Driving Innovation, Unleashing Prosperity and Revitalizing Communities
By Redeveloping America's Brownfields
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Testimony of James L. Connaughton

I. INTRODUCTION

Good morning, Chairman Griffith, Ranking Member Tonko, and members of the Sub-Committee. Thank you for the opportunity to testify on this important and exciting topic.

My name is Jim Connaughton. I am CEO of JLC Strategies, a technology and policy advisory firm, working with technology startups, innovation project developers, private and public companies, and a handful of policy think tanks, universities, and government organizations. Specific to this discussion, I also served for eight years as the Chairman of the White House Counsel on Environmental Quality and proud to have played a small role, along with thousands of others, in Congress' unanimous passage of the original Small Business Liability Relief and Brownfields Revitalization Act of 2002 ("Brownfields Act"). I was also Chairman and CEO of the AI data center infrastructure startup Nautilus Data Technologies; Executive Vice President of C3.ai, one of the earliest AI software technology companies; and Executive Vice President of Constellation Energy, one the nation's most innovative developers and operators of power generation and providers of energy technologies and services. I have spent the better part of my professional life in and around brownfields.

Growing our economy to meet the needs of a thriving population over the next 25 years will require both replacing a major portion of our existing industrial and infrastructure footprint, as well as at least doubling, or possibly, tripling it. That amounts to the development of hundreds of thousands of new projects. Significantly more rapid and widespread redevelopment of America's brownfields is essential to the deployment of US innovations in manufacturing and infrastructure, unleashing greater prosperity, and revitalizing lives and livelihoods in our local communities.

Brownfields are currently understood as abandoned or underutilized commercial and industrial properties where redevelopment is complicated by the potential for environmental contamination. Recognizing the economic, environmental, and community importance of these sites, the US government, states and localities have developed policies to encourage their assessment for potential contamination, cleanup where contamination is identified, and productive reuse.

As this sub-committee considers reauthorization and expansion of the Brownfields Act, I encourage you to substantially widen the lens of policy development to significantly amplify the benefits that redevelopment will deliver, while substantially lowering the cost of doing so. Making improvements at the edges of the program will not be of lasting value or

consequence. Go big. Enough to fully realize the opportunity. Here are some guiding principles to consider:

- Start with the objective of profitable redevelopment of all economically viable brownfields by 2050, at increasingly lower costs to taxpayers and consumers.
- Broaden what constitutes a brownfield to encompass all abandoned or underutilized locations that are or were zoned for industrial activity, which would encompass a multitude of locations and existing rights of way where there is no or extremely low potential for prior environmental contamination.
- Advance interdependent brownfield redevelopment opportunities systematically to support growth of critical industrial sectors—i.e. assuring parallel development of critical minerals, material processing, component manufacturing, commodity and supply chain delivery (pipelines, electrical lines, railways, roadways, shipping), and end production.
- Create a default policy of brownfield project approval by eliminating both process and litigation barriers to enable *immediate, lower cost* redevelopment, recognizing that:
    - the current siting, permitting and interconnection, and project completion lag of 7-10 years (or more) makes projects cost two the three times more than they should,
    - brownfield sites are already a well-established element of a local community's footprint, and are generally well-known, understood and accepted as preferable for redevelopment,
    - new projects must, and in fact do, comply with all the substantive performance requirements embedded in our highly stringent environmental and natural resource protection laws and regulations enacted over 50 years.
- Take greater advantage of private market forces and private certified professionals to better leverage existing governmental programs, incentives and personnel.
- Legislate. 50 years of deferring to executive branch task forces, regulatory reforms, and judicial decisions has not resulted in predictable and sustained progress at the scale and speed needed to replace and build out new infrastructure.

II. BROWNFIELDS HISTORY

Brownfields exist in nearly every community in the United States. According to the Environmental Protection Agency (EPA), there are over 450,000 brownfield sites nationwide: an average of nearly 10,000 per state and hundreds per congressional district. These sites range from former industrial complexes to small, abandoned gas stations.

The concept of brownfields redevelopment gained traction in the early 1990s as local and state governments struggled with economic downturns and declining urban and rural cores. In response, EPA initiated a pilot program in 1995, offering grants to communities to assess and clean up brownfield sites. This program marked a shift from traditional hazardous waste management toward economic revitalization. The early

brownfields programs provided financial assistance, liability protection, and technical guidance to encourage redevelopment.

Recognizing the success of the early programs, Congress unanimously passed the Small Business Liability Relief Act and Brownfields Revitalization Act at the end of 2001. This landmark legislation amended the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to provide clearer liability protections for property owners and prospective purchasers. It also expanded funding for site assessments and remediation. The Brownfield Act removed the financial and legal barriers that had previously discouraged investment in brownfield sites.[1]

At the same time, states and tribes have played a crucial and increasing role in brownfields redevelopment through tailored legislation and programs. Many states have established voluntary cleanup programs (VCPs) to offer incentives such as tax credits, liability waivers, and grant funding. EPA collaborates with state and tribal programs to support brownfields cleanup and redevelopment.

While brownfields as currently defined tend to have moderate contamination, they typically do not present an acute public health problem.[2] Extremely contaminated sites, e.g. those qualifying for the Superfund National Priorities List, are excluded from the brownfield category. Roughly 70% of brownfields assessed to date have contamination that exceeds regulatory safety standards and require well proven cleanup or remediation measures.[3] Approximately 30% of brownfields assessed to date have contamination below regulatory concern levels and typically can be redeveloped without further remediation. An expanded view of brownfields would encompass hundreds of thousands of locations that fall within the no further remediation category.

EPA recently reported that the federal program has assessed 40,477 properties, made 11,723 properties (149,094 acres) ready for reuse, cleaned up 2,828 properties, leveraged $41B of investment and created 279,884 jobs.[4] State level programs are also reportedly enrolling more than 33,000 properties annually and have completed more than 232,000 cleanups, and making nearly 4 million acres ready for anticipated use.[5] Included

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[1] Since the passage of the Brownfield Act, the EPA has distributed billions of dollars in grants to support brownfields redevelopment. Key federal initiatives include:

- **Brownfields Assessment Grants**: Funding to help local governments evaluate potential contamination levels.
- **Cleanup Grants**: Financial assistance to remove contaminants and prepare sites for redevelopment.
- **Job Training Grants**: Programs to train workers in environmental remediation techniques.
- **Multipurpose Grants**: Comprehensive funding for assessment, cleanup, and redevelopment. These efforts have resulted in significant economic benefits, including job creation, infrastructure improvements, and increased tax revenues in revitalized areas.

[2] osha.gov

[3] stacks.cdc.gov

[4] epa.gov

[5] The Environmental Protection Agency (EPA) maintains several databases that provide state-specific information on brownfield sites. One key resource is the **Assessment, Cleanup and Redevelopment Exchange System (ACRES)**, an online database where Brownfields Grant recipients submit data directly to the EPA. ACRES contains detailed information

among an exhaustive profile of the benefits of redeveloping brownfield, EPA has further note that cleaning up a brownfield can boost surrounding property values by 5% to 15% on average, as blight is removed and perceptions improve. Local governments can gain significant tax revenue (2 to 7 times the dollars invested by EPA) after sites are cleaned and returned to productive use. At the same time, private sector investment in brownfields is growing. Initially, public funds were crucial to kick-start redevelopment, but now many projects are driven by real estate market demand (for urban land) and public-private partnerships. Trends in real estate – such as the high demand for warehouse/logistics space and housing in cities – are leading developers to seek out brownfield sites, sometimes with less reliance on public subsidies.[6]

The progress over the last 25 years in identifying, assessing, and making sites ready for development is very encouraging.[7] But it begs the critical question: with so many sites now ready for redevelopment and even more on the way, why aren't more of these sites being redeveloped? In particular, shouldn't we be doing more to put these sites back to work with renewed deployment of modern, large scale industrial innovations that historically have been the hallmark and the foundation of American technology, economic, and national security leadership? That should be a major focus of brownfields redevelopment policy over the next 25 years.

III. BROWNFIELDS AS THE ENGINE OF AMERICAN INDUSTRIAL INNOVATION

Brownfields are ideal for development, deployment and substantial growth of modern, large scale industrial innovations. Construction of such projects requires a lot land and materials, hundreds of millions or billions of dollars, hundreds or thousands of skilled workers, engineers and service professionals at both the project and in mines, factories, and offices all along the project development and supply chain. Operating these projects requires highly reliable, cost-effective, scalable and secure physical infrastructure for electricity and gas, transportation (road, rail, shipping, aviation), digital services, storage and warehousing, and both onsite and offsite security and emergency response systems. Just as important, the construction and operation of these project requires substantial community infrastructure—project managers, operators, service, maintenance and public safety and service professionals; homes, schools, churches, stores, restaurants

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necessary to track environmental progress at brownfield facilities across various states. Additionally, the EPA's **Cleanups in My Community** web application allows users to explore sites where pollution is being or has been cleaned up throughout the United States. This tool provides maps, lists, and cleanup progress profiles for various programs, including Superfund, RCRA Corrective Action, Brownfields, Emergency Responses, and Federal Facilities. Users can define their geographic area of interest to access specific information about cleanups and grants in their communities. For more localized data, the **EPA's EnviroAtlas** offers an interactive map with hundreds of geospatial datasets, including those related to brownfields. This resource supports brownfields redevelopment by providing data layers and analysis tools relevant to specific projects.

[6] jsheld.com

[7] A different government report notes "Many Sites, Slow Progress: There is a vast inventory of brownfields in the U.S. (hundreds of thousands of sites), but only a small portion have been addressed so far. As of recent estimates, less than 7% of U.S. brownfields have even undergone environmental assessment, and only a fraction of those have been cleaned up through EPA's programs." stacks.cdc.gov

and other local amenities; and knowledgeable, professional and supportive regulators (with some prominent exceptions). Projects also benefit from the environmental and natural dimensions of a site being well developed and well understood. Brownfields have a substantial head start over greenfields in satisfying these requirements.

Most large brownfields, such as ports, military facilities and industrial parks also have undertaken campus-wide environmental assessments and operate under umbrella permitting schemes that allow greater flexibility for developers and tenants to add and subtract facilities. And most large brownfields have previously been extensively analyzed, situated, and engineered to ensure the least exposure and highest level of resilience to major weather events or natural disasters, with a long history and track record of experience bearing that out. When the big storm hits, significant damage to or shut down of industrial, public works, and services infrastructure is rare.

Given these advantages, the critical question for policymakers should be: what must done to add accelerators and remove the brakes to unleash and rapidly drive investment and deployment of such innovative infrastructure? In the Appendix, I highlight five of the most consequential areas of American industrial innovation where brownfields have and will promise to figure prominently—data centers, semiconductors, submarine and shipbuilding, energy production, and plastics recycling.[8]

Delivering on the proven promise of brownfield driven industrial innovation requires a significant modernization of governmental approval processes for site assessment, permitting and interconnecting. Consistent with the policy principles outlined above, the following describes a few of the most important and broadly consequential areas of policy improvement that Congress should address.

IV. KEY POLICY IMPROVEMENTS

a. Environmental Permitting

Legislative improvement to accelerating government approvals of critical infrastructure is the only way to meet the demands of a growing economy; to make infrastructure more available, reliable, affordable, and secure; and to unleash exports of innovative American infrastructure technologies, products, and expert services.

Several years ago, I was privileged to co-chair a bi-partisan permitting reform panel ("Panel") consisting of current and former policymakers, experts, and practitioners to consider solutions to permitting process delays. At the time, the national policy focus was on the urgency of confronting climate change. Today, the national policy focus is on the urgency of confronting our energy emergency. Regardless of which objective you prefer, both face a common reality. They are procedurally impossible.

[8] For a broader sampling of brhttps://www.epa.gov/brownfields/success-stories

Recognizing this fact, the Panel explored well-established precedent for legislative and regulatory tools that can streamline the approval process for energy projects that will bring net benefits and otherwise comply with strict requirements. These lessons apply with equal relevance to other critical infrastructure. The Panel endorsed four critical paths to success, built around the well-precedented "permit-by-rule" concept:[9]

> **Immediate approvals**: For categories of projects where environmental impacts are well understood, either due to the nature or location of the project, Congress should establish approval criteria that enable project clearance without delay.
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> **Accelerated approvals**: For projects that may cause unique or significant negative local environmental impacts, Congress should establish a bifurcated process that documents the categories of beneficial projects at the outset, and then focuses environmental review and permitting on any uniquely local conditions of a project on an accelerated timeline.
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> **Accelerated adjudications**: Once a project is approved, any adjudications for projects must include a final decision timeline of well under one year to ensure that protracted litigation does not undermine project viability.
>
> **State and local conformity**: Eligibility for any federal infrastructure or climate-related funding, tax incentives, or grants shall be conditioned on a state or locality conforming to the same framework and timeline for fast approval and adjudication of projects.

Each of these recommendations is discussed at length in the Panel report. Here are a few specific ideas for putting these recommendations into practical policy.

1. Immediate Approval: ABC

Legislating a framework for immediate approvals of infrastructure is the single most consequential policy that Congress could undertake. One way to accomplish this is through an approach I call "Approve, Build, and Comply."

Combining two standalone ideas from the Panel report, Congress would legislatively designate a list of pre-cleared types of locations along with a list of pre-cleared type of critical infrastructure projects. Such legislation would categorically approve any pre-cleared projects built in a pre-cleared location in lieu of any further permitting and

[9] See https://www.aspeninstitute.org/wp-content/uploads/2021/06/Building-Cleaner-Faster-Final-Report.pdf My discussion in this section is not precisely verbatim from the report, but a very close adaptation, for the purposes of illustrating the report's broader applicability to the significantly overlapping sets of urgent objectives of import to different policy makers.

judicial review. Importantly, such projects would remain subject to and must comply with the technical performance, monitoring, and reporting requirements specified in applicable federal environment and natural resource laws, regulations and resource management plans. And any non-compliance would remain subject to inspection, enforcement, civil and criminal penalties, liability for damages, and judicial review.

The list of pre-cleared locations would start with the 450,000+ US brownfield sites that are the focus of this hearing. And as noted earlier in my testimony, a number of federal laws have set national priorities for development a series of other categories of essentially brownfield locations:

- The Opportunity Zone legislation called on each state to work with their local communities to prioritize and designate specific economically disadvantaged census tracts for substantially tax incentivized private sector redevelopment. A substantial portion of these areas are ideal for innovative infrastructure investment. This program is ripe for legislating a second round of designations which could include automatic designation of industrial areas immediately adjacent to existing opportunity zones, as well as new designation for maritime opportunity zones and critical infrastructure opportunity zones.
- The Infrastructure Investment and Jobs Acts specifies project priorities worthy of locational pre-clearance.
- The Inflation Reduction Act establishes priorities for infrastructure redevelopment in Energy Communities, which have now been formally designated by the Department of Energy. These include, for example, operating and decommissioned thermal power plant locations and coal mining regions.
- The Community and Hydropower Improvement Act establishes a priority and accelerated licensing process for electrifying non-powered dams and for closed-loop and off-stream pumped storage projects.

A variety of administrative programs establish categories of expanded brownfield locations as priorities for redevelopment:

- Federal land management plan designation of areas prioritized for infrastructure development on public land
- EPA RE-Powering America's Land Initiative locations
- Current and former military bases and facilities
- U.S. National Laboratory campuses
- Ports
- Mines and abandoned mine areas
- Ash and mine tailing areas
- Oil and gas lease areas
- Geothermal tracts

State, tribal and local authorities have established various forms of Enterprise Zones that warrant pre-clearance, as well as existing rights of way (e.g. for electricity, pipelines, railways, roadways, and telecommunications) and public works facilities, including municipal recycling facilities.

The legislation would also specify a list of locations excluded from pre-clearance, such as national, state or local parks, national monuments, national recreation areas, national wildlife refuges, national watershed protection areas, national wilderness and wilderness study areas, superfund sites, and designate prime farmland, unique farmland, and farmland of statewide or local importance.

The list of pre-cleared projects would dovetail with the pre-cleared locations, and include for example: data centers and other digital infrastructure, semiconductor R&D and manufacturing, energy production, storage and export facilities, advanced manufacturing facilities, supply chain military facilities, submarine and ship construction, energy efficiency projects and installations, critical minerals production and processing, supporting system infrastructure (electricity lines and substations, pipelines, railways, roadways, and telecommunications systems), plastics recycling facilities.

2. Accelerated Approval: NEPA

The initially groundbreaking and originally modest National Environmental Policy Act process for developing environmental impact statements and assessments has evolved into an administrative quagmire and a litigation festival.[10] We can do a lot better.

The US Supreme Court is taking its first look in 20 years at the way the federal government conducts environmental reviews under the National Environmental Policy Act. At stake is an 88-mile railway bringing oil and farm goods out of rural Utah. Eagle County Colorado sued under the National Environmental Policy Act, claiming that the Surface Transportation Board's 3,600-page environmental-impact review was inadequate. The U.S. Circuit Court of Appeals for the District of Columbia agreed, holding that the board is required to analyze possible impacts as far away as the Gulf Coast, where the exported oil might be refined, and the environmental effects of "long-term employment and commercial activity" resulting from the railway. The Seven County Infrastructure Coalition contends that it shouldn't have to analyze the environmental impact of anything not directly associated with the new railroad and that it should be responsible only for the "proximate effects" of development over which it has regulatory authority.

Although ample legal precedent exists to reverse the lower court's decision, the odds are low that the Supreme Court will be able establish a predictable principle to guide future project review and litigation. During the oral arguments, the litigants predictably parried a barrage of hypotheticals about what the relevant proximate effects might be. This interpretive challenge may be exacerbated by the recent amendment to NEPA that added a new "reasonably foreseeable" filter to consideration of potential impacts. While well-intentioned, it may instead provide additional fodder for the burgeoning and increasingly

[10] https://thebreakthrough.org/issues/energy/understanding-nepa-litigation

unpredictable judicial common law of NEPA. As every first-year law school student learns in torts class: "on a clear day you can reasonably foresee forever."

Congress should instead consider a much simpler approach that would deliver process certainty and speed, and significantly reduce litigation, while fully sustaining compliance with all of our environmental and natural resource protections. Congress should refocus federal agencies on NEPA's threshold directive found in Section 102(b) that federal agencies assess and consider "presently unquantified environmental amenities and values." When NEPA was enacted in 1970, little in the environmental domain was quantified. More than 50 years later, almost everything is.

Since 1970, Congress has enacted more than 25 environmental and resource-protection statutes, compounded by a vast array of state, county, local and tribal laws. These laws cover every imaginable environmental topic. They amount to hundreds of thousands of technical rules established by countless experts constantly reviewing, monitoring, inspecting and enforcing every one of them. Each one has its own process for public notice and comment; monitoring, reporting, and inspection; public and private citizen enforcement; judicial review for any alleged non-compliance; and steep civil penalties, criminal liability, and essentially strict liability for economic damages and restoration costs for any harm to people, the environment and natural resources. In other words, there is very little that is still "unquantified" by NEPA's standards. If something can be studied, regulated, enforced, and penalized, there is probably another agency already doing so.[11]

Accordingly, Congress should simply clarify that an action agency should focus their NEPA reviews only "unquantified" environmental impacts, deeming any environmental impacts that are now regulated and managed under other laws as "quantified" environmental impacts, excluded from further evaluation under NEPA.

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[11] A couple of examples illustrate the value of distinguishing between unquantified and quantified environmental effects—as NEPA intended. In 2008 the Ninth Circuit enjoined the U.S. Navy from conducting submarine training in California on the ground that the Navy hadn't adequately assessed effects on whales and dolphins under NEPA. The court ignored that the Navy's plan had been approved as sufficiently protective by the National Oceanic and Atmospheric Administration under the Endangered Species Act and received a waiver under the Marine Mammal Protection Act. Although the Supreme Court reversed the injunction, the Navy still had to produce further analysis. But to what end, since the Navy was already doing what federal law required to assure protection of whales and dolphins?

This past summer, the D.C. Circuit blocked the Federal Energy Regulatory Commission from authorizing two liquefied-natural-gas projects, at brownfield locations in in Texas, mainly on the grounds that FERC hadn't adequately assessed the projects' effects on air quality. The court overlooked that the Texas Department of Environmental Quality had already approved the projects' air-quality permits and found them in line with standards set by the U.S. Environmental Protection Agency. The unquantified/quantified distinction would curtail such redundant NEPA analysis, while still assuring compliance with the specific environmental protection requirements that substantive law requires.

3. Accelerated Approval: Clean Air Act Section 309

Congress should also evaluate whether Section 309 of the Clean Air Act of 1990 has outlived its usefulness and consider repealing it.[12] Section 309 provides that EPA review all draft Environmental Impact Statements (EIS) prepared by other federal agencies and make these reviews public.[13] In this process, EPA deems an EIS either "satisfactory" or "unsatisfactory." An "unsatisfactory" determination puts in motion a prolonged process of re-evaluation and litigation-proofing of any EIS. After 35 years, it is not clear what the added value of this process is. EPA separately reviews infrastructure projects for compliance with the statutes under EPA's jurisdiction. And all infrastructure projects are reviewed by other federal, state, and local environmental and resource management agencies for compliance with the statutes under their jurisdiction. EPA does not possess any special expertise above and beyond what the other regulatory agencies already possess in their own particular domains. Similar to the needless NEPA redundancy discussed above, the Section 309 process is simply another redundant layer of process, one that likewise is less accountable than the direct regulatory processes and judicially reviewable decisions entrusted under other substantive laws to EPA and other expert agencies.

b. Site Assessment

Prolonged timelines for obtaining government agency sign off on site assessments for any contamination is a common barrier to fostering private sector interest in redeveloping brownfields. After 30 years and tens of thousands of assessments, the methods, practices and standard for performing site assessments and characterizing sites are quite mature and very well practiced. This work is performed relatively quickly and cost-effectively by competent, credentialed private sector experts. Drawing on this substantial body of experience with site assessments, Congress should consider authorizing an automatic sign-off process for site assessments, for all but the most exceptional circumstances.

c. Electricity Grid Interconnection

The most overlooked impediment to the deployment of innovative infrastructure in brownfields is the growing difficulty and delay that power plants and energy intensive consumers face in securing approval to connect to the grid.[14] Solving for permitting delays is of no use without also solving the problem of delay in interconnection.

[12] https://www.epa.gov/nepa/epa-review-process-under-section-309-clean-air-act

[13] EPA does this by posting EPA comment letters in the EIS database.

[14] https://clearpath.org/wp-content/uploads/sites/44/2023/08/all-queued-up-and-nowhere-to-go.pdf

Nearly 12,000 power generation projects representing 1,570 gigawatts (GW) of capacity and 1,030 GW of storage are actively seeking interconnection.[15] Only ~19% of projects requesting interconnection from 2000-2018 reached commercial operations by the end of 2023. And the typical project built in 2023 took nearly 5 years from the interconnection request to commercial operations, compared to 3 years in 2015 and under 2 years in 2008. Imagine being ready to move into your house and being told by the power company they can't turn the power on for five years. To compound the problem, two regional transmission operators, MISO[16] and PJM[17] have more than 50GW of projects each with signed interconnection agreements that are delayed or not being constructed due to issues including supply chains, siting & permitting, and financing.

In addition to the relatively modest actions currently being considered by the FERC, Congress should consider a more holistic suite of policies:

- Establish a national policy benchmark of interconnection decisions in no more than 6 months.
- Charge DOE to develop a program of action with the transmission system operators requiring them to co-fund over the next year, development and deployment of a series of potential private sector information technology solutions to more rapidly inform, analyze and automate grid interconnection analyses and decisions.
- Require coordination between FERC and other relevant agencies to create a fast track for approving the construction of new transmission capacity in existing corridors in concert with the Approve, Build and Comply framework discussed above.
- Establish a legislative process and a commission, similar to that used for military base re-alignment and closure, to conduct a phased program of federally approving National Interest Electric Transmission Corridors over the next three years, providing for regional and state differences in regulatory structure and utility business models.

[15] https://emp.lbl.gov/sites/default/files/2024-04/Queued%20Up%202024%20Edition_1.pdf

[16] https://cdn.misoenergy.org/20241210%20System%20Planning%20Committee%20of%20the%20BOD%20Item%2004%20Generator%20Interconnection%20Queue%20Update665714.pdf

[17] https://d1dth6e84htgma.cloudfront.net/03_05_2025_ENG_Testimony_Haque_08233b47af.pdf

APPENDIX

A. Data Centers

i. Nautilus Data Technologies

Nautilus Data Technologies, a startup company that I helped found and led for many years, has developed and deployed a patented data center cooling technology that eliminates the need for air cooling using mechanical chillers and refrigerants. Nautilus' approach significantly reduces energy consumption and essentially eliminates environmental impact. Unlike traditional data centers that consume millions of gallons of (mainly) drinking water per year to support evaporative cooling, Nautilus' system doesn't consume a single drop. The system also does not use any water treatment chemicals or potent zone depleting and greenhouse gas refrigerants, produces no wastewater, and makes no noise. Most important, the system can much more effectively cool the increasingly powerful, energy hungry, and therefore hotter AI computing chips and servers.

Nautilus engineered the system to enable factory construction of large modules containing most of the critical structural and components of a data center. The modules can readily be transported, assembled on site, and rapidly put into operation. As an option, Nautilus can fully construct and pre-commission a large data center in a shipyard by incorporating it onto a vessel—e.g. a barge or floating platform—transporting it to a waterside location, and simply plugging it into the local electricity and fiber optical networks. This modular approach creates steady factory jobs which offset a portion of temporary construction jobs. The result is a high-performance, AI ready data center, that costs less to build, costs less to operate, and is easy on the environment.

Brownfields are central to the Nautilus story. Nautilus invented, engineered and developed its first prototype and constructed its first data center at the former Mare Island Naval Shipyard in Vallejo, California. For more than 140 years, Mare Island served as a naval base, port, and ship and submarine construction and maintenance facility on more than 5200 acres. During World War II, it became a powerhouse of wartime production, with 50,000 workers turning out submarines, escort ships, and landing craft. Later, during the Cold War, it became a center for nuclear-powered submarine construction, keeping the Navy at the cutting edge of technology. Serendipitously, Mare Island was the home port of the world's first nuclear submarine named the "Nautilus."

The Navy decommissioned the facility in 1996 as part of the base realignment and closure process, leaving behind a hard-hit community and one of the nation's biggest brownfields and hard-hit community. Although the deepwater access, heavy-duty infrastructure, and manufacturing expertise remained, much of it sat idle waiting for a new purpose. Nearly 20 years later, Nautilus saw an opportunity to take advantage of the

residual skilled workforce and industrial capabilities needed for complex engineering projects. Nautilus played a significant role in the reestablishment of re-opening of the Mare Island dry dock for private sector shipbuilding and marine services. Nautilus invested tens of millions of dollars and employed dozens of skilled trade workers over four years at the site. In mid-summer of 2000, we launched our first water-cooled, floating data center out of the drydock and towed it up the San Joaquin River for mooring, commissioning and operation at the Port of Stockton in Stockton, California—another brownfield.

The Port of Stockton also has a long and storied history. Originally developed in 1933, it played a critical role during World War II as a Naval Supply Depot on Rough and Ready Island, providing inland security with infrastructure capable of berthing 13 ships simultaneously. After the war, the island remained a key Naval Communications Station until its decommissioning in 1996, when the property was transferred to a new port authority for commercial redevelopment. Today, the 4,200-acre port is one of California's largest, serving as a deepwater trade hub handling bulk cargo, breakbulk shipments, and foreign trade. Despite its industrial significance, however, very large portions of the port remained underutilized, presenting another opportunity. Redevelopment efforts—like the conversion of in the port's West Complex—demonstrated the potential to repurpose existing infrastructure for modern needs.

Nautilus found an ideal, albeit derelict, location on the west side of port—named "Rough and Ready Island"—for rapid commercial deployment from the perspective of as logistics, engineering, and a very routine brownfield site assessment and characterization for contaminants. We enjoyed strong support in the local community, the city and in the state capital. Nonetheless, the otherwise straightforward civil and electrical engineering work needed make the site ready to support the data center got bogged down by prolonged and overlapping permitting and approval processes. In a matter of just months, our environmental and technical experts prepared a 160-page CEQA environmental assessment (equivalent to a federal NEPA environmental impact statement) finding that the project would have no significant environmental impacts. Yet, it took years to get final sign-off on those findings, with fingers-crossed that we would avoid litigation. Only two aspects of our operations were ultimately subject to substantive regulation: our back-up diesel generator emissions and our thermal water discharge. And because both were well below regulatory thresholds, they qualified for general permits (a.k.a permit-by-rule), which are supposed to be automatic. Even so, it took extensive consultation, a substantial amount of delay, and agreement to a suite of ad hoc monitoring and operating requirements, before we were able to lock down those approvals.

Initially securing agreements for reliable and affordable power supply and upgrading electricity infrastructure was also very challenging, requiring innovative solutions to meet the growing demands of high-density operations. These delays substantially increased the costs of completing the project. Despite these setbacks, Nautilus provided family wage employment to over a hundred skilled workers to complete site construction and commission the data center, and to a dozen skilled operators,

security personnel and managers who operate the data center, contributing to the technological and economic success of a hardworking, heartland city in California. The Stockton data center project is now a model for the future—proving that high-performance computing and environmental responsibility can go hand in hand.

Some of the most advanced technology companies in the world have now chosen the Nautilus Stockton facility to support their operations. Cerebras, a leader in AI hardware, builds the most powerful AI processors in existence. Their systems push the limits of machine learning, requiring extreme cooling density—something Stockton can provide without the environmental costs of traditional solutions. Backblaze, a cloud storage provider with more than half a million customers, selected Stockton to expand its infrastructure, demonstrating that companies don't have to sacrifice performance to meet sustainability goals. These companies represent the future of computing—AI, cloud, and high-performance workloads that demand more efficient, scalable, and environmentally responsible data centers.

The proving grounds in the brownfields of the Mare Island Naval Shipyard and the Port of Stockton established a technology innovation and brownfield project development template that Nautilus and its partners can now replicate in the US and export abroad. For example, in Portugal, Nautilus is working with a development partner to transform a brownfield site at the Port of Sines into a global technology hub. The site was once home to heavy industry and a very large, decommissioned coal fired power plant. Taking advantage this readily available infrastructure, the campus will now support 1.2GW of high-performance computing and AI workloads—efficiently and sustainably. The Sines project is on track to be the largest data center campuses in Europe, the Middle East, and Africa (EMEA). The first phase of the project has already been completed in record time and on budget.

While at Nautilus, I visited and evaluated dozens of brownfields across the country and abroad that are locationally and logistically perfectly situated to support the rapid and beneficial growth of data centers, especially for data centers developers wanting to take advantage on infrastructure technology innovations such as what Nautilus offer. These include ports, industrial parks, municipal water facilities, former thermal power stations, former pulp and paper mills. In every location I visited, local officials, communities and regulators strongly supported the prospect of data center development.

At the same, in too many cases, such enthusiasm was overshadowed by very challenging constraints in permitting, electricity system interconnection, electricity supply, and the ever present "objector's veto." For example, at both the Port of Los Angeles in California and the Port of Shannon Foynes in Limerick, Ireland, Nautilus spent a couple of years securing leases and approvals for brownfield data center projects, only to told by the local electricity system operator that it would take them years to connect the projects to the grid. So, no projects.

Early in the process of trying to develop a data center project in the beleaguered brownfield community of East Palo, California (not the tech side of town), at a pre-planning meeting with regulators a US EPA official informed us that he "would NEVER permit a new water discharge into my bay." When we explained that we had already demonstrated in Stockton that the technology would fully comply with all federal, state and local environmental protection laws and would not cause any environmental harm, he simply replied, "well after I deny your permit, you can spend the next few years making that case to the court." So, no project.

About the same time, city officials in Alameda, California, courted Nautilus to construct a $1B data center inside a massive, concrete munitions bunker at the former Alameda Naval Air Station. The facility lay dormant since 1997 after it too was shuttered as part of the base closure process. The project would employ more than 100 local union workers, annually procure millions of dollars of emissions-free electricity from the city's municipal power authority and produce millions of dollars of new tax revenue for the City. Nautilus spent two years in extensive consultation with stakeholders explaining how the project would work and how it would fully comply with all federal, state and environmental laws. The City's own wildlife expert provided supportive public testimony concluding that project would not cause any harm to wildlife or the San Francisco Bay and instead would be a net environmental benefit. Nonetheless, a handful of local environmental group members raised objections to the project, persuading the City Council to shelve their approval of our lease—which was the predicate for us being able to get the permits to prove our point. But with the added delay and risk of future litigation we could not take the chance on moving forward. So, no project.

ii. AI Data Centers

Until recently, data center developers focused on building in "greenfield" locations near commercial real estate districts, tending to concentrate their development in places like Ashburn (VA), Silicon Valley/Los Angeles (CA), New York (NY, NJ), Chicago (IL), Dallas/Houston (TX), as well as Singapore, Dublin, Amsterdam, Paris, London and Frankfurt. As the AI data center boom unfolds, data center developers are scrambling to find brownfields that can support the much greater industrial scale of these new facilities and where there is greater prospect of finding an able workforce and securing existing and developing large quantities of electrical power supplies.

xAI recently proved at a brownfield in Memphis, Tennessee that it is possible to construct a massive new, state of the art data center in a span of just six months, following an equally rapid site development and environmental approval process. They have set the benchmark for what federal and state policy and management should fully commit to achieve at all brownfield data center projects nationwide. This will require a major rethinking of the present "accelerator and brake" reality of data center development and the enactment of federal and state improvements to the permitting process that aligns with building at the speed of the need.

The news is full of innovative and ambitious proposals to develop AI data centers in brownfields. These projects plan to use power from an existing nuclear power station, from the restart of a decommissioned nuclear power station, from an innovative modular nuclear power plant, from a massive new clean energy park and, further out, from an innovative nuclear fusion power plant.

B. Semiconductors

The US is undergoing an exciting renewal of semiconductor manufacturing and R&D. Many of these advanced technology production facilities have been or will be constructed on brownfield sites. To highlight just a few examples of completed and announced projects:

- Luther Forest Technology Campus (LFTC) in Malta and Stillwater, New York: This site, once home to the Malta Test Station—a rocket engine testing facility in the mid-20th century—has been transformed into a hub for semiconductor manufacturing. GlobalFoundries' Fab 8 facility operates here, producing advanced semiconductor wafers. The redevelopment of this area showcases the effective conversion of a former industrial site into a state-of-the-art technology campus.[18]
- SkyWater Technology's Facility in Bloomington, Minnesota: SkyWater Technology operates a semiconductor fabrication plant on a site with a rich industrial history. The facility was formerly part of Cypress Semiconductor and has been revitalized to serve as a U.S.-owned pure-play silicon foundry, contributing to domestic semiconductor manufacturing capabilities.[19]
- Intel's Fab 11X in Rio Rancho, New Mexico: Intel's manufacturing site in Rio Rancho has undergone significant upgrades over the years. Originally established in 1995, the facility has been modernized to accommodate advanced semiconductor fabrication processes, illustrating the adaptive reuse of existing industrial infrastructure.[20]
- Intel's Expansion in Chandler, Arizona: Intel has announced plans to construct two new semiconductor fabrication plants in Chandler, Arizona, expanding its existing Ocotillo campus. This site has a long industrial history, and the new development aims to rejuvenate the area while enhancing Intel's manufacturing capabilities.[21]
- GlobalFoundries' New Fab in Malta, New York**:** In February 2024, GlobalFoundries received a $1.5 billion investment under the CHIPS and Science Act to build a new semiconductor fabrication plant in Malta, New York. The development is set to occur on a site with prior industrial use, contributing to the revitalization of the area and strengthening domestic semiconductor manufacturing.[22]

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[18] en.wikipedia.org

[19] mysanantonio.com+2en.wikipedia.org+2investopedia.com+2

[20] en.wikipedia.org

[21] https://download.intel.com/newsroom/2024/corporate/Intel-Arizona-The-Silicon-desert.pdf

[22] en.wikipedia.org+1en.wikipedia.org+1

- Hemlock Semiconductor's Facility in Hemlock, Michigan**:** Hemlock Semiconductor has been awarded $325 million under the CHIPS Incentives Program to construct a new manufacturing facility in Hemlock, Michigan. The project is planned for a site with a history of industrial activity, aiming to enhance the domestic supply of hyper-pure polysilicon essential for semiconductor production.[23]
- Applied Material's EPIC Center in Santa Clara, California: Applied Materials is building the multibillion-dollar Equipment and Process Innovation and Commercialization (EPIC) Center on a brownfield in the heart of Silicon Valley. This will be the world's largest R&D facility of its kind—with a footprint of three football filed--focused on high-velocity innovation platform designed to accelerate development and commercialization of the foundational technologies needed by the global semiconductor and computing industries.[24]

C. Submarine and Ship Manufacturing

Restoration of U.S. capability to rapidly and cost-effectively build a new class of innovative submarines as well as naval and civilian vessels has moved to the top of the national security agenda.[25] Almost all of this critical renaissance will occur in brownfields. The recent acquisition of the Mobile Naval Yard in Alabama is a prime example of how this will unfold nationwide. The Mobile Naval Yard is a 355-acre shipyard, including 3 piers, 1 dry dock, plus access to deep-water ports and ideally located within a nexus of designated federal Opportunity Zones. The U.S. Navy prioritized the strategic value of Mobile, AL out of a selection of possible location for co-investment by the private sector and DOD. These investments will upgrade the shipyard's infrastructure and will likely include complementary investments in local or on-site production facilities, workforce housing, and training centers. An existing tenant is currently leasing legacy assets and additional off-take lease arrangements are being negotiated with 3rd parties for built-to-suit facilities.[26] Speed will be the most critical benchmark of success or failure for this complex undertaking.

[23] https://www.ourmidland.com/news/article/hemlock-semiconductor-officially-awarded-325m-20019821.php
[24] https://ir.appliedmaterials.com/news-releases/news-release-details/applied-materials-launches-multibillion-dollar-rd-platform
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D. Energy

The future of innovation in American energy infrastructure is also being written in brownfields. The following is a sampler of what is to come.

i. Nuclear Fission

- TerraPower's Advanced Reactor Demonstration Program (ARDP) project is being built adjacent to a retiring coal facility in Kemmerer, Wyoming.
- Oklo is characterizing a site at Idaho National Lab to deploy their Aurora microreactor.
- Kairos demonstration reactor, Hermes, is under construction at Oak Ridge National Lab. They intend to build two larger-scale reactors there as well.
- X-energy will soon break ground on its reactor in collaboration with Dow Chemical in Texas. This is both on an existing industrial site and within an Energy Community. They are also building a fuel fabrication facility at Oak Ridge National Lab, and are planning as second deployment near Pacific Northwest National Lab and the Hanford Site.
- Natura and NOV Shepherd Power plan to deploy microreactors in oil fields.
- Oklo was awarded a contract to deploy at Eielson Air Force Base in Alaska.
- Holtec plans to add its small modular reactor to existing nuclear site Palisades, where it's also restarting the plant. Holtec also proposed adding SMRs to the retired Oyster Creek site.

2. Nuclear Fusion

- Commonwealth Fusion Technologies is deploying its first commercial reactor at the James River Industrial Park in Virginia, in a Coal Closure Energy Community.
- Helion is planning to deploy its first commercial reactor in Malaga, Washington, which is adjacent to Rock Island Dam and likely will use existing right of ways.
- Type One Energy plans to build Infinity One at Bull Run Fossil Facility near Oak Ridge National Lab.

3. Geothermal

- Fervo Energy's Project Red in Nevada is being built in an Energy Community[27]
- Eavor Inc., Teverra, Zanskar Geothermal, Fervo Energy, GreenFire Energy, and Sage Geosystems are building projects on military sites.[28]
- Energy Communities are widespread in the west given the more expansive nature of western Metropolitan Statistical Areas. Given the strong geothermal potential in many western states, and large amounts of federal land, this designation is ripe to accelerate a new generation of geothermal development.

4. Hydrogen

- IPP Renewed is retiring existing coal-fueled units and replacing them with new natural gas-fueled electricity units designed to utilize 30% hydrogen fuel transition to 100% by 2045.[29]
- Idaho National Laboratory has deployed a high-temperature electrolysis test stand to work with industry partners and demonstrate performance.[30]

5. Carbon Dioxide Capture Use and Storage

- Petra Nova project in Thompsons, Texas: Retrofitting the existing W.A. Parish coal-fired power plant with post-combustion carbon capture technology. The captured carbon dioxide was transported to the West Ranch Oil Field for enhanced oil recovery.
- Archer Daniels Midland Co. is leading the Illinois Industrial Carbon Capture and Storage Initiative in Decatur, Illinois with a project that captures CO_2 from ethanol production and stores it underground in the Mt. Simon Sandstone saline aquifer.
- Rocky Mountain Power and 8 Rivers are collaborating to evaluate a carbon capture project at one of the utility's existing brownfield power plant sites in Wyoming.

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[27] https://fervoenergy.com/fervo-energy-announces-technology-breakthrough-in-next-generation-geothermal

[28] https://www.diu.mil/latest/three-additional-next-generation-geothermal-technology-companies-advancing; https://www.sagegeosystems.com/press-release-sage-geosystems-expands-collaboration-with-the-dod-to-enhance-energy-resilience-through-geothermal-energy-at-naval-air-station-corpus-christi/

[29] https://www.ipautah.com/ipp-renewed/

[30] https://www.hydrogen.energy.gov/docs/hydrogenprogramlibraries/pdfs/progress18/tahi_obrien_2018.pdf?sfvrsn=9f31960a_1

e. Circular Plastics Recycling

The United States is seeing a surge in molecular plastics recycling innovations aimed at tackling the growing plastic waste problem. Once again, brownfields figure prominently in the innovation equation. Companies are developing advanced technologies to break down plastics at the molecular level, transforming them into valuable raw materials for new products. Brownfields are the locus of development and deployment of this important industrial innovation. Many initial efforts are co-locating with large scale petrochemical operations. Several startups are building their commercial demonstration facilities inside of industrial parks to lower capital and operating costs and leverage existing infrastructure for power, gas, security, safety and emergency response, logistics and supply chains. Some innovators envision leveraging our current system of local collection of used plastics and redeveloping the more than 300 municipal recycling centers in the U.S. with large scale molecular recycling facilities---transforming what currently imposes substantial costs on municipalities with very limited net environmental value into a significant profit center for municipalities with very significant environmental value. Here are a few examples:

- Loop Industries, which uses a proprietary depolymerization technology to convert PET plastic waste into virgin-quality PET resin. Their process is designed to handle a variety of post-consumer plastics, including colored and contaminated PET, which traditional recycling methods struggle to process.
- Eastman Chemical Company with its carbon renewal technology. This method breaks down mixed plastic waste into simple molecules, which can then be reused in the production of new plastics and other materials. Eastman's facility in Tennessee has been actively processing millions of pounds of waste annually.
- A partnership between Shell and Nexus Fuels focuses on converting plastic waste into feedstock for chemical production. Through pyrolysis, they transform hard-to-recycle plastics into high-quality chemicals that can be used to manufacture new plastics, ultimately reducing reliance on fossil fuels.
- Startup GSF Upcycling has developed graphene-based nanomaterials—commonly known as carbon-nanotubes—than can be added to a pyrolysis process and enable any municipal or industrial entity to "upcycle" the 80+% of used plastics that are currently too hard to recycle and otherwise end up in landfills, incinerators, or lost to the environment. Examples include packaging materials—about 45% of the global problem—as well as medical devices, automobile parts, circuits boards, and even degraded plastics such as marine debris.

These initiatives represent crucial steps toward a circular economy, where plastic waste is continuously recycled and repurposed, significantly reducing environmental impact.