Potential for Wind Energy on the Fort Bidwell Reservation

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***Abstract*—Tribal lands account for 2.4% of U.S. total acreage and, as of 2021, nearly 8% of its wind energy potential. These lands are commonly rural and historically have had less than average access to electricity. This project's objective was to examine the Fort Bidwell Reservation and locate a site for wind energy generation using ArcGIS' buffer tool. The buffer tool's output boundaries were cross referenced with wind density maps and tribal territory to find a specific location suitable for a wind energy project. The project was technically successful. Results show two appropriate locations, around 100 acres and 200 acres respectively, much larger areas than needed for a wind farm. However, further research is necessary as these two sites are at the outer edges of the reservation and at high elevation. These limitations were outside of the scope of the project and, therefore, it cannot be said with absolute certainty that these two sites are 100% conforming. Furthermore, while an area may be technically suitable, it is also necessary to consult with tribal leadership to ensure the land is not of cultural significance and, therefore, not available for development.**

Keywords—Energy Sovereignty; Wind; ArcGIS.

I. INTRODUCTION AND PROBLEM DEFINITION

The power grid faces many new obstacles that range from technological innovation to climate change. The pivot away from fossil fuels and the diversification of the grid through alternative energy sources is central to both challenges. It is understood that rural populations present unpredictable stress on the power grid in times of instability. Shoring up these points of grid weakness can reinforce the grid's overall stability. The native people who inhabit U.S. tribal lands (2.4% of total U.S. acreage [1,2]) are under a particular set of circumstances. Many such communities are underserved, some without access to electricity at all [3], despite them representing nearly 8% of U.S. wind potential [4,5]. By focusing resources on these areas, we can address grid stability, grid diversification, and climate justice all at once. Wind energy generation is a more mature technology today than in the recent past and can be harnessed by these communities to pull themselves out of energy poverty, perhaps even achieving energy sovereignty.

This project's primary objective was to ascertain whether the Fort Bidwell Reservation can host a wind energy farm on its land. Most importantly, the will and desires of the Fort Bidwell Reservation community must be prioritized. As part of the project, other energy project proposals were researched. The goal of locating an appropriate wind farm site is not to be placed over other reasonable solutions available if they present themselves. Tribal land data and wind density maps were cross referenced. ArcGIS Pro's buffer tool created boundaries around watercourses, residential areas and a local airport. We expected that once these restrictions were in place, an appropriate site would be revealed given the area's rich resource and the large size of the reservation.

The Fort Bidwell Reservation tribal leadership is the intended audience of the research as well as government programs designed to diversify the power grid. Energy independence can be a steppingstone to a more educated and healthier community. If a large enough site is found, it may be possible that beyond supporting local infrastructure, energy could potentially be returned to the California grid to provide financial benefits to the people of the Fort Bidwell Reservation. This type of project, if at large enough scale, could also add jobs to the local economy. The benefits of a successful wind farm are many.

Section 2 reviews the literature. Section 3 describes the data selection and acquisition. Section 4 details the system used for the analysis. Section 5 lays out the methods used. Section 6 discusses the results. Section 7 concludes.

II. LITERATURE REVIEW

The topic of the project was selected because it is at the intersection of power diversification, emerging technologies, climate change, and energy justice. All energy producers will need to continue efforts to diversify the power grid to combat the negative impacts caused by climate change and increased demand. This increased demand will be in part due to migration to such newer energy technologies as electric vehicles. Given that native reservations are typically isolated and underdeveloped, it makes them unusually vulnerable to energy instability. However, native lands are generally rich in alternative energy potential and, thus, could be positioned to become energy sovereign soon.

The literature review was focused on two main areas. The first area is wind turbine farming: pros, cons and other relevant information. The review's goal was to determine what requirements must be met prior to project initiation, what exactly qualifies as a good candidate for wind farming and what alternatives to wind farming may be better suited for this specific geographic area. The second area of literature review was the history of renewable energy projects on or near Fort Bidwell and the history of the Fort Bidwell Reservation.

Rediske et al. [6] concisely stated that "wind energy is abundant, costless, widely distributed and its generation is pollution-free." Detailed in this article is a comprehensive guide to evaluating an area to determine if it is suitable for a wind farm project. The first step in such an investigation is accounting for restrictive factors, commonly referred to as exclusion criteria. To maintain a manageable scope for this project, only a limited number of restrictive factors were considered. The article details twenty considerations, but this project was limited to the most relevant five. The factors included road networks, urban areas, airports, wind speed and watercourses. A wind farm needs to be within 500 meters of the main road network [6]. Urban areas should be a minimum of 1,000 meters away from wind farms due to noise and shading generated by the turbine blades. Airports must be at minimum 2,500 meters away from wind farms because electromagnetic radiation from the turbines may interfere with telecommunication networks. One of the most crucial restrictions is wind speed, the site's wind speed must be greater than 7 meters per second and less than 25 meters per second to avoid damage from strong winds. Finally, the last restrictive factor for this project was proximity to watercourses and streams because wind farms should not be within 400 meters of rivers or streams. These restrictions should provide sufficient guardrails when assessing potential sites for a wind farm on the Fort Bidwell Reservation.

The barriers to renewable energy generation must be researched prior to any renewable energy generation project. The realities of historic disenfranchisement and the lingering effects thereof must be addressed to ascertain the feasibility of such a large scale project. U.S. native reservations are under the jurisdiction of the federal government. However, these tribes were historically unable to make use of federal tax credits which greatly incentivize renewable development [7]. Wolfe [8] stated, "Settler colonialism is an ongoing structure, not an event, upheld by institutions, policies and laws—many centuries old—that continue to shape renewable energy development on Native lands."

Through the course of this project, the goal was maintained alongside an openness to more efficient and appropriate alternatives to the initial research objective. Research was conducted with an eye for wind energy generation but with a willingness to acknowledge solar, geothermal or any other form of renewable energy as a superior option for the Fort Bidwell Reservation. For instance, it is known that geothermal energy has many advantages over solar and wind systems [9]. Such systems were briefly considered throughout this project.

The second area of research for this project is centered on the history of the Fort Bidwell Reservation as well as other tribes and their experiences in harnessing alternative energy on their land.

The native people of the Americas have a rich cultural heritage that runs parallel with a tragic and extensive history of colonialism. More recently, similar problems have arisen on their federally recognized lands: electricity inequality, educational gaps, and a generally lower standard of living [10–12]. It is true that there is a shared history, but it can also be said that due to cultural and geographic differences, each of these communities may tread different paths to an equitable future. Understanding the Fort Bidwell Indian Community is crucially important to this research when analyzing potential projects on their land. What may work for some communities may not work for all.

U.S. native tribes vary greatly in size. The largest U.S. tribe is the Navajo Nation, which, like the Cherokee, Choctaw, Chippewa, and Sioux, has a tribal membership of over 200,000 members [13]. On the other end of the spectrum, tribes like the Augustine Band of Cahuilla Indians have a total of 20 enrolled members [14]. The Fort Bidwell Indian Community is on the smaller side of the scale, according to the 2020 Census, 97 people reside on the Fort Bidwell Reservation [15]. The reservation has a slightly higher than national average employment rate of 62.3% and their median household income, $24,375, is less than one third the nation's [16].

A 2005 [17] study into the feasibility of installing a geothermal district heating system to provide low-cost heating by harnessing a geothermal well concluded that there is more than enough energy available from the FB-3 geothermal well to support the reservation and the entire town of Fort Bidwell. A second study in 2007 stated that drilling in a secondary location, FB-4, had begun in 2007 (Figure 1). This report stated that the FB-4 well had a temperature from 100 to 200 degrees Fahrenheit and, while the system would cost $1.5 million to install, it would have an annual energy savings of $124,300, yielding an estimated payback period of 12 years. In this report, consultant Dale Merrick went on to state that the Fort Bidwell Reservation could more than meet their own energy needs through geothermal means and that the reservation still had significant potential for developing both solar and wind energy to further bolster their future.

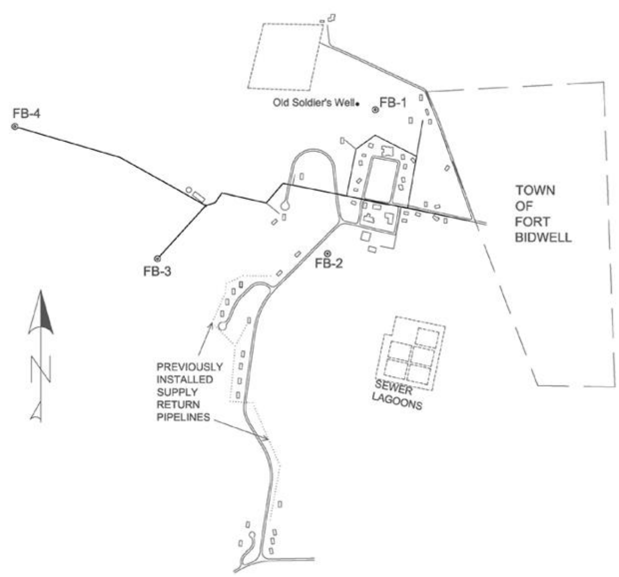

Figure 1. Map of the Fort Bidwell Area (adapted from [17]).

Of course, developing alternative energy on tribal lands is not a new idea. This being the case, there are examples of on-going projects to examine. One of the more enterprising tribes, The San Rincon Band of Luiseño Indians in the San Diego area, who may be most widely known as the owners of Harrah's Resort Southern California, have embarked on several energy projects to establish their own microgrid. Most recently, they received a grant for long-duration storage early in 2024 [18]. Prior to their latest investment into their energy sovereignty, they began work in 2020 to build a solar microgrid [19]. During the construction of this project, they issued a list of lessons learned that could be helpful to others attempting or planning similar endeavors. The first lesson was that microgrid projects can be extra complex; adding more components, such as meters, will ratchet up complexity.

Existing plans and information may be limited, rooftop solutions may not be feasible, and one may not be able to integrate existing energy assets. Furthermore, budget and time estimates should be ultra conservative, as costs will likely be higher than anticipated. Interconnection studies should be conducted as early as possible. A well-funded and resourced tribe like the San Rincon Band stressed that expert support is vital.

Not all native energy projects in California are as rosy. For example, the Campo Indian Reservation has been battling its neighbors in court to begin work on a vast wind farm to place 60 turbines on its land in San Diego. The project received approval in 2021, but, as of March 2024, the project was still tied up in litigation [20]. Other alternative energy projects have seen unobstructed success. For example, [21] reported that the Paskenta Band of Nomlaki Indians announced a plan to develop a large-scale solar and storage project on its reservation. The project was the recipient of a $32.75 million grant from the California Energy Commission under its Long Duration Storage Program and broke ground in April of 2024 [20]. The report went on to detail $31 million was awarded to Indian Energy LLC to develop a microgrid for the Viejas tribe of Kumeyaay Indians.

III. DATA SELECTION AND ACQUISITION

A. *Data Source 1*

The Global Wind Atlas [22] is a free, web-based application developed to help policymakers, planners, and investors identify high-wind areas for wind power generation. With this wind density mapping, areas with high potential for wind energy generation can be easily identified (see Figure 2).

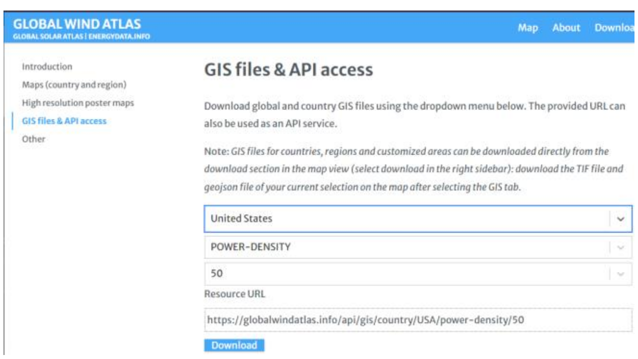

Figure 2. Downloading Wind Density Map [22].

B. *Data Source 2*

The California Energy Commission's federally recognized tribal lands map identifies tribal areas that fall within California's borders [23]. The data from the map is informed by the 2021 U.S. Census (see Figure 3).

C. *Data Source 3*

Building and geographical feature data came from OpenStreetMap (OSM) data [24] hosted by Esri, supported by Meta, and supplemented with additional data from Microsoft. The data is updated every month and aided in setting proper distances from existing infrastructure (see Figure 4).

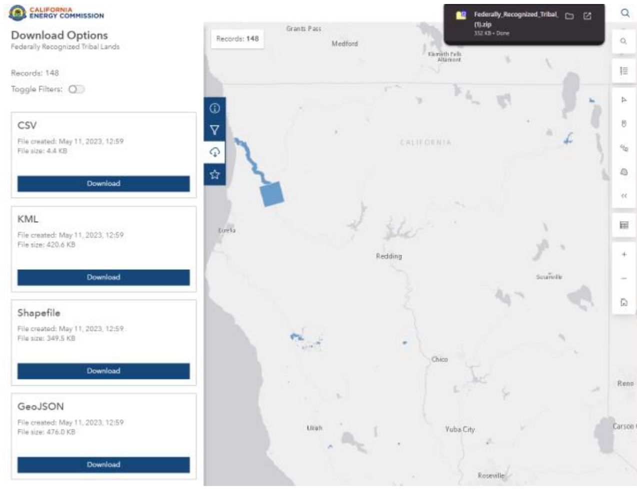

Figure 3. Downloading Tribal Land Map [23].

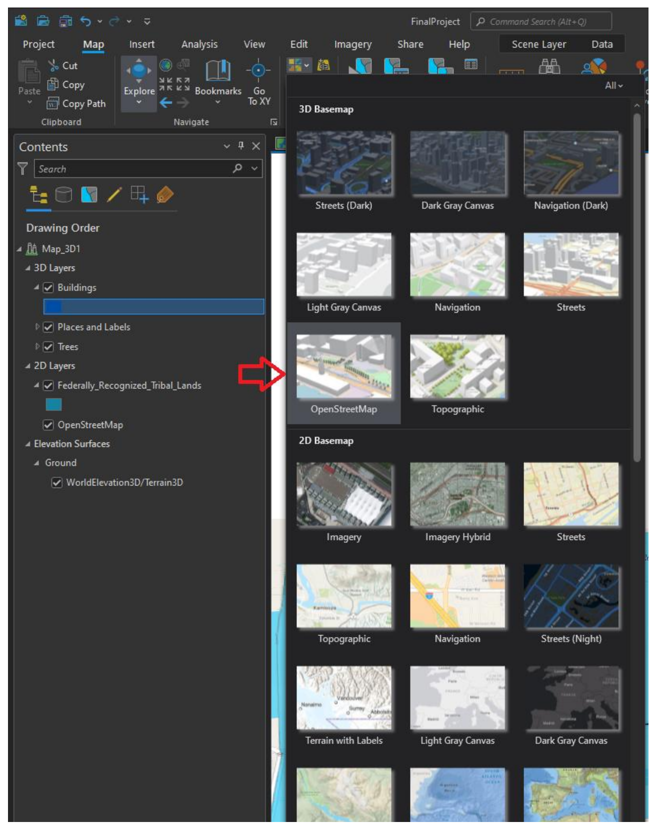

Figure 4. Selecting OpenStreetMap Basemap.

These data formed the basis of the analysis.

IV. SYSTEM

The primary tool for this project is ArcGIS Pro 3.3.1. The aforementioned datasets were compiled onto a single map using ArcGIS Pro, and the buffer tool was deployed to visualize the areas where a wind farm would not be appropriate. The computer used was a Windows 10 machine with an Intel i7-7700K processor and a Nvidia RTX 2070 Super GPU.

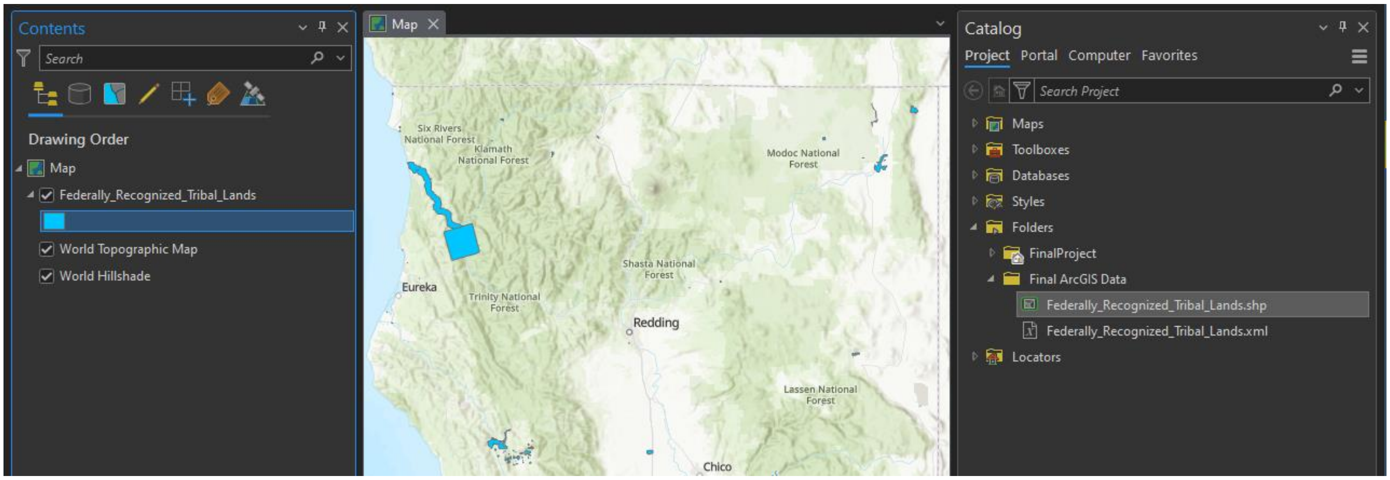

Figure 5. Adding Tribal Land Map.

V. METHODOLOGY

The first step of this project was adding the map of tribal land obtained from the California Energy Commission as a shapefile. The compressed folder was added to the project folder, extracted and then located in ArcGIS Pro in catalog view (see Figure 5).

Next, the wind density map from the Global Wind Atlas (as a TIFF image) was added to ArcGIS Pro. We selected Add Data under the Map tab. Figure 6 shows the results after it was processed.

OSM is a feature native to ArcGIS Pro under Basemap, this was used to identify roads, structures and water features. Figure 4 shows this process. These three steps form the basis of the project. Once these three elements were in place, more distinctive color schemes were chosen to differentiate the data. After that step, the main analysis tool was deployed. Buffer analysis was chosen for this project. This tool gives immediate visual information on which parts of the reservation would not be appropriate for a wind turbine. The buffer tool creates a visual radius around any feature selected by any distance specified. For this project, we used meters for the measurement as this was the usual unit of measurement in our cited references.

The first feature class processed using the buffer tool was Buildings containing residential-building information. The data of where these buildings were located was already present thanks to the basemap, OSM. A feature class named Buildings was created and the westernmost buildings were manually marked with yellow triangles (Figure 7).

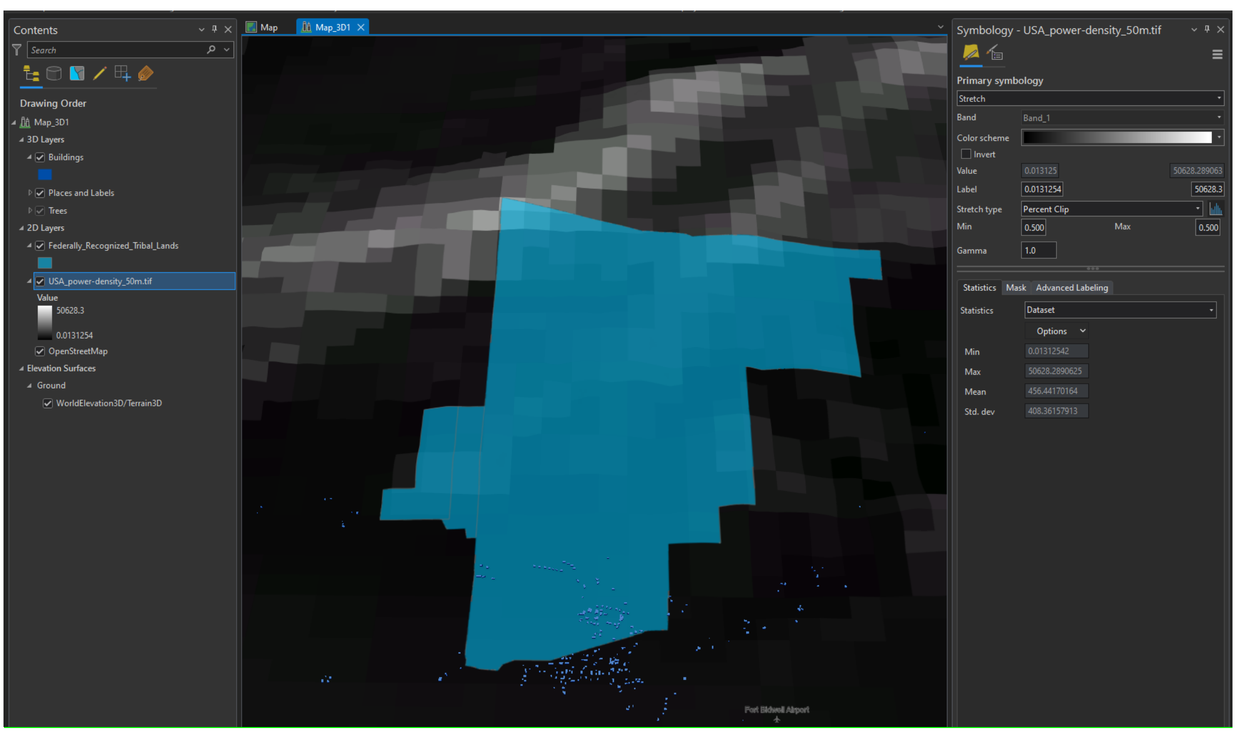

Figure 6. Adding Wind Density Map.

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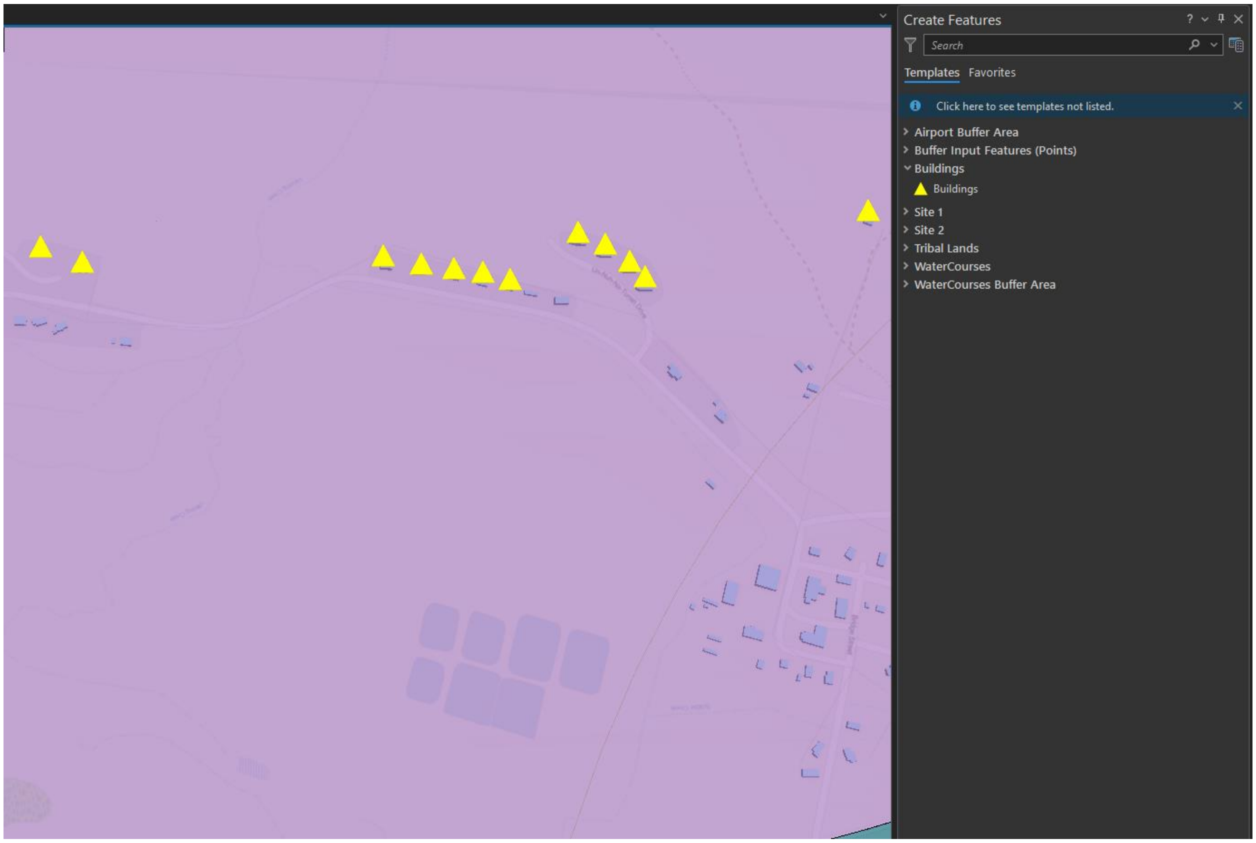

Figure 7. Feature Class Buildings After Marking.

The same process was followed for the local airport and all watercourses on the Fort Bidwell Reservation. These feature classes were named Airport and Watercourses respectively. Once all the restrictive factors were located and marked, the Buffer tool was then used. We selected the Buildings feature class, input the distance and chose the unit of measure (Figure 8).

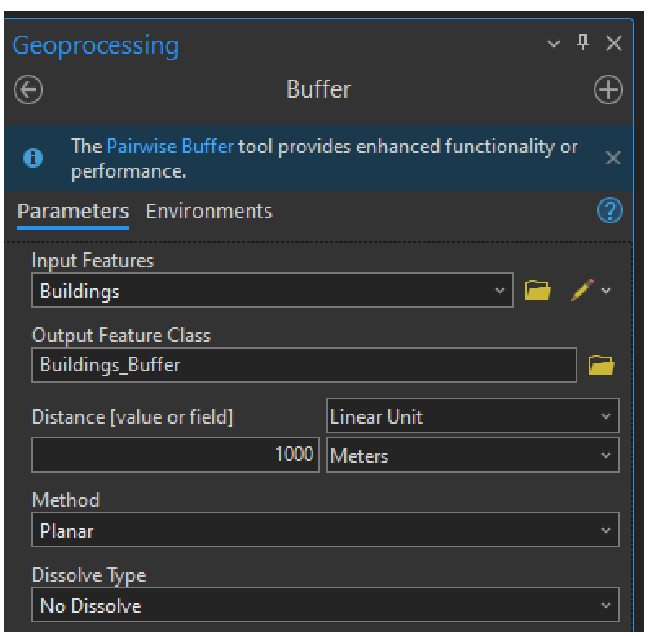

Figure 8. Buffer Tool Process for Buildings Feature Class.

VI. RESULTS AND DISCUSSION

The analysis located two sites that could theoretically be capable of hosting a wind turbine farm: Site 1 in the southwest corner of the reservation and Site 2 along the western border of the reservation. Both sites, according to the area measurement tool, are over the 40-acre minimum requirement for a wind turbine operation. Site 1 is approximately 200 acres and Site 2 is approximately 90 acres. Figure 9 shows that the airport was a negligible obstruction. The residential areas are also far enough from the high-wind areas to matter little to site selection. The greatest restrictive factor was watercourses. The wind speeds on the reservation do not reach dangerous speeds, so this restriction was excluded from the analysis early in the project. Distance from roads was also eventually abandoned as a consideration because the roads near the two sites are dirt service roads that could be easily traversed.

VII. CONCLUSION AND FUTURE WORK

The project resulted in useful data, but the sites need further scrutiny and expert input. We believe the project produced a solid starting point for energy-project evaluation on the reservation. The research portion highlighted the use of geothermal energy. Unfortunately, we were unable to locate any information on the success of these projects which would be of great value to any future energy project on the Fort Bidwell Reservation. Regardless of the success of those projects, wind or solar options would still be worth

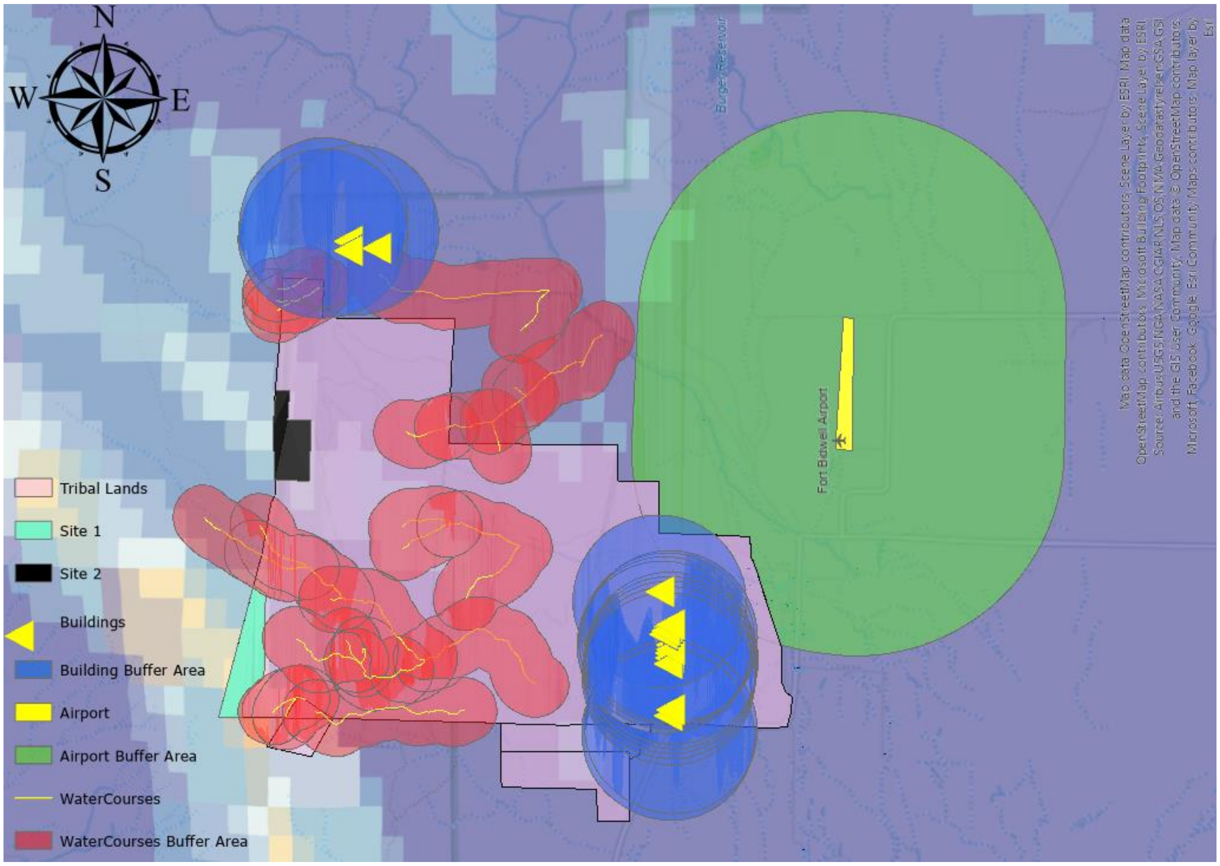

Figure 9. Analysis Results.

considering. Diversification of energy sources would help insulate the community from instability if any one source is disrupted by climate change, natural disaster, or technical challenges. We recommend for this particular area that anyone interested in beginning an energy project contact tribal leadership. This is a common hurdle for energy projects on tribal land. Furthermore, in some instances, appropriate land was determined, but projects ultimately failed when the tribal communities notified researchers that the land was of cultural importance. This made developing some projects infeasible on the grounds that the native communities would be uncooperative to defend their cultural heritage. In this specific case, according to research on the Fort Bidwell Reservation, geothermal energy had the potential to cover all energy needs of the community. If further research concludes that wind energy is not suitable, then it would be wise to survey the reservation for potential solar energy generation sites.

REFERENCES

[1] G. Rediske et al., "Wind power plant site selection: A systematic review," Renewable and Sustainable Energy Reviews, vol. 148, art. 111293, 2021. [Online]. Available from: https://doi.org/10.1016/j.rser.2021.111293

[2] C. Grosse and B. Mark, "Does renewable electricity promote indigenous sovereignty? Reviewing support, barriers, and recommendations for solar and wind energy development on native lands in the United States," Energy Research & Social Science, vol. 104, art. 103243, 2023. [Online]. Available from: https://doi.org/10.1016/j.erss.2023.103243

[3] P. Wolfe, "Settler colonialism and the elimination of the native," Journal of Genocide Research, vol. 8, no. 4, pp. 387–409, 1999. [Online]. Available from: https://doi.org/10.1080/14623520601056240

[4] K. Li, H. Bian, C. Liu, D. Zhang, Y. Yang, "Comparison of geothermal with solar and wind power generation systems." Renewable & Sustainable Energy Reviews, vol. 42, pp. 1464–1474, 2015. [Online]. Available from: https://doi.org/10.1016/j.rser.2014.10.049

[5] D. Merrick, "Renewable energy development on tribal lands," Energy.gov, 2007. [Online]. Available from: https://www.energy.gov/indianenergy/articles/project-reports-fort-bidwell-indian-community-2005-project. Accessed January 12, 2025.

[6] B. Edwards, "Northern California tribe sets path to energy sovereignty with large-scale solar and storage microgrid project," Tribal Business News, June 19, 2023. [Online]. Available from: https://tribalbusinessnews.com/sections/energy/14371-northern-california-tribe-sets-path-to-energy-sovereignty-with-large-scale-solar-and-storage-microgrid-project. Accessed January 12, 2025.

[7] M. Temp and R. Nikolewski, "Wind project in San Diego's backcountry runs into turbulence," San Diego Union-Tribune, March 22, 2024. [Online]. Available from: https://www.sandiegouniontribune.com/2024/03/22/wind-project-in-san-diegos-backcountry-runs-into-turbulence. Accessed January 12, 2025.

[8] Global Wind Atlas, "Introduction," 2015. [Online]. Available from: https://globalwindatlas.info/en/about/introduction. Accessed January 12, 2025.

[9] California Energy Commission, "Federal recognized tribal lands," 2023. [Online]. Available from: https://cecgis-caenergy.opendata.arcgis.com/datasets/21620043addf4c9da3540538671e47ba_0/explore?location=41.861547%2C-120.143269%2C13.21. Accessed January 12, 2025.

[10] OpenStreetMap, Esri. [Online]. Available from: https://openstreetmap.maps.arcgis.com

 ISBN: 978-1-68558-242-5