



# Understanding URANIUM

Pinyon Plain uranium mine (formerly Canyon Mine) in the Kaibab National Forest south of Grand Canyon National Park. BLAKE MCCORD

## How is uranium described and quantified?

Uranium is described in many different terms, including **deposits**, **reserves**, and **resources**. Answering the question “how much uranium is there?” is complicated. It depends on whether the uranium is physically confirmed or simply speculated to exist, and whether current technology can extract it cheaply enough for mining companies to make a profit. It helps to have a basic understanding of some of the different ways that uranium is measured and described. There are three categories of uranium resources:<sup>1</sup>

### **RAR** Reasonably assured resources

Uranium in known mineral deposits that are large enough, high enough grade, and accessible enough to be mined at or below a given cost using current technology and under current law and regulations. Quantity and grade estimates are based on sampling and measurements. Also known as “uranium reserves.”<sup>2</sup>

### **EAR** Estimated additional resources

Uranium expected to occur, based on geological evidence or geological trends in an area. This can include little-explored or undiscovered uranium deposits. Estimates about quantity and quality of uranium deposits are based on available sampling data or similar deposits.<sup>3</sup>

### **SR** Speculative resources

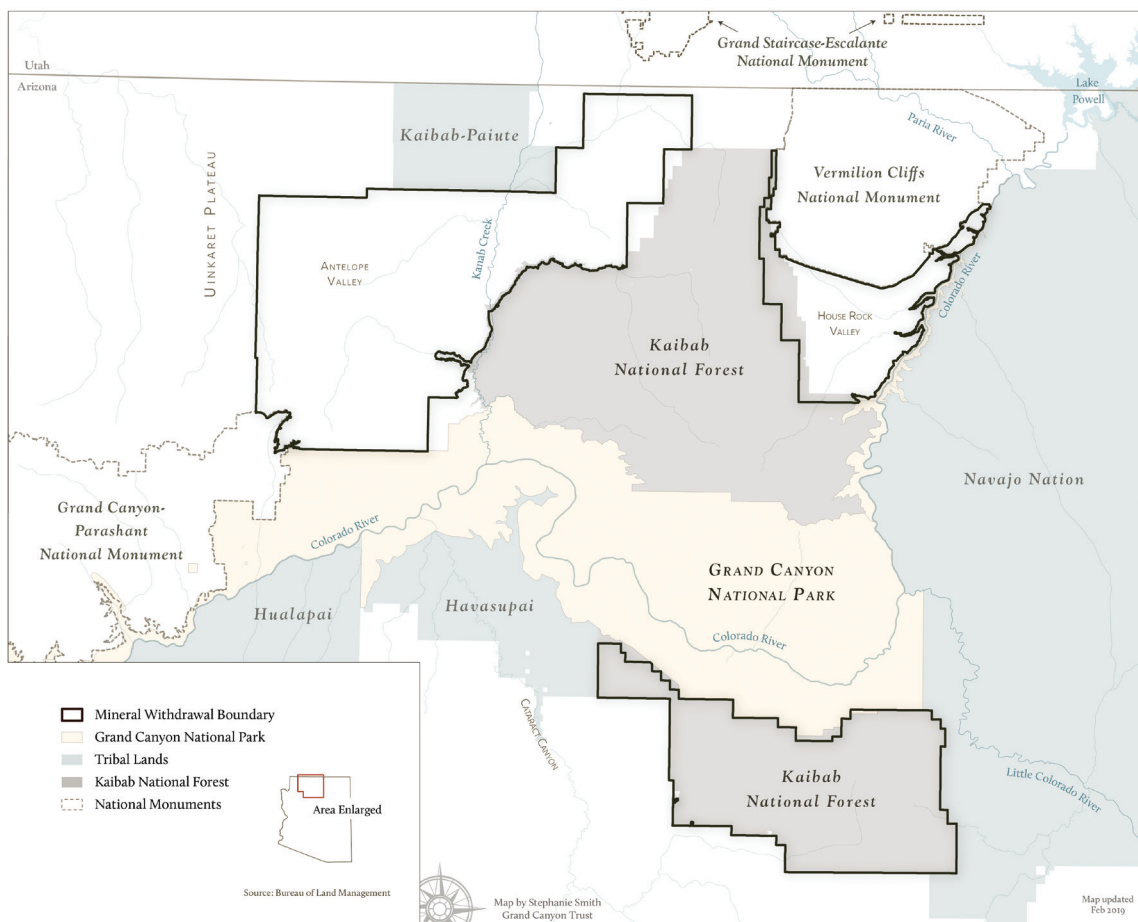
Uranium thought to exist, mostly based on indirect evidence and extrapolations. Specific locations of uranium deposits are unknown.<sup>4</sup>

There are also **uranium resource areas**—areas speculated to contain valuable uranium deposits.<sup>5</sup>



## How much uranium is in the Grand Canyon region?

In 2012, the secretary of the Interior temporarily banned new uranium mines on about 1 million acres of federal public lands near Grand Canyon National Park because of public concern about the negative impacts of uranium mining.



According to analyses done for that ban, called the “Northern Arizona Mineral Withdrawal,” there are:

### WITHIN THE BOUNDARIES OF THE GRAND CANYON MINING BAN<sup>6</sup>

**30.3 million** lbs of uranium reserves/reasonably assured resources<sup>7</sup>

**49 million** lbs of estimated additional resources<sup>8</sup>

**278 million** lbs of speculative resources<sup>9</sup>

### WITHIN THE UNITED STATES<sup>10</sup>

**1,227 million** lbs of uranium reserves/reasonably assured resources

**4,850 million** lbs of estimated additional resources

**3,480 million** lbs of speculative resources

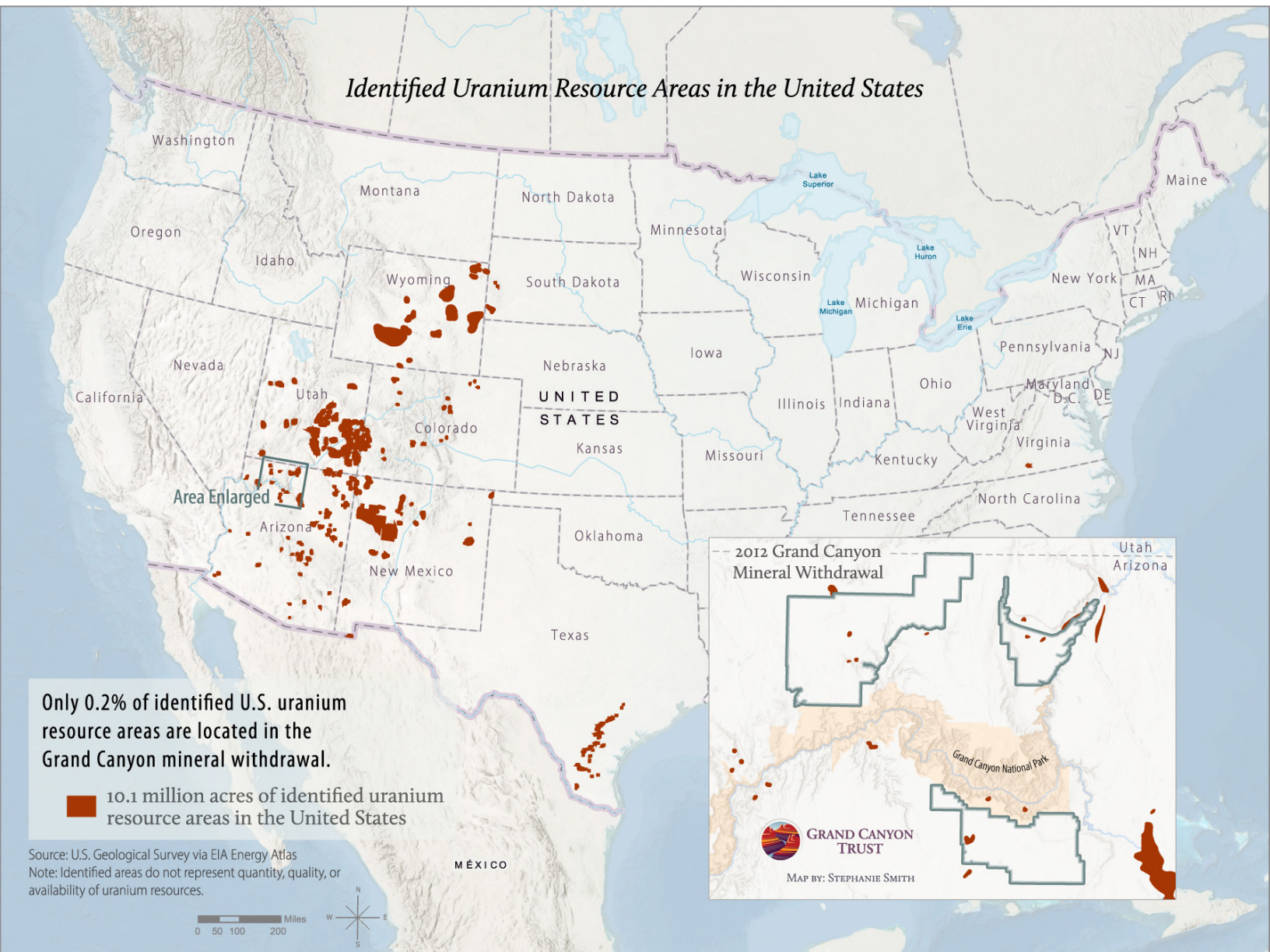
### ▶ **1.3 %**

Only 1.3 percent of U.S. uranium reserves and estimated additional resources are found within the Grand Canyon mining ban boundaries.<sup>11</sup>

### ▶ **0.2 %**

Only 0.2 percent of U.S. uranium resource areas are found within the Grand Canyon mining ban boundaries<sup>12</sup>

The bottom line: The Grand Canyon region does not host a significant portion of domestic mineable uranium.

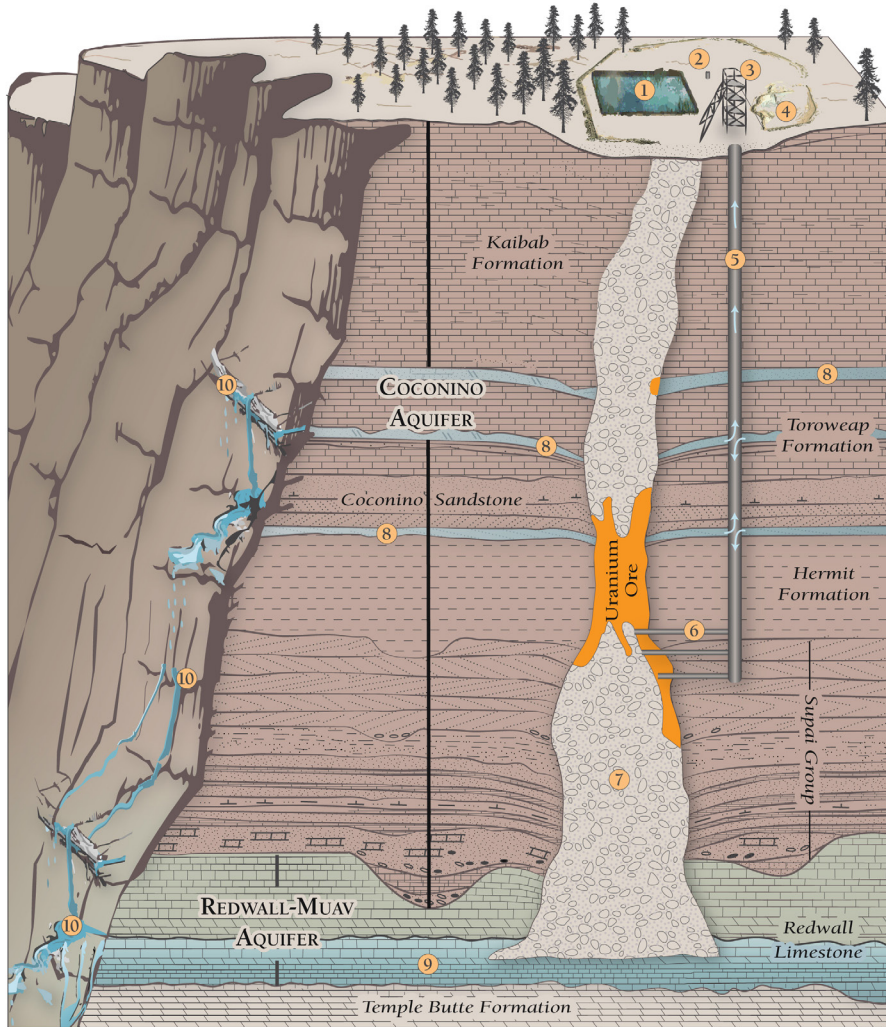


## Confused?

This map shows uranium resource areas, which are areas *speculated* to contain uranium. These are different from uranium reserves and estimated or speculative resources, which reflect actual or speculated *quantities* of uranium based on sampling or extrapolation from existing data. We mapped the uranium resource areas because more specific data about the locations of reserves and estimated resources are not publicly available.

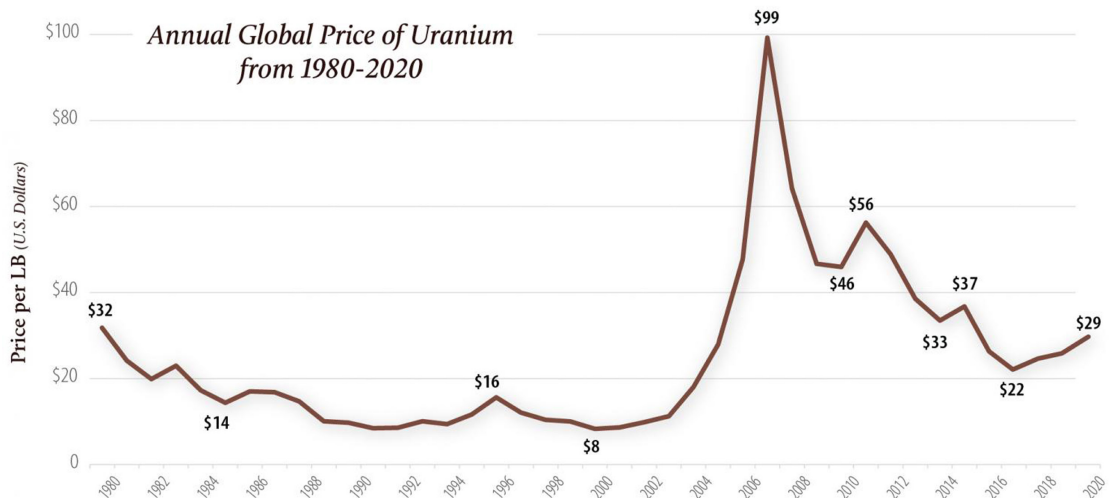


## Characterization of Uranium Deposits and Mining near Grand Canyon



SOURCE: Generalized and modified from the USGS Site Characterization of Breccia Pipe Uranium Deposits in Northern Arizona and Uranium Mine Conceptual Model  
 GRAPHIC BY STEPHANIE SMITH, GRAND CANYON TRUST

- |                                            |                               |                                       |
|--------------------------------------------|-------------------------------|---------------------------------------|
| ① Containment pond                         | ⑤ Mine shaft                  | ⑨ Regional aquifer                    |
| ② Ventilation shaft                        | ⑥ Horizontal shaft ("drifts") | ⑩ Seep or spring                      |
| ③ Mine headframe                           | ⑦ Breccia collapse feature    | ⬇️ Potential water flow in mine shaft |
| ④ Waste rock, ore pile, & top soil storage | ⑧ Perched aquifer             |                                       |



Data source: International Monetary Fund, Global price of Uranium, retrieved from FRED, Federal Reserve Bank of St. Louis.



## Understanding uranium terminology

### BRECCIA PIPE

Breccia pipes are columns of mineral deposits that typically range from 100 to 400 feet in diameter and up to 3,000 feet deep. Uranium deposits within breccia pipes formed over millennia as oxygenated groundwater carried trace amounts of uranium through the pipe, depositing uranium where oxygen levels dropped, rendering the uranium no longer soluble in water.

### FORWARD COST CATEGORY

The break-even cost of mining a pound of uranium (labor, fuel, insurance, etc.). Estimates of U.S. uranium reserves vary greatly depending on the forward cost category used in analyses.<sup>13</sup> The market price has to be at or above this figure to make mining a given deposit economically feasible.

### GRADE

The grade of uranium ore is determined by the percent of uranium oxide ( $U_3O_8$ ) it contains. For instance, uranium deposits at the Pinyon Plain Mine (formerly known as Canyon Mine) near the Grand Canyon have an ore grade of 0.88 percent,<sup>14</sup> meaning only about 0.88 percent of the mined ore will become yellowcake after it is milled. The rest will become uranium mill tailings—a toxic and radioactive waste product.

### URANIUM DEPOSIT

A confirmed concentration of mineralized uranium that could be of economic interest.<sup>15</sup> The International Atomic Energy Agency defines 15 major deposit types based on geology.<sup>16</sup> “Breccia pipes” are the type of uranium deposits of interest to mining companies near the Grand Canyon.<sup>17</sup>

### URANIUM ENDOWMENT

Uranium with a grade of at least 0.01 percent  $U_3O_8$  (uranium oxide) estimated to exist in rock. Uranium endowment estimates do not take economics into account.<sup>18</sup> An endowment does not necessarily represent what can actually be profitably mined.

### URANIUM MILL TAILINGS

Sand-like materials left over after uranium is separated from its ore. More than 99 percent of the ore becomes tailings.<sup>19</sup> Uranium mill tailings are radioactive and toxic, and include chemicals used to process uranium ore as well as other minerals and heavy metals found in the ore.

### URANIUM OXIDE ( $U_3O_8$ )

Uranium concentrate or yellowcake. Usually a yellow or brown powder produced by milling uranium ore.<sup>20</sup> The amount of  $U_3O_8$  that can be milled from a ton of ore indicates the particular grade of that ore.

### URANIUM RESERVES

Estimated quantities of uranium in known mineral deposits that are large enough, high enough grade, and accessible enough to be mined at or below a given cost using current technology and under current law and regulations. Reserves are estimated based on direct measurements of deposits through drill holes and other types of sampling. Ore grades, how deep deposits are located, mining and reclamation methods, distances to milling facilities, and how difficult the ore would be to process are considered in estimating reserves.<sup>21</sup>

## How confident are you?

The terms "reasonably assured resources" (RAR) and "uranium reserves" generally indicate a greater level of confidence in both the presence of uranium and the feasibility of mining it. But look for the forward cost used in the analysis (the U.S. Energy Information Administration uses categories of \$50 or less and \$100 or less per pound to estimate reserves). The forward cost will tell you what range the price of uranium has to be in for the ore to count as a reserve in that analysis. You can then look at the current market price of uranium at any given time to get a better idea of how close to reality a reserve estimate might be (i.e. if the current market price is \$40 per pound, and a reserve estimate used \$100 or less per pound as the forward cost category, at least some of that estimated reserve is not currently mineable).

With the exception of "reasonably assured resources," the terms "resource" and "endowment" indicate a greater level of uncertainty about the presence of uranium and the feasibility of mining uranium.

Some estimates will describe the quantity of uranium in both reserves and estimated additional resources (EAR) (i.e., uranium that is probable, though not confirmed, but also not as uncertain as speculative resources (SR)). This is why you might see headings like "Reserves and Resources" in analyses like the 2012 Northern Arizona Mineral Withdrawal Final Environmental Impact Statement.<sup>22</sup> This shows you that the analysis is accounting for both uranium reserves in which there is higher confidence and uranium resources in which there are varying degrees of uncertainty.

## Endnotes

<sup>1</sup> The international community uses these three categories to indicate differing levels of confidence about whether uranium resources exist. You can read about how these categories compare to the U.S. Department of Energy's three potential resource categories ("probable potential resources," "possible potential resources," and "speculative potential resources") in the U.S. Department of Energy Office of Scientific and Technical Information's "Estimation of potential uranium resources," see page 4, available at <https://www.osti.gov/servlets/purl/5325527-n9n1et/>. Accessed November 15, 2022.

<sup>2</sup> Energy Information Administration. "Reasonably assured resources (RAR)." <https://www.eia.gov/tools/glossary/index.php?id=uranium>. Accessed November 15, 2022.

<sup>3</sup> Energy Information Administration. "Estimated additional resources (EAR)." <https://www.eia.gov/tools/glossary/index.php?id=uranium>. Accessed November 15, 2022.

<sup>4</sup> Energy Information Administration. "Speculative resources (SR)." <https://www.eia.gov/tools/glossary/index.php?id=uranium>. Accessed November 15, 2022.

<sup>5</sup> U.S. Geological Survey. Mineral resource areas of the Yellowstone River Basin, Montana and Wyoming. "Mineral resource areas are defined as those areas with a high likelihood of containing occurrences of valuable mineral deposits." [https://water.usgs.gov/GIS/metadata/usgswrd/XML/yell\\_mineral.xml](https://water.usgs.gov/GIS/metadata/usgswrd/XML/yell_mineral.xml). Accessed November 15, 2022.

<sup>6</sup> The 2012 Northern Arizona Proposed Mineral Withdrawal Final Environmental Impact Statement does not specify the forward cost category for reserves and resources in the withdrawal area, but does compare them to the estimates in the \$100/lb forward cost category nationwide. See table Table 3.17-30. "Comparison of World, United States, and Withdrawal Area Reserves and Resources of Uranium, Year-End 2008 (in million pounds U<sub>3</sub>O<sub>8</sub>)," page 3-295 of the document (page 381 of the PDF). [https://www.grandcanyontrust.org/sites/default/files/resources/gc\\_FEIS\\_Northern\\_Arizona\\_Proposed\\_Withdrawal.pdf](https://www.grandcanyontrust.org/sites/default/files/resources/gc_FEIS_Northern_Arizona_Proposed_Withdrawal.pdf). Accessed November 15, 2022.

<sup>7</sup> Ibid., page 3-294.

<sup>8</sup> Without an estimated additional resources or speculative resources estimate, the 2012 FEIS instead assumes 15 percent of the estimated uranium endowment could be economic to mine; the remainder is considered speculative. Ibid.

<sup>9</sup> Ibid.

<sup>10</sup> Ibid., Table 3.17-30, page 3-295.

<sup>11</sup> This is determined by adding reserves and estimated additional resources within the withdrawal area and dividing it by the reserves and estimated additional resources found nationwide. Using the most generous estimate, including speculative resources, the figure becomes 3.73 percent of national uranium reserves and resources.

<sup>12</sup> Grand Canyon Trust. "Identified Uranium Resources in the United States Map." <https://www.grandcanyontrust.org/identified-uranium-resources-united-states-map>. Accessed November 18, 2022.

<sup>13</sup> U.S. Energy Information Administration. "U.S. Uranium Reserves Estimates." <https://www.eia.gov/uranium/reserves/table3.php>. Accessed November 15, 2022.

<sup>14</sup> Energy Fuels Inc. "Technical Report on the Pinyon Plain Project." Table 14-1: Summary of Attributable Mineral Resources. February 22, 2022. Page 70. <https://www.grandcanyontrust.org/sites/default/files/resources/2022TechnicalReportPinyonPlainProject.pdf>. Accessed December 5, 2022.

<sup>15</sup> U.S. Energy Information Administration. "Uranium deposit." <https://www.eia.gov/tools/glossary/index.php?id=uranium>. Accessed November 15, 2022.

<sup>16</sup> World Nuclear Association. "Geology of Uranium Deposits." Updated May 2020. <https://world-nuclear.org/information-library/nuclear-fuel-cycle/uranium-resources/geology-of-uranium-deposits.aspx>. Accessed November 15, 2022.

<sup>17</sup> Smith, Stephanie. Grand Canyon Trust. "Characterization of Uranium Deposits and Mining Near the Grand Canyon." April 23, 2018. <https://www.grandcanyontrust.org/characterization-uranium-deposits-and-mining-near-grand-canyon>. Accessed November 15, 2022.

<sup>18</sup> U.S. Energy Information Administration. "Uranium endowment." <https://www.eia.gov/tools/glossary/index.php?id=uranium>. Accessed November 15, 2022.

<sup>19</sup> U.S. Energy Information Administration. "Uranium mill tailings." <https://www.eia.gov/tools/glossary/index.php>. Accessed November 15, 2022.

<sup>20</sup> U.S. Energy Information Administration. "Uranium oxide." <https://www.eia.gov/tools/glossary/index.php>. Accessed November 15, 2022.

<sup>21</sup> U.S. Energy Information Administration. "Uranium reserves." <https://www.eia.gov/tools/glossary/index.php?id=uranium>. Accessed November 15, 2022.

<sup>22</sup> U.S. Department of Interior. "Northern Arizona Mineral Withdrawal: Final Environmental Impact Statement." 2012. Pages 3-294 to 3-295 (pages 380-381 of the PDF). [https://www.grandcanyontrust.org/sites/default/files/resources/gc\\_FEIS\\_Northern\\_Arizona\\_Proposed\\_Withdrawal.pdf](https://www.grandcanyontrust.org/sites/default/files/resources/gc_FEIS_Northern_Arizona_Proposed_Withdrawal.pdf). Accessed November 15, 2022.



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