coral reefs existed in the location on or after November 28, 1975.

and such critical habitat warrants additional proactive protection.

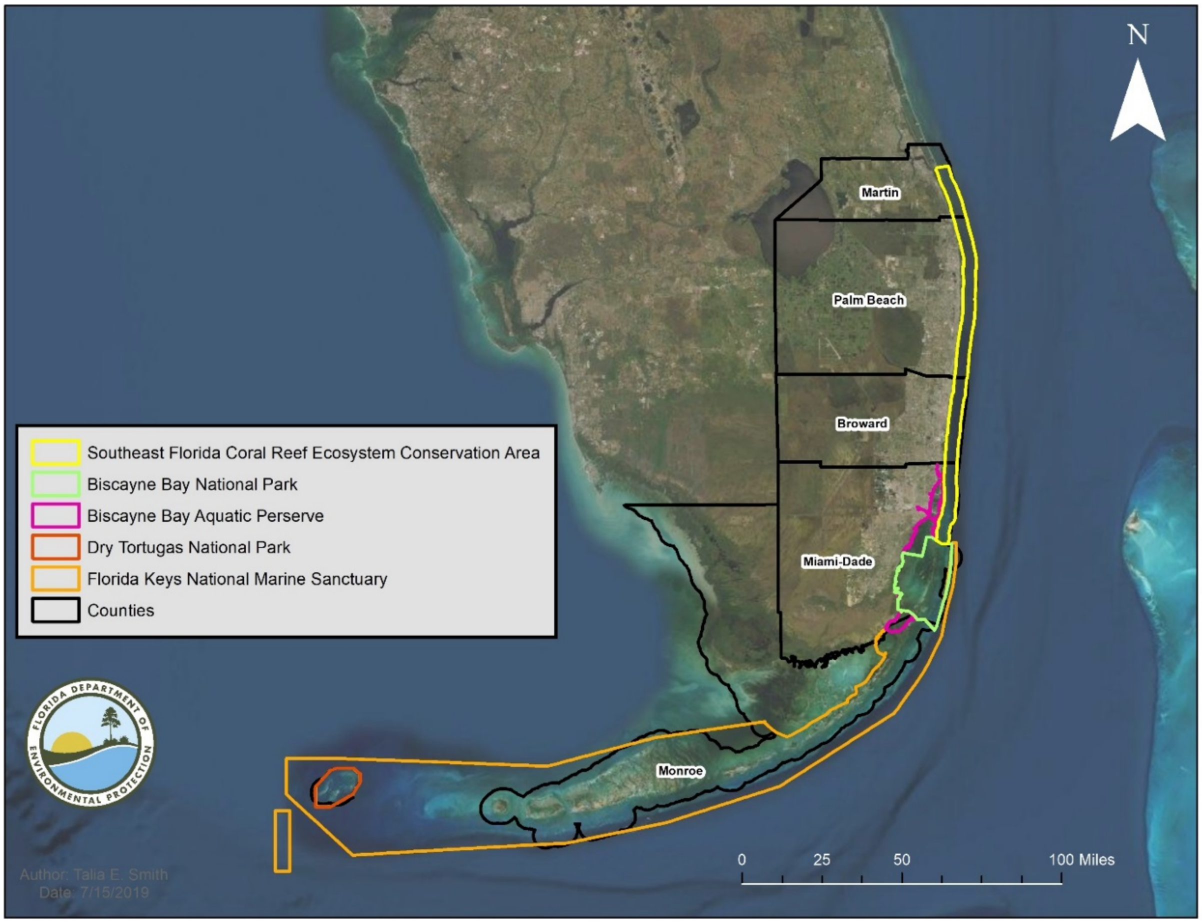

Figure 1. Florida Reef Tract.

The spatial distribution of hardbottom communities outside of the FRT is patchier, and not well delineated (**Figure 2**). Therefore, paragraph 62-302.530(70)(b), F.A.C, only applies in areas outside of the FRT to waters where coral reef or hardbottom communities are present. Coral reef shall mean a limestone structure composed wholly or partially of the living or dead skeletal remains of marine invertebrates in the Class Anthozoa; and the Orders Scleractinia (stony) corals, Stolonifera (organ-pipe corals), Antipatharia (black) corals, and Hydrozoa (hydrocoral). Hardbottom community shall mean a marine benthic community of organisms characterized by the presence of corals and associated reef organisms or worm reefs created by the genus *Phragmatopoma.*

Spatial distribution of coral reefs and worm rock habitats on the southwest and southeasSpatial distribution of coral reefs and worm rock habitats on the southwest and southeas

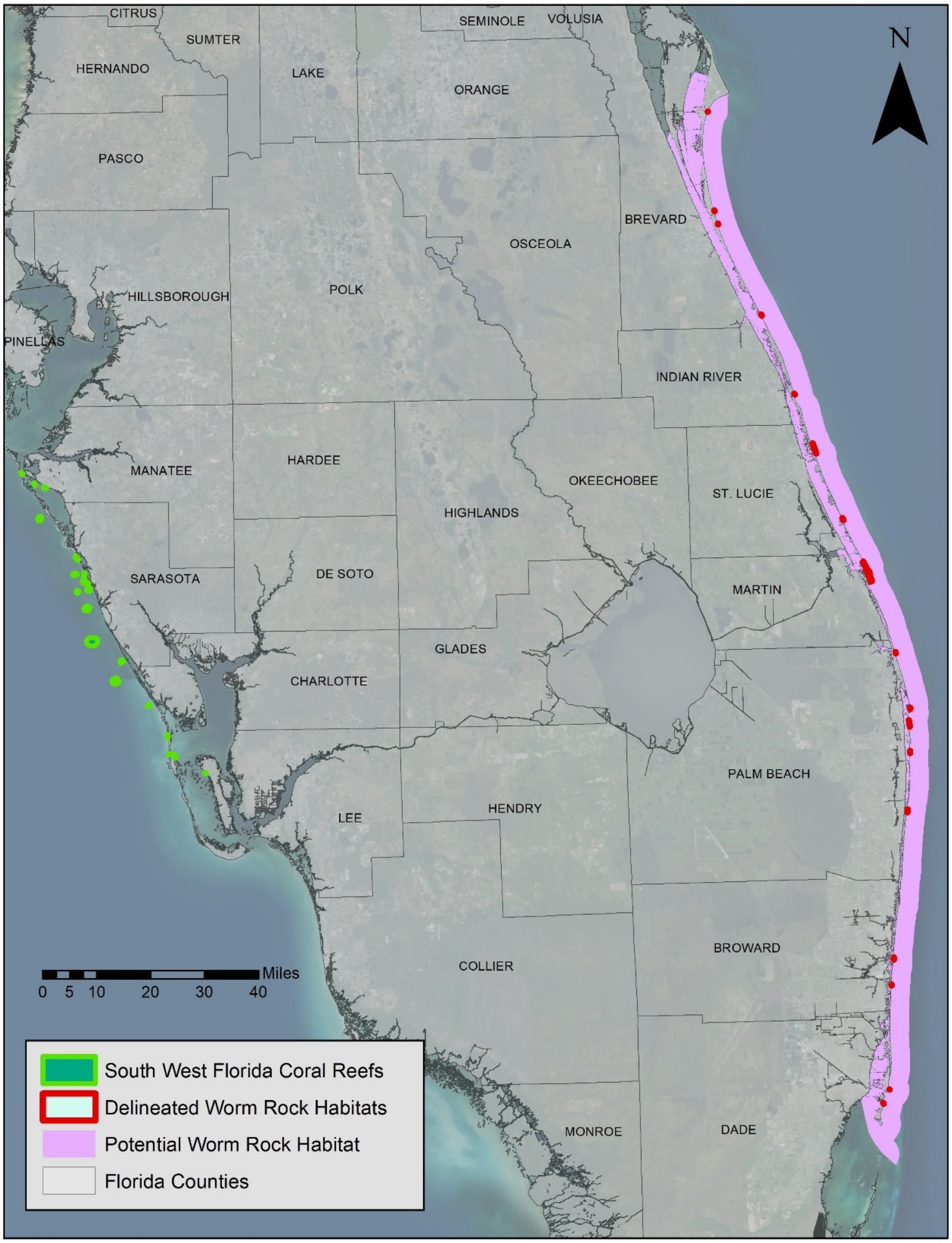

Figure 2. Spatial distribution of coral reefs and worm rock habitats on the southwest and southeast, respectively, coasts of Florida. Potential worm reef habitat is based on Kirtley and Tanner (1968) and shows where *Phragmatopoma* worm rock reefs may potentially occur.

Delineated worm rock reef habitats are from the Florida Fish and Wildlife Commission (FWC) (http://geodata.myfwc.com/datasets/dff9b71b85c04e47b8e54d0eed167205_2) and show the location of surveyed worm rock reefs.

1.4 Outstanding Florida Waters (OFW) Considerations

Large portions of the South Florida and the FRT are designated as Outstanding Florida Waters (OFW). As of May 2019, there are 32 separate designated OFWs within the area, including Florida Keys, Biscayne Bay National Park, Great White Heron National Wildlife Refuge, John Pennekamp Coral Reef State Park, Biscayne Bay Aquatic Preserves, Key Largo National Marine Sanctuary, and St. Lucie Inlet Preserve State Park (see Rule 62-30.700, F.A.C.). Projects regulated by the Department or a Water Management District that are proposed within an OFW may not lower (degrade) existing water quality, which is defined as the water quality at the time of OFW designation or the year prior to the permit, whichever is better (see paragraph 62-4.242(2)(c), F.A.C.). For activities that increase turbidity, the OFW requirements have generally been interpreted to not allow any increase above natural background (defined below) levels. However, Department rules allow for temporary increases in turbidity in OFWs within a mixing zone for certain permitted activities provided that turbidity at the edge of the approved mixing zone does not exceed natural background levels by more than the range observed through a normal tidal cycle, as described in paragraph 62-4.242(2)(b), F.A.C., which states:

> *(b) The Department recognizes that it may be necessary to permit limited activities or discharges in Outstanding Florida Waters to allow for or enhance public use or to maintain facilities that existed prior to the effective date of the Outstanding Florida Water designation, or facilities permitted after adoption of the Outstanding Florida Water designation. However, such activities or discharges will only be permitted if:*
>
> *1. The discharge or activity is in compliance with the provisions specified in subparagraph (2)(a)2.[2], of this rule, or*

[2]Subparagraph 2(a)2., F.A.C., states:

2. The proposed activity of discharge is clearly in the public interest, and either:

a. A Department permit for the activity has been issued or an application for such permit was complete on the effective date of the Outstanding Florida Water designation, or

b. The existing ambient water quality within Outstanding Florida Waters will not be lowered as a result of the proposed activity or discharge, except on a temporary basis during construction for a period not to exceed thirty days; lowered water quality would occur only within a restricted mixing zone approved by the Department; and, water quality criteria would not be violated outside the restricted mixing zone. The Department may allow an extension of the thirty-day time limit on a construction-caused degradation for a period demonstrated by the applicant to be unavoidable and where suitable management practices and technology approved by the Department are employed to minimize any degradation of water quality.

2. For dredging beach-quality sand from inlets and related channels, or restoration/nourishment of beaches and the use of offshore borrow areas, the applicant demonstrates that:

a. Turbidity has been minimized for both magnitude and duration to the maximum extent practicable,

b. Turbidity at the edge of the approved mixing zone does not exceed natural background levels by more than the range in natural background turbidity levels measured throughout a normal tidal cycle for the applicable sand dredging or beach restoration/nourishment site; and in no case shall it exceed 29 NTUs above natural background; and,

c. Turbidity levels, both inside and outside of the mixing zone, are not expected to have an adverse impact on marine resources, recreational value or public safety, or

3. Management practices and suitable technology approved by the Department are implemented for all stationary installations including those created for drainage, flood control, or by dredging or filling; and there is no alternative to the proposed activity, including the alternative of not undertaking any change, except at an unreasonably higher cost.

The application of the turbidity criterion for coral reef and hardbottom communities (paragraph 62-302.530(70)(b), F.A.C.) is similar to the implementation of antidegradation standards for turbidity within designated OFWs. Implementation of both standards requires characterization of background turbidity conditions and only allows deviation from that level within the range of background variability. However, this document establishes more extensive data requirements for establishing background turbidity conditions, including sampling over more background tidal cycles, and provides a different statistical approach for determining attainment of the criterion.

Rule 62-302.200, F.A.C., defines the terms "background" and "natural background" differently. Background (subsection 62-302.200(3), F.A.C.) is defined as *the condition of waters in the absence of the activity or discharge under consideration, based on the best scientific information available to the Department*, while natural background (subsection 62-302.200(19), F.A.C.) is defined as *the condition of waters in the absence of man-induced alterations based on the best scientific information available to the Department. The establishment of natural background for an altered waterbody may be based upon a similar unaltered waterbody, historical pre-alteration data, paleolimnological examination of sediment cores, or examination of geology and soils* (note that additional language related to background in lakes is not shown). Although there is a difference between natural background and background conditions, in practice both the current turbidity criterion [*i.e*., 29 NTU (Nephelometric Turbidity Unit) above natural background] and antidegradation requirements in paragraph 62-4.242(2)(b), F.A.C., are typically assessed using the best available background conditions because true natural conditions are seldom available. Therefore, a minimally or least disturbed background condition serves as the estimate of natural background based on the best available scientific information.

Minimally and least disturbed conditions are typically characterized based on reference stations. A minimally disturbed reference station is characterized as a location with a high percentage of nature land-uses (e.g., forest, wetlands, prairies) and limited human land-uses (e.g., urban areas, impervious surfaces, residential) or influences (e.g., waste water or industrial discharge). A least disturbed reference station may not necessarily have a high percentage of natural land-use; however, it will have the lowest level of human influence and highest percentage of natural land-use compared to other locations within the area of interest; and, it will be unaffected by the disturbance of concern (e.g., construction related turbidity, effluent discharge).

1.5 Natural Factors Influencing Background Turbidity Levels

Turbidity in coastal waters can be generated and influenced by natural events such as wind patterns, wave height and frequency, water currents, and land runoff. Sediments can be naturally resuspended in a system when exposed to wind driven waves. The amount of sediment that is picked up varies based on the strength and duration of the wind creating the waves. Storms can also influence the amount of suspended sediment within the water column. As storms pass through an area, they block the normal wind patterns of an area and may result in alternating periods of low winds with small waves followed by large waves, which creates a highly variable amount of turbidity in different locations (Storlazzi and Jaffe 2008). The duration and severity of the storm are integral factors in the amount of suspended sediment introduced into the water column.

Tidal cycles can be another strong influencer of natural turbidity. Experiments performed in estuaries showed that turbidity was highest at or near low tide when the more turbid, lower salinity water from the upper estuary extended seaward (Ward 2004). The magnitude of the tidal range also impacts the amount of sediments suspended in the water column. Larger spring tides can cause higher amounts of sediment to be picked up during the low tide, subsequently making the water more turbid when the tide rises (Ward 2004). Tidal Stage can be very important near inlets as well.

2. Implementation in Permitting

2.1 Permitting Background Information

The turbidity criterion for corals (paragraph 62-302.530(70)(b), F.A.C.) will affect dredging, beach nourishment, and other projects that may generate turbidity, in coastal waters within the FRT or other areas of the state where coral and/or hardbottom communities are present. Specifically, it affects the boundaries (size) of turbidity mixing zones, limits applied to permits, and associated water quality monitoring requirements for Joint Coastal Permits (JCP) and Environmental Resource Permits (ERP) in these areas whenever there is an expectation that the project will generate turbidity above the existing background.

Neither the criterion in paragraph 62-302.530(70)(b), F.A.C., nor this Implementation Document alter the opportunities or requirements for permittees to obtain mixing zones available under Rule 62-4.244, F.A.C., or variances. They only affect how background is defined and determined. Compliance is still intended to be determined at the edge of an authorized mixing zone. However, turbidity levels, both inside and outside of the mixing zone, must not have an adverse or acute impact on marine resources, recreational value or public safety.

Activities that require a JCP include beach restoration or nourishment; construction of erosion control structures, such as groins and breakwaters; construction of public fishing piers; maintenance of inlets and inlet-related structures; and dredging of navigation channels that include disposal of dredged material onto the beach or in the nearshore area. Beach restoration and nourishment have been the main methods of managing beach erosion and maintaining beach habitat. Key rules and statutes that govern JCPs include: Chapter 161 Florida Statutes (F.S.), Chapter 62B-41, F.A.C., Chapter 62B-49, F.A.C., Chapter 18-20, F.A.C., Chapter 18-21, F.A.C., Chapter 62-4, F.A.C., Chapter 62-302, F.A.C., Chapter 62-330, F.A.C., Chapter 253, F.S., Chapter 258, F.S., part IV Chapter 373, F.S., and Chapter 403, F.S.

The ERP Program regulates activities in, on or over surface waters or wetlands, as well as any activity involving the alteration of surface water flows. The Program regulates almost any change to the landscape, including all tidal and freshwater wetlands and other surface waters (including isolated wetlands) and uplands. The ERP program deals with dredging and filling in wetlands and other surface waters (including ports and navigational channels), as well as stormwater runoff quality and quantity. The ERP Program is implemented jointly by the Department and four of the WMDs (all except the Northwest WMD). This program ensures that water quality is not degraded, and that wetlands and other surface waters continue to provide a productive habitat for fish and wildlife. Key rules and statutes that govern ERPs include Chapter 18-20, F.A.C., Chapter 18-21, F.A.C., Chapter 62-4, F.A.C., Chapter 62-302, F.A.C., Chapter 62-330, F.A.C., Chapter 253, F.S., Chapter 258, F.S., part IV Chapter 373, F.S., and Chapter 403, F.S.

Paragraph 62-302.530(70)(b), F.A.C., and the requirements described in this Implementation Document apply to all permitted dredging and beach nourishment projects conducted in the FRT regardless of the presence of coral or hardbottom communities. However, the criterion and associated implementation requirements shall also apply in other coastal waters of the state where coral or hardbottom communities are present[3]. Documentation supporting the presence or absence of corals or hardbottom shall be based on site-specific evaluation of the habitat and epifaunal species present. The evaluation must be based on benthic surveys within the area affected by the project or construction area.

2.2 Measuring Background (Pre-project) Levels

Permit applicants will have the responsibility to provide the information needed to establish the background turbidity, including the natural variability in background turbidity levels, for the area where the permitted activity will take place. Natural background variability will be established based on pre-project turbidity data collected at "baseline" stations. Turbidity data and calculations (described below) provided by applicants will be reviewed by the Department and used to develop permit-required turbidity limits for use throughout the duration of the project. Compliance with these permit-required turbidity limits will constitute attainment of the turbidity criterion.

The preferred method of obtaining turbidity readings is using a hand-held Nephelometric Turbidity Meter in accordance with standard protocols (*i.e.*, DEP-SOP-001/01 FT 1600 Field Measurements of Turbidity) and meeting all applicable QA/QC requirements under Chapter 62-160, F.A.C. When using hand-held meters, the person conducting turbidity monitoring should observe conditions at the station to confirm tidal stage and should actively avoid outside influences that could elevate turbidity (*e.g.*, passing boats or construction activities) above background conditions.

If the applicant prefers to use a data sonde to collect turbidity data, they must demonstrate that the equipment was properly maintained (*i.e.*, cleaned regularly to prevent fouling), was deployed at a location that avoided outside influences to the maximum extent practicable (*i.e.*, minimal boat traffic), and retained calibration throughout the deployment.

Pre-project baseline stations shall be established independently for each project sub-area (*e.g.*, offshore borrow areas, nearshore placement stations, nearshore dredging areas, offshore dredging areas) and samples shall be taken in portions of the project area where there are minimal man-induced alterations that might influence turbidity. Pre-project baseline conditions shall be established no more than three months before the beginning of the project. The pre-project baseline station(s) shall be located above

[3] The requirements will apply within seagrass communities if coral or hardbottom organisms are also found in the area.

living coral or hardbottom community if any of these communities are present within the project area. If multiple community types are present within the project area, multiple baseline stations may be needed to address the different background conditions. Additionally, projects expected to last longer than three months may have season-specific turbidity limits. Applicants are encouraged to have a pre-application meeting so that DEP permitting staff can provide site-specific guidance on the appropriate siting of pre-project baseline stations and seasonal requirements (if any).

The minimum duration over which background turbidity variation must be assessed is three tidal cycles at each pre-project baseline station. The tidal cycles may either be consecutive or non-consecutive. However, care must be taken to ensure that background turbidity data are collected at the same location for each tidal cycle. GPS coordinates must be provided to verify the baseline station location. The location of each baseline station shall not differ by more than 10 meters between tidal cycle events. Turbidity measurements must be collected at the surface (0.5 – 1 meter below surface) and bottom (0.5 – 1 meter off bottom) at a minimum of one representative baseline station for each project area. For example, borrow areas and beach placement areas must each have representative baseline stations. In some cases, there may be more than one borrow area or placement area, and each of these areas must have at least one baseline station. Turbidity samples must be collected at a frequency of no greater than 4 hours apart throughout each tidal cycle, and applicants must report turbidity at the peak of each tidal stage. Pre-project turbidity samples may be collected more frequently (e.g., hourly) at the applicant's discretion to help ensure a more accurate and complete representation of the range of background variability. The measurement of turbidity may be started at any point in the tidal cycle and must end at the same point in the next cycle, such as from high to low to high, or from low to high to low.

The applicant must provide the Department with reasonable assurance that the collected turbidity data are representative of the natural variation in turbidity over a typical tidal cycle. This demonstration must include 1) tidal data (*i.e.*, tide charts, observed water levels) and other meteorological data (*i.e*., wave height, wind speed and direction, precipitation) for the period over which background samples were collected; and, 2) longer-term tide and weather data for the project area. "Typical" shall mean that the height of the low and high tide are within the range of the 5^{th} and 95^{th} percentiles, respectively, of the historic data. The sampling must also be conducted when weather conditions remain relatively uniform throughout the tidal cycle. Applicants must avoid sampling when weather fronts are moving through the area or when wind speed or direction are expected to change significantly. Extreme weather conditions such as tropical storms are not considered typical and must be avoided. Data collected during these periods of changing or extreme weather conditions shall not be used or considered in the establishment of the baseline condition.

Because the pre-project data set requirements are relatively small in terms of sample size, the results are prone to undue influence from statistical outliers. Therefore, the turbidity results must be screened for outliers and any outliers shall be removed from the dataset prior to the calculation of background variability and calculation of permit-required turbidity limits. For purposes of this analysis, an outlier shall mean any turbidity value that is greater than the mean of the data set plus three times the standard deviation, and the outlier analysis shall be conducted for each station and depth independently.

2.3 Calculation of Background Variability

The turbidity criterion in paragraph 62-302.530(70)(b), F.A.C., is intended to protect coral and hardbottom communities from deleterious effects associated with elevated turbidity levels. It is assumed that any sessile benthic organisms present within an area are adapted to the background turbidity in that area, including natural variability in background levels. However, increases in the magnitude, duration or frequency (*i.e.*, increased variability) of turbidity above background conditions have deleterious effects on the resident coral. Thus, the turbidity criterion is designed to maintain the pre-project background turbidity magnitude, frequency, and duration. Permits for dredging or other activities that may increase turbidity in waters subject to paragraph 62-302.530(70)(b), F.A.C., will be subject to permit-required turbidity limits based on pre-project variability. These permit-required turbidity limits will be established based on the observed turbidity range at the representative pre-project baseline station(s) and will be expressed as the allowable increase in turbidity between the project background and compliance stations.

The allowable increase in turbidity over pre-project background levels and associated permit-required turbidity limit shall be calculated, using data collected at the baseline station(s), as an upper confidence interval of the mean difference between minimum and maximum turbidity over a typical tidal cycle. The upper 90% prediction interval shall be used if baseline turbidity levels are provided for 3 or 4 pre-project tidal cycles and shall be calculated using the follow equation:

$$\text{Upper 90\% confidence interval} = \bar{X} + 1.64 \times \frac{S}{\sqrt{n}}, \text{ where(Equation 1)}$$

$\bar{X}$ = Mean of differences between minimum and maximum turbidity over each baseline tidal cycle

S = Standard deviation of the differences between minimum and maximum turbidity over all baseline tidal cycles

n = the number of baseline tidal cycles

If background turbidity levels are provided for 5 or more pre-project baseline tidal cycles, the upper 95% confidence shall be used and shall be calculated using the follow equation:

$$\text{Upper 95\% confidence interval} = \bar{X} + 1.96 \times \frac{S}{\sqrt{n}}, \text{ where} \quad \text{(Equation 2)}$$

$\bar{X}$ = Mean of differences between minimum and maximum turbidity over each baseline tidal cycle

S = Standard deviation of the differences between minimum and maximum turbidity over all baseline tidal cycles

n = the number of baseline tidal cycles

The applicant must report and use all collected pre-project baseline turbidity data collected during typical tidal cycles that passed applicable quality assurance requirements in the calculation of the confidence interval and cannot pick a sub-set of the pre-project baseline tidal cycles that provides the highest possible confidence interval. The calculated upper confidence intervals shall be applied as the permit-required turbidity limits.

2.4 Assessment of Turbidity Levels During Construction Operations

To assess compliance with the turbidity criterion during construction, permittees must sample turbidity at both representative background and compliance stations. The background data collected during construction should be collected at station(s) located in an area clearly outside of the influence of any construction activities and not at the same location(s) as the pre-project background station(s). The locations of these compliance and background stations will generally not be fixed, but rather will change between monitoring events in response to changes in the plume direction as the work area (portion of the project area that is being dredged or filled) shifts or in response to changing tidal conditions over the course of the construction. Individual permits will specify the number of required stations, sampling frequency (minimum of 3 per day collected 4 hours apart), and specific conditions for siting compliance and background stations. However, there must be at least one background station and one compliance station at the edge of each authorized mixing zone, with turbidity samples collected at surface (0.5 to 1 m) and bottom depth at both locations. Individual permits will specify a minimum distance between the work zone and background station.

Typically, permittees are required to collect turbidity samples 3 times per day, 4 hours apart, during daylight hours only. The permittee shall report all turbidity data (*i.e.*, raw field sheets and processed data in an electronic database), and shall also report the following information:

a. Time of day samples were taken;
b. Dates of sampling and analysis;
c. GPS location of sample;
d. Depth of water body;
e. Depth of each sample;
f. Weather conditions, including wind direction and velocity;
g. Tidal stage and direction of flow;
h. Water temperature;
i. A map, overlaid on an aerial photograph, indicating the sampling locations, dredging and discharge locations, direction of flow, boundaries of natural resources (e.g., coral reefs, hardbottom, worm reefs, seagrass beds) and GPS coordinates for all vessels operating during the monitoring period.
j. A statement describing the methods used in collection, handling, storage and analysis of the samples; and
k. A statement by the individual responsible for implementation of the sampling program concerning the authenticity, precision, limits of detection, calibration of the meter, accuracy of the data and precision of the GPS measurements.

Each compliance sample shall be independently compared to the corresponding depth-specific background turbidity value, and any increase in turbidity at the compliance station above the background station must be equal to or less than the allowable increase in turbidity (*i.e.*, permit-required turbidity limit), as calculated using Equation 1 or 2. Dredging projects lasting longer than three months may have season-specific permit-required turbidity limits. The turbidity increase between the two stations shall be calculated as the measured compliance station turbidity minus the measured background station turbidity.

2.5 Example Application of the Permit Required Turbidity Limit

Table 1 provides an example calculation of the permit-required turbidity limit for a hypothetical dredging project. The hypothetical applicant collected turbidity measurements at a representative pre-project baseline station through five typical tidal cycles. No outliers were identified in the data set. The applicant tabulated the differences between maximum and minimum turbidity for each tidal cycle at both depths (*i.e.*, independently for samples collected at each the surface and bottom depth), calculated the mean and standard deviation of the difference independently for each depth, and then used Equation *2* to calculate the upper 95% confidence interval for each depth. The calculated upper 95 percent confidence intervals (i.e., 2.1 and 2.6 NTU) will serve as maxima allowed increase between the background and compliance stations, and the permit shall specify both surface (0.5 – 1 m) and bottom depth limits.

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Table 1. Pre-project baseline turbidity measurements collected to calculate the surface and bottom depth permit-required turbidity limits for a hypothetical dredging project within the Southeast Florida Coral Reef Ecosystem Conservation Area. The baseline data were used to calculate upper 95% confidence intervals, which will serve as the applicable permit-required turbidity limits for the project.

Tidal Cycle	Surface Minimum Turbidity (NTU)	Surface Maximum Turbidity (NTU	Bottom Minimum Turbidity (NTU)	Bottom Maximum Turbidity (NTU)	Turbidity Difference Surface	Turbidity Difference Bottom
1	1.5	2.8	1.2	2.6	1.3	1.4
2	3.1	3.5	2.9	4.1	0.4	1.2
3	1.1	2.7	1.1	2.5	1.6	1.4
4	3.5	3.8	2.5	4.4	0.3	1.9
5	2.4	5.1	2.3	5.6	2.7	3.3
				Mean Difference	1.26	1.84
				Standard Deviation	0.981	0.856
				Sample size (n)	5	5
				Upper 95% C.I.	2.1	2.6

The permittee conducted the required compliance and background station turbidity monitoring throughout the duration of the project. Turbidity measurements were collected at all monitoring stations 3 times per day at a frequency of every four hours at both surface and bottom depth at the background and compliance stations. **Table 2** provides an example background and compliance turbidity dataset collected over four days of the project. The pre-project background values calculated in **Table 1** (i.e., 2.1 and 2.6 NTU for the surface and bottom depth background measurement, respectively) were added to the turbidity values at the background (BG) sampling locations during construction to determine whether any of the samples taken at compliance stations during construction were out of compliance with the permit-required turbidity limits. In this example, none of the surface or bottom depth compliance measurements exceeded the applicable turbidity limits; therefore, the dredging operation was in full compliance with the turbidity permit requirements.

Table 2. Hypothetical dredging project turbidity compliance data reported in NTU (Nephelometric Turbidity Unit). Turbidity measurements were collected at background and compliance stations at surface and bottom depth. Allowable increases in turbidity of 2.1 and 2.6 were added to the surface (BG_s) and bottom depth (BG_b) background turbidity values, respectively, for each time and depth used to evaluated compliance with the permit-required turbidity limits.

Date	Time (HH:MM)	Surface Background Turbidity (NTU, BG_s)	Surface Turbidity Limit (NTU, BG_s +2.1)	Surface Compliance Turbidity (NTU)	Bottom Background Turbidity (NTU, BG_b)	Bottom Turbidity Limit (NTU, BG_b +2.6)	Bottom Compliance Turbidity (NTU)
5/27/2019	7:00	3.9	6.0	5.6	3.4	6.0	5.4
5/27/2019	11:00	3.2	5.3	4.1	3.3	5.9	4.9
5/27/2019	15:00	2.1	4.2	4.0	2.3	4.9	4.3
5/28/2019	7:00	3.7	5.8	5.5	4.0	6.6	6.0
5/28/2019	11:00	4.7	6.8	4.8	3.7	6.3	5.3
5/28/2019	15:00	2.5	4.6	4.2	2.5	5.1	4.5
5/29/2019	7:00	3.6	5.7	4.9	4.4	7.0	6.4
5/29/2019	11:00	2.9	5.0	5.0	2.1	4.7	4.7
5/29/2019	15:00	5.1	7.2	3.2	2.1	4.7	4.1
5/30/2019	7:00	4.7	6.8	4.1	5.0	7.6	7.3
5/30/2019	11:00	4.0	6.1	5.9	3.8	6.4	6.2
5/30/2019	15:00	3.9	6.0	5.7	4.1	6.7	6.7

3. Implementation in Impaired Waters Assessments

3.1 Assessment Overview

The Department will assess the attainment of the turbidity criterion for coral reefs and hardbottom communities as part of the 303(d) Assessment of Florida's surface waters using the methodology in the Impaired Waters Rule (IWR, Chapter 62-303, F.A.C.). Only waters where coral and hardbottom communities are known to occur or potentially occur are subject to these turbidity assessment provisions. The specific applicable waters include the FRT and all open coastal waters within Manatee, Sarasota, Charlotte, Lee, Collier, Monroe, Miami-Dade, Broward, Palm Beach, Martin, St. Lucie, Indian River, and Brevard counties.

A key component of this assessment will be to determine the baseline turbidity at the time of criterion adoption and allowable increase in turbidity above baseline for the assessment units (**W**ater**b**ody

Identification Units or WBIDs) with coral reefs and hardbottom communities. The baseline condition is discussed and described in **Appendix A**.

3.2 Data Requirements for Determining Background Turbidity

Ambient turbidity data used for the assessment of the turbidity criterion for corals reefs and hardbottom communities under the IWR are subject to the data requirements in subsections 62-303.320(1), (2), (4), (7), (8), (9), and (12), F.A.C., for the Planning List, and subsections 62-303.450 (1), (2), (3), (5), (6), and (7), F.A.C., for the Verified List.

3.3 Assessment of Attainment of Criterion

Appendix A provides summary statistics for the baseline condition for waterbody segments within the FRT and open coastal[4] waters where coral or hardbottom communities are potentially present. To evaluate whether turbidity levels have increased above the baseline condition, data from the assessment period for a waterbody (WBID) will be compared to the 90th percentile in **Appendix A** for that waterbody. Some WBIDs currently have insufficient data (less than 20 samples) to calculate 90th percentile values. The Department will update **Appendix A** during the next Triennial Review. WBIDs with insufficient baseline data will not be assessed for attainment of paragraph 62-302.530(70)(b), F.A.C., until 90th percentile values are added to **Appendix A**.

Attainment of the 90th percentile values will be evaluated using a binomial hypothesis test at the 80 percent and 90 percent confidence levels for the Planning List and Verified Lists, respectively. The use of the binomial hypothesis test is consistent with the assessment for other single-sample water quality parameters conducted under Chapter 62-303, F.A.C. The number of exceedances required to have 80 percent and 90 percent confidence that 10 percent or more of the measurements exceed the baseline are provided in Chapter 62-303, F.A.C., Tables 1 and 3, respectively. Stations within 200 meters of shore may be influenced by tidal or wave action and shall be excluded from IWR assessments. Waterbodies that exceed the number of exceedances for a given sample size in Tables 1 and 3 will be placed on the Planning and Verified Lists, respectively.

[4] Subsection 62-303.200(14), F.A.C., defines "Open coastal waters" as all gulf or ocean waters that are not classified as estuaries or open ocean waters. Estuary is defined as predominantly marine regions of interaction between rivers and nearshore ocean waters, where tidal action and river flow mix fresh and salt water. Such areas include bays, mouths of rivers, and lagoons, in subsection 62-303.200(16), F.A.C.

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Appendix A

Purpose

This appendix provides baseline conditions data necessary to assess attainment of the turbidity criterion under the Impaired Waters Rule (IWR). It provides WBID-specific turbidity background thresholds (90^{th} percentile values) for the Florida Reef Tract, which includes the Southeast Florida Coral Reef Ecosystem Conservation Area (Coral ECA), Biscayne National Park, Biscayne Bay Aquatic Preserve, Florida Keys National Marine Sanctuary excluding canals, and Dry Tortugas National Park; and, open coastal waters within Manatee, Sarasota, Charlotte, Lee, Collier, Monroe, Miami-Dade, Broward, Palm Beach, Martin, St. Lucie, Indian River, and Brevard (to Cape Canaveral) counties. The 90^{th} percentile values shall be used as the basis of criteria attainment decisions under the IWR.

Data Processing

Data were obtained from the Department's IWR Run 57 database and DEP's Florida Reef Tract Nutrient Water Quality Assessment project for the Coral ECA[5]. Data were processed and analyzed in Excel and Systat 10.2. All turbidity data that passed quality assurance checks were included in the calculations, with exception of data from stations within canals or within 200 meters of shore which were excluded from the analysis to avoid biasing the results. Summary statistics (arithmetic mean and 90^{th} percentile) were calculated for each WBID with at least 20 turbidity measurements. In some cases, neighboring WBIDs were combined to attain the 20-measurements minimum. WBIDs 8077 and 8078 were split between waters within the Florida Keys National Marine Sanctuary (FKNMS) and outside the FKNMS (*i.e.*, Florida Bay portion of the WBIDs) to create homogenous (relative to turbidity) water segments for assessment purposes. Sufficient turbidity data were available for most WBIDs in the area of interest with the exception of open ocean WBIDs along the Atlantic Coast north of Martin County. WBIDs with insufficient data are not listed and cannot currently be assessed under the IWR methodology for attainment of the turbidity criterion.

Results

Mean and 90^{th} percentile turbidity values for each WBID are summarized in Table A-1. The table also provides the period or record used for each WBID. The periods of record are provided as a minimum date (earliest record) and maximum date (most recent record).

[5] The Florida Reef Tract Nutrient Water Quality Assessment is managed by the Office of Resilience and Coastal Protection. The data from this project were not loaded into WIN or the IWR database at the time of report preparation.

Table A-1. Summary of existing background turbidity (NTU) within WBIDs within the FRT and open coastal WBIDs within Manatee, Sarasota, Charlotte, Lee, Collier, Monroe, Miami-Dade, Broward, Palm Beach, Martin, St. Lucie, Indian River, and Brevard (to Cape Canaveral) counties. The listed 90^{th} percentile values shall be used for IWR assessments and listing decisions. Entries of "ID" in the Sample Size (N) column indicate that there were insufficient data to calculate a 90th percentile. The spatial extent of WBIDs was based on IRW Run 57.

WBID	Area	Sample Size (N)	Period of Record Min. Date	Period of Record Max. Date	Mean (NTU)	90^{th} (NTU)
8091[1]	Coral ECA	54	9/25/2017	3/21/2019	1.8	3.6
8092[1]	Coral ECA	54	9/25/2017	3/21/2019	1.8	3.6
8093	Coral ECA	190	9/25/2017	3/21/2019	0.8	1.6
8094	Coral ECA	114	9/27/2017	3/12/2019	0.7	1.3
8095	Coral ECA	114	9/27/2017	3/7/2019	0.5	0.9
8096	Coral ECA	285	9/26/2017	3/11/2019	0.6	1.1
8097	Coral ECA	57	9/28/2017	3/26/2019	0.3	0.4
8098	Coral ECA	162	9/28/2017	3/26/2019	0.5	1.2
8099	Coral ECA	114	9/21/2017	3/6/2019	0.6	0.8
8100	Coral ECA	76	9/21/2017	3/6/2019	0.6	1.2
8101	Coral ECA	158	9/20/2017	3/4/2019	1	2
8102	Coral ECA	21	1/18/2019	3/4/2019	0.6	1
6001	Biscayne Bay	9470	5/6/1970	8/10/2017	1.3	2.9
8088	Biscayne Bay	339	3/28/1995	12/4/2018	1.3	1.8
8089	Biscayne Bay	316	5/6/1970	12/4/2018	1.7	2.7
8090	Biscayne Bay	204	9/30/1993	6/28/2016	2.1	1.9
3226H	Biscayne Bay	3851	8/14/1974	1/16/2018	2.4	5.3
3226H1	Biscayne Bay	467	3/19/1979	11/28/2017	1.3	2.2
3226H2[2]	Biscayne Bay	2025	3/19/1979	8/7/2017	2.5	4.7
3226H3	Biscayne Bay	2025	3/19/1979	8/8/2017	2.5	4.7
6002	Manatee Bay – Barnes Sound	688	12/5/1985	8/9/2017	1.2	2.4
6003	Manatee Bay – Barnes Sound	1300	1/9/1986	8/9/2017	1.7	3
6001C	Card Sound	2093	5/6/1970	8/9/2017	0.9	1.9
6009	Florida Keys	ID				
6010	Florida Keys	ID				
6016	Florida Keys	ID				
6017	Florida Keys	ID				
6018	Florida Keys	132	3/23/1995	6/24/2013	1.5	1.8
6019	Florida Keys	ID				

WBID	Area	Sample Size (N)	Period of Record Min. Date	Period of Record Max. Date	Mean (NTU)	90th (NTU)
8073	Florida Keys	864	3/22/1995	2/27/2019	2.1	3.3
8074	Florida Keys	425	4/5/1995	5/3/2013	2.5	3.6
8075	Florida Keys	682	3/26/1995	5/3/2013	2.3	3.3
8076	Florida Keys	464	3/26/1995	4/10/2013	1.7	2.1
8079	Florida Keys	723	3/22/1995	2/27/2019	1.6	2.2
8080	Florida Keys	281	3/23/1995	2/26/2019	1.6	2.4
8081	Florida Keys	272	1/17/1989	6/24/2013	1.5	2.4
8082	Florida Keys	60	3/24/1995	1/23/2013	1.1	1.4
8083	Florida Keys	264	3/24/1995	1/23/2013	1.8	2.6
8084	Florida Keys	257	3/24/1995	1/22/2013	1.6	2.7
8085	Florida Keys	367	3/27/1995	1/22/2013	1.5	2.1
8086	Florida Keys	264	3/28/1995	4/9/2013	1.5	2.2
8087	Florida Keys	324	3/28/1995	1/17/2013	1.5	1.9
6005A	Florida Keys	293	12/5/1985	1/29/2019	4.7	10.1
6005B	Florida Keys	207	10/19/1989	12/5/2018	1.2	2.1
6006A	Florida Keys	ID				
6006B	Florida Keys	ID				
6011A	Florida Keys	ID				
6011B	Florida Keys	ID				
6011C	Florida Keys	ID				
6012A	Florida Keys	97	12/29/1982	6/24/2013	1.7	2.5
6012C	Florida Keys	ID				
6012D	Florida Keys	ID				
6012E	Florida Keys	ID				
6013A	Florida Keys	ID				
6013B	Florida Keys	ID				
6013C	Florida Keys	ID				
6013D	Florida Keys	ID				
6014A	Florida Keys	ID				
6014B	Florida Keys	ID				
6014C	Florida Keys	60	4/5/1995	10/5/2011	2	2.2
8072	Dry Tortugas	363	5/26/1995	10/5/2011	1.3	1.2
8071	Florida Bay	369	12/2/1981	12/17/2018	11.7	26.1
8077 (Portion outside FKNMS)	Florida Bay	1868	12/2/1981	1/29/2019	7.5	16.9
8077 (Portion within FKNMS)[3]	Florida Keys	273	3/26/1995	4/10/2013	1.9	2.7
8078 (Portion outside FKNMS)	Florida Bay	1409	12/2/1981	1/29/2019	7.2	15.5

WBID	Area	Sample Size (N)	Period of Record Min. Date	Period of Record Max. Date	Mean (NTU)	90th (NTU)
8078 (Portion within FKNMS)[3]	Florida Keys	273	3/26/1995	4/10/2013	1.9	2.7
8065	10,000 Islands	125	10/19/1992	3/11/2019	4.8	8.9
8066	10,000 Islands	253	7/31/1996	1/17/2019	5.9	8.2
8067	10,000 Islands	ID				
8068	10,000 Islands	ID				
8069	10,000 Islands	188	9/15/1992	4/24/2019	4.4	8.6
8070	10,000 Islands	ID				
8050	Gulf of Mexico	91	8/8/1990	12/16/2014	2.8	6.1
8051	Gulf of Mexico	364	8/8/1990	12/16/2014	2.7	5.8
8052	Gulf of Mexico	214	10/26/1987	12/16/2014	3.2	6.9
8053	Gulf of Mexico	152	8/8/1990	12/16/2014	3	6.9
8054	Gulf of Mexico	92	9/3/1985	12/16/2014	3	5.2
8055	Gulf of Mexico	ID				
8056	Gulf of Mexico	20	1/7/1999	12/13/2000	2.9	6.3
8057	Gulf of Mexico	ID				
8058	Gulf of Mexico	38	3/29/1993	3/13/2019	2.8	7.7
8059	Gulf of Mexico	27	9/22/1983	12/17/2018	3.4	11.5
8060	Gulf of Mexico	ID				
8061	Gulf of Mexico	ID				
8062	Gulf of Mexico	34	2/21/2006	11/16/2010	2.6	4.5
8063	Gulf of Mexico	85	1/26/1999	3/11/2019	2.7	4.9
8103	Atlantic Coast	ID				
8104	Atlantic Coast	ID				
8105	Atlantic Coast	ID				
8106	Atlantic Coast	ID				
8107	Atlantic Coast	ID				
8108	Atlantic Coast	ID				
8109	Atlantic Coast	ID				
8110	Atlantic Coast	ID				
8111	Atlantic Coast	ID				

1. Calculated based on combined WBIDs 8091 and 8092
2. Values were based on the neighboring WBID 3226H3 due to insufficient data in WBID 3226H2.
3. Values were based on combined WBID 8077 and 8078 stations within the FKNM.