Executive Summary

As Congress considers an infrastructure package, it is critical that it include investments in ocean infrastructure, which will have far-reaching benefits: it will help us better understand the changing climate and prepare for its impacts, which in turn will give our nation the tools needed to adapt equitably, equally protecting and addressing the needs of all communities. By providing jobs in the near-term, these investments will also help the Blue Economy — and our economy as a whole — recover from the ongoing pandemic.

We now have the opportunity to think in a transformative way about ocean infrastructure and for these investments to extend even beyond providing jobs and helping us understand enough about climate change to enable proactive, science-based decision making and to address inequities in how we respond to and mitigate climate change. In 2015, the National Academies' *Sea Change: 2015-2025 Decadal Survey of Ocean Sciences* quoted American businessman Roger McNamee, “We need to stop thinking about infrastructure as an economic stimulant and start thinking about it as a strategy. Economic stimulants produce Bridges to Nowhere. Strategic investment in infrastructure produces a foundation for long-term growth.”

While our nation is certainly in a place where economic stimulation is badly needed, we must think strategically now about how to successfully provide that while also setting up ocean infrastructure that can effectively lead us into the future as it relates to long-term growth in ocean knowledge. We know our ocean is facing myriad challenges, from climate change to pollution to overfishing. We can only have a healthy ocean that meets the needs of America and all humanity if we fully understand it, which will then allow us to solve these problems and effectively address other issues related to the changing ocean (e.g., an opening Arctic). We don’t have the infrastructure we need now, much less in the future, to gain the requisite knowledge to address these significant concerns.

A global ocean observing system fit for the future is of paramount importance, as it provides the foundation for how we predict and respond to oceanic, atmospheric, and climatic changes. The ocean observing system we need requires much more than just maintenance and recapitalization of existing infrastructure or increases in buoys, gliders, and other devices. Those items are certainly necessary, but as part of a bigger picture of what is needed, we must start envisioning and developing a much broader infrastructure. That includes investment in and implementation of the right cutting-edge technologies, a diverse and educated workforce, innovative thinking about what observing and decision-making structures and processes look like (e.g., having a wind turbine also serve as an observatory), and community-wide support and collaborations.

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The following infrastructure asks are broken into three categories:

1. **Address ocean science infrastructure (such as ocean observations and exploration) in a holistic manner that includes growing the workforce.**
2. **Ensure research buildings and aquariums are modernized and that these, and other educational opportunities, improve access for underserved and underrepresented communities.**
3. **Address challenges facing the ocean as well as human health and safety issues related to a changing ocean (e.g., coastal resilience, sea level rise).**

In the full letter, we provide a broad, overarching request with specific examples of individual requests that fall under that category, and we are happy to provide more detail if desired. In this Executive Summary, specific requests from individual institutions and organizations have been removed for privacy purposes but may be available upon request. While we know individual small asks won’t transform ocean science to help us gain the knowledge we need, we can’t transform ocean science without them.

**Section 1: Address ocean science infrastructure (such as ocean observations and exploration) in a holistic manner that includes growing the workforce.**

We cannot protect, or even sustainably use and manage, what we do not know. We do not know enough about our ocean — more than 80 percent of it is unexplored, unmapped, or unobserved. Ocean observing allows us to track, predict, manage, and adapt to changes in the marine environment, including the impacts of climate change. These abilities have the potential to unlock unprecedented discoveries in ocean science and inform a new level of resource management. A fully effective ocean observing system will require a strong, shared plan of action and mechanisms for industry, academia, philanthropy, and government to contribute.

Hand-in-hand with observing is ocean exploration, including initial mapping and characterization of unknown areas of the seafloor and water column, which has implications for understanding climate change and other environmental conditions, ensuring national security, and enabling resource management. The deep ocean remains one of the least understood of Earth’s environments yet is increasingly relied upon for essential resources and may soon be a key source of rare earth minerals and novel biopharmaceuticals.

Additionally, it is critical that, hand-in-hand with these efforts to address observing and exploration infrastructure, are actions to grow and prepare the workforce. Due to the current challenges facing the ocean-STEM pipeline because of COVID-19, without appropriate support and opportunities, we could end up with a hole in the pipeline. Of critical importance are also efforts not just to maintain those in the pipeline but to grow a diverse and equitable workforce prepared to use and operate new and existing technologies.

**Section 1 Infrastructure Asks:**

1. **Maintain and modernize the Academic Research Fleet (ARF),** which consists of 18 vessels supporting 59 University-National Oceanographic Laboratory System (UNOLS) partner institutions that are utilized for at-sea research across multiple federal agencies, including, from
2015-2019, ACOE, DOE, EPA, Inst/State, BOEM, NASA, Navy, NOAA, NSF, and USGS. This includes:

a. **Rebuilding and increasing shoreside facilities** for both traditional and autonomous ships. Adequate dock space in many areas is significantly limited. Increasing such shoreside facilities, including in coastal and inland waterways vulnerable to sea level rise, will stimulate innovation in a wide science and economic base, while also bolstering opportunities for the fleet\(^2\). Modernizing ocean science and technology infrastructure, including marine facilities designed for climate and weather resilience, will help stimulate innovation across a wide science base, bolster the fleet, and provide critical access to the ocean for the current and future geoscience workforce. Crumbling and new marine, water-dependent infrastructure should be rebuilt and constructed with the future in mind, providing access for autonomous, academic, government, and commercial vessels; ensuring resilience to sea level rise and extreme weather events; and incorporating capabilities to help accelerate the design, development, and deployment of new technologies. Advanced planning and investment in facilities design and construction now will significantly reduce future operation and maintenance costs and will extend their lifespan.

b. **Ensuring fleet-wide upgrades place modern mapping tools on all ships**, including autonomous capabilities. Most ships do not currently have modern mapping tools, meaning only a few vessels are able to map the U.S. exclusive economic zone. Autonomous vehicles are necessary components of ongoing mapping strategies, which cannot be accomplished with just the crewed fleet.

c. **Expanding the Polar Research Vessels**, including a build-out of the U.S. Coast Guard Polar Security Cutters. Better understanding the polar regions is critical to understanding climate change, so the need for ice-capable research vessels that can access these regions will only grow. However, every U.S. Polar Security Cutter now in service is expected to be retired by 2030\(^3\).

d. **Modernizing cyber infrastructure across the ARF**, allowing for more rapid provision of crucial ocean data across the ocean science enterprise, as it can currently take up to a year for datasets to be shared with the larger science community. Funding would also enable data streams to be accessed in real-time and in perpetuity and two-way communications between scientists on land and at sea. Increasing bandwidth and broadband communication above and below the surface of the water for the entire fleet would open up a world of possibilities.

e. **Supporting the infrastructure and operations for ongoing U.S. leadership in scientific ocean drilling and discovery.**

2. **Advance new technology and instrumentation to meet current and future observing and mapping capabilities, as well as renewable energy technologies.** This includes:

a. **Utilizing NOAA’s recently developed science and technology strategies** around AI, uncrewed systems, and ‘omics, which have shovel-ready projects and present an

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\(^3\) Ibid
opportunity to take great strides in understanding our ocean. However, dedicated funding support is necessary to ensure their full potential is realized, which will benefit the ocean science and technology community writ large. NOAA has already worked with partners to use uncrewed systems to adapt to COVID-19 restrictions, including by using them in research operations, exploration, and fisheries management.

b. **Supporting small-scale instrumentation and infrastructure that will help small schools and provide assistance to students impacted by COVID.** Some instrumentation needs fall between those that can be covered in a research grant and those covered under NSF’s Major Research Instrumentation Program. Providing fiscal support for some of these projects would help carry programs for decades.

c. **Creating an innovation hub** that would allow for the co-location of resources and personnel to rapidly advance these cutting-edge technological developments and to connect academics with industry partners.

d. **Increasing support for the Department of Energy Water Power Technologies Office programs that directly support the development of the nascent U.S. Marine Renewable Energy and Blue Economy industries**, including tidal energy, wave energy, ocean current, offshore wind applications, and power at sea for ocean sensing, aquaculture, resilient coastal communities, and marine microgrids. Specifically, the National Marine Renewable Energy Centers make critical infrastructure available to address the ongoing needs for research and development and testing to advance marine renewable energy technologies towards commercialization and to develop powering the blue economy solutions.

3. **Maintain and grow existing structures and programs.** This includes:

   a. **$95.3 million for the Integrated Ocean Observing System (IOOS),** a regional coastal observing network for restoring, sustaining, and building resiliency for critical observations in support of weather forecasting, safe and efficient marine operation, and search and rescue missions. This includes $20 million for profiling gliders, $23 million for surface current mapping, $22.3 million for moorings (ecosystem, meteorological, and wave), and $30 million for the National Harmful Algal Bloom Observing Network. These investments do not create novel programs but bolster existing regional observational networks. These networks are already providing essential information and are ready to be scaled for maximal benefit to coastal communities and ecosystems. Additionally, each of the 11 IOOS regions has shovel-ready projects designed to aid coastal economies (especially maritime commerce, coastal resilience, fisheries, and tourism) that are ready to be deployed within 3-6 months of funding.

   b. **Increasing support for sustained ocean observation networks in the Gulf of Maine that link observations from offshore platforms to new coastal ocean observing platforms across the region.** Arctic waters enter the Gulf of Maine from the north and the Gulf Stream waters enter from the south. Both impact marine life distributions in different ways, including, but not limited to, range/distribution shift, invasive species, and predator-prey relationships. In a time of dynamic change due to warming waters and ocean acidification in the Gulf of Maine, previous understanding of how waters flowing from the north and south may not necessarily apply in the same way as they used to.
Measurements made in the Gulf of Maine with this network will provide vital baseline ocean information relevant to managers and regulators tasked with advancing renewable energy technologies in the Gulf of Maine, as well as impacting national interests related to security and food.

c. **Increasing appropriations by $20 million over FY 2021 enacted levels to NOAA’s Sustained Ocean Observations and Monitoring program**, which funds an array of monitoring capabilities necessary to understand the long-term impacts of the changing climate; to enhance hurricane forecasting, tsunami warning systems, and storm surge monitoring; to improve weather forecasting beyond two weeks; to assess and plan for environmental variability and change; and to sustainably manage marine ecosystems.

d. **Taking advantage of recent executive action to grow the offshore wind industry to deploy 30 gigawatts of offshore wind by 2030** by enabling a full suite of ocean observing technologies and sensors to go along with every wind turbine put in the water. If observing capabilities were a requisite part of offshore wind infrastructure, it would significantly grow our ocean monitoring capabilities, helping us better understand everything from carbon sequestration to harmful algal blooms.

4. **Encourage coordination among federal agencies and private partners to set data collection standards and to improve access for users and the public**, as data collection is not often coordinated, even between groups with common goals. This includes:
   
a. NOAA, NASA, USGS, and NSF enabling data coordination for marine biodiversity observations. Agencies could develop integrated, multidisciplinary data repositories and enable big data mining and analytics through AI and machine learning through public-private partnerships.
   
b. Creating a pilot data discovery portal for data from the deep ocean, with particular emphasis on pilot implementation of the Clarion Clipperton Zone and the Azores, which were both identified as priorities by the deep-ocean community.

5. **Encourage federal agencies to provide additional support for students in the ocean-STEM pipeline**. This includes:
   
a. Providing additional support, including through innovative partnerships, for undergraduate and graduate students in the pipeline in the form of scholarships and fellowships.
   
b. Growing opportunities to engage and support underserved and underrepresented communities.
   
c. Creating new initiatives to bridge gaps and help address the potential delayed career progression many early career scientists are experiencing due to missed opportunities to network and connect with other scientists and program managers at conferences and other events.
   
d. Expanding and increasing funding for important workforce development and training programs like the Sea Grant College Program; the Education Partnership Program; the

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Environmental Literacy Program; Bay-Watershed Education and Training Grants; education offices at our federal agencies; and public science and formal and informal educational activities at museums, aquariums, and zoos.

**Section 2: Ensure research buildings and aquariums are modernized and that these, and other educational opportunities, improve access for underserved and underrepresented communities.**

Students and researchers still need buildings in which to learn and engage in research, from university buildings using formal education to aquariums using informal education techniques, including remote learning. Improving access for underserved and underrepresented communities should be an integral part of these modernization efforts.

**Section 2 Infrastructure Asks:**

1. **Establish a grant program to modernize and enhance university research labs and address maintenance backlogs.**

2. **Provide grants for aquariums to upgrade and create new education projects, particularly focused on ensuring access for underrepresented communities.**

3. **Provide funding for new laboratories and buildings that improve resiliency and that provide STEM pipeline and training opportunities for students.**

4. **Provide funding to education offices throughout our federal science agencies to better reach underserved and underrepresented through the National Ocean Sciences Bowl (NOSB) communities.** The NOSB, which included teams from 31 states in 2020, is a quiz bowl competition for high school students that is run by COL in partnership with universities, aquariums, state Sea Grant offices, and more. The NOSB seeks to grow the ocean-STEM pipeline by introducing high school students to ocean topics and careers before they go to college. Funding specifically to reach underserved and underrepresented communities would provide this important opportunity to more students, ultimately strengthening and growing the ocean-STEM pipeline and associated workforce, whose stability and diversity are at risk due to the COVID-19 pandemic and lingering inequities.

**Section 3. Address challenges facing the ocean as well as human health and safety issues related to a changing ocean (e.g., coastal resilience, sea level rise).**

A healthy ocean enables a healthy planet and society and is critical in addressing the changing climate. In addition to the ocean’s role in providing basic necessities like food and oxygen, it can also provide pharmaceuticals that will keep humans healthy. While this issue is currently understudied, technological advances can make doing so easier. But for us to take advantage of any resources from the ocean, we first have to ensure it is done through a sustainable process that keeps our ocean healthy.

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Coastal resilience is growing the ability of a community to bounce back after hazardous events. Not all communities share the same level of resilience; those that are socially and economically vulnerable are facing a disproportionate burden of climate impacts, which is often evidenced after natural disasters, such as Hurricanes Sandy and Katrina. As our ocean warms and acidifies with the changing climate, coastal communities will be facing a growing number of ocean-related threats, including sea level rise threatening homes and businesses, ocean acidification and fish migrations closing local aquaculture and fisheries businesses and restaurants, harmful algal blooms impacting tourism and human health, and much more. Infrastructure related to both ensuring ocean and human health and safety are critical components of ocean infrastructure.

COL supports the letter⁶ to President Biden led by Congresswoman Suzanne Bonamici and Congressman Bill Posey that would include $10 billion for coastal restoration and resilience projects.

**Section 3 Infrastructure Asks:**

1. **Provide a one-time infusion of funding to NOAA’s Coastal Resilience Grants** to ensure our coastal communities are prepared for the 2021 hurricane season. Since 2015, NOAA’s Coastal Resilience Grants have provided $35.8 million in federal funds (with $22.3 million in matching funds) to 48 projects that help coastal communities and ecosystems prepare for and recover from extreme weather events, changing ocean conditions, and climate hazards. However, the agency has received a total of 411 proposals requesting $327 million⁷.

2. **Ensure a specific focus on socially and economically vulnerable communities when funding coastal resilience projects.**
   a. **Develop a matrix of socially and economically vulnerable communities with those expected to experience severe climate impacts.** The matrix should also include needs prioritized by these communities.

3. **Increase support for NOAA’s Disaster Preparedness Program to bolster the National Ocean Service’s emergency response efforts to coastal storms and other disasters.** The Disaster Preparedness Program provides workshops and training to support a resilient disaster preparedness infrastructure that relies on regional and national intra- and interagency agency coordination to insure effective, inclusive and robust response when the nation is facing complicated, co-occurring disasters.

4. **Establish a dynamic ocean compound library to help advance the discovery of pharmaceuticals from the ocean.** Funding would support sequencing of the marine environment necessary to make medicine and to expanding the collection of deep-sea samples.

5. **Advance ongoing and new efforts to eliminate ocean plastic pollution,** particularly those that address both production and waste management. This includes

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a. **Incentivizing research and technology development around topics such as collection technologies and new standards for wastewater management** (such as microplastic catch filters) through prize competitions and government subsidies.

b. **Investing in improvements to recycling infrastructure and storm drains.**

6. **Increase funding for the United States Army Corps of Engineers Civil Works to support a multi-university partnership in collaboration with relevant federal agencies (e.g., USACE, USGS, BOEM, NOAA) through the US Coastal Research Program to focus on three key themes:** long-term coastal evolution, extreme events, and human and ecosystem health. Communities, infrastructure, commerce, and resources linked to the coastal near shore region are all vulnerable to damage from extreme coastal events and long-term coastal change. This collaborative effort could be used to identify engineering frameworks that address coastal resilience needs, develop adaptive pathways that lead to coastal resilience, measure the coastal forces that lead to infrastructure damage and erosion during extreme storm events, and improve coupling of terrestrial and coastal models.

Thank you for your time and consideration of these requests, which will help ensure an ocean observing infrastructure fit for the future.

**Consortium for Ocean Leadership Member Institutions**

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