

Final Report

Ketron Island Microgrid Study

Ketron Island, WA

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Acronyms

ASIL	acceptable source impact level
BESS	battery energy storage system
BMP	best management practice
DAHP	Washington Department of Historic Preservation
dBA	A-weighted decibels
DEEP	diesel engine exhaust particulate
EDNA	Environmental Designation for Noise Abatement
EPA	U.S. Environmental Protection Agency
GIS	geographic information system
HDR	HDR Engineering, Inc.
HIA	health impact assessment
kVA	kilovolt-ampere(s)
kW	kilowatt(s)
kWh	kilowatt hour(s)
NOC	Notice of Construction
PHS	protected habitats and species
PSCAA	Puget Sound Clean Air Agency
PV	photovoltaic
R10	Rural 10
SQER	small quantity emissions rates
TAP	toxic air pollutant
tBACT	best available control technology for toxics
V	volt(s)
WISAARD	Washington Information System for Architectural and Archaeological Records Data

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1 Executive Summary

Ketron Island is a small community in the Puget Sound currently served by a single underwater power cable that has exceeded its usable life, prompting the need for a long-term, reliable replacement solution. HDR Engineering, Inc. (HDR), was tasked with developing a four-phase study culminating in this final report and conceptual microgrid design for the island. HDR's work leading up to this final report includes the following documentation: Real Estate Potential Assessment and Peak Electrical Energy Load Forecast (October 2025; HDR 2025), Microgrid Technology Screening Memorandum (March 2026; HDR 2026a), and Analysis of Alternatives (July 2026; HDR 2026b). These efforts estimated the island's future load requirements, identified feasible microgrid technologies, and evaluated potential system configurations based on technical, operational, financial, and permitting considerations. The Analysis of Alternatives study (HDR 2026b) was provided to Tacoma Power to support their selection of a preferred configuration. Tacoma Power subsequently selected the configuration that includes solar, battery storage, and diesel generation.

A conceptual design was developed and evaluated against the known development constraints. The evaluation identified no fatal flaws that would preclude development of the proposed Solar PV + BESS + Diesel Generation microgrid at the selected site. The preferred alternative is capable of meeting projected island electrical demand while reducing reliance on diesel fuel through integration of renewable energy generation and battery storage. The conceptual design includes a 216-kilowatt (kW AC) solar photovoltaic (PV) array, a 979-kW/3,916-kilowatt hour (kWh) battery energy storage system (BESS), 300 kW of diesel generation, and approximately 12,000 gallons of diesel fuel storage to support reliable year-round operation under planning-level load and weather scenarios.

Desktop reviews of regulatory, environmental, and cultural resources constraints indicate that project development is feasible, although additional permitting, coordination, and site-specific investigations will be required during future project phases. Key considerations include obtaining local land use approvals; completing air quality analysis and air permitting for the diesel generation facility; demonstrating compliance with applicable noise standards; and confirming site-specific natural resource, cultural resources, geotechnical, and stormwater conditions.

Based on the findings of the study, the proposed concept is feasible and could advance into preliminary design and permitting. Recommended next steps include agency coordination with Pierce County and other regulatory authorities; completion of site-specific environmental and engineering investigations; refinement of project costs and schedule; and development of a higher level of engineering design to support permitting, procurement, and implementation. Subject to completion of these activities, the proposed microgrid represents a technically feasible and reliable long-term solution for maintaining electric service to Ketron Island following retirement of the existing submarine cable.

2 Ketron Island Microgrid Study Review

2.1 Real Estate Potential Assessment and Peak Electrical Energy Load Forecast

Task 1 of the Ketron Island Microgrid Study consisted of a Real Estate Potential Assessment and Peak Electrical Energy Load Forecast to evaluate future development potential and associated electrical demand on the island. The assessment examined zoning, historical development trends, water and wastewater availability, transportation access, public services, and existing utility infrastructure to establish realistic growth scenarios over a 20-year planning horizon (HDR 2025).

The Task 1 analysis determined that significant future development on Ketron Island is unlikely due to substantial development constraints, including limited ferry access, restricted water system capacity, challenges associated with septic system approvals, and the absence of public services and commercial infrastructure. Based on these factors, a no-growth scenario was identified as the most likely future condition. A conservative high-growth scenario was also evaluated, assuming development of up to 14 additional full-time residences based on the remaining capacity of the existing water system.

The assessment also established the electrical demand criteria that would be used to evaluate potential microgrid alternatives in subsequent phases of the study. Under the no-growth scenario, maximum daily energy consumption was projected at approximately 1,763 kWh, with a peak demand of 85 kW during normal weather conditions, increasing to approximately 2,061 kWh with a peak demand of 108 kW under severe weather. Under the high-growth scenario, maximum daily energy consumption was projected at approximately 4,227 kWh, with peak demand of 200 kW under normal weather conditions, increasing to approximately 4,941 kWh with a peak demand of 260 kW under severe weather. These load projections defined the performance envelope for the microgrid alternatives evaluated during the next phase of the study.

The findings from Task 1 provided the foundation for subsequent tasks, including the evaluation, sizing, and comparison of potential microgrid configurations and supporting electrical infrastructure improvements for Ketron Island.

2.2 Microgrid Technology Screening Memorandum

Task 2 of the Ketron Island Microgrid Study consisted of a Microgrid Technology Screening Memorandum that built upon the electrical load forecasts developed during Task 1. Using the established load range of approximately 1,763 kWh/day with an 85-kW peak demand under the no-growth scenario and 4,227 kWh/day with a 200-kW peak demand under the high-growth scenario, the study evaluated commercially available technologies capable of supporting a permanently islanded microgrid for Ketron Island. These demand projections established the performance requirements and sizing criteria used to screen potential generation and energy storage technologies (HDR 2026a).

The assessment evaluated a range of centralized and decentralized energy technologies, including solar PV systems, wind turbines, diesel and biodiesel generators,

hydrogen fuel cells, and BESSs. Technologies were screened based on indicative performance, land requirements, compatibility with existing infrastructure, technology maturity, reliability, capital cost, and operating expenses. Natural gas, compressed natural gas, and ocean energy technologies were eliminated from further consideration due to one or more of the following reasons based on the technology: infrastructure limitations, operational complexity, technology immaturity, permitting challenges, and high costs. Centralized systems were generally found to offer greater efficiency, lower lifecycle costs, and improved operational reliability compared to decentralized alternatives.

Based on the technology screening, five candidate microgrid configurations were identified for further evaluation in Task 3. These included Alternative 1: Solar PV + BESS + Diesel Generation; Alternative 2: Solar PV + Wind + BESS + Backup Diesel Generation; Alternative 3: High-Capacity Solar + BESS + Diesel Generation; Alternative 4: Hydrogen Fuel Cell + BESS; and Alternative 5: a decentralized Residential Diesel Generation + BESS alternative. Each configuration was developed to balance reliability, renewable energy integration, fuel requirements, operational complexity, and compatibility with Ketron Island's existing electrical infrastructure and site constraints.

The findings from this Task 2 assessment narrowed the range of feasible technologies and established a set of representative microgrid alternatives for detailed technical, operational, and economic evaluation during the subsequent Analysis of Alternatives phase of the Ketron Island Microgrid Study.

2.3 Analysis of Alternatives

Task 3 of the Ketron Island Microgrid Study consisted of an Analysis of Alternatives (HDR 2026b) that evaluated the five candidate microgrid configurations identified during Task 2. Using the load projections established in the Real Estate Potential Assessment and Peak Electrical Energy Load Forecast (HDR 2025), the study assessed each alternative's operational performance, cost, reliability, permitting considerations, land requirements, and implementation risks. The purpose of this phase was to provide Tacoma Power with the technical, financial, and operational information necessary to compare the alternatives and select a preferred microgrid concept for advancement into the conceptual design phase (HDR 2026b).

The study evaluated the five potential microgrid configurations that were identified in the Microgrid Technology Screening Memorandum (HDR 2026a). Each alternative was analyzed under current and projected future load conditions and normal and severe weather scenarios to assess its ability to provide reliable islanded power service.

Results of the analysis demonstrated that all five alternatives were technically capable of serving Ketron Island's projected electrical demand but differed substantially in capital cost, lifecycle cost, fuel consumption, operational complexity, permitting requirements, and implementation risk. Alternatives with greater renewable energy generation reduced diesel consumption and long-term fuel dependence but generally required increased capital investment or introduced additional operational uncertainties. The Solar + Wind + BESS + Backup Diesel Generation configuration provided increased renewable diversity but added maintenance complexity and the highest lifecycle cost, while the Hydrogen Fuel Cell + BESS alternative offered the greatest decarbonization potential but was

dependent on hydrogen supply-chain and had additional storage and transportation limitations. The Residential Diesel Generation + BESS alternative reduced centralized infrastructure requirements but increased fuel consumption, maintenance burdens, and reliance on multiple independent systems. High-Capacity Solar + BESS + Diesel Generation reduced diesel runtime and fuel consumption while maintaining a relatively simple and reliable technology mix. The expanded solar array, however, required additional land, and its incremental fuel savings were partially limited by midday curtailment once the BESS reached its state-of-charge cap. Given the island's land constraints, this alternative was not carried forward in favor of the more compact selected configuration. The analysis also included planning-level cost estimates, lifecycle cost comparisons, and risk assessments to identify the strengths, limitations, and key implementation considerations associated with each alternative.

The findings from the Analysis of Alternatives (HDR 2026b) were provided to Tacoma Power to support their selection of a preferred microgrid approach. Based on the results of the alternatives analysis and Tacoma Power's project objectives, Alternative 1 (Solar PV + BESS + Diesel Generation) was selected for advancement into the final phase of the study.

3 Conceptual Design

3.1 Design Summary

Based on the results of the technology screening and alternatives analysis, Tacoma Power selected Alternative 1, consisting of solar PV generation, battery energy storage, and diesel generation, for advancement to conceptual design. This section describes the selected alternative and summarizes the design concept, which represents an approximately 10 percent level of design completion. The design is intended to support project planning and final documentation for the grant funding agencies. It does not include detailed engineering and is not suitable for construction.

The conceptual design consists of the following drawings and supporting information:

- A plan-view general arrangement showing the major equipment, fuel storage, battery energy storage, and solar on the preferred site.
- A conceptual single-line diagram showing the principal electrical equipment and system connections.
- A major equipment list identifying key planning-level parameters, including equipment capacity and voltage.

The conceptual design is included in Appendix A and should be reviewed together with the narrative presented in this section.

3.2 Design Basis

The conceptual design is based on Alternative 1, a centralized microgrid consisting of a 216-kW alternating current (AC) solar PV array, a Tesla Megapack BESS (rated 979 kW and 3,916 kWh), and 300 kW of diesel generation. The system is intended to operate as

a permanently islanded microgrid serving the existing Ketron Island distribution system. The selected equipment capacities were established in the Analysis of Alternatives (HDR 2026b) using the load forecasts developed under the Real Estate Potential Assessment and Peak Electrical Energy Load Forecast (HDR 2025) and the technologies evaluated in the Microgrid Technology Screening Memorandum (HDR 2026a).

The diesel generation provides firm capacity and was sized to serve the projected 260-kW peak island demand under the high-growth, severe-weather scenario without relying on solar generation. The solar array and BESS supplement the firm generation by reducing diesel fuel use, storing renewable energy, and improving operational flexibility.

The general operating philosophy prioritizes available solar energy and stored battery energy while maintaining diesel generation as the firm, dispatchable resource. During periods of adequate sunlight, the solar array supplies the island load and charges the BESS. The BESS supplies energy when solar production is less than the island demand and supports the system during normal operation until reserves are insufficient.

The diesel generation operates when the available solar generation and BESS reserve are insufficient to serve the load reliably. Once started, the generator supplies the island load and recharges the BESS. This approach reduces the number of generator starts, limits extended light-load operation, and restores the battery reserve for subsequent operation.

The conceptual design establishes the overall equipment arrangement and principal electrical connections. It does not include detailed equipment specifications, final protection settings, protection coordination, detailed controls design, construction details, or final civil design. These items will be developed during later design phases

3.2.1 General Arrangement

The plan-view general arrangement included in Appendix A shows the preliminary placement of the major microgrid equipment on the preferred site. The centralized equipment area includes the diesel generation, BESS, medium-voltage electrical equipment, microgrid control equipment, and diesel fuel storage. The solar PV array is located on a separate open area roughly 0.4 mile south-southwest of the BESS and diesel generator equipment area, and ties into the existing island power distribution system.

The conceptual arrangement provides planning-level space for equipment access, operation and maintenance, fuel delivery, equipment removal and replacement, and future battery augmentation. The equipment is arranged to maintain practical separation among the battery, diesel generation, electrical distribution, and fuel storage systems. Final equipment dimensions, access requirements, working clearances, grading, drainage, security, and equipment foundations will be confirmed during later design phases.

The BESS and diesel generation connect to common collector switchgear through their associated power conversion equipment and transformers. The collector system connects the centralized microgrid facility to the existing 12.47-kV Ketron Island distribution system. The conceptual single-line diagram included in Appendix A identifies

the principal electrical connections, voltage transformation, switching, protection, and metering points.

3.2.2 Major Equipment

The major equipment considered in the conceptual design is summarized below. The equipment ratings are planning-level values and are also listed on the major equipment list included in Appendix B.

- Solar PV system: The design includes a nominal 216 kW AC, fixed-tilt, ground-mounted solar PV array. The solar array is a grid-following source that is dispatched first, reducing diesel runtime and long-term fuel dependence. The selected 216 kW AC array uses high-efficiency 695–730 W bifacial modules, which deliver the required capacity with fewer panels and a smaller footprint, an important advantage given the island's land constraints. Because solar output is intermittent, it is supported by the grid-forming BESS and diesel generation and is curtailed by the microgrid controller at high BESS state of charge to prevent over-power.
- BESS: The conceptual design is based on one Tesla Megapack 2 XL system rated at 979 kW and 3,916 kWh. The Megapack has a nominal output voltage of 480 V, three-phase, and includes integrated power conversion and thermal systems. The Tesla system supports off-grid microgrid operation among its available control applications. The Megapack enclosure is approximately 28.9 feet long, 5.4 feet deep, and 9.1 feet high, with a maximum weight of approximately 84,000 pounds.

  Tesla Megapack 2 XL is selected as the microgrid's grid-forming source, required to establish voltage and frequency for a permanently islanded system and to blackstart the island. It is a factory-integrated block (i.e. battery, power conversion, thermal, and the Tesla Site Controller in one enclosure), uses lithium iron phosphate (LFP) chemistry for safety and cycle life, and supports future augmentation.
- Diesel generation: The conceptual design includes 300 kW of diesel generation to provide firm capacity during periods of low solar production, elevated island demand, or reduced BESS state of charge. The diesel generation supplies the island load and recharges the BESS when required.

  The Generac SD300 provides firm, dispatchable grid-forming capacity during periods of low solar production, elevated island demand, or reduced BESS state of charge. For a permanently islanded system, at least one generator must be capable of blackstarting the microgrid. A paralleling generator configuration was selected because it allows the microgrid controller to charge the BESS, share load between sources, and optimize fuel use. In this configuration, a dedicated paralleling controller manages the engine governor, automatic voltage regulator (AVR), fuel valve, starter, synchronization check, and breaker, while the Tesla Microgrid Controller issues start/stop and setpoint commands and treats the generator as an independent, coordinated source.
- Medium-voltage electrical equipment: The design includes a single pad-mounted, dry-type 300-kilovolt-ampere (kVA) transformer, collector switchgear, protective devices, and associated equipment required to connect the 480-volt (V) BESS and diesel generation to the existing 12.47-kV island distribution system. The design

includes a single pad-mounted, dry-type 300-kVA transformer, collector panelboard, protective devices, and associated equipment required to connect the 480-V solar generation to the existing 12.47-kV island distribution system. Key planning-level equipment ratings and voltage levels are shown on the conceptual single-line diagram and major equipment list included in Appendix B.

Dry-type transformers were selected because they contain no dielectric fluid, eliminating spill risk and the need for secondary oil containment. This was also considered because of the generator/BESS yard's proximity to regulated shoreline jurisdiction and the potential for the presence of wetlands.

- Microgrid control system: The microgrid is coordinated by the Tesla Microgrid Controller, which operates natively within the Tesla Site Controller integrated into the Megapack; no separate control hardware is required. Because the system is permanently islanded, this integrated control layer operates continuously, establishing the grid-forming reference for the microgrid. Its functions include dispatch of the BESS, solar, and diesel generation; automatic generator start and stop based on load and battery state of charge; spinning-reserve management; frequency control; and solar curtailment at high state of charge. Third-party assets, including the diesel generator paralleling controller, the PV inverter-level controls, and the protective relaying and metering, operates as stand-alone devices that interface with the Tesla controller and are monitored through Tesla's Powerhub.

3.2.3 Fuel Storage

The Analysis of Alternatives (HDR 2026b) estimated annual diesel consumption of approximately 39,819 liters, or approximately 10,500 gallons, for the current-development (no growth), severe-weather case. A plus or minus 10 percent planning allowance was applied to account for potential variation in annual fuel use. This produces an upper planning value of approximately 11,550 gallons, which was rounded up to a common diesel storage tank size of 12,000-gallon capacity.

The double-wall 12,000-gallon tank provides year-long storage under the selected planning case and reduces dependence on frequent fuel deliveries to Ketron Island. Actual annual consumption will vary based on weather, island demand, solar production, BESS availability and operating strategy, and generator performance. This tank size is considered conservative for the purposes of planning. A smaller tank and more frequent fuel delivery is feasible.

The aboveground tank is shown on the conceptual general arrangement in Appendix A together with the diesel generation equipment and fuel-delivery access. The conceptual layout provides planning-level space for the tank. Final tank dimensions, usable capacity, reserve volume, setbacks, and fire protection provisions will be determined during subsequent design based on vendor data and applicable environmental, fire, and permitting requirements.

Because the intent is to store approximately 1 year of diesel, subsequent design and operating procedures should also address fuel quality management and turnover. This may include provisions for fuel sampling, filtration, water removal, and periodic fuel conditioning, subject to Tacoma Power’s maintenance practices and the requirements of the selected tank and generator suppliers.

3.2.4 Civil Design Considerations

This section summarizes the key civil design considerations reflected in the conceptual general arrangement. These items are developed at a planning level to support siting, permitting, and grant documentation. All grading, drainage, surfacing, foundations, access geometry, and fencing details will be completed during subsequent design phases and are not included in the scope of this conceptual design.

The fenced generator and BESS equipment yard is surfaced with yard rock (crushed rock or gravel) covering the full extent of the equipment area, except at concrete equipment foundations and other designated surfaces. This surfacing provides a stable, well-drained working surface, supports maintenance access, and limits vegetation growth within the fenced area. The generator/BESS site loop road is composed of compacted decomposed granite. The final surfacing limits, aggregate type and depth, subgrade preparation, geotextile requirements, grading, drainage, and grounding provisions will be established during detailed civil and electrical grounding design.

The fenced solar site is natural grass covering the full extent of the equipment area, except at concrete equipment foundations and other designated surfaces. This surfacing provides a stable, well-drained working surface; supports maintenance access; and is aesthetically pleasing within the fenced area. There is typically no site loop road for small solar installations. The solar site parking area is compacted decomposed granite. The final surfacing limits, aggregate type and depth, subgrade preparation, geotextile requirements, grading, drainage, and grounding provisions will be established during detailed civil and electrical grounding design.

General vehicular access is provided to both the solar site and the generator/BESS site from the adjacent roadway to accommodate equipment delivery and installation, routine operation and maintenance, fuel delivery to the diesel storage tank, and future equipment replacement. Both sites are enclosed by secured perimeter fencing to restrict unauthorized access and protect the electrical equipment, fuel storage, and battery systems, with lockable access gates sized for maintenance and delivery vehicles. The final access road alignment, width, turning radii, gate locations and widths, surfacing, and load-bearing requirements; along with the final fence type, height, materials, grounding, and gate hardware; will be developed during detailed design based on the selected equipment, delivery-vehicle requirements, Tacoma Power standards, and applicable code requirements.

The associated 1-inch fiber conduit and 4-inch conduit are routed to remain within the project parcel and follow the road right-of-way, avoiding encumbrance of adjacent private properties. The routing shown is conceptual, and the final alignment will be confirmed during detailed design based on survey, utility location, easement, and constructability considerations. The site drawings also show the available parcel lines with planning-level setback envelopes for the proposed equipment and fencing. These offsets are approximate and based on available geographic information system (GIS) parcel information rather than a boundary survey, and they should be verified by survey during subsequent design. The current planning basis is a 25-foot front setback, 10-foot interior side setbacks, and a 30-foot rear setback, with the classification of each boundary to be confirmed.

Finally, the regulated shoreline boundary is identified on the site drawings as a reference siting constraint. The proposed solar site is located entirely outside the regulated shoreline jurisdiction. The generator/BESS property falls partially within the regulated shoreline jurisdiction, as shown on the generator/BESS site plan; however, all proposed equipment within that site is sited outside the shoreline boundary. As a result, no solar, generator, or BESS equipment is located within regulated shoreline jurisdiction, which generally extends landward 200 feet from the ordinary high water mark. As a result, the conceptual arrangement avoids shoreline-related siting limitations, and no shoreline permitting constraints are anticipated to affect the proposed equipment locations.

4 Siting Considerations

Site selection for the proposed microgrid considered several operational, environmental, and regulatory factors to identify a location capable of supporting the preferred Solar PV + BESS + Diesel Generation alternative. Key considerations included proximity to the existing distribution system to minimize interconnection infrastructure and associated costs, availability of previously cleared or disturbed land to reduce site development requirements and environmental impacts, and adequate solar exposure to maximize PV energy production. Additional factors evaluated included site accessibility for construction and maintenance activities; sufficient area to accommodate the solar array, BESS, diesel generation equipment, and fuel storage; and ability to meet applicable zoning, setback, and permitting requirements. Critical areas were also considered during the siting process. Ketron Island contains several mapped critical areas including fish and wildlife habitat conservation areas, erosion hazard areas, landslide hazard areas, and wetlands. Depending on site-specific conditions, these critical areas may impose additional setbacks, development restrictions, and design limitations that affect the allowable location and configuration of microgrid infrastructure (Title 18E Pierce County Code). Collectively, these considerations were used to identify two sites that balance constructability, operational efficiency, environmental compatibility, regulatory compliance, and long-term reliability of the proposed microgrid facility; these sites are shown in Figure 1 below.



Figure 1. Selected Potential Construction Sites

4.1 Natural Resources

A review of available natural resources information was conducted using Pierce County GIS mapping and the Washington Department of Fish and Wildlife Priority Habitats and Species (PHS) database (WDFW 2026). Pierce County GIS identifies the selected parcels as being within an area that may require review for potential wetlands; however, no mapped wetlands, streams, or other regulated surface waters are mapped on the site (Pierce County 2026a). In addition, a review of the PHS database did not identify any mapped priority habitats, priority species occurrences, or other known sensitive biological resources within the project area (WDFW 2026). Based on the desktop review, no significant natural resources constraints have been identified that would preclude development of the proposed microgrid facility. However, because available mapping resources are generalized and may not capture site-specific conditions, additional field investigations, including wetland and critical area assessments, may be required during future project development and permitting to confirm existing conditions and regulatory requirements.

4.2 Cultural Resources

A desktop review of cultural resources information was conducted using the Washington Department of Archaeology and Historic Preservation (DAHP) Washington Information System for Architectural and Archaeological Records Data (WISAARD) mapping system (DAHP 2026). The review indicates that the selected parcels are located within an area classified as having very high archaeological predictive risk, suggesting an elevated potential for the presence of previously unidentified archaeological or cultural resources (DAHP 2026). The WISAARD screening results do not confirm the presence of archaeological sites within the project footprint; however, the high-risk designation indicates that cultural resources may be encountered during ground-disturbing activities. As a result, additional cultural resources evaluation, including consultation with DAHP and potentially a professional archaeological survey, may be required during project development and permitting. These future studies would help determine the presence of cultural resources and identify any measures necessary to avoid, minimize, or mitigate potential impacts.

5 Regulatory Considerations

5.1 Land Use

Appendix C identifies key land use and environmental factors that may affect feasibility under Pierce County regulations. The selected parcels sited for Alternative 1 are all within the Rural 10 (R10) zoning designation. All electrical generation facilities, including solar facilities up to 5 acres in size, are permitted within the R10 zone with approval of a Conditional Use Permit.

Shoreline jurisdiction generally extends landward 200 feet of the ordinary high water mark of the Puget Sound. The parcel identified for the diesel generation site is partially within the Conservancy shoreline environment (Appendix C). Although utilities are

allowed to be permitted with a shoreline substantial development permit in the Conservancy shoreline environment, all infrastructure has been located outside of the shoreline environment.

Generators and associated fuel storage must comply with all applicable International Fire Code and National Fire Protection Association requirements, as well as applicable air quality regulations, as further detailed in Section 5.3.

The proposed aboveground 12,000-gallon diesel tank would need to be a protected fuel tank with a UL 2085 rating or an equivalent or higher level of protection. In addition to complying with the zoning minimum building setback requirements, the fuel tank must also meet applicable fire separation requirements. These standards generally require at least 20 feet of separation from the property lines and public rights-of-way, as well as additional clearance from buildings and potential ignition sources. Final separation distances may be modified by Pierce County based on the tank's rating and other site-specific design considerations.

The following permits were identified as potential permit requirements for the project:

- State Permit Requirements:
    - State Environmental Policy Act Checklist (Washington State Department of Ecology)
    - Notice of Construction Permit (Puget Sound Clean Air Agency)
- Local Permit Requirements:
    - Boundary Line Adjustment (Pierce County) – may be required to consolidate parcels into a single development parcel for the proposed solar facility to maximize the usable area for the solar arrays and associated equipment
    - Conditional Use Land Use Permit (Pierce County)
    - Commercial Construction Permit (Pierce County)
    - Fire Permit (Pierce County)
    - Electrical Permit (Tacoma Power)

5.2 Noise

Alternative 1 must comply with Pierce County noise standards at the property line. The surrounding area of parcels sited for Alternative 1 falls under Environmental Designation for Noise Abatement (EDNA) Class A, which limits permissible noise to 60 dbA during the day and 50 dbA between 10 p.m. and 7 a.m., as summarized in Appendix C.

A typical 300-kW diesel generator equipped with a standard sound-attenuated enclosure produces approximately 75 A-weighted decibels (dBA) at a distance of 7 meters (23 feet). Without additional noise mitigation, the generator would need to be located approximately 130 feet from the property lines for sound levels to decrease to 60 dBA to meet Pierce County daytime noise limits. Based on the size and configuration of the potential parcel, this setback is not achievable along the north and south property lines without mitigation.

5.3 Air Quality

5.3.1 EPA Requirements

Although the generator will require an air quality permit with the local permitting agency, the source will likely be subject to applicable federal requirements including New Source Performance Standards Subpart IIII - Standards of Performance for Stationary Compression Ignition Internal Combustion Engines and National Emissions Standards for Hazardous Air Pollutants Subpart ZZZZ – National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines. These regulations include possible testing, maintenance, recordkeeping, and reporting requirements. These requirements would most likely be included in the air quality permit issued by the local regulatory authority.

5.3.2 Washington State Department of Ecology Requirements

In Washington State, air quality construction permit applications are referred to as a Notice of Construction (NOC). The project will require submitting a NOC to the Puget Sound Clean Air Agency (PSCAA), which is the local air permitting jurisdiction for the project location.

As part of the NOC process, an Air Toxics Review is required. To pass an Air Toxics Review, it must be demonstrated that the emissions of toxic air pollutants (TAPs) fall below individually set small quantity emissions rates (SQER) or, if above SQER, an air dispersion model must demonstrate values of TAPs concentrations below the acceptable source impact level (ASIL). Not meeting these requirements would require best available control technology for toxics (tBACT), which would require emissions controls to be put in place until a passing SQER or ASIL is achieved.

The TAP most likely to exceed either the SQER or ASIL would be diesel engine exhaust particulate (DEEP), which, for a diesel generator, is the total particulate emitted. A U.S. Environmental Protection Agency (EPA) Tier 3 engine, running at 523 hours per year (based on the anticipated generator run hours for current development [no growth] and severe weather conditions listed in Appendix C of the Analysis of Alternatives; HDR 2026b) and using commonly accepted emission factors developed by California's South Coast Air Quality Monitoring District, would exceed the SQER threshold for DEEP. Even with tBACT-required controls such as a diesel particulate filter, it would not be possible to bring emissions below the SQER at the anticipated annual usage outlined in the Task 3 report. Exceeding the SQER would require modeling to be performed to demonstrate emission concentrations below ASIL; the emissions concentrations can be affected by changing the release height of the exhaust stack for the generator. If ASIL cannot be met with possible stack configurations, a health impact assessment (HIA) will be required. The HIA will require additional analysis, discussions with PSCAA, and possible community outreach efforts to support the NOC application. However, the requirement to conduct the HIA will most likely not prevent the air permit from being issued.

5.4 Stormwater

Pierce County identifies minimum requirements for stormwater control and site development constraints for all new development and redevelopments through their adoption of the 2026 Pierce County Stormwater Management and Site Development Manual (Pierce County 2026b). In addition to the standard requirements in the manual, it is expected that this project will exceed 5,000 square feet of conversion of pasture to impervious surfaces (Chapter 4.7 of the manual) and will require some level of flow control. The stormwater requirements associated with the project will need to be evaluated during subsequent design phases through development of a drainage report that follows the requirements established by the manual and determines appropriate stormwater best management practices (BMPs).

6 Potential Impacts and Mitigation

Development and operation of the proposed Solar PV + BESS + Diesel Generation microgrid have the potential to result in environmental and community impacts typical of utility-scale energy infrastructure projects. Based on the desktop reviews completed for this study, no fatal flaws or significant impacts have been identified that would preclude project development. However, additional site-specific investigations and permitting reviews will be required during subsequent project phases to confirm existing conditions and identify any necessary avoidance, minimization, or mitigation measures.

6.1 Natural Resources

Construction activities associated with grading, equipment installation, access improvements, and utility connections could affect natural resources if unmapped wetlands, critical areas, or other sensitive environmental features are present within or adjacent to the project area. Although desktop reviews did not identify mapped wetlands, streams, or priority habitat resources within the proposed development area, available mapping may not fully reflect site-specific conditions.

Potential impacts can be minimized through site-specific environmental investigations, avoidance of regulated critical areas where practicable, implementation of erosion and sediment control BMPs, and compliance with applicable Pierce County critical area requirements. Additional field verification to confirm the absence of wetlands, streams, or other jurisdictional resources is recommended.

6.2 Cultural Resources

The proposed project is located within an area identified as having high archaeological sensitivity. Ground-disturbing activities associated with grading, trenching, foundation construction, and utility installation could potentially affect previously unidentified archaeological or cultural resources.

The potential for impacts can be reduced through consultation with DAHP, completion of cultural resources studies, avoidance of identified resources where feasible, and implementation of inadvertent discovery procedures during construction.

6.3 Air Quality

Operation of the proposed diesel generators will require a NOC permit from the Puget Sound Clean Air Agency. As part of this process, an Air Toxics Review will be required to evaluate emissions of toxic air pollutants.

DEEP is anticipated to be the primary air permitting challenge and may exceed applicable SQER thresholds based on projected generator operating hours. If this occurs, air dispersion modeling will be required to demonstrate compliance with ASIL criteria. Potential mitigation measures may include optimization of generator operations, evaluation of exhaust stack configurations, and implementation of tBACT. If compliance with ASIL criteria cannot be demonstrated, an HIA may be required. While these requirements may require additional effort and time, they are not expected to preclude project development.

6.4 Noise

Diesel generator operation has the potential to generate noise levels that may exceed applicable Pierce County noise standards at nearby property lines. Noise impacts are expected to be most pronounced during periods when the generators are operating for extended durations during low-solar conditions or elevated electrical demand.

Potential noise mitigation measures include:

- Installing a wall or solid fence that extends above the height of the generator, which may reduce noise levels by approximately 5 to 10 dBA
- Adding sound-absorptive materials to the interior surface of the wall or fence, which may provide an additional noise reduction of up to 5 dBA
- Enclosing the generator within a properly designed building, which could reduce noise levels by approximately 15 to 35 dBA

An acoustical engineer should evaluate the specific site conditions and verify expected sound levels to ensure compliance with applicable noise standards.

6.5 Stormwater

Construction of the microgrid facility will introduce new impervious surfaces and may require grading activities that alter existing drainage patterns. Temporary construction-related impacts may also occur due to equipment mobilization, material storage, and site access activities.

Potential impacts can be minimized through implementation of stormwater management BMPs, preparation of site-specific drainage plans, minimization of disturbed areas, stabilization of exposed soils, and compliance with applicable stormwater and grading requirements. Future geotechnical and stormwater investigations should be completed to support final design and permitting.

6.6 Summary

Based on the information currently available, the primary environmental considerations associated with the proposed microgrid facility are related to air quality permitting, noise compliance, potential cultural resources sensitivity, and confirmation of site-specific natural resource and stormwater conditions. These issues are common for utility infrastructure projects and are generally manageable through additional studies, design refinement, permit compliance, and implementation of standard mitigation measures during project development.

7 Project Schedule

7.1 Level One Project Schedule Overview

A planning-level Level One Project Schedule was developed to identify the major activities required to advance the Ketron Island Microgrid Project from conceptual design through commissioning and commercial operation. The schedule assumes a traditional design-bid-build project delivery approach and is based on the expectation that permitting, environmental reviews, equipment procurement, and regulatory approvals will be key drivers of the overall project duration. The schedule should be refined during subsequent project phases as additional information becomes available regarding permitting requirements, site conditions, equipment lead times, and funding considerations.

7.2 Schedule Milestones and Implementation

The milestones shown in Table 1 represent a reasonable planning-level implementation schedule for the proposed microgrid project.

Table 1. Planning-Level Implementation Schedule

Milestone	Estimated Duration
Project Initiation and Funding Authorization	1–3 months
Environmental Reviews and Site Investigations (Natural Resources, Cultural Resources, Geotechnical, Stormwater)	3–6 months
Preliminary Design (30%)	3 months
Agency Coordination and Permit Strategy Development	Concurrent with preliminary design
Intermediate Design (60%)	2 months
Permit Application Preparation and Submittal	3–4 months
Final Design (90%)	2 months
Issued for Construction Design	1 month
Permit Review and Approval	12–18 months
Major Equipment Procurement (Solar Equipment, BESS, Generators, Electrical Equipment)	9–15 months

Milestone	E
Construction and Site Development	6–9 months
Equipment Installation and Integration	2–3 months
Testing and Commissioning	1–2 months
Commercial Operation Date	Project completion

Based on typical permitting, design, procurement, and construction durations, the overall project schedule is anticipated to require approximately 30 to 42 months from project authorization to commercial operation. The most significant schedule risks are expected to be permitting approvals, air quality permitting, and long-lead equipment procurement. Early coordination with Pierce County, PSCAA, and equipment suppliers is recommended to reduce schedule uncertainty and support successful project implementation. This assumes that there are no wetlands, streams, or cultural resources identified during site investigations.

8 Findings and Recommendations

8.1 Summary of Key Findings

The Ketron Island Microgrid Study evaluated future electrical demand, screened potential microgrid technologies, analyzed feasible alternatives, and developed a conceptual design for the preferred microgrid configuration. Based on the technical, operational, economic, and regulatory evaluations completed throughout the study, a centralized microgrid consisting of solar PV generation, battery energy storage, and diesel generation was identified as a feasible solution for providing reliable electric service to Ketron Island following retirement of the existing submarine cable.

The conceptual design and desktop-level environmental review did not identify any fatal flaws that would preclude development of the proposed microgrid facility. However, several permitting, environmental, and technical considerations remain to be addressed during subsequent project phases. These considerations include air quality permitting associated with the diesel generators, potential cultural resources constraints due to the site's high archaeological sensitivity, verification of natural resources conditions, and confirmation of site-specific geotechnical and stormwater management requirements.

8.2 Risks, Constraints, and Issues

Key project risks and constraints include obtaining local land use and environmental permits and complying with applicable noise and air quality regulations. While desktop reviews did not identify mapped wetlands, streams, or priority habitat resources within the proposed project area, additional field verification is recommended. The selected site's designation as a high archaeological risk area may also necessitate further cultural resources investigations and agency coordination. Additional uncertainty exists regarding site-specific geotechnical conditions and stormwater management requirements. Future investigations will be needed to confirm soil characteristics, foundation requirements, drainage considerations, and the site's ability to support stormwater infiltration.

8.3 Recommendations

Based on the findings of this study, HDR recommends advancing the project into the next phase of design and permitting. Key next steps should include:

- Advance the conceptual design to a higher level of engineering detail to support permitting, cost estimating, procurement planning, and project implementation.
- Initiate coordination with Pierce County to confirm applicable land use requirements, permitting pathways, zoning considerations, and development constraints associated with the selected site.
- Conduct a site-specific air quality assessment to support permitting of the proposed diesel generation facility and identify any required emissions controls or mitigation measures.
- Perform field investigations to verify natural resources conditions, including the presence or absence of wetlands, streams, and other critical areas that may affect project development.
- Complete cultural resources coordination and studies, including consultation with DAHP and, if required, an archaeological survey of the project area.
- Conduct geotechnical investigations to evaluate subsurface conditions, foundation requirements, grading needs, and site constructability.
- Evaluate stormwater management requirements, including site drainage characteristics and the feasibility of stormwater infiltration within the proposed development area.
- Refine project costs, schedule assumptions, and permitting requirements as additional site-specific information becomes available.

Completion of these activities will reduce project uncertainty, support environmental and regulatory approvals, and provide Tacoma Power with the information necessary to advance the proposed Ketron Island microgrid toward implementation.

9 References

DAHP (Washington Department of Archaeology and Historic Preservation)

2026 Washington Information System for Architectural and Archaeological Records Data (WISAARD). https://dahp.wa.gov/project-review/wisaard-washington-information-system-for-architectural-and-archaeological-records-data

HDR (HDR Engineering, Inc.)

2025 *Real Estate Potential Assessment and Peak Electrical Energy Load Forecast*. Ketron Island Microgrid Study. October 27, 2025.

2026a *Microgrid Technology Screening Memorandum*. Ketron Island Microgrid Study. March 5, 2026.

2026b *Analysis of Alternatives*. Ketron Island Microgrid Study. July 7, 2026.

Pierce County (Pierce County Planning and Public Works)

2026a PublicGIS. https://matterhornwab.co.pierce.wa.us/publicgis/

2026b *Pierce County Stormwater Management and Site Development Manual*. https://docaccess.com/docviewer.html?url=https%3A%2F%2Fwww.piercecountywa.gov%2FDocumentCenter%2FView%2F159370%2F2026_Stormwater_Manual&url_hash=95df2027f09f3bc13feaae555ed9cdd5&domain=piercecountywa.gov&found_on=https%3A%2F%2Fwww.piercecountywa.gov%2F2969%2FStormwater-Site-Development-Manual

WDFW (Washington Department of Fish and Wildlife)

2026 Priority Habitats and Species (PHS) on the Web. https://wdfw.wa.gov/species-habitats/at-risk/phs/maps

Appendix A:
Conceptual Design

Final Report
Ketron Island Microgrid Study

August 31, 2026



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SCALE IN FEET
CONTOUR INTERVAL = 1'
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NOTES:

1. PROVIDE DECOMPOSED GRAVEL FOR THE DRIVEWAY LOOP AREA.
2. PROVIDE CRUSHED STONE IN ALL EQUIPMENT AREAS OTHER THAN DRIVEWAY LOOP.

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NOTES:

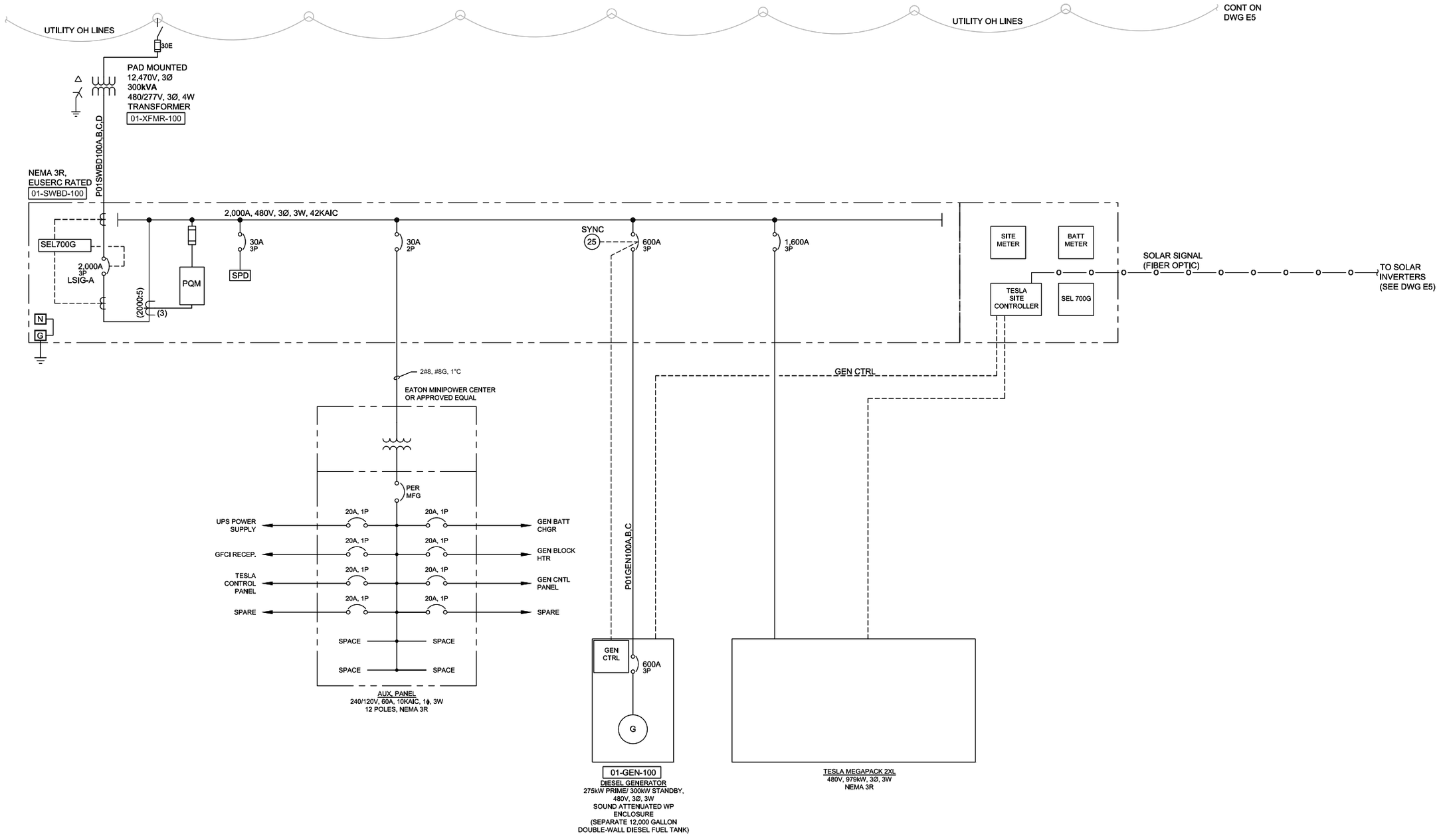
1. PROVIDE DECOMPOSED GRANITE PARKING LOT.

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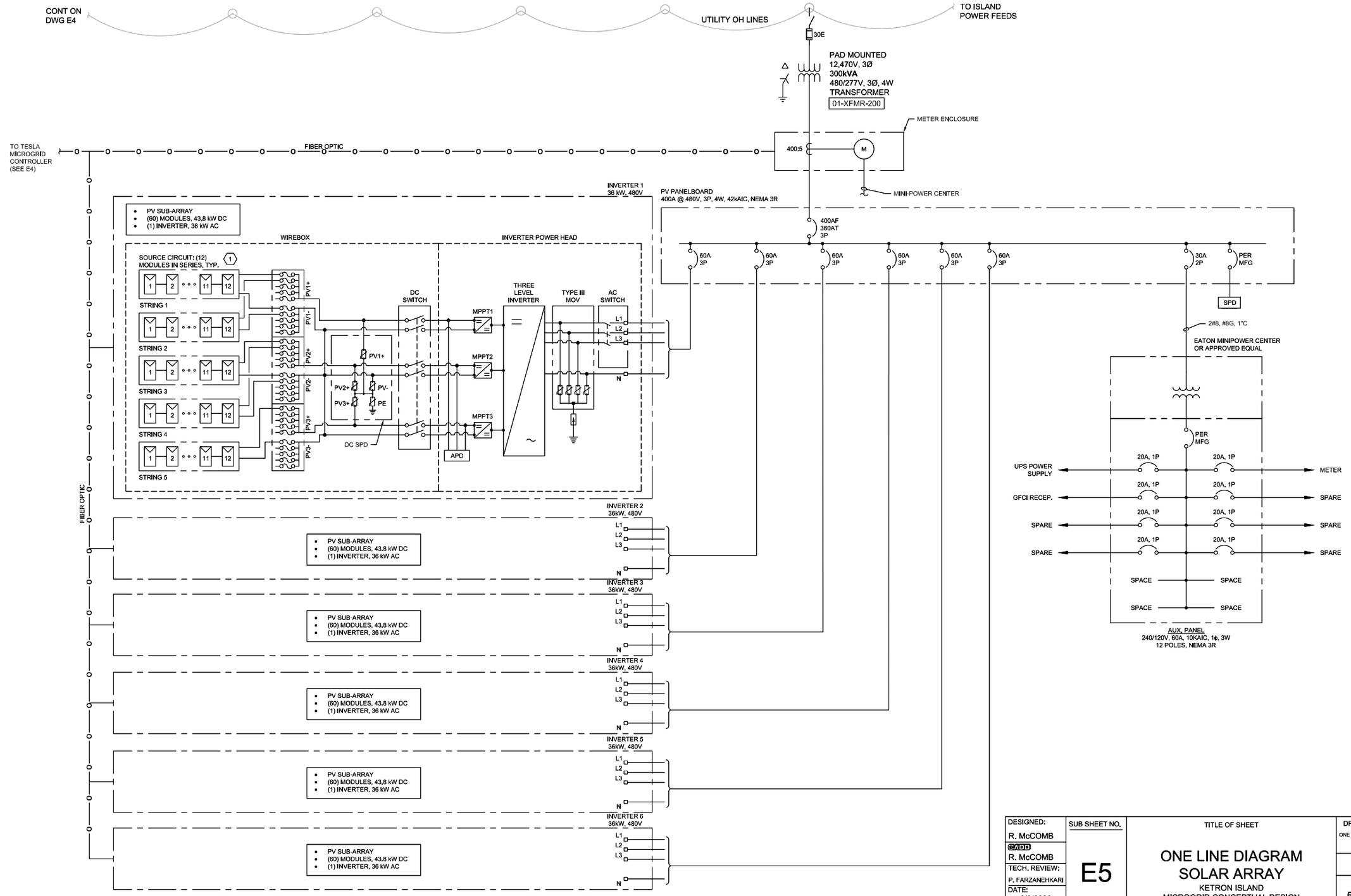
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Appendix B:
Major Equipment List

Major Equipment List — Planning-Level Parameters

#	Equipment	Mfr / Model	Qty	Unit Capacity Rating	Voltage	Total Capacity	Key Parameters
1	Battery Energy Storage System (BESS)	Tesla Megapack 2 XL (4-hr)	1	979 kW/ 3,916 kWh (≈3.9 MWh); inverter 1,320 kVA max	480 V AC, 3-ph	0.98 MW/ 3.9 MWh	60 Hz; LFP; 93.7% RTE (4-hr); IP66/NEMA 3R; UL 9540 / 1741 SB
2	Standby Generator	Generac SD300 (10.3L diesel)	1	300 kW/375 kVA standby (275 kW / 343 kVA prime)	277/ 480 V, 3-ph	300 kW / 375 kVA standby (275 kW / 343 kVA prime)	60 Hz; Iveco/FPT 6-cyl; 0.8 PF; Class H alt.; UL2200, NFPA 110
3	Diesel Fuel Storage Tank	FIREGUARD double-wall aboveground tank	1	12,000 gallons	N/A	12,000 gallons	Fire-protected, double-wall (UL 2085) with integral secondary containment; ~102 in dia. × 390 in long, approx. 28,000 lb dry. ~1 year of severe-weather storage.
4	PV Inverters	Chint Power Systems (CPS) SCA36KTL-DO/US-480 V2	6	36 kW each (3-phase string)	480 V AC/ 1,000 V DC	216 kW AC	60 Hz; 97.4% CEC eff.; NEMA 4X; PVRSS certified for rapid shutdown
5	PV Modules	Canadian Solar TOPBiHiKu7	360	695 W ~ 730 W each (N-Type bifacial)	1,500 V DC max	263 kW DC	21.4% eff.; temp. coeff. −0.34%/°C
6	Padmount Transformer	TBD (Dry Type)	2	300 kVA	480 V sec./MV 12.47 kV	1- BESS/GEN XFMR 300 kVA 2- Solar XFMR 300 kVA	3-phase, 60 Hz; primary voltage to be confirmed
7	Switchgear	TBD (LV switchgear)	1	2,000 A bus	480 V, 3-ph	2,000 A/ 480 V	60 Hz; short-circuit 42 AIC rating
8	Panelboard	TBD (LV Switchboard)	1	400 A bus	480 V, 3-ph	400 A/ 480 V	60 Hz; short-circuit 42 AIC rating
9	Mini Power Center	Eaton	2	60 A	240 V/ 120 V, 1-ph	60 A/ 240 kV	(12) 120-V circuits

Note: A = amperes; AC = alternating current; DC = direct current; Hz = hertz; kV = kilovolt(s); kVA = kilovolt-amperes; MW = megawatt(s); MWh = megawatt hours; NEMA = National Electrical Manufacturers Association; NFPA = National Fire Protection Agency; ph = phase; TBD = to be determined; W = watt(s).

Appendix C:
Permitting and Environmental Constraints

Alternative 1: Solar PV + BESS + Diesel Generation	
Designation	R10
Pierce County Permitting R10 Limitations	Electrical generation facilities are allowed with a Conditional Use Permit.
Pierce County Minimum Building Setbacks in R10	Front – 25 feet Interior – 10 feet Rear – 30 feet Notes: Solar energy equipment that is less than 6 feet in height may project into the required setbacks; however, in no case may the equipment be located closer than 5 feet from a property line. Corner lots may be able to reduce the front yard setback on one street side by 15 feet.
Pierce County Shoreline Limitations	Conservancy – Utilities are permitted in with a Shoreline Substantial Development Permit.
Potential Pierce County Critical Areas	Erosion hazards Landslide hazards Wetland buffer and setbacks (varies, depending on the delineated wetland category)
Pierce County Noise Limitations	60 dBA at the property line 50 dBA at the property line (nighttime limitation between the hours of 10 p.m. and 7 a.m.) Note: Both assume EDNA Class C Noise Source and EDNA Class A Receiving Property
Pierce County R10 Height Limitations	40 feet Shoreline jurisdictions – 35 feet
Fuel Storage Setbacks	20-foot minimum from property lines

Note: dBA = A-weighted decibels; EDNA = Environmental Designation for Noise Abatement; R10 = Rural 10.