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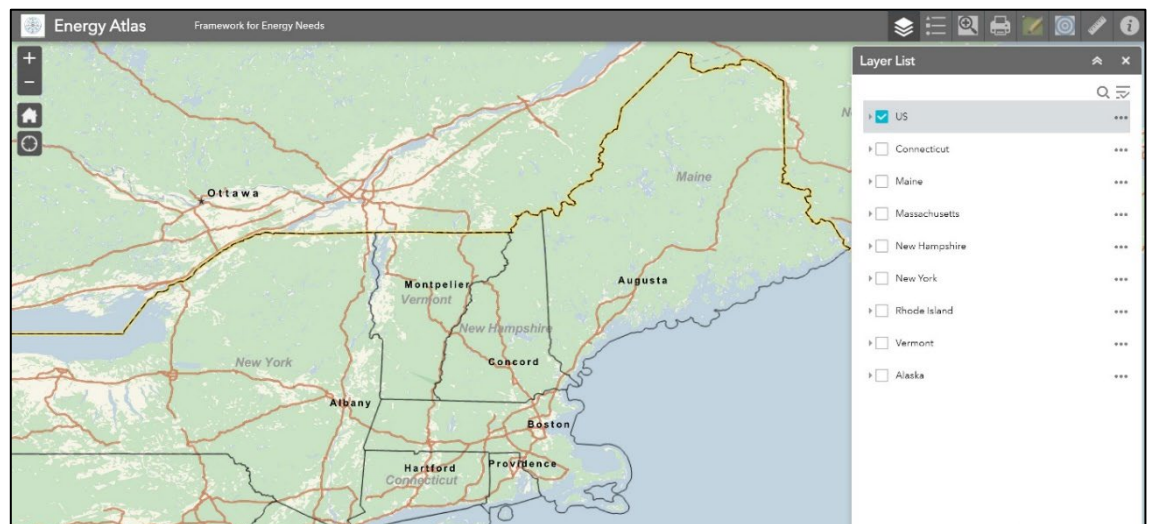


Energy Atlas—Mapping Energy-Related Data for DoD Lands

Phase 3—Data and Portal Expansion: Northeast CONUS

Matthew F. Bigl, Caitlin A. Callaghan, Jacqueline M. Willan,
Paulina H. Lintsai, and Jamie T. Potter

October 2023



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Energy Atlas—Mapping Energy-Related Data for DoD Lands

Phase 3—Data and Portal Expansion: Northeast CONUS

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Abstract

The DoD is a significant land user in northeast United States overseeing approximately 375 k acres of land with a total value of \$113 B. The Department of Energy has found that major impacts from climate change will threaten energy infrastructure in the northeast US moving into the future. Current spatial information related to the energy resources and infrastructure on and adjacent to DoD installations can play a vital role in decision-making for sustainable and resilient installation planning in the region. The Energy Atlas (EA) portal provides a secure value-added resource to inform the decision-making process for current and future investment in installation infrastructure, energy management, and improvements to energy resiliency and sustainability.

The EA aggregates spatial data for energy, infrastructure, and related environmental resources and facilitates access to that information through a secure online portal. The EA is hosted on a Common Access Card–authenticated portal accessible to DoD decision-makers and their partners through the Intelligence Community Geographic Information System (GIS) portal. The expansion of data coverage within the EA portal helps the DoD account for energy in contingency planning, acquisition, and lifecycle requirements in the northeast US and ensures facilities can maintain operations in the face of disruption.

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Preface

This study was conducted for Headquarters, US Army Corps of Engineers, under Program Element 0633119A, “Ground Advanced Technology”; Project B03, “Military Engineering Technology Demonstration”; Task A1030, “Energy Technology Research in Cold and Arctic Regions.” The technical monitor was Mr. Timothy J. Cooke, US Army Engineer Research and Development Center–Cold Regions Research and Engineering Laboratory (ERDC-CRREL).

The work was performed by the Engineering Resources Branch of the Research and Engineering Division, ERDC-CRREL. At the time of publication, Dr. Melisa Nallar was branch chief; and Dr. John W. Weatherly was acting division chief. The deputy director of ERDC-CRREL was Dr. Ivan P. Beckman and the director was Dr. Joseph L. Corriveau. The work was also performed by the Data Representation Branch of ERDC-Geospatial Research Laboratory (GRL). At the time of publication, Mr. Vineet Gupta was branch chief; and Mr. Mike Mailloux was acting division chief. The deputy director of ERDC-GRL was Ms. Valerie L. Carney, and the director was Mr. David R. Hibner.

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The Energy Atlas–Alaska is at <https://portal.geo.nga.mil/portal/apps/webappviewer/index.html?id=26439eca88b34b3daf1607cb1d3dac45>. Portions of this document include intellectual property of Esri and its licensors and are used under license. Copyright © 2023 Esri and its licensors. All rights reserved.

COL Christian Patterson was commander of ERDC, and Dr. David W. Pittman was the director.

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1 Introduction

1.1 Background

Understanding where energy resources and related infrastructure exist on and adjacent to DoD lands can help inform Army decision-makers, especially in regions experiencing an extreme shift in climate such as those installations in the northeast United States. The ability to communicate the current energy and environmental resources securely and efficiently across these lands and how they relate to adjacent DoD installations is critical for ensuring that increased resilience and sustainability are achieved when investing and making strategic decisions at these sites. The Army is accounting for energy in contingency planning, acquisition requirements, and ensuring facilities can maintain operations in the face of disruption. This process is complicated in northern regions because of the extreme conditions and drastically changing weather patterns due to climate change, requiring planning, and investment. The aim of expanding the Energy Atlas (EA) data coverage to the northeast US is to provide a more efficient manner for DoD decision-makers to access and analyze critical spatial datasets for future energy and infrastructure planning and investment.

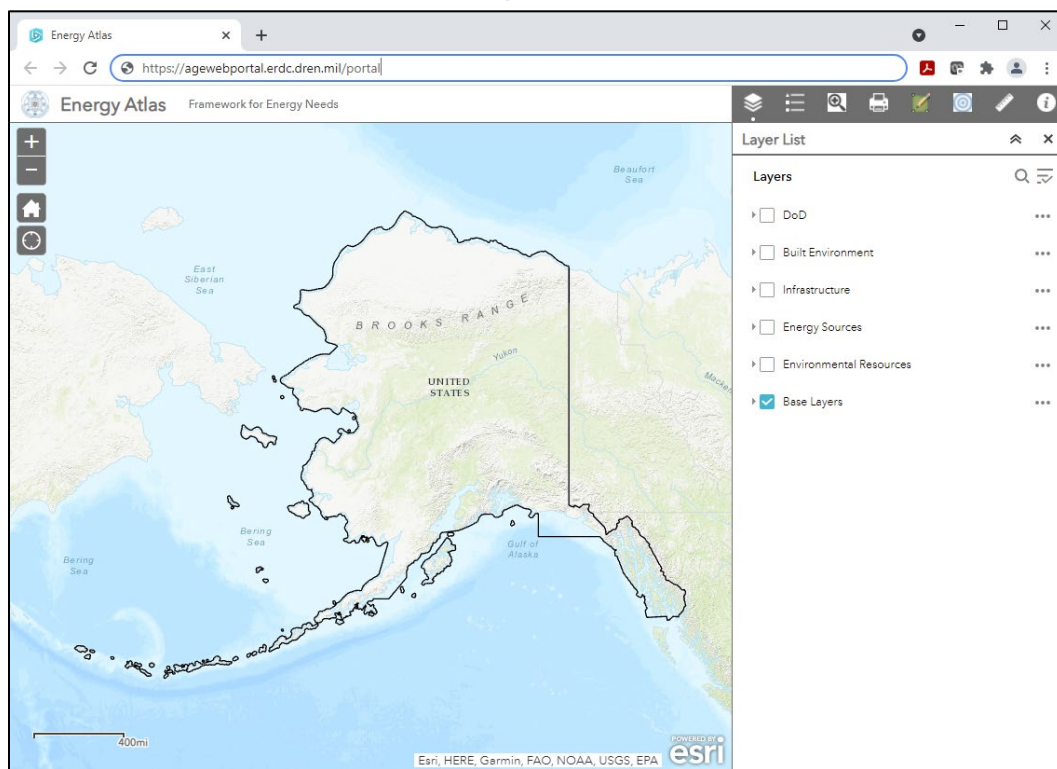
1.2 Objectives

The objective of this project is to leverage data repositories at the local, state, and federal level to develop an underlying database of energy information related to DoD lands in the northeast United States. These data can then be integrated into the EA portal, previously developed under Phase 2 of this effort, to break down data silos and provide efficient access to these data for DoD decision-makers. To achieve this, we will expand and refine a Common Access Card (CAC)-enabled online data portal, providing effective visualization and functionality that supports analysis and informs the DoD and its partners. The EA will provide a value-added resource to support decision-making for investments in infrastructure and diligent energy management, helping DoD installations become more resilient and sustainable.

1.3 Approach

This project leverages existing data sources and previous work in this mission space to identify data gaps and collect spatial information at the installation, state, federal, and regional level to be compiled into the final data portal hosted through the Intelligence Community (IC) Geographic Information System (GIS) portal. Leveraging previous work in developing the EA–Alaska (Figure 1) the IC GIS EA portal will serve as the final hosting site for this information allowing CAC-enabled security to ensure data is accessible to relevant stakeholders while ensuring data security.

Figure 1. Energy Atlas (EA)–Alaska portal landing page developed under earlier iterations of this research program (powered by Esri).



Sections 2 and 3 provide more-detailed information about data collection, integration, the design and functionality, and the transition of the EA hosting from the Army Geospatial Center to the IC GIS portal. These sections also address future stakeholder engagement, data gaps, and potential improvements identified for future consideration.

1.4 Impact to DoD and the Army

The DoD oversees approximately 375 thousand acres of land throughout the northeast United States with a total Plant Replacement Value of \$113 billion. The Department of Energy (DOE) has found that there are several major climate change impacts that will increasingly threaten the energy infrastructure of the northeastern states including more extreme heat waves, more intense storms and storm surges, increased precipitation, and sea level rise. The increasing frequency and severity of these events leave the current energy infrastructure vulnerable and in order to increase resiliency, investment and planning will be needed. The EA provides a more efficient manner for DoD decision-makers to access and analyze critical spatial datasets for future energy and infrastructure planning and investment.

The EA aggregates data from many sources and provide a visualization of the data, based on user preferences, to inform several energy-related decision areas. The data layers in the atlas were specifically selected to help DoD decision-makers consider information about the built and natural environments, both on and off DoD lands, and the infrastructure (e.g., road systems, water systems, electricity systems, and energy supply systems). For example, these data can help inform decisions about the following:

- Planning for new development
- Planning for retrofits or updates to the existing built environment
- Resilience investments (e.g., energy and water)
- Infrastructure analysis and expansion (e.g., electricity distribution networks and natural gas pipelines)
- Connectivity to and reliance on non-DoD supply networks
- Integration of alternative energy supplies (e.g., wind, solar, geothermal, and natural gas)
- Energy and resilience policies and objectives for DoD installations

While there are many other areas that the data compiled in the EA can inform, the above provide a representative list. Additionally, through leveraging an online data portal through the IC GIS portal, the EA was designed such that, as needed and available, more data can be integrated to provide a comprehensive tool with a readily understandable visualization of the data relevant to the user's inquiry. The third phase of this portal development is proof in concept that this capability is flexible and expandable to the needs of the DoD provided interest and investment.

2 Technical Approach Overview

Expansion of the EA portal to the northeastern US was a follow-on effort to Phases 1 and 2 where the proof-of-concept plug-in and portal designs, respectively, were created for the State of Alaska. The expansion to the northeastern US was intended to increase user base in cold regions and provide a demonstration of the ease in which this resource can be scaled to meet the evolving needs of DoD decision-makers. Section 2.1 highlights the newly incorporated states and their respective datasets and sourcing. The discussion that follows describes the newly expanded EA portal. Appendix summarizes specific data sources and where those data and their associated metadata can be accessed.

2.1 Data collection

Primary data identification and collection efforts focused on state level resources, as many federal repositories were identified in the previous phases of the project. The previously incorporated data is described in Callaghan et al. (2021) and Bigl et al. (2022). Appendix also includes a comprehensive list of data included in the EA. The following states focused on for this phase were in the northeastern contiguous US: Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. State governments often had relevant and available repositories of spatial data relevant to this project. Data collection focused on spatial data that included downloadable tabulated data values with assigned coordinates.

2.1.1 State level resources

For the purposes of this study, data sets that pertained to major infrastructure, such as roads or utility lines, and energy resource potential were collected. Infrastructure can be important in determining supply chain or construction options. Water resources are included as often large electricity generation plants require water. Data sets are separated by state and are described in further detail below.

2.1.1.1 Alaska

The data sourcing for the State of Alaska have been fully discussed in Callaghan et al. (2021) and Bigl et al. (2022) and will not be summarized here. However, the primary change to the Alaska data coverage and portal

access is that these data will be merged with those described below for the northeastern US into the EA providing information across both regions.

2.1.1.2 Connecticut

Data available from the State of Connecticut for the purpose of this study included roads, railroads, and airports. All datasets are from the Connecticut Department of Energy and Environmental Protection (DEEP) GIS Open Data Website. DEEP develops and shares authoritative geospatial information with federal, state, and municipal government agencies such as the US Geological Survey (USGS), Environmental Protection Agency, Federal Emergency Management Agency, Connecticut Department of Public Health, Connecticut Department of Transportation, and the Connecticut Office of Policy and Management. Connecticut Roads and Trails is 1:24,000-scale base map data. It depicts the location of all roads and trails published on the USGS topographic quadrangle maps. It was last updated on 25 March 2021. However, for the purposes of the EA, Open Street Map data was utilized for roads within Connecticut as it had a higher level of detail than the roads data accessed through the state repository. Connecticut Railroads is 1:24,000-scale base map data. It depicts the location of all railroad trails published on the USGS topographic quadrangle maps. It was last updated on 19 February 2021. A dataset of the Connecticut airports is included as major infrastructure. Airports Polygon is a 1:24,000-scale, feature-based layer that includes all airport features depicted on all of the USGS 7.5 minute topographic quadrangle maps that cover the State of Connecticut and was last updated on 25 March 2021.

2.1.1.3 Maine

Data collected for the State of Maine included roads, railroads, New England Clean Energy Connect (NECEC) power lines, electricity provider coverage area, and electric vehicle (EV) charger locations. The EV charger locations dataset was available from Efficiency Maine, while the rest of the Maine datasets were from the State of Maine Geolibrary. The State of Maine roads dataset includes all emergency services (E911) known roads as centerline and road name data at 1:24,000 scale. This data was last updated on 18 December 2022. Even though the Maine E911 roads layer was quite detailed it was decided by the project team that the data available through Open Street Maps had a higher level of detail than the roads data accessed through the state repository and the addresses

provided by E911 would not be needed for the purposes of the EA. The railroad data was obtained by the Maine Department of Transportation and is a 1:24,000 scale. It includes data such as route, owner, operator, and track type and was last updated on 25 June 2021. The NECEC power transmission line location is included in the EA as a centerline dataset from the State of Maine. This major high-voltage line project has several sections. The dataset was last updated on 2 June 2021. The electrical service area map includes service territory for Maine's transmission and distribution electric utilities as of 25 March 2021. It includes the utility provider name for the shapefile area. The EV charger location dataset for Maine consists of public direct current fast and level 2 chargers which comprise 413 station locations with 860 electric vehicle supply equipment (EVSE) ports in total.

2.1.1.4 Massachusetts

Data collected for the State of Massachusetts for the purpose of this study included roads, railroads, transmission lines, utility providers, buildings, wind speeds and wind power density, water service area, streams, ponds, aquifers, and land use. All datasets were publicly available from the State of Massachusetts MassGIS Bureau of Geographic Information. The roads layer is the official state-maintained street transportation dataset. It represents all the public and many of the private roadways in Massachusetts and includes designations for Interstate, US and State routes. As with other states in this expansion of EA, Open Street Map data was utilized for roads within Massachusetts as it had a higher level of detail than the roads data accessed through the state repository and would be consistent from state to state. The railroad dataset includes rail linework and station points for passenger, freight, and Amtrak and Massachusetts Bay Transportation Authority (MBTA) Commuter Rail trains. The transmission line data set shows transmission lines in Massachusetts. It was digitized from USGS topographical (topo) maps and as of the publication of this report is not complete. The Public Utility Service Providers for Massachusetts includes electricity and natural gas providers by community. The building dataset consists of 2D roof outlines (i.e., roofprints) for all buildings larger than 150 square feet for all of Massachusetts. The wind speed layers are a modeled representation of wind velocities at various heights in the Commonwealth of Massachusetts. The original wind resource data were developed by Truewind Solutions, LLC under contract to AWS Scientific, Inc. as part of a project jointly funded by the Connecticut Clean Energy Fund, the

Massachusetts Technology Collaborative (MTC), and Northeast Utilities System. This data has undergone further processing to make it more suitable for analyses that utilize other geographic data layers maintained by MassGIS. The Wind Power Density at 50 meter data layer is a vector version of the AWS Truewind, LLC, Massachusetts Technology Collaborative 50 meter elevation wind power density raster layer. The Water/Sewer Service Areas polygon data layer shows the areas across the commonwealth with water and sewer service as provided by the Massachusetts Water Resources Authority. The Public Water Supply (PWS) data layer contains the locations of public community surface and groundwater supply sources and public noncommunity supply sources as defined in Massachusetts Drinking Water Regulations. Large water bodies and rivers are included in two layers and a subset of hydrographic features from the Hydrography (1:100,000) layer from the USGS's National Marine Division 1:100,000 digital line graph (DLG). Underground water aquifer sources of high, medium, and low yield are also included in this project. Finally, a statewide dataset of a combination of land cover mapping from 2016 aerial imagery and land use derived from standardized assessor parcel information for Massachusetts is included for land cover and land use.

2.1.1.5 New Hampshire

Data collected for the State of New Hampshire for this study included roads, railroads, land use, and transmission or pipelines. All datasets were publicly available from the State of New Hampshire Geodata Portal administered by NH GRANIT at the University of New Hampshire. The New Hampshire road data were provided by the New Hampshire Department of Transportation, which is updated quarterly with its last update on 10 January 2023. It is a statewide dataset containing the location of state, local and selected private roads and their associated attributes, including road names. However, for the purposes of the EA, Open Street Map data was utilized for roads within New Hampshire as it had a higher level of detail. The New Hampshire railroads dataset provides a digital representation of the railroad line features mapped on standard 7.5-minute USGS quadrangles. It was last updated on 1 June 2022. The land use data set is from photo-interpreted land use data. This data set contains detailed land use data (polygons) for 45 communities in southeastern New Hampshire. The primary source used to map the land use was high resolution (1-foot), true color aerial photography, collected in the spring of 2015. Data development was completed by Rockingham

Planning Commission (27 communities) and Strafford Regional Planning Commission (18 communities), with GRANIT providing technical support, metadata development, and standardizing or merging of the datasets into a regional product. It was last updated 10 June 2022. The transmission lines and pipeline map provide a digital representation of the pipeline and transmission line features mapped on standard 7.5-minute USGS quadrangles. It was last updated on 1 June 2022.

2.1.1.6 New York

Data collected for the State of New York included railroads, natural gas and electricity utility service territories, oil, gas, water, and other wells, and aquifers. The railroad dataset is a line shapefile of active railroad lines from the New York State Department of Transportation. As with other states, Open Street Map data was utilized for roads within New York due to its higher level of detail and to stay consistent across the region. The Natural Gas Service Territories for Companies Regulated by New York State Department of Public Service (NYSDPS) is a dataset dissolved from the New York State (NYS) municipal boundary coverage (1:100,000) using the Northeast Gas Association Regional Natural Gas System Map of New York (created in 2008) for visual confirmation (created Fall 2010). The dataset of the New York State Electric Service Territories for Companies Regulated by NYSDPS is also dissolved from the New York State municipal boundary coverage (1:100,000). A dataset contains locations of oil, gas, storage, solution salt, stratigraphic, geothermal, and other service wells. The Division of Mineral Resources maintains information and data on over 40,000 wells, categorized under New York State Article 23 Regulated wells. The dataset reflects the status of the wells as of the previous business day. The location data has not been field verified but is expected to be within 100 meters of the actual well location. The data should not be used for precise determination of distances to buildings, property boundaries or other features. This is a public dataset. Wells currently afforded confidential status are plotted but confidential data is redacted. Water wells are shown in a dataset that has locations and attributes for water wells in New York State. This information has been collected by the Department of Environmental Conservation (DEC) since April 2000 as required by law. The aquifer dataset shows the location of primary aquifers in New York State. Primary aquifers are highly productive aquifers presently being utilized as sources of water supply by major municipal water supply systems and is 1:24,000 scale.

2.1.1.7 Rhode Island

Data collected for the State of Rhode Island for this study included roads, railroads, natural gas and electrical transmission lines, buildings, water supply districts, groundwater reservoirs, sewer lines, lakes and ponds, land use and land cover. All datasets were publicly available from the State of Rhode Island Geographic Information System from the University of Rhode Island Environmental Data Center and Rhode Island Geographic Information System. The road dataset contains street center lines for all transportation highways, roads, and streets for the entire State of Rhode Island as of 20 October 2022. As with other states in this expansion of EA, Open Street Map data was again utilized for roads within Rhode Island because of its higher level of detail and consistency from state to state. The railroad dataset represents railroad rights of way (including rail lines, active and inactive, as well as abandoned trolley lines) present within Rhode Island as of 28 May 2021. Major above ground high voltage electrical transmission lines as shown on USGS 7.5-minute topo quads and confirmed through identification of visible right of way cuts on digital orthophotography are included as the electrical transmission lines as of 15 November 2016. Major natural gas transmission lines in Rhode Island are included in the project. The dataset was last updated on 28 May 2021. The building dataset is representative, computer-generated building footprints for Rhode Island as of June 2018. Public water supplier districts and main sewer lines, force mains, and interceptors for public and private sewer system in Rhode Island are included datasets updated 31 October 2022 and 28 May 2021, respectively. Lakes and ponds data set shows lakes and ponds in Rhode Island as identified and delineated from 1997 1:5000 orthophotography and updated on 28 May 2021. A dataset shows groundwater aquifers in Rhode Island as of 2009. Land use and land cover are provided in a statewide, seamless, vector-formatted geospatial dataset created under the direction of the Rhode Island Department of Administration, Rhode Island Division of Statewide Planning depicting 2020 land use and land cover ground conditions.

2.1.1.8 Vermont

Data collected for the State of Vermont for the purpose of this study included roads, railroads, electricity utility area and infrastructure, lakes, and predicted wind speed at 30, 50, and 70 meter height. All datasets were publicly available from the State of Vermont Open Geodata Portal. The Vermont Road Centerline data layer contains all town and state highways,

as well as many private roads. The Vermont Agency of Transportation (VTrans) is the steward of this data layer and has updated and maintained the road centerline data layer to match official highway mileage. It was last updated on 1 June 2021. Even though Vermont provided a roads layer through their repository, Open Street Map data was utilized for roads within Vermont to keep consistent with the other states and because of its higher level of accuracy. Vermont rail lines data set includes data related to line name, operator, division, subdivision, and ownership and was last updated on 16 November 2020. The Electric Utility Franchise Area layer depicts the Vermont electric distribution utility franchise boundaries. It is a compilation of many data sources compiled by the Vermont Department of Public Service and last updated on 1 March 2021. For the Vermont electric utility provider Green Mountain Power, distribution of poles, lines, and underground structure exists in spatial datasets from the Vermont Center for Geographic Information. The lakes in Vermont are included in a dataset from the USGS DLG Surface Waters coverage. DLG data are digital representations of cartographic information converted to digital form from maps and related sources. It was last updated on 8 December 2020. Wind speed predictions at 30 meters, 50 meters, and 70 meters height above ground are generated by a numerical model simulating weather conditions over a 15-yr period, using geophysical inputs such as elevation, land use, and vegetation. The information was produced by TrueWind Solutions using their Mesomap system. This work was commissioned by the Massachusetts Technology Collaborative, in conjunction with the Connecticut Clean Energy Fund and Northeast Utilities, and the results have been validated by NREL (National Renewable Energy Laboratory).

2.1.2 National level resources

For the purposes of this portal expansion the national level datasets that were utilized in Phases 1 and 2 remained the same and were discussed in detail in Callaghan et al. (2021) and Bigl et al. (2022). These data were applied to the new states that added to the portal, where appropriate. Many of these data sources had been updated in the intervening years and those updates were incorporated into the current version of the EA at the time of publication. The national level data sets that were previously compiled pertained to major infrastructure, such as roads or utility lines, and energy resource potential. In addition to this there were also data relating to DoD infrastructure and environmental data such as land cover and precipitation. Land cover data was updated to include Esri 2020 Land Cover.

2.2 Portal Transition to IC GIS Portal

The EA portal will be hosted by the IC GIS portal. The US Army Geospatial Center (AGC) Geospatial Enterprise (AGE) Portal, which had hosted the EA–Alaska portal, was no longer available for hosting. Being hosted by the IC GIS portal allows easy access by stakeholders to the energy and infrastructure sources found in the Energy Atlas to assist in their decision-making efforts.

The data for the EA portal is structured into nested groups with sources for state coverage being listed under a state grouping and sources with nationwide coverage being listed under the heading *US*. Within each of these groups, the data is then grouped by function such as Energy Resources and Infrastructure.

2.3 Data gaps

We assessed data gaps and future data needs based on discussions within the EA expansion team and consultation with stakeholders during previous phases of development.

There continue to be gaps in the ability to forecast sea-level rise in the Arctic and therefore we did not include any sea-level rise datasets in this expansion. As we move forward the addition of sea-level rise data for both the Arctic and Contiguous United States (CONUS) would be critical for low lying coastal installation planning. In the future if the expansion for coverage across CONUS or at command level were to occur various datasets related to climate forecasting would be crucial to include.

Beyond traditional data gaps the project team identified some functionality gaps that would be good to close. One is to either include a buffer layer or buffer tool that could be used for on-the-fly analyses within the EA such as creating standoff buffers for built environments such as airports or cantonment areas. Second useful tool is a solar power estimation tool where an Area of Interest (AOI) could be drawn over a particular site and by using the photovoltaic (PV) potential layer a quick estimate of solar yield could be generated for the user. This would be useful for not only large area solar assessment but rooftop power generation as well.

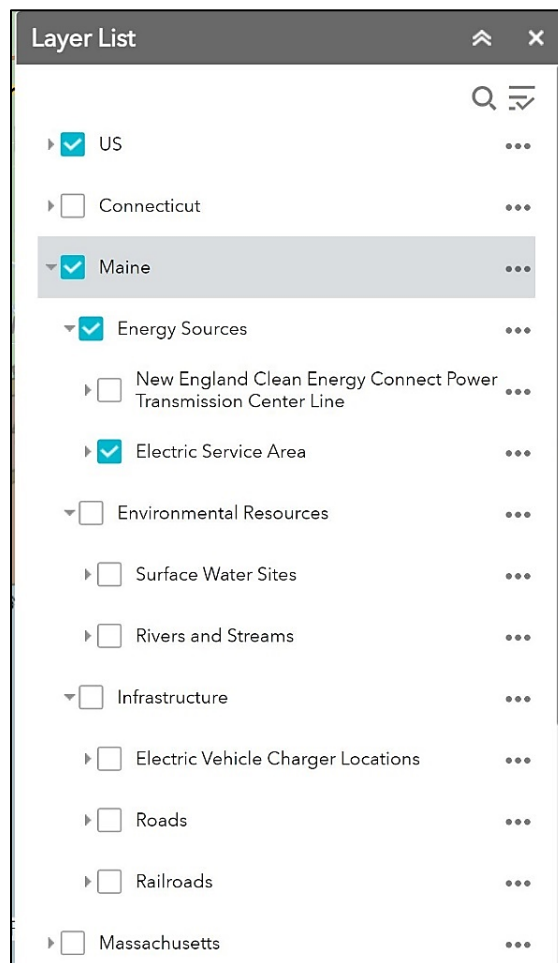
3 Energy Atlas Portal

3.1 Hosting and design

The EA portal was developed to function on Esri's ArcGIS Enterprise Portal software. The EA portal site is hosted by the IC GIS portal. Access to the portal requires a valid DoD CAC card. The EA portal consists of a web application created with Esri's Web AppBuilder.

Within the portal, layers are organized into nested groups. The highest grouping is by state or national level. These groups contain some or all of the following subgroup headings: DoD, Built Environment, Energy Sources, Environmental Resources, and Infrastructure. This nested data structure allows layers to be organized by topic and easily visualized (Figure 2).

Figure 2. Nested data structure showing subgroups under Maine.



Within the web application, Python code was used to create several tools (Figure 3).

Figure 3. EA web application toolbar listing the available functions, including (left to right) Layers tool, Legend tool, Zoom to Base tool, Print tool, AOI (Area of Interest) tool, Buffer tool, Measure tool, and Query tool.



Data is stored in ArcGIS File shapefiles and geodatabases. These files are symbolized with layer files. The data layers are then published as web layers to the hosting server.

The EA includes Alaska data layers compiled under the previous version of the EA–Alaska, layers covering the entire US, and layers within individual states in the northeastern US. The data layers are organized in the application as either national coverage layers or state coverage layers.

3.2 Functions

3.2.1 Layers tool

The Layers tool allows the user to check layers on, making the layer visible in the map (Figure 4). If the layer is within a group, then the group layer must also be checked on for the layer to be visible.

Figure 4. EA web application toolbar with the Layers tool (highlighted with an orange box).



3.2.2 Legend tool

The Legend tool allows the user to view the legend for the layers that are turned on (Figure 5).

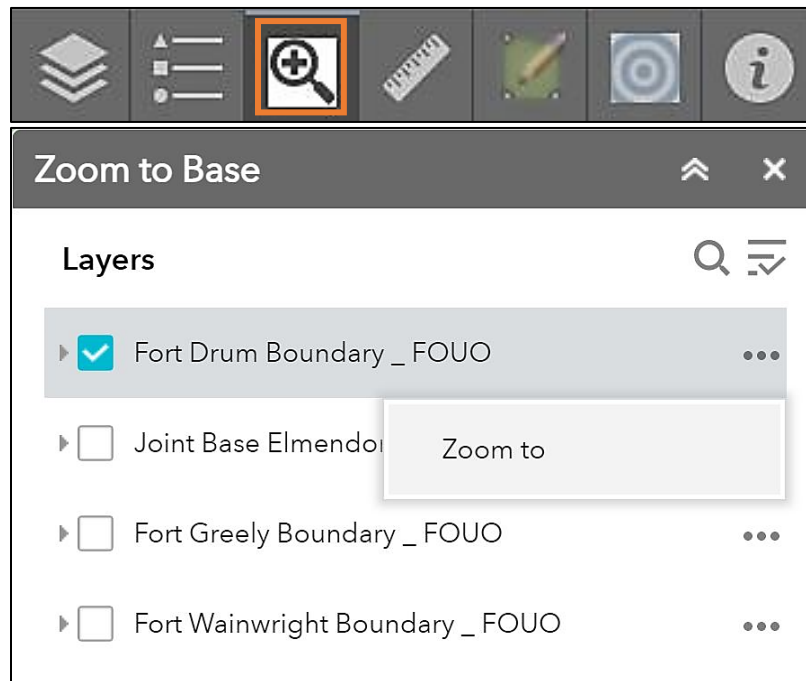
Figure 5. EA web application toolbar with the Legend tool (orange box).



3.2.3 Zoom to Base tool

The Zoom to Base tool allows user to easily zoom in to the extent of the base selected by right-clicking and selecting *Zoom to* from the drop-down menu (Figure 6).

Figure 6. EA web application toolbar with the Zoom to Base tool (*orange box*) and the dropdown selection options shown underneath.



3.2.4 Area of Interest (AOI) tool

The AOI Tool allows the user to draw an AOI on the map to begin a site selection analysis or just as a reference for data layer review. This AOI can then be displayed with other data layers to start an analysis of an area. To run the tool, a user selects a shape to interactively draw the AOI (Figure 7). The user then clicks *Run*, after which, an AOI polygon layer is drawn on the map and added as a layer to the layer list. The polygon will remain on the screen for visual comparison to other layers within the area. To delete the AOI polygon from the screen, select the Input tab, then click the red button, which will clear the AOIs from the screen. To delete the AOI from the layer list, select the Output tab, then click the light gray X next to the three dots (Figure 8).

Figure 7. EA web application toolbar with the Area of Interest (AOI) Tool (*orange box*) and the Input tab open with options shown underneath.

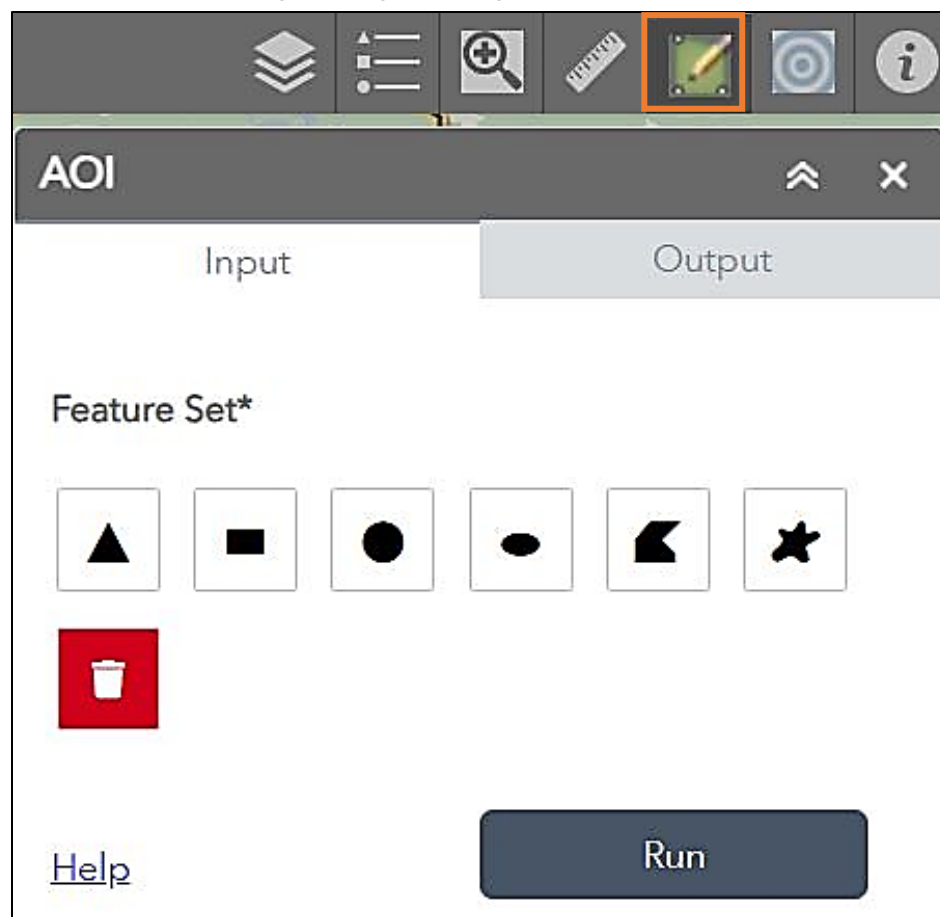
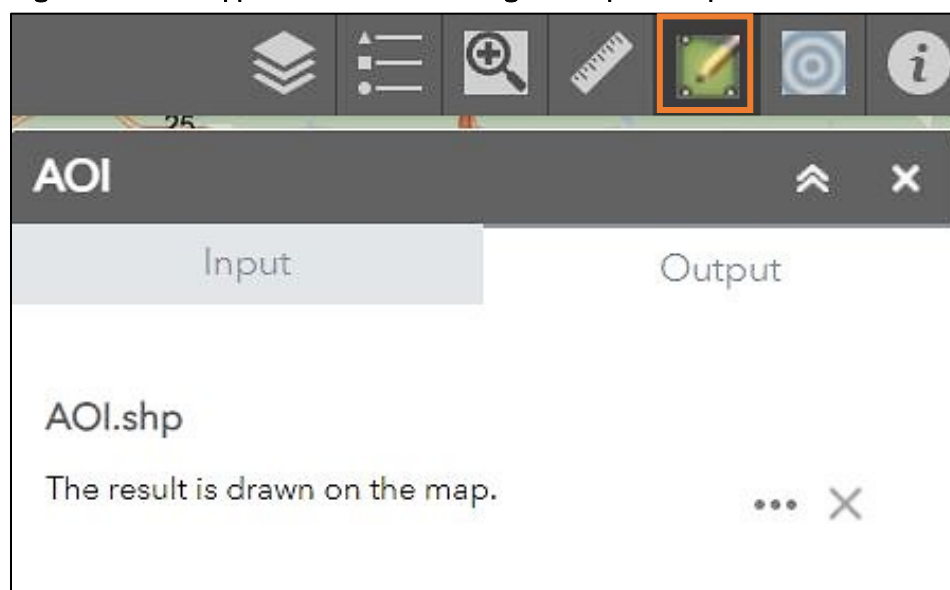


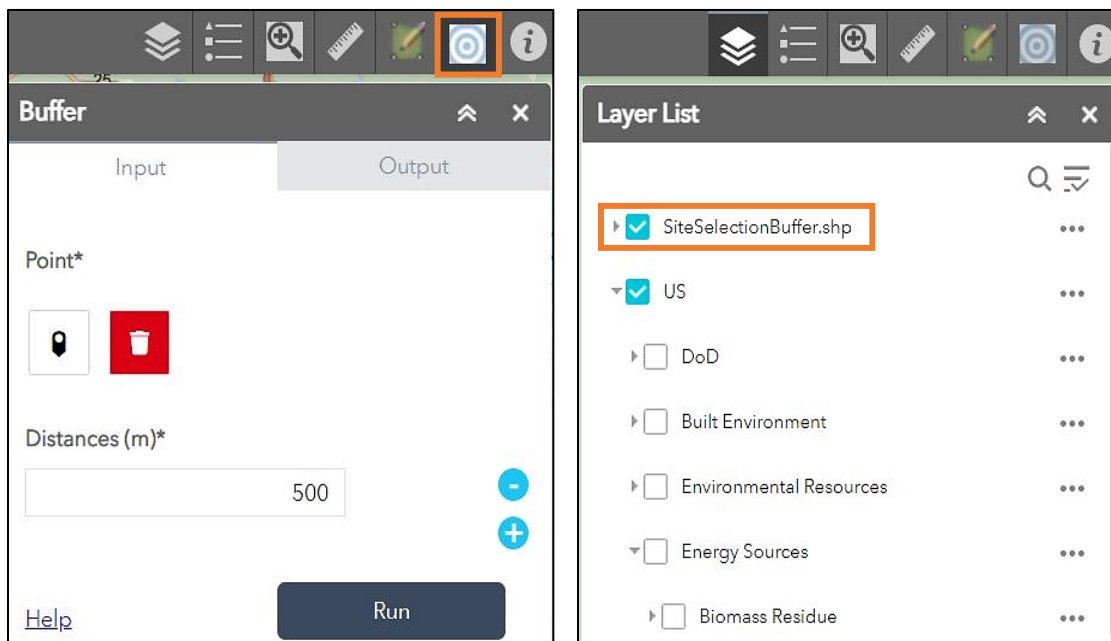
Figure 8. EA web application toolbar showing the Output tab options for the AOI tool.



3.2.5 Buffer tool

The Buffer Tool allows the user to specify one or more distances for buffer analysis of a proposed site. This could assist the user in determining proximity of a possible site to existing infrastructure. To run the tool, a user clicks the Point button to draw a point on the map. The user then adds the distance in meters for the buffer (Figure 9). Next, the user clicks *Run* to execute the tool. After running the tool, a buffer polygon layer is drawn on the map and added to the layer list. The polygon will remain on the screen for visual comparison to other layers within the area. To delete the site selection buffer from the screen and the layer list, select the Output tab, then click the X. To delete the point from the screen, select the Input tab, then click the red button, which will clear the point from the screen.

Figure 9. EA web application toolbar with the Buffer tool (*orange box*) and the Input tab open with options shown underneath (*left*). The layers list shown on the *right* highlights the output layer from the Buffer tool (*orange rectangle*).



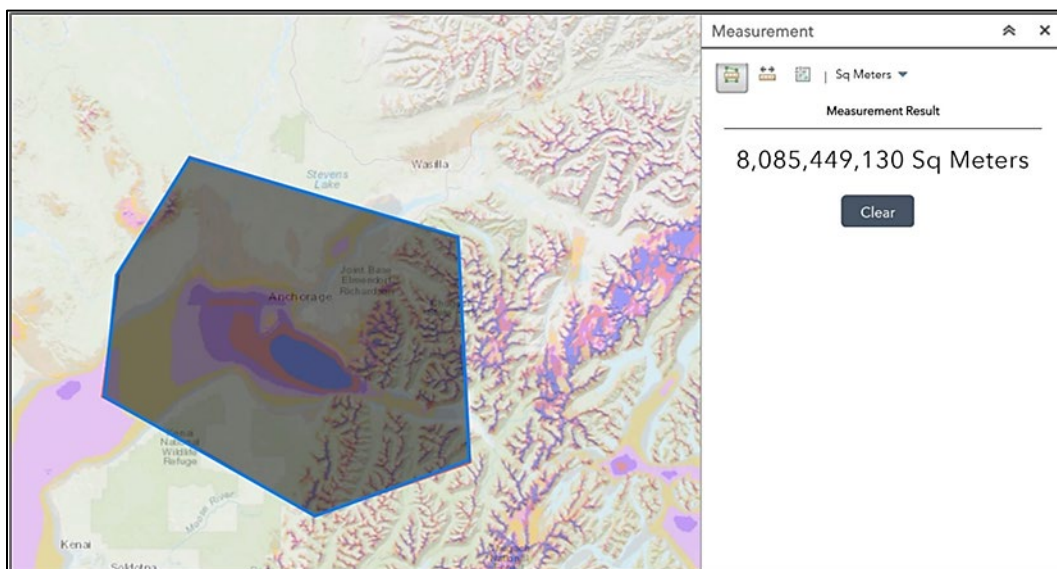
3.2.6 Measure tool

The Measure tool allows the user to measure distances and areas on the map (Figure 10 and 11). The tool also allows the user to click on a point and obtain the latitude and longitude of the location in degrees.

Figure 10. EA web application toolbar with the Measure tool (orange box).



Figure 11. Example of the Measure tool being used with the area function within the EA web application.



3.2.7 Map navigational tools

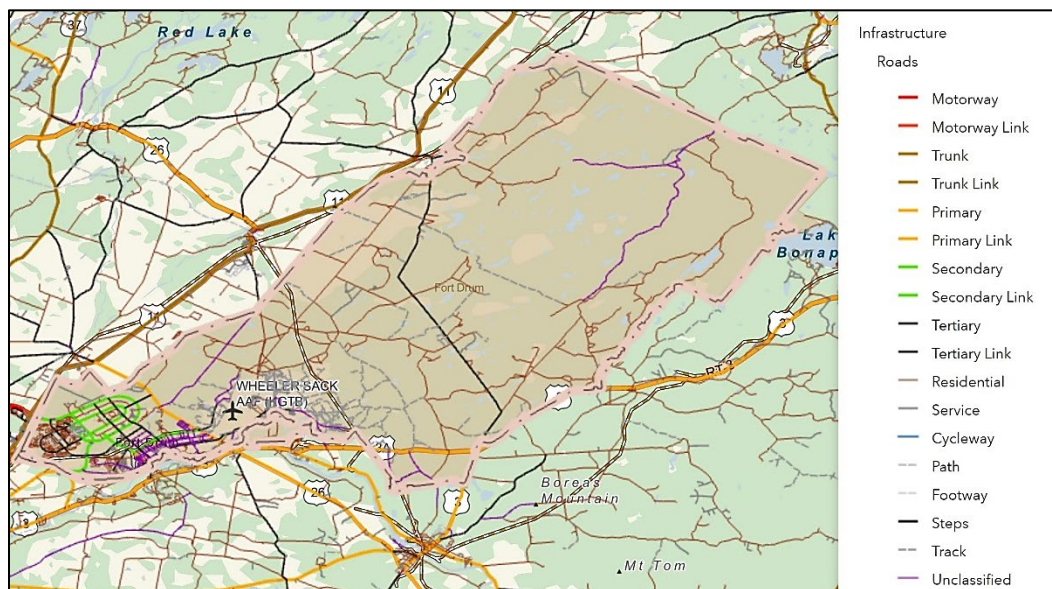
Three tools can be used for navigating around the map. The Default Extent tool allows the user to click on the home button (🏠) to zoom to the custom extent of Northeast (NE) states. The “+” and “-” tools zoom in and out.

4 Use Case: Site Selection for Potential Solar Power Generation Near Fort Drum, New York

This scenario demonstrates use of the EA portal to assist in the initial data investigation and site selection process for placing a new solar array within or around the cantonment area to supply more resilient power.

When selecting a site for a solar array in a northern latitude the amount of solar insolation in an area is critical for maximizing the power yield and therefore the return on investment (ROI) from investing in a solar array (Figure 12). For this purpose, the photovoltaic layer could be viewed in the desired area to narrow down suitable locations from a power generation standpoint.

Figure 12. Overview of the use-case region with the roads layer overlain on the background topographic (topo) map.



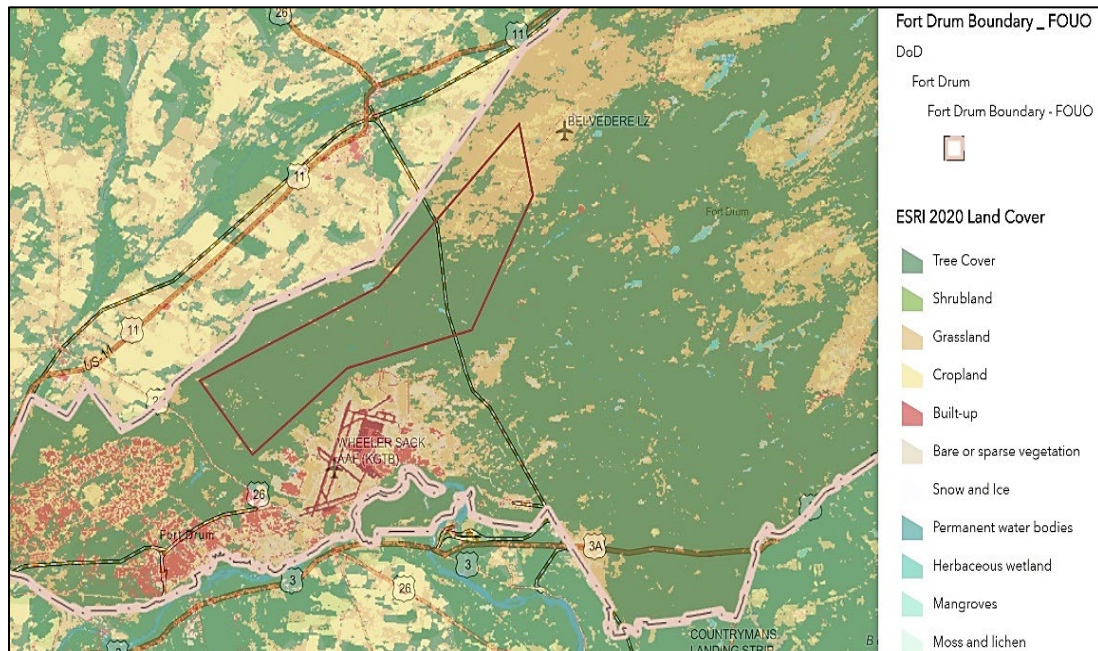
Viewing the photovoltaic layer in the desired area shows that the entire area under consideration averages 4.0 hours to 5.0 hours of solar power when the average intensity of sunlight is 1,000 watts per square meter (Figure 13).

Figure 13. Solar Photovoltaic overlaying the topo map.



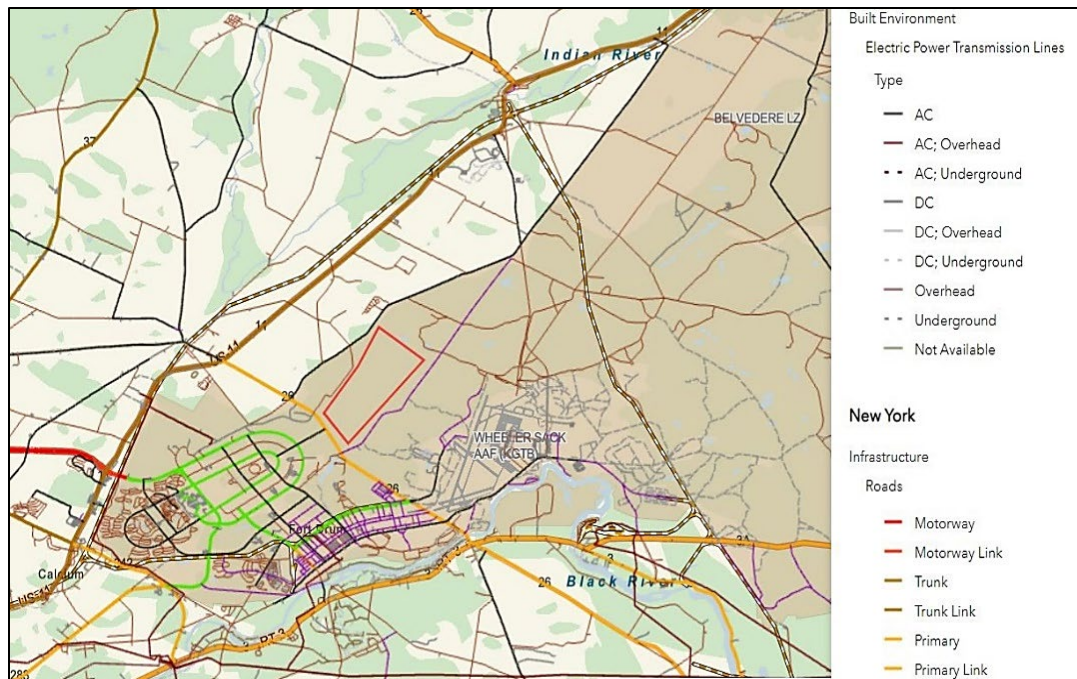
Other considerations would be the existence of nearby roads, land cover, surface water (e.g., streams and rivers, ponds, wetlands, etc.), and distance from active impact areas. The AOI tool could be used to select an initial area of investigation (Figure 14).

Figure 14. Detail figure of use-case area with example AOI drawn for further investigation based on photovoltaic power generation and land cover.



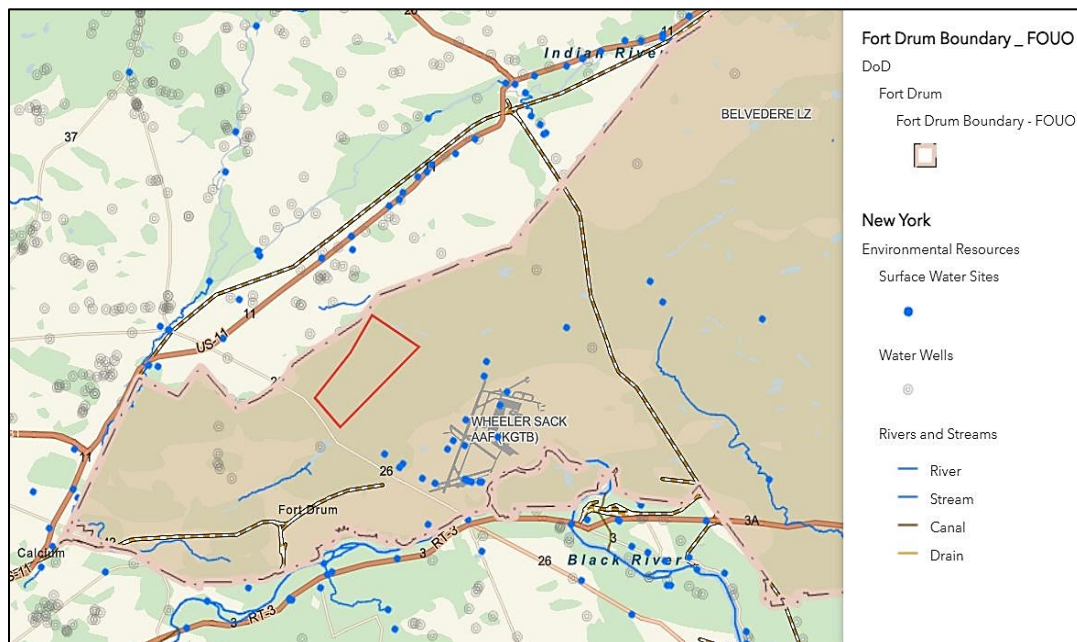
The road and power line access would then be considered. Areas within the cantonment area surrounding built structures would provide the easiest access and power hookup (Figure 15).

Figure 15. Detail figure of use-case area with AOIs drawn over large open areas with road access.



Next, the proximity to surface water could be reviewed through using the rivers and streams layer and the surface water sites layer for the state of New York (Figure 16).

Figure 16. Detail figure of use-case area with river and streams and surface water sites layers overlain.



Based on all of the reviewed information a final set of AOIs could be generated for future on site and more detailed GIS analysis for slope, viewshed, and geologic suitability for anchoring solar arrays (Figure 17).

Figure 17. Detail figure of use-case area final AOIs for future investigation overlain.



By performing a quick in-portal analysis of the provided infrastructure and environmental layers, the user can locate a potential site for new construction and then investigate it further with additional geospatial analysis and on site to confirm suitability. Using the layers within the EA saves time during this process and allows additional in-depth site suitability analyses on these layers to identify other sites for field investigations.

5 Next Steps

As the EA portal continues to evolve, we expect to expand data coverage and functionality. This process will be based on feedback from decision-makers and their needs, the availability of new and more accurate datasets, and new geospatial tools and functionality made available through Esri or future research partnerships. The third phase of this effort focused on the expansion of data coverage to northeastern CONUS to include previously identified national datasets and newly identified state-level spatial data repositories. Moving forward, we intend to continue expanding the installation data coverage across all study regions and to all DoD installations within those regions through additional collaborative research efforts. Beyond Alaska and northeastern CONUS, the portal developed for the EA can easily be applied to other states and territories as demonstrated here as many data sources consulted have coverage across CONUS.

The project team, pending continuation of funding, intends to incorporate the following improvements and expansions in subsequent phases of the EA effort.

We will continue to expand the current data coverage of the web-based ArcGIS Enterprise Portal to cover all DoD facilities within the current study regions. In addition, there is the intent to expand to other northern states within CONUS. By continuing to communicate with the GIS professionals that support installations and energy and infrastructure decision-making across these regions, we will expand the data coverage and ensure consistent visualization and better cross-functionality.

The project team will also investigate additional funding sources and engage additional customers and research partners to provide new and transition existing tools to the EA platform to provide further utility to the end users. To ensure the EA reaches its fullest potential, next steps include determining and involving the appropriate parties for energy planning on DoD installations. Transitioning the tool to the decision makers will not only provide for better informed decisions, but aid in feedback for tool improvements. Training for energy managers and other relevant parties on the use and benefits of the tool would be subsequent steps in the transition plan.

The expansion of the EA portal collected and organized relevant information related to energy, infrastructure, and the environment for DoD lands across the northeastern US and integrated it into the secure portal system previously developed in earlier phases of research. In addition to this, by migrating the hosting of the EA portal to the IC GIS portal, we can efficiently expand the available datasets and coverage while allowing easy access of the EA across the DoD and IC. By locating all these data in one easy-to-use resource we can break down data silos which in turn saves time and money while making our Arctic and cold regions DoD installations more efficient, resilient, and cost effective as we move into the future.

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Appendix A: Data Sources

Table A-1. National data sources integrated into the Energy Atlas (EA).

Data—National	Description	Sources, Citations, and URLs
Base Layers—County Boundary	County Boundary—2022 Topologically Integrated Geographic Encoding and Referencing Line file	US Census Bureau. Retrieved 1/30/2023 from https://www.census.gov/geographies/mapping-files/time-series/geo/cartographic-boundary.html .
Base Layers—State Boundary	State Boundary—2022 Topologically Integrated Geographic Encoding and Referencing Line file	US Census Bureau. Retrieved 1/30/2023 from https://www.census.gov/geographies/mapping-files/time-series/geo/cartographic-boundary.html .
Biomass Residue	Biomass residue—Biopower potential estimated based on available residue data	National Renewable Energy Laboratory. Retrieved 1/27/2023 from https://maps.nrel.gov/?da=re-atlas
Coal Fields	Coal fields Most of the material for the conterminous United States was collected from James Trumbull's <i>Coal Fields of the United States, Conterminous United States</i> map (sheet 1, 1960). The Gulf Coast region was updated using generalized, coal-bearing geology obtained from State geologic maps. The Alaska coal fields were collected from Farrell Barnes's <i>Coal Fields of the United States, Alaska</i> map (sheet 2, 1961).	USGS—National Atlas of the United States of America. Homeland Infrastructure Foundation-Level Data (HIFLD) open data portal. Retrieved 3/14/2023 from https://gii.dhs.gov/gii/home/ .
DoD Buildings—For Official Use Only (FOUO)	Locations of buildings and structures on DoD sites	Defense Information Spatial Data Infrastructure (DISDI)—HIFLD secure data portal. Retrieved 2/10/2023 from https://gii.dhs.gov/gii/home/v
DoD Site Boundaries—FOUO	Military Installations, Ranges, and Training Areas (MIRTA)—boundaries	DISDI—HIFLD secure data portal. Retrieved 2/10/2023 from https://gii.dhs.gov/gii/home/
DoD Site Locations—FOUO	MIRTA—point locations	DISDI—HIFLD secure data portal. Retrieved 2/10/2023 from https://gii.dhs.gov/gii/home/
Electric Power Plants	Electric power plants	Oak Ridge National Laboratory (ORNL), Los Alamos National Laboratory (LANL), Idaho National Laboratory (INL), National Geospatial-Intelligence Agency (NGA)—Homeland Security Infrastructure Program (HSIP)—HIFLD open data portal. Retrieved 2/13/2023 from https://gii.dhs.gov/gii/home/

Table A-1 (cont.). National data sources integrated into the Energy Atlas.

Data—National	Description	Sources, Citations, and URLs
Electric Power Transmission Lines	Electric power transmission lines	ORNL, LANL, INL, NGA—HSIP—HIFLD open data portal. Retrieved 2/13/2023 from https://gii.dhs.gov/gii/home/
Land Cover—Esri 2020	Esri 2020 Land Cover— This dataset is based on the dataset produced for the Dynamic World Project by National Geographic Society in partnership with Google and the World Resources Institute. Created 9/8/2021, it is based on ESA Sentinel-2 imagery at 10 m resolution	Impact Observatory for Esri. https://tiledimageservices.arcgis.com/P3ePLMys2RVChkXj/arcgis/rest/services/Esri_2020_Land_Cover_V2/ImageServer .
Natural Gas Pipelines	Natural gas pipelines	US Energy Information Administration—HIFLD open data portal. Retrieved 2/13/2023 from https://gii.dhs.gov/gii/home/
Oil and Natural Gas Fields	Oil and natural gas fields	ORNL, Argonne National Laboratory (ANL)—HIFLD open data portal. Retrieved 2/13/2023 from https://gii.dhs.gov/gii/home/
Oil and Natural Gas Wells	Oil and natural gas wells	ORNL, ANL, NGA—HSIP—HIFLD open data portal. Retrieved 2/13/2023 from https://gii.dhs.gov/gii/home/
Petroleum Product Terminals	Petroleum product terminals	Retrieved 1/31/2023 from https://gem.anl.gov/
Petroleum Refineries	Petroleum refineries	Retrieved 1/31/2023 from https://gem.anl.gov/
Precipitation—Absolute Change in Average Annual Precipitation between (1975–2005 vs 2071–2090, RCP 8.5) (mm)	Absolute change in average annual precipitation between (1975–2005 vs 2071–2090, RCP 8.5) (mm) Processing: Merged lower48 raster with AK raster	US Forest Service (USFS)—National Forest Climate Change Maps. Retrieved 2/14/2023 from https://www.fs.usda.gov/rm/boise/AWAE/projects/NFS-regional-climate-change-maps/categories/us-raster-layers.html
Precipitation—Historical Annual Precipitation for (1975 to 2005) (mm)*	Historical annual average precipitation for 1975 to 2005 (mm) Processing: Merged lower48 raster with AK raster	USFS—National Forest Climate Change Maps. Retrieved 2/14/2023 from https://www.fs.usda.gov/rm/boise/AWAE/projects/NFS-regional-climate-change-maps/categories/us-raster-layers.html

*For a full list of the spelled-out forms of the units of measure used in this document, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office, 2016), 248–52, <https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf>.

Table A-1 (cont.). National data sources integrated into the Energy Atlas (EA).

Data—National	Description	Sources, Citations, and URLs
Precipitation— Percent Change in Average Annual Precipitation (1975– 2005 vs 2071– 2090, Representative Concentration Pathway [RCP] 8.5) (mm)	Percent change in average annual precipitation (1975–2005 vs 2071– 2090, RCP 8.5) (mm) Processing: Merged lower48 raster with AK raster	USFS—National Forest Climate Change Maps. Retrieved 2/14/2023 from https://www.fs.usda.gov/rm/boise/AWAE/projects/NFS-regional-climate-change-maps/categories/us-raster-layers.html
Precipitation— Projected Annual Precipitation (2071– 2090, RCP 8.5) (mm)	Projected annual precipitation (2071– 2090, RCP 8.5) (mm) Processing: Merged lower48 raster with AK raster	USFS—National Forest Climate Change Maps. Retrieved 2/14/2023 from https://www.fs.usda.gov/rm/boise/AWAE/projects/NFS-regional-climate-change-maps/categories/us-raster-layers.html
Temperature— Absolute Change in Average Annual Temperature between (1975– 2005 vs 2071– 2090, RCP 8.5) (°C)	Absolute change in average annual temperature between (1975–2005) and (2071–2090) (°C) Processing: Merged lower48 raster with AK raster	USFS—National Forest Climate Change Maps. Retrieved 2/14/2023 from https://www.fs.usda.gov/rm/boise/AWAE/projects/NFS-regional-climate-change-maps/categories/us-raster-layers.html
Temperature— Historical Annual Average Temperature for 1975 to 2005 (°C)	Historical annual average temperature for 1975 to 2005 (°C) Processing: Merged lower48 raster with AK raster	USFS—National Forest Climate Change Maps. Retrieved 2/14/2023 from https://www.fs.usda.gov/rm/boise/AWAE/projects/NFS-regional-climate-change-maps/categories/us-raster-layers.html
Temperature— Projected Annual Average Temperature for 2071 to 2090 RCP 8.5 (°C)	Projected annual average temperature for 2071 to 2090 RCP 8.5 (°C) Processing: Merged lower48 raster with AK raster	USFS—National Forest Climate Change Maps. Retrieved 2/14/2023 from https://www.fs.usda.gov/rm/boise/AWAE/projects/NFS-regional-climate-change-maps/categories/us-raster-layers.html
Wind Speed at 100 m	Wind Speed at 100 m (2007–2013)	Retrieved 1/27/2023 from https://www.nrel.gov/gis/wind-resource-maps.html
Wind Speed at 80 m	Wind Speed at 80 m (2007–2013)	Retrieved 1/27/2023 from https://www.nrel.gov/gis/wind-resource-maps.html
Solar Photovoltaic	Solar Photovoltaic	Retrieved 1/27/2023 from https://maps.nrel.gov/?da=re-atlas

Table A-2. Connecticut data sources integrated into the EA.

Data—Connecticut	Description	Sources, Citations, and URLs
Airports	Connecticut Airports	Retrieved 3/22/2023 from https://deepmaps.ct.gov/datasets/CTDEEP::connecticut-airports/about .
Railroads	Connecticut Railroads is 1:24,000-scale base map data. It depicts the location of all railroad trails published on the USGS topographic quadrangle maps.	Retrieved 3/22/2023 from https://ct-deep-gis-open-data-website-ctdeep.hub.arcgis.com/datasets/CTDEEP::connecticut-railroads/about .
Rivers and Streams	Rivers and Streams	Open Street Map—US Army Geospatial Center (AGC)— Common Map Background Online portal. Retrieved 1/31/2023 from https://agcwfs.agc.army.mil/CMB_Online/default.html
Roads	Roads	Open Street Map—AGC— Common Map Background Online portal. Retrieved 1/31/2023 from https://agcwfs.agc.army.mil/CMB_Online/default.aspx
Surface Water Sites	Surface Water Sites (selected all sites classified as Surface Water) https://maps.waterdata.usgs.gov/mapper/help/sitetype.html#SW for types of surface water sites Added URLs for station site data which includes detailed statistics for site.	USGS—National Water Information System portal. Retrieved 2/1/2023 from https://waterdata.usgs.gov/nwis

Table A-3. Maine data sources integrated into the EA.

Data—Maine	Description	Sources, Citations, and URLs
Electric Service Area	“Service territory for Maine's transmission and distribution electric utilities.”	Retrieved 2/9/2023 from https://maine.hub.arcgis.com/maps/2020-electric-service-area-web
Electric Vehicle Charger Locations	Public, DC Fast, Level 2	Retrieved 2/13/2023 from https://www.efficiencymaine.com/charging-station-locator/#/analyze?fuel=ELEC&region=US-ME&show_map=true
New England Clean Energy Connect Power Transmission Center Line	“New England Clean Energy Connect Power Transmission Center Line” (NECEC Centerline)	Retrieved 2/9/2023 from https://maine.hub.arcgis.com/datasets/maine::necec-centerline-layer/explore?location=44.808222%2C-70.168820%2C7.78
Railroads	“RailRouteSys provides statewide railroad transportation coverage. Data at this scale is suitable for detailed studies and local planning. Not for use in scales finer than 1:24000.”	Retrieved 2/13/2023 from https://maine.hub.arcgis.com/datasets/maine::mainedot-railroads/explore?location=43.634995%2C-70.290431%2C13.72

Table A-3 (cont.). Maine data sources integrated into the EA.

Data—Maine	Description	Sources, Citations, and URLs
Rivers and Streams	Rivers and Streams	Open Street Map–AGC— Common Map Background Online portal. Retrieved 1/31/2023 from https://agcwfs.agc.army.mil/CMB_Online/default.aspx
Roads	Roads	Open Street Map–AGC— Common Map Background Online portal. Retrieved 1/31/2023 from https://agcwfs.agc.army.mil/CMB_Online/default.aspx
Surface Water Sites	Surface Water Sites (selected all sites classified as Surface Water) https://maps.waterdata.usgs.gov/mapper/help/sitetype.html#SW for types of surface water sites Added URLs for station site data which includes detailed statistics for site.	USGS—National Water Information System portal. Retrieved 2/1/2023 from https://waterdata.usgs.gov/nwis

Table A-4. Massachusetts data sources integrated into the EA.

Data—Massachusetts	Description	Sources, Citations, and URLs
Aquifers	Underground water sources of high, medium and low yield are in this layer	Retrieved 3/21/2023 from https://www.mass.gov/info-details/massgis-data-aquifers
Amtrak Stations	Rail linework and station points for passenger, freight, and Amtrak and MBTA Commuter Rail trains. Note: Using Mass GIS Layers files to symbolize data	Retrieved 2/23/2023 from https://www.mass.gov/info-details/massgis-data-trains
Building Structures	This dataset consists of 2D roof outlines (roofprints) for all buildings larger than 150 sq ft for all of Massachusetts.	Retrieved 2/24/2023 from https://www.mass.gov/info-details/massgis-data-building-structures-2-d
Cable TV Providers, by Town	Cable television providers by community	Retrieved 2/24/2023 from https://www.mass.gov/info-details/massgis-data-public-utility-service-providers
Electricity Providers, by Town	Electric service providers by community	Retrieved 2/24/2023 from https://www.mass.gov/info-details/massgis-data-public-utility-service-providers
Massachusetts Bay Transportation Authority (MBTA) Commuter Rail (Active and Proposed)	Rail linework and station points for passenger, freight, and Amtrak and MBTA Commuter Rail trains. Note: Using Mass GIS Layers files to symbolize data	Retrieved 2/23/2023 from https://www.mass.gov/info-details/massgis-data-trains
Natural Gas Providers, by Town	Natural gas providers by community	Retrieved 2/24/2023 from https://www.mass.gov/info-details/massgis-data-public-utility-service-providers

Table A-4 (cont.). Massachusetts data sources integrated into the EA.

Data—Massachusetts	Description	Sources, Citations, and URLs
Public Water Supplies	The Public Water Supply (PWS) data layer contains the locations of public community surface and groundwater supply sources and public non-community supply sources as defined in 310 CMR 22.00.	Retrieved 3/21/2023 from https://www.mass.gov/info-details/massgis-data-public-water-supplies
Railroads—Type of Service	Rail linework and station points for passenger, freight, and Amtrak and MBTA Commuter Rail trains. Note: Using Mass GIS Layers files to symbolize data	Retrieved 2/23/2023 from https://www.mass.gov/info-details/massgis-data-trains
Rivers and Streams	Rivers and Streams	Open Street Map—AGC— Common Map Background Online portal. Retrieved 1/31/2023 from https://agcwfs.agc.army.mil/CMB_Online/default.aspx
Roads	Roads	Open Street Map—AGC— Common Map Background Online portal. Retrieved 1/31/2023 from https://agcwfs.agc.army.mil/CMB_Online/default.aspx
Surface Water Sites	Surface Water Sites (selected all sites classified as Surface Water) https://maps.waterdata.usgs.gov/mapper/help/sitetype.html#SW for types of surface water sites Added URLs for station site data which includes detailed statistics for site.	USGS—National Water Information System portal. Retrieved 2/1/2023 from https://waterdata.usgs.gov/nwis
Transmission Lines	This layer shows transmission lines in Massachusetts. It was digitized off of USGS topo maps and is not complete.	Retrieved 3/21/2023 from https://www.mass.gov/info-details/massgis-data-transmission-lines
Waterbodies	Large water bodies.	Retrieved 3/21/2023 from https://www.mass.gov/info-details/massgis-data-major-ponds-and-major-streams
Water and Sewer Service Areas	This polygon data layer shows the areas across the commonwealth with water and sewer service as provided by the Massachusetts Water Resources Authority.	Retrieved 2/24/2023 from https://www.mass.gov/info-details/massgis-data-mwra-watersewer-service-areas
Wind Power Density at 50 m	This data layer is a vector version of the AWS Truewind, LLC, Massachusetts Technology Collaborative 50 m elevation wind power density raster layer.	Retrieved 3/21/2023 from https://www.mass.gov/info-details/massgis-data-wind-power-density-at-50m

Table A-4 (cont.). Massachusetts data sources integrated into the EA.

Data—Massachusetts	Description	Sources, Citations, and URLs
Wind Speed at 30 m	These layers are a modeled representation of wind velocities at various heights in the Commonwealth of Massachusetts.	Retrieved 2/23/2023 from https://www.mass.gov/info-details/massgis-data-modeled-wind-speed-grids
Wind Speed at 50 m	These layers are a modeled representation of wind velocities at various heights in the Commonwealth of Massachusetts.	Retrieved 2/23/2023 from https://www.mass.gov/info-details/massgis-data-modeled-wind-speed-grids
Wind Speed at 70 m	These layers are a modeled representation of wind velocities at various heights in the Commonwealth of Massachusetts.	Retrieved 2/23/2023 from https://www.mass.gov/info-details/massgis-data-modeled-wind-speed-grids
Wind Speed at 100 m	These layers are a modeled representation of wind velocities at various heights in the Commonwealth of Massachusetts.	Retrieved 2/23/2023 from https://www.mass.gov/info-details/massgis-data-modeled-wind-speed-grids

Table A-5. New Hampshire data sources integrated into the EA.

Data—New Hampshire	Description	Sources, Citations, and URLs
Railroads	“These data may be used to construct municipal, regional, or statewide base maps. The New Hampshire Railroads dataset provides a digital representation of the railroad line features mapped on standard 7.5-minute USGS quadrangles.”	Retrieved 2/22/2023 from https://www.nhgeodata.unh.edu/datasets/NHGRANIT::new-hampshire-railroads/about
Rivers and Streams	Rivers and Streams	Open Street Map—AGC— Common Map Background Online portal. Retrieved 1/31/2023 from https://agcwfs.agc.army.mil/CMB_Online/default.aspx
Roads	Roads	Open Street Map—AGC— Common Map Background Online portal. Retrieved 1/31/2023 from https://agcwfs.agc.army.mil/CMB_Online/default.aspx
Surface Water Sites	Surface Water Sites (selected all sites classified as Surface Water) https://maps.waterdata.usgs.gov/mapper/help/sitetype.html#SW for types of surface water sites Added URLs for station site data which includes detailed statistics for site.	USGS—National Water Information System portal. Retrieved 2/1/2023 from https://waterdata.usgs.gov/nwis

Table A-5 (cont.). New Hampshire data sources integrated into the EA.

Data—New Hampshire	Description	Sources, Citations, and URLs
Transmissions and Pipelines	“These data may be used to construct municipal, regional, or statewide base maps.” The NH Transmission/Pipelines dataset provides a digital representation of the pipeline and transmission line features mapped on standard 7.5-minute USGS quadrangles.”	Retrieved 2/15/2023 from https://new-hampshire-geodata-portal-1-nhgranit.hub.arcgis.com/datasets/NHGRANIT::nh-transmission-pipelines/about

Table A-6. New Jersey data sources integrated into the EA.

Data—New Jersey	Description	Sources, Citations and URLs
Surface Water Sites	Surface Water Sites (selected all sites classified as Surface Water) https://maps.waterdata.usgs.gov/mapper/help/sitetype.html#SW for types of surface water sites Added for URLs station site data which includes detailed statistics for site.	USGS—National Water Information System portal. Retrieved 2/1/2023 from https://waterdata.usgs.gov/nwis
Rivers and Streams	Rivers and Streams	Open Street Map—AGC— Common Map Background Online portal. Retrieved 1/31/2023 from https://agcwfs.agc.army.mil/CMB_Online/default.aspx
Roads	Roads	Open Street Map—AGC— Common Map Background Online portal. Retrieved 1/31/2023 from https://agcwfs.agc.army.mil/CMB_Online/default.aspx

Table A-7. New York data sources integrated into the EA.

Data—New York	Description	Sources, Citations, and URLs
Gas Utility Service Territories	New York State (NYS) Gas Service Territories for Companies Regulated by New York State Department of Public Services (NYSDPS). Dissolved from the NYS municipal boundary coverage (1:100,000) using the Northeast Gas Association Regional Natural Gas System Map of NY (2008) for visual confirmation (Fall 2010)	New York State Department of Public Service—Data.gov Portal. Retrieved 2/27/2023 from https://catalog.data.gov/dataset/nys-gas-utility-service-territories
Electric Utility Service Territories	NYS Electric Service Territories for Companies Regulated by NYSDPS. Dissolved from the NYS municipal boundary coverage (1:100,000)	NYSDPS—Data.gov Portal. Retrieved 3/23/2023 from https://catalog.data.gov/dataset/nys-electric-utility-service-territories
NYS Railroad Lines	Line shapefile of active railroad lines. UTM NAD 83 Zone 18. Copyright 2001 by NYS Dept of Transportation.	Retrieved 3/23/2023 from http://gis.ny.gov/gisdata/inventories/details.cfm?DSID=904

Table A-7 (cont.). New York data sources integrated into the EA.

Data—New York	Description	Sources, Citations, and URLs
Oil, Gas, and Other Regulated Wells	This dataset contains locations of oil, gas, storage, solution salt, stratigraphic, geothermal, and other service wells. The Division of Mineral Resources maintains information and data on over 40,000 wells, categorized under NYS Article 23 Regulated wells. The dataset reflects the status of the wells as of the previous business day. The location data has not been field verified but is expected to be within 100 m of the actual well location.	Retrieved 3/23/2023 from https://www.dec.ny.gov/energy/1603.html
Primary Aquifers - 1:24,000	This layer shows the location of primary aquifers in NYS. Primary aquifers are highly productive aquifers presently being utilized as sources of water supply by major municipal water supply systems.	Retrieved 3/23/2023 from http://gis.ny.gov/gisdata/inventories/details.cfm?DSID=1232
Rivers/Streams	Rivers/Streams	Open Street Map—AGC—Common Map Background Online portal. Retrieved 1/31/2023 from https://agcwfs.agc.army.mil/CMB_Online/default.html
Roads	Roads	Open Street Map—AGC—Common Map Background Online portal. Retrieved 1/31/2023 from https://agcwfs.agc.army.mil/CMB_Online/default.html
Surface Water Sites	Surface Water Sites (selected all sites classified as Surface Water) https://maps.waterdata.usgs.gov/mapper/help/sitetype.html#SW for types of surface water sites Added url's for station site data which includes detailed statistics for site.	USGS—National Water Information System portal. Retrieved 2/1/2023 from https://waterdata.usgs.gov/nwis
Water Wells	This file shows locations and attributes for water wells in New York State. This information has been collected by DEC since April 2000 as required by law.	Retrieved 3/23/2023 from http://gis.ny.gov/gisdata/inventories/details.cfm?DSID=1203

Table A-8. Rhode Island data sources integrated into the EA.

Data—Rhode Island	Description	Sources, Citations, and URLs
Building Structures	Representative, computer generated building footprints for Rhode Island.	Retrieved 3/23/2023 from https://www.rigis.org/datasets/edc::building-footprints/explore?location=41.442466%2C-71.621880%2C18.31

Data—Rhode Island	Description	Sources, Citations, and URLs
Electrical Transmission Lines	Major above ground high voltage electrical transmission lines as shown on USGS 7.5 minute topo quads and/or as confirmed through identification of visible right of way cuts on digital orthophotography.	Retrieved 3/23/2023 from https://www.rigis.org/maps/electrical-transmission-lines
Groundwater Reservoirs	Groundwater aquifers in Rhode Island	Retrieved 3/23/2023 from https://www.rigis.org/datasets/edc::groundwater-reservoirs/explore
Natural Gas Transmission Lines	Major natural gas transmission lines in Rhode Island.	Retrieved 3/22/2023 from https://www.rigis.org/maps/natural-gas-transmission-lines
Railroads	This dataset represents railroad rights of way (including rail lines, active and inactive, as well as abandoned trolley lines) present within Rhode Island.	Retrieved 3/23/2023 from https://www.rigis.org/datasets/edc::railroad-rights-of-way/explore?location=41.698622%2C-71.513893%2C11.40
Rivers/Streams	Rivers/Streams	Open Street Map—AGC—Common Map Background Online portal. Retrieved 1/31/2023 from https://agcwfs.agc.army.mil/CMB_Online/default.html
Roads	Roads	Open Street Map - US Army Geospatial Center (AGC)—Common Map Background Online portal. Retrieved 1/31/2023 from https://agcwfs.agc.army.mil/CMB_Online/default.html
Sewer Lines	Main sewer lines, force mains, and interceptors for public and private sewer system.	Retrieved 3/23/2023 from https://www.rigis.org/maps/sewer-lines
Surface Water Sites	Surface Water Sites (selected all sites classified as Surface Water) https://maps.waterdata.usgs.gov/mapper/help/site_type.html#SW for types of surface water sites Added URL's for station site data which includes detailed statistics for site.	USGS—National Water Information System portal. Retrieved 2/1/2023 from https://waterdata.usgs.gov/nwis
Water Supply Districts	Public water supplier districts in Rhode Island.	Retrieved 3/23/2023 from https://www.rigis.org/datasets/caf19790b31446349b445f73a7640c64_0/explore?location=41.586359%2C-71.516324%2C10.92
Waterbodies	Lakes and ponds in Rhode Island as identified and delineated from 1997 1:5000 orthophotography.	Retrieved 3/23/2023 from https://www.rigis.org/maps/lakes-and-ponds-15000

Table A-9. Vermont data sources integrated into the EA.

Data—Vermont	Description	Sources, Citations, and URLs
Electric Utility Franchise Areas	“The Electric Utility Franchise Area layer depicts the Vermont electric distribution utility franchise boundaries. It is a compilation of many data sources.” Note: Symbolized by Company (has “Municipals” instead of each individual company)	Retrieved 2/3/2023 from https://geodata.vermont.gov/maps/vtpsd::vt-data-electric-utility-franchise-areas
Green Mountain Power Line	“Green Mountain Power (GMP) linear distribution model.”	Retrieved 2/7/2023 from https://geodata.vermont.gov/maps/vt-green-mountain-power-underground-structure-data
Green Mountain Power Pole	“GMP pole distribution model.”	Retrieved 2/7/2023 from https://geodata.vermont.gov/maps/vt-green-mountain-power-underground-structure-data
Green Mountain Power Underground Structure	“GMP underground structure distribution model.”	Retrieved 2/3/2023 from https://geodata.vermont.gov/maps/vt-green-mountain-power-underground-structure-data
Lakes Inventory	The Vermont Department of Environmental Conservation manages an inventory of lake and pond information. The “Lakes and Ponds Inventory” stores the Water Quality Division's survey and monitoring information used to determine water quality problems and ways to solve them.	Retrieved 4/26/2023 from https://geodata.vermont.gov/datasets/VTANR::lakes-inventory/about
Railroads	Vermont rail lines including data related to line name, operator, division, subdivision, and ownership.	Retrieved 2/2/2023 from https://geodata.vermont.gov/datasets/VT-rans::vt-rail-lines
Rivers/Streams	Rivers/Streams	Open Street Map—AGC—Common Map Background Online portal. Retrieved 1/31/2023 from https://agcwfs.agc.army.mil/CMB_Online/default.html
Roads	Roads	Open Street Map—AGC—Common Map Background Online portal. Retrieved 1/31/2023 from https://agcwfs.agc.army.mil/CMB_Online/default.html
Surface Water Sites	Surface Water Sites (selected all sites classified as Surface Water) https://maps.waterdata.usgs.gov/mapper/help/site_type.html#SW for types of surface water sites Added URL's for station site data which includes detailed statistics for site.	USGS—National Water Information System portal. Retrieved 2/1/2023 from https://waterdata.usgs.gov/nwis

Table A-9 (cont.). Vermont data sources integrated into the EA.

Data—Vermont	Description	Sources, Citations, and URLs
Wind Power Density at 50 m	Wind speed predictions at 50 m generated by a numerical model simulating weather conditions over a 15-yr period. Note: Wind power density, measured in watts per square meter (W/m ²)	Retrieved 2/7/2023 from https://geodata.vermont.gov/documents/vt-predicted-mean-wind-power-50-meter-height
Wind Speed at 30m	Wind speed predictions at 30 m generated by a numerical model simulating weather conditions over a 15-yr period. Note: Wind speed, measured in meter per second (m/s)	Retrieved 2/7/2023 from https://geodata.vermont.gov/documents/vt-predicted-mean-wind-speed-30-meter-height
Wind Speed at 70m	Wind speed predictions at 70 m generated by a numerical model simulating weather conditions over a 15-yr period. Note: Wind speed, measured in meter per second (m/s)	Retrieved 2/7/2023 from https://geodata.vermont.gov/documents/vt-predicted-mean-wind-speed-70-meter-height

Table A-10. Alaska data sources integrated into the EA.

Data—Alaska	Description	Sources, Citations, and URLs
Roads on Installations—FOUO	Road centerlines located on DoD sites	DISDI—HIFLD secure data portal. Retrieved 4/3/2020 from https://gii.dhs.gov/gii/home/
Roads—FOUO	Major roads and roads located on DoD sites	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Fort Greely Space Missile Command—FOUO	Created from Installation layer, which was split into two layers (Fort Greely Space Missile Command and Installation boundaries near Fort Wainwright)	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Helipad—FOUO	Pavement section airline—helipads on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Levee—FOUO	Levees on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Railroad—FOUO	Rail segment—railroads on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Fence—FOUO	Fence on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Landuse—FOUO	Landuse on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Vehicle Parking—FOUO	Vehicle parking on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Pavement Section Road—FOUO	Pavement section road on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Pavement Section Airfield—FOUO	Pavement section airfield on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)

Table A-10 (cont.). Alaska data sources integrated into the EA.

Data - Alaska	Description	Sources, Citations, and URLs
Airfield / Helipad Markings—FOUO	Airfield / helipad markings on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Electrical Utility Outlet—FOUO	Electrical utility outlet on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Electrical Utility Generator—FOUO	Electrical utility generator on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Electrical Utility Node Junction—FOUO	Electrical utility node junction on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Electrical Utility Meter—FOUO	Electrical utility meter on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Electrical Utility Substation—FOUO	Electrical utility substation on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Electrical Utility Switch—FOUO	Electrical utility switch on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Electrical Utility Transformer—FOUO	Electrical utility transformer on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Electrical Utility Segment—FOUO	Electrical utility segment on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Utility Feature Support—FOUO	Utility feature support on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
POL Utility Junction—FOUO	Petroleum, oil, and lubricants utility junction on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
POL Storage Tank—FOUO	Petroleum, oil, and lubricants storage tank on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
POL Utility Pipeline—FOUO	Petroleum, oil, and lubricants utility pipeline on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Thermal Utility Node—FOUO	Thermal utility node on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Thermal Utility Fitting—FOUO	Thermal utility fitting on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Thermal Utility Valve—FOUO	Thermal utility valve on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Thermal Utility Line—FOUO	Thermal utility line on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Future Projects Location—FOUO	Future projects location on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Future Projects Pavement—FOUO	Future projects pavement on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Future Projects Building—FOUO	Future projects building on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Future Projects Area—FOUO	Future projects area on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Towers—FOUO	Towers on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)

Table A-10 (cont.). Alaska data sources integrated into the EA.

Data - Alaska	Description	Sources, Citations, and URLs
Access control—FOUO	Access control on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Building Location—FOUO	Building location on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Land Management Zone—FOUO	Land management zone on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Structure—FOUO	Structure on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Land Parcel—FOUO	Land parcel on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Installation—FOUO	Installation layer was split into 2 layers (Fort Greely Space Missile Command and Installation boundaries near or on Fort Wainwright)	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Outside Installation—FOUO	Outside installations near Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Building Footprint—FOUO	Building footprint on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Site—FOUO	Site on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Stormwater Utility Inlet—FOUO	Stormwater utility inlet on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Stormwater Utility Discharge—FOUO	Stormwater utility discharge on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Stormwater Utility Junction—FOUO	Stormwater utility junction on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Culvert—FOUO	Culvert on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Stormwater Utility—FOUO	Stormwater utility on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Stormwater Utility Open Drainage—FOUO	Stormwater utility open drainage on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Wastewater Utility Sludge Bed—FOUO	Wastewater utility sludge bed on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Wastewater Utility Fitting—FOUO	Wastewater utility fitting on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Wastewater Utility Junction—FOUO	Wastewater utility junction on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Wastewater Utility Pump—FOUO	Wastewater utility pump on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Wastewater Utility Valve—FOUO	Wastewater utility valve on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Wastewater Utility Segment—FOUO	Wastewater utility segment on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)

Table A-10 (cont.). Alaska data sources integrated into the EA.

Data - Alaska	Description	Sources, Citations, and URLs
Water Utility Fitting—FOUO	Water utility fitting on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Water Utility Hydrant—FOUO	Water utility hydrant on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Water Utility Meter—FOUO	Water utility meter on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Water Utility Pump—FOUO	Water utility pump on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Water Utility Tank—FOUO	Water utility tank on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Water Utility Treatment Plant—FOUO	Water utility treatment plant on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Water Utility Valve—FOUO	Water utility valve on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Water Utility Segment—FOUO	Water utility segment on Fort Wainwright	Fort Wainwright, Fairbanks, Alaska (Ostrom 2019)
Coal District Boundary	Coal district boundary	Alaska Department of Natural Resources (DNR) Division of Geological and Geophysical Surveys (DGGS). Retrieved 5/4/2020 from https://dggs.alaska.gov/pubs/id/2636
Coal Basin Boundary	Coal basin boundary	Alaska DNR DGGS. Retrieved 5/4/2020 from https://dggs.alaska.gov/pubs/id/2636
Coal Field Boundary	Coal field boundary	Alaska DNR DGGS. Retrieved 5/4/2020 from https://dggs.alaska.gov/pubs/id/2636
Coal Locations	Coal locations—location of coal occurrence of unknown extent	Alaska DNR DGGS. Retrieved 5/4/2020 from https://dggs.alaska.gov/pubs/id/2636
Coal Ranks	Coal ranks	Alaska DNR DGGS. Retrieved 5/4/2020 from https://dggs.alaska.gov/pubs/id/2636
Heat Flow	Heat Flow—geothermal gradient test hole	Alaska DNR DGGS. Retrieved 4/28/2020 from https://dggs.alaska.gov/pubs/id/671
Thermal Springs	Thermal springs—hot springs data file was split into two feature classes using symbol field, based on map published by DGGS: thermal springs and thermal wells	Alaska DNR DGGS. Retrieved 4/28/2020 from https://dggs.alaska.gov/pubs/id/671
Volcanic Rocks	Volcanic rocks—Quaternary or Quaternary-Tertiary volcanic rocks	Alaska DNR DGGS. Retrieved 5/4/2020 from https://dggs.alaska.gov/pubs/id/2636
Volcanic Vents	Volcanic vents	Alaska DNR DGGS. Retrieved 4/28/2020 from https://dggs.alaska.gov/pubs/id/671
Wind Resource Potential at 50 m	Wind resource potential at 50 meters—data layer had over 1.3 million polygons without any attribute information so a DISSOLVE operation was performed, reducing the number of polygons to 9	NREL—Wind Energy Resource Atlas of the United States. Retrieved 1/28/2020 from http://www.nrel.gov/gis/wind_maps.html

Table A-10 (cont.). Alaska data sources integrated into the EA.

Data - Alaska	Description	Sources, Citations, and URLs
Wind Speed at 100 m	Wind speed at 100 meters	ANL (Argonne National Laboratory)—GEM (Geospatial Energy Mapper). Retrieved 5/11/2020 from https://gem.anl.gov/
Wind Speed at 80 m	Wind speed at 80 meters	ANL (Argonne National Laboratory)—GEM (Geospatial Energy Mapper). Retrieved 5/11/2020 from https://gem.anl.gov/
Climate Reference Network Sites	Climate reference network sites—added URLs for sensor site data, which includes daily data at that site	NOAA—National Centers for Environmental Information (NCEI) portal. Retrieved 6/9/2020 from https://gis.ncdc.noaa.gov/maps/ncei/
Hourly Climate Normals Sites	Hourly climate normals sites	NOAA—NCEI portal. Retrieved 6/9/2020 from https://gis.ncdc.noaa.gov/maps/ncei/
Daily Climate Normals Sites	Daily climate normals sites—added URLs for station site data, which includes daily data at that site	NOAA—NCEI portal. Retrieved 6/9/2020 from https://gis.ncdc.noaa.gov/maps/ncei/
Active Layer Thickness, 2100 (meters)	Projected active-layer thickness in 2100 under RCP 8.5 scenario (meters)	University of Alaska Fairbanks (UAF), Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36
Active Layer Thickness, 2090 (meters)	Projected active-layer thickness in 2090 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36
Active Layer Thickness, 2080 (meters)	Projected active-layer thickness in 2080 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36
Active Layer Thickness, 2070 (meters)	Projected active-layer thickness in 2070 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36
Active Layer Thickness, 2060 (meters)	Projected active-layer thickness in 2060 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36
Active Layer Thickness, 2050 (meters)	Projected active-layer thickness in 2050 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36

Table A-10 (cont.). Alaska data sources integrated into the EA.

Data - Alaska	Description	Sources, Citations, and URLs
Active Layer Thickness, 2040 (meters)	Projected active-layer thickness in 2040 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36
Active Layer Thickness, 2030 (meters)	Projected active-layer thickness in 2030 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36
Active Layer Thickness, 2020 (meters)	Projected active-layer thickness in 2020 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36
Active Layer Thickness, 2010 (meters)	Projected active-layer thickness in 2010 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36
Permafrost Base, 2100 (meters)	Projected annual minimum depth of permafrost base, 2100 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36
Permafrost Base, 2090 (meters)	Projected annual minimum depth of permafrost base, 2090 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36
Permafrost Base, 2080 (meters)	Projected annual minimum depth of permafrost base, 2080 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36
Permafrost Base, 2070 (meters)	Projected annual minimum depth of permafrost base, 2070 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36
Permafrost Base, 2060 (meters)	Projected annual minimum depth of permafrost base, 2060 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36

Table A-10 (cont.). Alaska data sources integrated into the EA.

Data - Alaska	Description	Sources, Citations, and URLs
Permafrost Base, 2050 (meters)	Projected annual minimum depth of permafrost base, 2050 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36
Permafrost Base, 2040 (meters)	Projected annual minimum depth of permafrost base, 2040 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36
Permafrost Base, 2030 (meters)	Projected annual minimum depth of permafrost base, 2030 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36
Permafrost Base, 2020 (meters)	Projected annual minimum depth of permafrost base, 2020 under RCP 8.5 scenario (meters)	UAF, Geophysical Institute Permafrost Laboratory. Retrieved 11/25/2020 from https://catalog.snap.uaf.edu/geonetwork/srv/eng/catalog.search#/metadata/c24a957b-8a56-40bf-bc09-43a567182d36
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Rivers/Streams	Rivers/streams	Open Street Map—US AGC Common Map Background Online portal. Retrieved 3/9/2020 from https://agcwfs.agc.army.mil/CMB_Online/default.html
Surface Water	Surface water	USGS—National Water Information System portal. Retrieved 3/24/2020 from https://waterdata.usgs.gov/ak/nwis
Roads	Roads	Open Street Map—AGC Common Map Background Online Portal. Retrieved 3/9/2020 from https://agcwfs.agc.army.mil/CMB_Online/default.html

Abbreviations

AGC	Army Geospatial Center
AGE	AGC Geospatial Enterprise
ANL	Argonne National Laboratory
AOI	Area of interest
CAC	Common Access Card
CONUS	Contiguous United States
DEC	Department of Environmental Conservation
DEEP	Department of Energy and Environmental Protection
DGGS	Division of Geological & Geophysical Surveys
DISDI	Defense Installation Spatial Data Infrastructure
DLG	Digital line graph
DNR	Department of Natural Resources
DOE	Department of Energy
E911	Emergency services
EA	Energy Atlas
EV	Electric vehicle
EVSE	Electric vehicle supply equipment
EZMT	Energy Zones Mapping Tool
FOUO	For official use only
GEM	Geospatial Energy Mapper
GIS	Geographic Information System
GMP	Green Mountain Power

GTN-P	Global Terrestrial Network for Permafrost
HIFLD	Homeland Infrastructure Foundation-Level Data
HSIP	Homeland Security Infrastructure Program
IC	Intelligence community
INL	Idaho National Laboratory
LANL	Los Alamos National Laboratory
MBTA	Massachusetts Bay Transportation Authority
MTC	Massachusetts Technology Collaborative
NCEI	National Centers for Environmental Information
NE	Northeast
NECEC	New England Clean Energy Connect
NGA	National Geospatial Agency
NREL	National Renewable Energy Laboratory
NSIDC	National Snow and Ice Data Center
NYS	New York State
NYSDPS	New York State Department of Public Services
ORNL	Oak Ridge National Laboratory
PV	Photovoltaic
PWS	Public water supply
RCP	Representative Concentration Pathway
ROI	Return On Investment
UAF	University of Alaska Fairbanks
USACE	US Army Corps of Engineers

USFS	United States Forest Service
USGS	United States Geological Survey
VTrans	Vermont Agency of Transportation

REPORT DOCUMENTATION PAGE

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14. ABSTRACT The DoD is a significant land user in northeast United States overseeing approximately 375 k acres of land with a total value of \$113 B. The Department of Energy has found that major impacts from climate change will threaten energy infrastructure in the northeast US moving into the future. Current spatial information related to the energy resources and infrastructure on and adjacent to DoD installations can play a vital role in decision-making for sustainable and resilient installation planning in the region. The Energy Atlas (EA) portal provides a secure value-added resource to inform the decision-making process for current and future investment in installation infrastructure, energy management, and improvements to energy resiliency and sustainability. The EA aggregates spatial data for energy, infrastructure, and related environmental resources and facilitates access to that information through a secure online portal. The EA is hosted on a Common Access Card–authenticated portal accessible to DoD decision-makers and their partners through the Intelligence Community Geographic Information System (GIS) portal. The expansion of data coverage within the EA portal helps the DoD account for energy in contingency planning, acquisition, and lifecycle requirements in the northeast US and ensures facilities can maintain operations in the face of disruption							
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