



3.0 Proposed Amendment to HA Req. 1.0 Storm Surge + Sea Rise

Introduction. Protections need to be in place for the 2' - 6' of sea level rise (SLR) flooding in the pipeline recognized by the U.S. Climate Assessment Report (USCAR). RELi compliance deadlines set seven years ago need to be updated for buildings, homes, and infrastructure.

In summary, the current RELi prerequisite for protections from 6' of rise by 2022, is proposed to be changed to 2' of rise by 2030 with 12' of protection for storm surge and king tides, and optional credit for higher levels of protection. See table below and attached Thwaites Glacial Collapse Schematic with a summary documentation of the rationale.

Important scientific findings for setting SLR flooding protections. SLR flooding can be abrupt coming in pulses, as documented by historical geologic data. *"Fossilized corals off Texas show that in the past, sea level rose several meters in just decades, probably due to collapsing glaciers."*¹ This imperative means that it's likely given Antarctica's Thwaites glacier ongoing irreversible collapse described below, increasing global rise 10 times according to NASA and other experts, that 6' - 10' of rise could occur in 10-20 years overwhelming society. This is an unacceptable risk to commerce and national security.

There is a scientific consensus including by NASA leaders and experts in the International Thwaites Glacier Collaboration, that Thwaites is melting faster than any other major glacier, and rapidly and irreversibly proceeding from its current 4% contribution to global rise, to about 40%. Thwaites is receding at about one mile per year but the exact timing of this 10 times increase progression is unknown and specifically recommended for high priority data gathering by NASA and IPCC leaders.² Thwaites has most likely caused catastrophic abrupt SLR flooding increases historically and thus is given high priority by the scientific community.

NASA conclusions about Thwaites are supported by actual data of the grounding line retreat by ice-penetrating aerial imagery that goes through thousands of feet of glacier. The grounding line is the intersection of ice, bedrock, and ocean and a key point at which glacier stability and retreat are measured. Thwaites grounding line is only about 10 miles from a downsloping ridge expected to rapidly and irreversibly cause the collapse of Thwaites and several glaciers Thwaites backstops.

Important policy facts for setting SLR flooding protections. This RELi deadline which must be updated is not when significant increased levels of rise will occur. To the contrary, it is best professional judgment when protections need to be in place to account for:

- Long lead times for financing, design and construction of protections
- Incorporation of a margin of safety to prevent unacceptable risks
- Protection of coasts where most structures and population exist in order to maintain commerce & national security

¹ *Oceans can rise in sudden bursts*, Scientific American (Oct. 20, 2017)), (*"Fossilized corals off Texas show that in the past, sea level rose several meters in just decades, probably due to collapsing glaciers"*), reviewing Khanna et al., *Coralgal reef morphology records punctuated sea-level rise during the last deglaciation*, Nature Communications (Oct. 19, 2017). Khanna et al. state in Nature Communications: *"These systematic and common terraces are interpreted to record punctuated sea-level rise events over timescales of decades to centuries during the last deglaciation, previously recognized only during the late Holocene."*

² FSLR Flooding Protection Data Support (Rignot, Yohe & Italiano 2021)

- Reliance on actual empirical data on sea level rise (SLR) flooding due to well documented limitations and inaccuracies of projection models used which are unvalidated *in situ*,³ with no stated precision (replicability) and accuracy (closeness to the truth), contrary to non-climate change environmental modeling. Further showing the need to use actual data is IPCC's statement that climate change operates on chaos theory which for most impacts, is unpredictable as demonstrated in City of South Miami SLR Flooding Pilot and its peer review.⁴

RELi 2.0 Sea Level Rise (SLR) Flooding Protection Deadlines

Avoid tidal zones inundated by SLR flooding, or provide an engineering solution as follows –

Assumptions: 60 yr. design & service life for buildings & 100 yr. for infrastructure since SLR flooding could very likely continue to increase for centuries & such structures are risk intolerant to SLR flooding

Existing Deadline	Proposed Updated Deadlines
<u>Prerequisite:</u> Complete 6' by 2022	<u>Prerequisite:</u> Complete 2' by 2030 with 12' of additional storm surge / king tide protection For areas where design life may be shortened by 10 yrs. or more due to increased SLR flooding within the design / service life of the structure(s), describe how decommissioning & restoration of the structure(s) will occur.
	<u>Optional Credit:</u> Complete by 2037: areas inundated by more than 2' up to 4' SLR flooding Complete by 2040 (and beyond): areas inundated by more than 4' up to 6' SLR flooding Complete by 2040 (and beyond): areas inundated by more than 6' SLR flooding

Financing to front the costs for protections is available now, and federal and State financing for debt service is being developed. The availability of such financing facilitates difficult local sea level rise flooding protection decisions.

This update was Informed by experts:

Dr. Hal Wanless, Professor, University of Miami, sea level rise expert witness

Dr. Phil Stoddard, former Mayor, City of South Miami, Professor, Florida International University

Dr. Eric Rignot, NASA JPL, IPCC, National Academy of Sciences, leading SLR expert

Dr. Gary Yohe, IPCC, former Vice Chairman, U.S. Climate Assessment Report

Dr. Kurt Preston, Environmental Security, DoD, responsible for military SLR projections & protections

Lindene Patton, Earth & Water Law Group, former Zurich Insurance Chief Climate Product Officer

Doug Pierce, AIA, LEED Fellow, Perkins&Will Global Resilience Director

Mike Italiano, USGBC Founder, CEO, Capital Markets Partnership

³ IPCC §5.5.2 Observations of Sea Level Changes: "Although there has been some model validation, especially for (glacial isostatic adjustment (GIA) models, systematic problems with such techniques, including short data spans, have yet to be fully resolved (2007)."

⁴ Lorenz at MIT was apparently the first to publish that climate from an atmospheric perspective alone, is chaotic followed by IPCC and others (The Index Cycle is Alive & Well 1963. Concurring is "A voyage through scales, a missing quadrillion and why the climate is not what you expect," *Climate Dynamics* June 2015. Also concurring are IPCC Third Assessment Report (TAR), The Scientific Basis, § 7.1.3 Predictability of the Climate System at 422, "The Earth's atmosphere-ocean dynamics is chaotic: its evolution is sensitive to small perturbations in initial conditions." Also concurring is IPCC Third Assessment Report (TAR) Chapter 14, 2001 at 771, "Advancing Our Understanding:" "The climate system is a coupled non- linear chaotic system, and therefore the long-term prediction of future climate states is not possible.")

Executive Summary of Findings

Sources

Peer-Reviewed City of South Miami SLR Flooding Pilot (Wanless, Stoddard, Pierce & Italiano 2020)

SLR Flooding Protection Data Support (Rignot, Yohe & Italiano 2021)

Thwaite Pending Glacial Collapse Schematic (Rignot, Stoddard, Pierce, Italiano, Carter 2021)

Footnotes are taken from these sources except notes 4, 5 & 10.

Background. The City of South Miami Pilot Document shows 2015 -2017 NASA JPL ice-penetrating radar aerial imagery of W. Antarctic accelerating, and as stated by NASA, “*explosive and disturbing*” melt of 9 miles in two years of Thwaites glacier at the grounding line (intersection of ice, bedrock & ocean).⁵ NASA states that these data have not been incorporated in any global models. NASA data show that Thwaites grounding line is moving at one mile per year only 10 miles from a downsloping ridge where the accelerating and irreversible melt will increase from Thwaites’ current 4% contribution to global melt, to about 40%; Thwaites is melting faster than any other major glacier.⁶ Thwaites 2020 grounding line water temperature was 5.4° F above ocean water freezing, and temperature at the seafloor below the ice shelf away from the coast was 7.2° F.⁷ IPCC states that the timing of rise will be much sooner than model predictions if new empirical data from Antarctica show accelerating melting.

Abrupt Sea Level Rise Flooding Empirical Data. The geologic record indicates that sea level rise tends to be sudden and episodic.⁸ Contrary to IPCC and USCAR models incorrectly assuming slow gradual rise, during the last period of glacial melt like today, sea level rise most likely came in bursts of about six feet in decades like 10 - 20 yrs.⁹ Actual data show that abrupt sea level rise from glacial melt has been the norm, like now from Greenland and Antarctica, with corroborating documentation from coral reef analyses around the world.¹⁰ Universities of Florida and Wisconsin Geology Professor, paleoclimate expert, IPCC cited SLR expert, and MacArthur Prize-winner Andrea Dutton confirms this historical record of abrupt sea level rise:

“We’ve known for quite some time that there was at least one very rapid pulse of sea-level rise during the deglaciation between the last ice age and the present — we’ve known for a very long time that sea level can rise with a sudden jump related to the dynamics of the ice sheet,” (Scientific American, *Oceans Can Rise in Sudden Bursts* (Oct. 20, 2017)

Although the onset of such saltatory rise periods cannot be determined exactly at this time, not being prepared for a sea level rise episode of this nature, with a margin of safety to maintain commerce and national security, is an unacceptable risk to society.

⁵ *Huge Cavity in Antarctic Glacier Signals Rapid Decay*, NASA JPL (Jan. 30, 2019) based on NASA led and NASA funded study: Milillo et al., *Science Advances*, “Heterogeneous retreat and ice melt of Thwaites Glacier, West Antarctica” (Jan. 30, 2019).

⁶ Eric Rignot, NASA JPL in SLR Flooding Protection Data Support (2021).

⁷ Feb. 16, 2020 email to Wanless, Stoddard, Pierce & Italiano from Dr. Ted Scambos, Principal Investigator, International Thwaites Glacier Collaboration on results of Thwaites glacial borings to grounding line with ocean water temperature measurements.

⁸ City of South Miami Pilot pp. 10-11 on “*Abrupt Sea Level Rise Actual Empirical Data*” citing published reports by Wanless, Dutton, Khanna et al. & Overpeck et al.

⁹ *Oceans can rise in sudden bursts*, Scientific American (Oct. 20, 2017)), (“*Fossilized corals off Texas show that in the past, sea level rose several meters in just decades, probably due to collapsing glaciers*”), reviewing Khanna et al., *Coralgal reef morphology records punctuated sea-level rise during the last deglaciation*, *Nature Communications* (Oct. 19, 2017). Khanna et al. state in *Nature Communications*: “*These systematic and common terraces are interpreted to record punctuated sea-level rise events over timescales of decades to centuries during the last deglaciation, previously recognized only during the late Holocene.*”

¹⁰ Wanless, *Our Coming Inundation* June 25, 2019; *Hawaii’s drowned coral reefs—victims of sudden climate change?* Monterey Bay Aquarium Research Institute (Feb. 26, 2004). See also J. T. Overpeck et al., *Paleoclimatic Evidence for Future Ice-Sheet Instability and Rapid Sea-Level Rise*, *Science* **311** (2006) no. 5768 pp. 1747-1750.)

Implications for coastal communities. There is a consensus that models have historically underpredicted the pace of climate change and sea level rise¹¹ due to complexity of the global climate system, which IPCC recognized primarily operates under chaos theory, thus substantially limiting the ability to accurately model impacts. The possibility exists that the 2'–6' of rise calculated by the USCAR has already begun. Accelerated rise of this nature, not predicted by current models, could occur faster than resilient infrastructure could be financed and built if we wait until the rise is fully evidenced to the standards of scientific peer-review. Thus, prudence dictates that resilience financing be provided now.

Key requirements identified by the 2020 Pilot and 2021 Protection Data Support:

Financial contagion triggers need to be prevented. They currently exist in South Florida due to porous bedrock preventing permanent engineering solutions: (1) potential litigation by coastal mortgage holders due to permanent coastal property devaluation and evidence of fraud, and (2) credit rating downgrades. There is currently no market confidence that protections will be in place on a timely basis, thus conditions are ripe to trigger contagion like the 2009 Financial Crisis / Great Recession or worse. Existing structures are very risk intolerant to SLR flooding. S&P threatened to downgrade the State of Florida's credit rating forcing increased State resilience priorities in order to prevent associated higher borrowing costs and damage to the economy.¹²

Providing notice to localities and the design / engineering community of required protections for existing structures that have a low tolerance for sea level rise flooding risk because they have high sunk capital costs, in order to avoid liability from the need to stamp and seal final engineering / design drawings. Such structures are not amenable to limited application flexible adaptive pathways with higher tolerance for sea level rise flooding risk.

Providing protections now to required military operations' support functions of government and the private sector, to allow military facilities to continuously operate to maintain national security.

Ensuring critical infrastructure support facilities operate continuously so regions and metropolitan areas are not shut down: water supply, wastewater treatment, transportation, electrical supply, communications. This prevents cascading risk where (1) a regional service / function if disabled like wastewater treatment, can shut down critical facilities like hospitals, (2) power failures without backup non-grid power and communications can cause injury and death including to the infirm, and (3) key facilities that supply food can be prevented from operating.

National consensus resilience standard sea level rise flooding deadline for buildings, homes and infrastructure must be amended to reflect these requirements. The graph on page 12 of the City of South Miami Pilot shows 2' of rise predicted by 2039 *without* taking the NASA findings into account. The Pilot also includes the need to incorporate a margin of safety. Accordingly, at this time the proposed deadline for compliance is adjusted to 2030 to protect for 2' of rise with optional added credit for higher levels of protection, as set forth in the table above "*RELi 2.0 Sea Level Rise (SLR) Flooding Protection Deadlines*" for HA Req. 1.0.

¹¹ IPCC's sea level rise projections were over 60% underestimated based on satellite verifications, Rahmstorf et al 2012 Environ. Res. Lett. 7 044035); *Climate Science Predictions Prove Too Conservative*, Scien. Amer. Dec. 6, 2012

¹² Florida Chief Resilience Officer Report (2020) at p. ES-2