CITY OF BAINBRIDGE ISLAND

Climate Change Advisory Committee
Regular Meeting
March 20, 2024
5:30 PM
Council Conference Room
280 Madison Avenue N
+ Zoom Webinar

The Climate Change Advisory Committee will hold this meeting
in person and using a virtual, Zoom webinar platform

Members of the public will be able to attend at City Hall
or by calling in to the Zoom webinar

Please click the link below to join the webinar:
https://bainbridgewa.zoom.us/j/91390380790
Or Telephone: 1-253-215-8782
Webinar ID: 913 9038 0790

AGENDA

5:30 Call meeting to Order/Roll Call/Accept of Modify Agenda/Conflict of Interest Disclosure

5:35 Approve Minutes from February 21, 2024 meeting.

5:40 Public Comment

5:45 Discussion on possible objective and goals for Solid Waste Program (Blair King, City Manager)

- Increase waste diversion.
- Reduction in Greenhouse Gas emissions.
- Organic Waste Management (commercial anaerobic digester).
- Improved community aesthetics – less visible garbage cans in the community.
- Maintain high quality service.
- Increased innovation and sustainability.

6:10 Review ETIPP Resilience report (ETIIP Staff – see attached)

- Do you have any feedback or clarifications you would like to see in the report?
- How do you think the Committee, City and community can leverage this work to take next steps towards achieving Bainbridge's 100% renewable energy goal?
- Are there any action items for the CCAC you would like to see mentioned or discussed in the report?

6:55 Draft Dashboard and examples of Dashboards (Mike – see attached)
8 Local Government Public Dashboard Examples | Envisio
https://www.govtech.com/biz/why-cities-are-turning-to-climate-change-dashboards
https://results.wa.gov/measuring-progress/statewide-data-dashboards

7:05 General Updates (Ellen Schroer, Deputy City Manager)

- 2023 Annual Report and 2024 Workplan for CCAC.
- Solar PV/carbon offset project update.
- Heat pump pilot program update.
- Ebike voucher program.
- Hire a new Climate Officer.

7:15 CCAC Updates

- Home Electrification Expo (Kevin/Mike)
- Groundwater Committee

7:30 Adjourn

Materials

1. February minutes
2. ETIIP Resilience Report
3. Draft Dashboard
4. Draft 2023 annual report and 2024 workplan

Climate Change Advisory Committee
February 21, 2024 Meeting Minutes

Meeting called to order at 5:35 PM by Kevin.

Roll call:

- Committee members: Derik Broekhoff, Julie Matthews, Sanjay Bhat (online), Michael Cox, Kevin Thomas, Michael Kleeman (online)
- City Staff liaisons: Autumn Salamack, Ellen Schroer
- City Council liaisons: Kirsten Hytopoulos, Leslie Schneider

Agenda: No amendments

Conflicts of Interest: Sanjay disclosed he is marketing director at Kitsap Transit, which has a contract with COBI to promote transit, which is managed by Autumn's group at the city. He also serves on the Board with Courtyards on Madison, working with Department of Energy on community solar grant projects.

Minutes for December and January meetings: Julie motioned for approval, Michael seconded, unanimously adopted.

City climate officer staffing update

Autumn indicated she will be leaving her job as the city's climate officer. Ellen Schroer will serve as interim climate officer until a replacement is hired. Those present discussed the process & timeframe for the replacement hire. CCAC members offered to assist with job description & outreach.

ETIPP Project Update

- PNNL staff will provide further insight into how other communities have leveraged these kinds of analyses.
- Mike shared suggestions for topics to address in report (including incorporate of PSE efforts to deploy renewables) and follow-up actions – including possibly convening community group to discuss next steps along with the city
    - o Autumn noted that Spark Northwest could help with this convening role (since they were initially brought ought to help with community facilitation).
- Autumn also noted there is lots of demand for assistance to do solar projects, and the ETIPP analysis could be useful to prioritize sites.
- Sanjay noted that it is important to do further due diligence on site location & feasibility (final 20%). Plus, there is still work that needs to be done to apply for funding, etc.
- Kevin offered to send further comments related to the report.

Climate Officer Updates

Autumn provided updates on city activity related to the climate action plan (CAP).

- The city's EV grant application for four level 2 EV chargers was approved – two at city hall, two at the new justice center – which will serve the city fleet.
- Heat pump pilot program
    - o The city conducted a final interview with Kicking Gas (who submitted a full proposal)

DRAFT

- Once contracted, Kicking Gas will help administer a $200K program for low- & moderate-income households to install heat pumps.
    - The city is working to get the contract finalized.
- Carbon offset project at Ted Spearman Justice Center
    - Funds allocated to install a 120kV PV system.
    - Received 7 proposals (from school district, Woodward school; Parks & Rec Center; two proposals from Washington State Ferries, including on covered walkway; and Fire Department submitted proposals for three stations).
    - Consultant will evaluate Woodward, Fire Station 21, the two state ferry sites; and will continue to look at Rec Center option.
    - Evaluations will be done in March and the city hopes to have recommendation in April.
- Other questions (form Mike)
    - Status of PSE franchise? No updates.
    - Waste management evaluation – city in negotiation with BI disposal to conduct this; still proceeding.

Dashboard update

Committee members continued discussion of development of a climate dashboard. The dashboard would show community how BI is progressing in achieving goals of the CAP.

- Committee members discussed how to allocate work by topic.
- Agreed on criteria for what kinds of data and indicators should be included in the dashboard.
- Members discussed what platform to use and how we use the dashboard to communicate (what story do we want to tell).
- Key concerns include who will collect data & keep it updated over time, and how ongoing updates will be supported.
- For next steps, the committee discussed convening focus group(s) to explore what would be most useful – including with city council.

Other updates

- Council members Kirsten and Leslie briefed the committee on updates to advisory committee rules and guidelines. Key updates relevant to the CCAC include:
    - Updates on guidance for soliciting public comment.
    - Formalization of the process in city code to select new members.
    - All committees will be sized to 5-7 members going forward.
    - The City Council will hear from each committee with a work plan in March.
- Planning is underway for a home electrification expo, which would bring speakers, equipment demos, info on rebates, etc. related to home electrification and efficiency upgrades. Decision to move the expo to September to give more time to plan. Have now convened subcommittees and adopted a marketing track. Reaching out to vendors. Nailing down roster of speakers & identifying breakout sessions.
- CCAC and city council members briefly discussed opportunity to express support for a “fossil fuel non-proliferation treaty”.

Meeting was adjourned at 6:52PM. Julie motioned, Derik seconded.

DRAFT

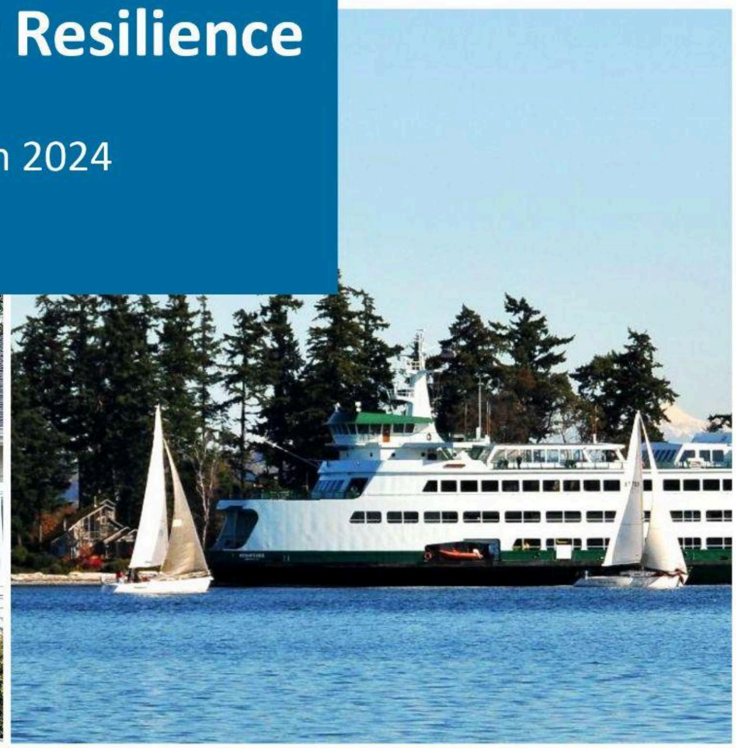
ENERGY TRANSITIONS INITIATIVE

U.S. Department of Energy

Bainbridge Island

Improving Resilience

March 2024



Energy Transitions Initiative Partnership Project: Bainbridge Island, Washington

Cohort 2 Technical Assistance: Improving Resilience

March 2024

Deborah Rose[1], Katie Arkema[1], Malcolm Moncheur de Rieudotte[1], Mia Devine[2], Sean Esterly[3], Autumn Salamack[4]

1. Pacific Northwest National Laboratory
2. Spark Northwest
3. National Renewable Energy Laboratory
4. City of Bainbridge Island

DRAFT

DISCLAIMER: This report was prepared as an account of work by Pacific Northwest National Laboratory, operated by Battelle Memorial Institute, for the United States Department of Energy under Contract DE-AC05-76RL01830. Neither the United States Government nor any agency thereof, nor Battelle Memorial Institute, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or Battelle Memorial Institute. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Suggested Citation: Rose, D.; Arkema, K.; Moncheur de Rieudotte, M.; Devine, M.; Esterly, S.; Salamack, A. 2024. ETIPP Report: Bainbridge Island Improving Resilience. PNNL-35698.

Report Cover Photo Credits: Clockwise from top left, Clockwise from top left, solar panels at Senior Center photo by Autumn Salamack; ferry photo by City of Bainbridge Island; Crystal Springs Road photo by Autumn Salamack, and EV Charging at City Hall by Autumn Salamack.

DRAFT

Table of Contents

DRAFT

The Energy Transitions Initiative leverages the experiences of islands, states and cities that have established a long-term vision for energy transformation and are successfully implementing energy efficiency and renewable energy projects to achieve established clean energy goals. Through the initiative, the U.S. Department of Energy and its partners provide government entities and other stakeholders with a proven framework, objective guidance, and technical tools and resources for transitioning to a clean energy system/economy that relies on local resources to substantially reduce reliance on fossil fuels.

Tables and Figures

Acronyms

BESS	Battery Energy Storage System
BIFD	Bainbridge Island Fire Department
COBI	City of Bainbridge Island
DNR	Department of Natural Resources
ETIPP	Energy Transitions Initiative Partnership Program
EV	Electric Vehicle
FEMA	Federal Emergency Management Agency
HIVA	Hazard Identification and Vulnerability Analysis
NOAA	National Oceanic and Atmospheric Administration
NREL	National Renewable Energy Laboratory
O&M	Operations and Maintenance
PNNL	Pacific Northwest National Laboratory
PSE	Puget Sound Energy
PV	Photovoltaic
REopt	Renewable Energy Integration & Optimization
TSJC	Ted Spearman Justice Center
TSRF	Total Solar Resource Fraction
WSDOT	Washington State Department of Transportation

DRAFT

Executive Summary

The City of Bainbridge Island (COBI) aims to achieve 100% renewable electricity generation by 2040, five years ahead of the Washington State goal, and to advance its energy resilience in the face of increasing hazards related to climate change (COBI 2020)[1]. To help support these dual goals, the City applied for and received technical assistance from the Energy Transitions Initiative Partnership Project (ETIPP), funded by the U.S. Department of Energy (DOE). Pacific Northwest National Laboratory (PNNL) completed the technical analysis aspects of the project, supported by the community partner Spark Northwest and the program administrator, the National Renewable Energy Laboratory (NREL). The results from the energy resilience analysis are discussed in this report.

The overarching objectives of the resilience analysis are to better understand hazards and threats to critical energy infrastructure on Bainbridge Island and develop recommendations to address resilience gaps. This analysis builds on extensive previous work on hazards and risk assessment on Bainbridge Island, placing a specific focus on energy infrastructure. The team also worked to align analysis with current activities conducted by Puget Sound Energy (PSE) and other efforts within the Bainbridge Island community around resilience to draw on existing expertise. Results from this report can help to inform future hazard mitigation plans and highlight potential projects for funding. Finally, while this report focuses on the resilience aspects of the ETIPP, we recognize that investing in on-island renewable energy technologies can also help to support resilience. For more information on the City's renewable energy goals see the accompanying report: Pathways to 100% Renewable Energy[2].

The resilience analysis presented here consisted of three main steps: 1) identify hazards and critical infrastructure, 2) assess the relative risk of each hazard for each location of critical infrastructure, 3) identify the highest risk critical infrastructure and recommendations for increasing resilience. First, PNNL worked with the City to select the hazards and energy infrastructure of highest priority for the analysis. The hazards and threats identified for Bainbridge Island include severe storm, flood, sea level rise, tsunami, earthquake, erosion/landslide, wildfire, extreme heat/cold, and terrorism/vandalism.

The priority critical energy infrastructure identified on Bainbridge Island is shown in Figure E1 and includes:

- PSE transmission lines and substations:
    - Port Madison Substation
    - Winslow Substation
    - Murden Cove Substation
    - Winslow Transmission Tap
    - Murden Cove Transmission Tap
    - Murden Cove - Winslow Transmission Line
- 18 Community Disaster Hubs:
    - Bloedel Reserve
    - Seabold United Methodist
    - Island School
    - Grace Episcopal Church

[1] COBI. (2020). Climate Action Plan: A Plan for Mitigating and Adapting to Climate Change on Bainbridge Island. https://www.bainbridgewa.gov/DocumentCenter/View/14354/Final-Bainbridge-Island-Climate-Action-Plan-November-12th-2020
[2] Arkema, K.; Rose, D.; Moncheur de Rieudotte, M.; Sheridan, L.; Caruso, O.; Solana, A.; Piazza, A.; Grear, M.; Devine, M.; Esterly, S.; Salamack, A. 2024. ETIPP Report: Bainbridge Island Pathways to 100% Renewable Energy. PNNL-35643.

DRAFT

    - Recreation Center
    - Rolling Bay Presbyterian
    - Battle Point Park
    - Sakai Intermediate School
    - Island Center Hall
    - Bethany Lutheran
    - Senior Center (Warming/Cooling Center)
    - Strawberry Hill Park
    - Bainbridge High School (Child Reunification Center)
    - Virginia Mason Medical Center (Disaster Medical Hub)
    - Wing Point Country Club
    - Hyla Middle School
    - Islandwood
    - Fort Ward Community Hall
- City Facilities:
    - Ted Spearman Justice Center (City Emergency Operations Center)
    - Public Works Operations & Maintenance Yard (including charging stations for City fleet electric vehicles)
    - City Hall
    - Winslow Wastewater Treatment Plant
- Kitsap County Sewer District #7 Wastewater Treatment Plant
- Winslow Ferry Terminal
- Fire Stations 21, 22, 23

DRAFT

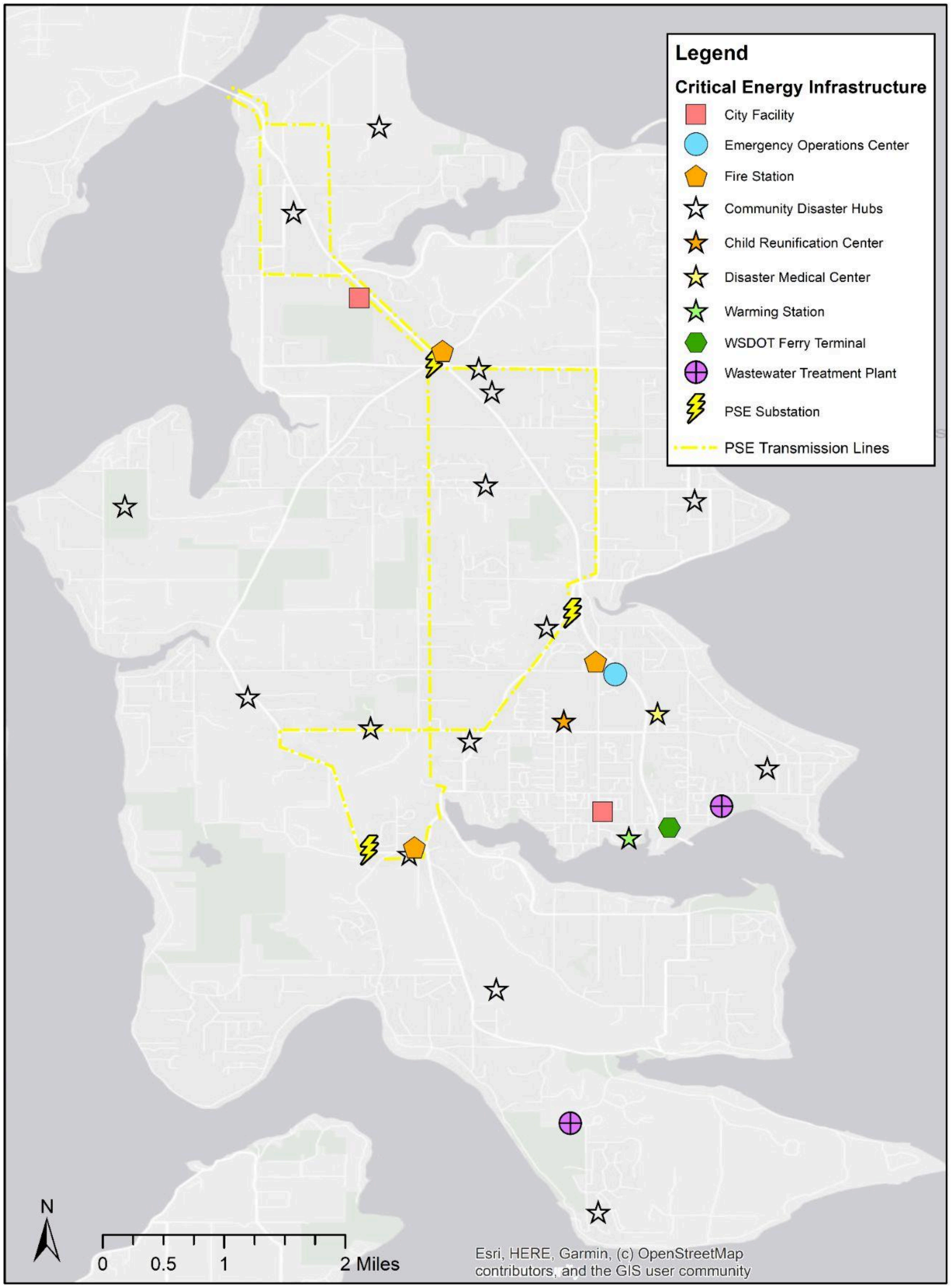


Figure 1. Critical energy infrastructure locations on Bainbridge Island. Data compiled from COBI sources, Google Maps, and PSE information.

Second, we assessed the relative risk of each hazard for each location of critical energy infrastructure based on the probability of the hazard occurring, the vulnerability of each type of energy infrastructure to that particular hazard, and the consequence for the community of loss of power. Each location was characterized to estimate the daily electrical power needs in an emergency, and then each location was compared to spatial maps of all hazards to determine the probability, vulnerability, and consequence of occurrence from high, moderate, to low. From this, the overall relative risk was estimated for each location and hazard. The critical energy infrastructure locations facing the highest overall risks from multiple hazards (in no particular order) are:

- Winslow Tap and Murden Cove Tap - Severe Storm, Tsunami, Earthquake
- New Murden Cove - Winslow Tap - Severe Storm, Earthquake
- Virginia Mason Medical Center - Earthquake, Wildfire
- Winslow Wastewater Treatment Plant - Sea Level Rise, Tsunami, Earthquake

Several additional locations are are facing a single high risk overall from earthquakes:

- Port Madison, Winslow, and Murden Cove Substations
- Bethany Lutheran
- Senior Center
- Bainbridge High School
- Hyla Middle School
- Ted Spearman Justice Center
- City Hall
- Kitsap Wastewater Treatment Plant
- Winslow Ferry Terminal
- Fire Station 21

Improved resilience to risks from hazards can be accomplished by reducing a vulnerability, reducing a consequence, or reducing the probability that the hazard or threat (an outage) would occur. Several projects have already been proposed or are underway to improve the resilience of the energy systems and existing facilities on Bainbridge Island and the City has completed preliminary assessments for other projects. To build on this existing work, our recommendations include conducting a more thorough assessment of wildfire risk at the Virginia Mason Medical Center, planning for sea level rise at the Winslow Wastewater Treatment Plant, and adding building-specific vulnerabilities to a comprehensive earthquake risk assessment. Another recommendation is to conduct further analysis to understand the potential for solar and battery storage to increase resilience of critical energy infrastructure. To begin to address this last recommendation, we conducted a high level, preliminary feasibility analysis to identify critical energy infrastructure sites that could increase resilience with solar and battery storage, and provide rough estimates of solar potential and battery size to prioritize efforts.

In addition to increasing resilience of existing infrastructure to hazards, there is a need to consider the implications of adding more renewable energy generation to the Bainbridge Island grid, and the risks to those new installations as critical energy infrastructure. Using the hazard levels and site specific risks to aid in siting additional renewable energy as well as other electric infrastructure such as electric vehicle charging stations is recommended to avoid generating new vulnerabilities.

DRAFT

Key Takeaways:

- Various natural hazards exist on Bainbridge Island that need to be considered in planning for resilience and siting new renewables. In particular, sea-level rise, extreme heat, and extreme cold that were not considered in past assessments, should be considered in future planning.
- Risk is assessed considering probability of hazards, vulnerability at locations, and consequences of occurrence.
- The most at-risk critical energy infrastructure on Bainbridge Island based on this analysis includes existing and planned transmission lines, the Virginia Mason Medical Center, and the Winslow Wastewater Treatment Plant. Several other locations may be at high risk due to earthquakes.
- Resilience actions to address these risks include:
    - a more thorough assessment of wildfire risk at the Virginia Mason Medical Center
    - planning for sea level rise specifically at the Winslow Wastewater Treatment Plant
    - adding building-specific vulnerabilities to a comprehensive earthquake risk assessment
- Based on our high-level analysis, several critical energy infrastructure locations could increase resilience to power outages in general with the installation of solar and battery storage. These locations include the Island School, Rolling Bay Presbyterian, Bethany Lutheran, Wing Point Country Club, Virginia Mason Medical Center, Grace Church, Sakai Intermediate School, the Public Works O&M Yard, the Winslow Ferry Terminal, and Fire Stations 21, 22, and 23. More detailed analysis for each site is needed for project design.

DRAFT

Introduction

Bainbridge Island has a population of around 25,000 people. The island is connected to the Kitsap Peninsula by a single bridge, and to Seattle by a single 35-minute ferry crossing, indicating limited means for evacuation or access during emergencies. Bainbridge Island experiences frequent power outages, with the majority of outages caused by falling tree limbs or branches interfering with power lines. When the power goes out, for many homes and buildings, there is no water, no heat, and no internet, which can cause threat to human life as well as normal operations. Kitsap County and Bainbridge Island encourage citizens to prepare to be self-sufficient for at least 7 days if an emergency or disaster occurs, though typically power from local outages is restored within a few hours.

The City of Bainbridge Island (COBI) applied for and received technical assistance from the Energy Transitions Initiative Partnership Program (ETIPP) to support their goal of increasing energy resilience. The U.S. Department of Energy defines energy resilience as: "the ability… to withstand and rapidly recover from power outages and continue operating with electricity, heating, cooling, ventilation, and other energy-dependent services."[3] The technical assistance task assigned to Pacific Northwest National Laboratory (PNNL) was to identify and assess vulnerabilities to critical energy infrastructure, evaluate alternative options for addressing these vulnerabilities, and provide recommendations for increasing energy resilience. The City's other goal of 100% renewable electricity generation by 2040 is discussed in a separate report[4].

PNNL worked with the City to ensure selection of hazards and energy infrastructure of highest priority and integration of existing expertise into the analysis, as well as align analysis with current activities conducted by Puget Sound Energy (PSE), the local utility.

PSE has been working on improving the resilience and reliability of the Bainbridge Island power system through several recent projects, including:

- *Bainbridge Island Electricity Needs Assessment (2019)*
  The Needs Assessment identified transmission and distribution system needs and upgrades for reliability, system capacity, and aging infrastructure for the next 10 years. This report indicated the need for replacing the aging Winslow Tap due to frequent and prolonged outages, as well as an additional substation and feeder for the coming electric ferry load.
- *Bainbridge Island Electric Systems Solutions Report (2019)*
  The Solutions Report pairs with the Needs Assessment to propose various solutions and alternatives (wired and non-wired, see below) for the identified needs. The proposed solution is a combination of a new 115kV transmission line, battery storage, distributed energy resources, and infrastructure replacements.
- *Non-Wires Alternatives Report (2019)*
  PSE contracted with Quanta and Navigant to conduct a non-wires analysis to consider the feasibility of more battery storage and distributed energy resources to meet the needs identified. They found that a hybrid of wires and non-wires components would meet the reliability and capacity needs, while non-wires upgrades only would not be realistic.

---

[3] https://www.energy.gov/eere/energy-resilience

[4] Arkema, K.; Rose, D.; Moncheur de Rieudotte, M.; Sheridan, L.; Caruso, O.; Solana, A.; Piazza, A.; Grear, M.; Devine, M.; Esterly, S.; Salamnack, A. (2024). ETIPP Report: Bainbridge Island Pathways to 100% Renewable Energy. PNNL-35643.

More information on PSE's current efforts to improve energy resilience and reliability on Bainbridge Island is available on their website.[5]

The Bainbridge Island community has been proactive in planning for extreme weather, natural disasters, emergencies, and climate change to increase resilience. Examples of their previous resilience efforts include the Bainbridge Island Climate Action Plan (2020); the Climate Impact Assessment (EcoAdapt 2016); the Bainbridge Island Hazard Assessment and Vulnerability Assessment (2012); the Bainbridge Prepares Community Disaster Hubs[6]; and the Sea Level Rise on Bainbridge Island (2019) report. Work on these topics has also been done at the county, state, and federal levels. Key examples include:

- Kitsap County Multi-Hazard Mitigation Plan (2013, 2019)
- Kitsap Risk Report (FEMA 2015)
- Kitsap County Hazard Identification and Vulnerability Assessment (2008, 2019)
- Kitsap County Comprehensive Emergency Management Plan (2020)
- Kitsap County Climate Change Resiliency Assessment (2020)
- Projected Sea Level Rise for Washington State – A 2018 Assessment (2018)
- State of Knowledge: Climate Change in Puget Sound (2015)
- Managing Washington Wildfire Risk in a Changing Climate (2019)
- Extreme Coastal Water Level in Washington State: Guidelines to Support Sea Level Rise Planning (2019)
- Washington State's Energy Assurance Plan (being updated this year)
- US Department of Energy's Energy Sector Risk Profile for Washington State (2021)

This report, conducted under the ETIPP project in partnership with the City of Bainbridge Island, aims to build on this existing knowledge base with a specific focus on energy resilience. The report begins by identifying hazards and threats on Bainbridge Island, identifying and characterizing the critical energy infrastructure, assessing the risk(s) at each location, and analyzing resilience gaps to make recommendations for City priorities moving forward.

DRAFT

[5] https://psebainbridge.com/projects/

[6] https://bainbridgeprepares.org/teams/hubs/

Hazards and Threats

Bainbridge Island is vulnerable to a number of natural hazards, many of which are described and compiled on the City website[7] as well as the Kitsap Department of Emergency Management website[8], and the reports listed above. As our collective knowledge about the effects of climate change on both natural and human systems grows, synthesizing and updating these reports is an ongoing process that occurs at many management and planning levels. The aim of this report in particular is to focus on the hazards that could impact the critical energy infrastructure on Bainbridge Island, identify upgrades or mechanisms that could improve energy resilience, and inform future funding proposals to support increasing resilience.

To assess the vulnerability of the critical energy infrastructure on Bainbridge Island to identified threats, it is necessary to understand both the level of risk and the severity of each hazard. Risk is typically defined as the likelihood of a hazard's occurrence, based on historic frequency or models of future occurrence. The Bainbridge Island HIVA (2012) and the Kitsap County HIVA (2019) use a 25-year span to measure risk, such that events that occur annually or are likely to occur every 25 years are high risk, events that have a moderate likelihood of occurring within a 25-year span are moderate risk, and events that are expected to occur beyond 25 years are low risk. Severity is slightly more subjective, but includes the scale of people, property, environment, and economy vulnerable to loss or damage from the occurrence of a hazardous event that impacts critical energy infrastructure or services.

In the context of energy resilience, the Technical Resilience Navigator[9] describes risk as the relationship between a particular hazard or threat that might degrade the performance of infrastructure and the consequences (immediately downstream, and for communities broadly) that might result from a degradation of performance. The overall risk to critical energy infrastructure can be determined by analyzing the probability of a hazard occurring at a particular location, the susceptibility of the particular type of infrastructure to fail or be impaired by the hazard (vulnerability), and the consequences of infrastructure failure. If quantified numerically, this is a multiplied calculation, as shown below.

Risk = Probability of Hazards and Threats * Vulnerability * Consequence

The threats to critical energy infrastructure are summarized in Table 1 according to the approach used by the previous HIVAs, identifying risk and severity broadly without quantification. Each threat is described in detail in the following sections.

[7] https://www.bainbridgewa.gov/767/Hazard-and-Risk-Info

[8] https://www.kitsapdem.com/disasters/

[9] https://trn.pnnl.gov/

DRAFT

Table 1. Hazards and threats to critical energy infrastructure on Bainbridge Island, identified by previous reports and conversations with the City. Levels of risk and severity taken from Bainbridge Island HIVA (2012), Kitsap County HIVA (2019) or determined based on the definitions provided for each and the most current information.

Hazards / Threats	Risk and Severity	Impact(s) to Critical Energy Infrastructure
Severe Storm	High Risk Moderate Severity	• Blowdown of trees/branches that knock out power lines • Damage to critical facilities
Flood	Moderate Risk Moderate Severity	• Restricted access • Damage to critical facilities
Sea Level Rise*	Moderate Risk Moderate Severity	• Limited access to wastewater treatment plant during king tide coupled with power malfunction resulted in release • Siting of ferry docks and charging infrastructure
Tsunami**	Moderate Risk Moderate Severity	• Seawater inundation up to 30 feet • Damage to critical facilities
Earthquake***	High Risk High Severity	• Power loss if transmission infrastructure disrupted • Damage to critical facilities
Erosion, landslide	Moderate Risk Moderate Severity	• Power loss if transmission infrastructure disrupted • Damage to critical facilities
Wildfire	Moderate Risk High Severity	• Restricted access • Damage to critical facilities
Extreme Temperatures*	Moderate Risk Low Severity	• Potential changes to future loads (size and seasonality), especially considering adaptations (A/C or electric heat pump)
Terrorism, vandalism	Moderate Risk High Severity	• Power loss • Damage to critical facilities

*These hazards were not assessed in the most recent Bainbridge Island Hazards Identification and Vulnerability Assessment (2012). Levels of risk and severity were calculated based on the definitions provided in the HIVA and the Kitsap County Comprehensive Emergency Management Plan (2020).

**The risk level for tsunami reported in the 2012 HIVA was low, but has been updated to Moderate based on the update from the 2016 HIVA based on the Kitsap County Comprehensive Emergency Management Plan overall risk rating as well as 2022 information from Washington Department of Natural Resources[10].

***The risk level for earthquake includes both the risk of a Cascadia Fault rupture and a Seattle Fault rupture.

[10] https://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/Tsunamis#tsunami-hazard-maps

Severe Storm

Severe storms occur on Bainbridge Island most often in the winter months and can include high winds (40-60 mph), heavy precipitation including snowfall, and lightning strikes. More intense and more frequent extreme precipitation events are expected, up from two events per year historically to seven events per year (EcoAdapt 2016), and the Kitsap Emergency Management department plans for three potentially dangerous storms each winter (Kitsap HIVA 2013).

High winds in particular can knock down tree branches, disrupting the power supply for variable numbers of homes and businesses depending on location. When severe storms are coupled with high tides, storm surge can occur (see Flood section). In the event of a snowstorm, power loss can increase exposure to extreme cold (see Extreme Temperatures section). During snow and ice events, City Operations & Maintenance staff work around the clock and have a Snow and Ice control plan and designated snow plow routes. Residents are encouraged to prepare their own emergency kits for storms. Severe weather shelters are opened if there is an extended power outage (>4 hours) and the weather is forecasted below 32˚F overnight.

Flood

Flooding is the most common hazard that occurs in Kitsap County generally and on Bainbridge Island in particular. Heavy, sustained rainfall in the autumn, winter or spring can saturate the ground and raise streamflows. Due to the varied topography of the island, this excess water pools more rapidly than it can be drained via natural runoff or stormwater systems. As such, structures in low-lying areas or areas with poor drainage tend to flood during prolonged periods of rain. Flooding can also obstruct access to roadways, impacting access to key locations for maintenance or general island operations. The Federal Emergency Management Agency (FEMA) has designated Flood Hazard Areas, which are available on the Critical Areas Web Application Map[11].

King tides (the highest of high tides, seasonally) may also cause flooding on Bainbridge Island, especially when coupled with sea level rise. Over time, as the average daily water levels are rising, the high tides reach further inland than in the past, affecting structures that were not designed for seawater inundation or proximity. As a result, king and high tides are reaching higher and extending further inland than in the past (see Sea Level Rise section).

Bainbridge Island has collected and developed multiple resources for residents on preparation for flooding[12]. Sandbags are typically available at the City Operations & Maintenance (O&M) Facility in the winter season. The City is also preparing for additional flood risk mitigation linked to sea level rise with submission of grants, described in the Sea Level Rise section.

[11] https://cityofbi.maps.arcgis.com/home/index.html
[12] https://www.bainbridgewa.gov/767/Hazard-and-Risk-Info, under Flood tab

Sea Level Rise

Sea level rise was not assessed in the 2012 HIVA, but multiple new tools have been developed to assess sea level rise in Washington State. According to the 2019 Sea Level Rise Assessment for Bainbridge Island[13], the most likely projections indicate that Bainbridge Island will experience one foot of sea level rise by the year 2060[14] and various other scenarios are available[15].

Several power lines located along the shoreline have already been leaning as a result of seawater exposure and are planned for replacement. The effects of sea level rise are compounded with strong high tides and winter storms, and have already prompted significant City action to prepare for this threat.

As an island, Bainbridge is particularly vulnerable to the effects of sea level rise, with a lot of infrastructure located near shorelines in low-lying areas and few options for relocation or elevation. In 2022, upgrades were made on a stormwater outfall to prevent flooding during high tides or with rising seas. The City has submitted grant applications under FEMA's Building Resilient Infrastructure and Communities program for replacement of the Wing Point Sewer Pump station and to conduct a Shoreline Roadway Sea Level Rise Assessment Project that are currently under review.

The City also received grants to conduct a more high-resolution assessment of local sea level rise impacts in 2023-2024, and selected Environmental Science Associates as a consultant to conduct analysis. Sea level rise is addressed explicitly as an effect of concern in the Climate Action Plan (2020)[16], with key vulnerable assets identified (i.e., sewer service around Eagle Harbor, WSF ferry terminal and maintenance facilities, Wyckoff Superfund Site, Fay Bainbridge Park, Winslow Wastewater Treatment Plant, and private waterfront residences) as well as other infrastructure impacts (shoreline stability, critical habitat loss, inundation of roadways, saltwater intrusion and effects on groundwater and drinking water, changes required to Shoreline Management Plan). The community has also been active in preparing, with an EcoAdapt project funded by the Bainbridge Community Foundation[17], to understand community opinions and concerns.

Tsunami

Much of Bainbridge Island is located in the tsunami inundation zone and current modeling indicates a tsunami resulting from a Seattle Fault or Cascadia Fault earthquake could produce a roughly 3 - 6 ft tsunami in low-lying waterfront areas. Tsunamis could also be caused by landslides, which would have larger though more localized impacts.

[13] Climate Change Advisory Committee. (2019). Sea Level Rise on Bainbridge Island: A Preliminary Assessment. Available at https://www.bainbridgewa.gov/DocumentCenter/View/12893/Sea-Level-Rise-Assessment-October-24-2019
[14] National Oceanic and Atmospheric Administration's Sea Level Rise Viewer: https://coast.noaa.gov/slr/#/layer/slr/
[15] University of Washington's Sea Level Rise Data Visualizations: https://cig.uw.edu/projects/interactive-sea-level-rise-data-visualizations
[16] COBI. (2020). Climate Action Plan: A Plan for Mitigating and Adapting to Climate Change on Bainbridge Island. https://www.bainbridgewa.gov/DocumentCenter/View/14354/Final-Bainbridge-Island-Climate-Action-Plan-November-12th-2020
[17] EcoAdapt. (2023). Bainbridge Island Sea Level Rise: Community Survey and Adaptation Support. Available at https://ecoadapt.org/projects/6/Bainbridge-Island-Community-Sea-Level-Rise-Survey

The Department of Natural Resources (DNR) has produced models indicating the tsunami inundation resulting from a 9.0 Cascadia Fault rupture[18] and a 7.6 Seattle Fault rupture[19]. Areas of significant inundation in both maps include Adams Park (Eagle Harbor), Pritchard Park, Wing Point, Manitou Beach, and Fay Bainbridge Park; with significantly higher water levels predicted for the Seattle Fault rupture (e.g., Manitou Beach is 32 feet underwater in the Seattle Fault rupture model, but only 6 feet underwater in the Cascadia Fault rupture model). Hazard maps are available to explore in more detail on the DNR website[20].

There are no mitigation plans for tsunami at present on Bainbridge other than existing efforts related to sea level rise and coastal flooding. The significantly higher water levels, though temporary, could cause damage to structures and residences all along the shoreline and in low-lying areas. In addition to inundation, tsunamis can cause changes in current patterns that make it dangerous to be on the water, with speeds over 25 knots (~12.8 meters per second) in some areas.

Earthquake

Washington State overall has the second highest risk of earthquakes in the country. These primarily occur in Western Washington, and the two main fault lines to be concerned about on Bainbridge Island are the Cascadia Subduction Zone and the Seattle Fault, though many other active faults exist[21]. A Cascadia earthquake is not expected to occur in the near term, but if it were to occur scenarios show around a magnitude 9.0 earthquake, resulting in very strong shaking intensity on Bainbridge Island[22]. This type of earthquake would be catastrophic not only to Bainbridge Island but to the region in general, disrupting nearly all services and causing massive damage. The scenario for a Seattle Fault earthquake is a 7.2 magnitude earthquake occurring just east of Lake Sammamish, resulting in severe shaking on most parts of Bainbridge Island and high damage to the wastewater treatment plant, potential damage to the Agate Pass bridge and ferry terminal, and low to moderate damage at the fire stations and schools[23].

Bainbridge Island has several measures in place to mitigate and prepare for earthquakes. Buildings are required to be engineered to resist 7.5 magnitude earthquakes under the United Building Code in Seismic Risk Zone 3, though older buildings are less likely to be built to code and may require retrofits, and earthquakes of greater magnitude are possible in the area. The Fire Department has a disaster preparedness website[24] specific to earthquakes, and Bainbridge Prepares is an active community nonprofit that helps residents prepare for all disasters with a primary focus on earthquakes[25].

---

[18] https://www.bainbridgewa.gov/DocumentCenter/View/16345/Tsunami-Bainbridge-Map-Cascadia-SZ?bidId=
[19] https://www.bainbridgewa.gov/DocumentCenter/View/16344/Tsunami-Bainbridge-Submersion-Map-Seattle-Fault?bidId=
[20] https://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/Tsunamis#tsunami-hazard-maps
[21] https://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/geologic-hazard-maps #active-faults-and-earthquakes-in-washington-state
[22] https://www.dnr.wa.gov/seismic-scenarios
[23] https://geologyportal.dnr.wa.gov/
[24] https://www.bifd.org/disaster-preparedness
[25] https://www.bainbridgeprepares.org/s/Bainbridge-Resource-for-Residents-Aug-2023-6b6t.pdf

DRAFT

Erosion, Landslide

Bainbridge Island is subject to landslides and soil erosion due to wind, water, and flooding anytime throughout the year. Landslides can cause deaths, significant damage to properties and infrastructure, and in some cases, losses of the use of land for many years due to the extensive cost of restoration.

Landslide occurrences on the island have been concentrated along its coastal bluffs. Past landslides have been mapped by the United States Geological Survey (USGS) and are available in the Critical Areas Web Application[26]. The 2016 Climate Impact Assessment by EcoAdapt[27] provides a closer look at increased coastal erosion concerns due to sea level rise impacts on slope stability.

Bainbridge Island Public Works and the Police Department opportunistically monitor areas with steep slopes (in particular, Rolling Bay, Sunrise Drive, Rockaway Beach, Toe Jam Hill, and Logg Road) to note changes in conditions and identify mitigation or repair actions such as retaining walls or drainage improvements. Hillsides and steep slopes are considered critical areas in the City's Municipal Code, and have limitations on types of development that can occur and what additional geotechnical reviews may be required before new building.

None of the critical energy infrastructure locations noted later in the report are at risk presently from erosion or landslides, though this may change with sea level rise.

Wildfire

The risk of wildfire in the Puget Sound region is generally expected to increase due to climate change, with changes in drought patterns and temperatures. Wildfires on Bainbridge Island can be caused by downed power lines, stray sparks from propane tanks or barbeques, or other human errors. The risks are highest at the wildland-urban interface[28], where homes or other developments are located closely near natural areas. The Fire Department has mapped the severity of wildfire based on the slope of the landscape, the type of fuel, and the frequency of critical fire weather[29]. As part of this analysis, priority mitigation areas were identified.

The City of Bainbridge Island in partnership with the Fire Department and the Police Department has developed a Wildfire Response and Evacuation Plan (2022)[30] that describes the evacuation zones and routes. The Fire Department has also developed a Community Wildfire Protection Plan (2022)[31], which includes an assessment of

---

[26] https://cityofbi.maps.arcgis.com/apps/webappviewer/index.html?id=69e8fb8e73ea44029468811910a28fd4, USGS Mapped Landslides layer

[27] EcoAdapt. (2016). Bainbridge Island Climate Impact Assessment. Available at https://www.bainbridgewa.gov/DocumentCenter/View/12544/BICIA-Final-28-July-2016?bidId=

[28] View the Department of Natural Resource's map of the wildland-urban interface on Bainbridge here: https://wadnr.maps.arcgis.com/apps/View/index.html?appid=21683af70ece4bd495c319915f7a9232

[29] Bainbridge Island Fire Department. (2010). Bainbridge Island Community Wildfire Protection Plan. Available at https://www.dnr.wa.gov/publications/rp_burn_cwpp_bainbridgeIsland.pdf

[30] COBI. (2022). Comprehensive Emergency Management PLan: Hazard Specific Annex - Wildfire Response and Evacuation Plan. Available at https://www.bainbridgewa.gov/DocumentCenter/View/12163/Wildfire-Response-and-Evacuation-Plan---Hazard-Specific-Annex-?bidId=

[31] BIFD. (2022). Bainbridge Island Community Wildfire Protection Plan. Available at https://www.bifd.org/pdfs/FINAL_CWPP_UPDATE_101322.pdf

DRAFT

risk considering key island locations and many more details on fire types, frequencies, and best practices for prevention and mitigation.

Extreme Temperatures

Extreme heat and extreme cold are hazards that were not assessed in the 2016 Hazard Identification and Vulnerability Assessment, but are increasingly expected with climate change in the Pacific Northwest and are a rising concern for the Bainbridge Island community. While normal temperatures on Bainbridge are quite mild (average low of 38°F in the winter and average high of 75°F in the summer[32]), these values may be changing. The NOAA Climate Explorer[33] shows an increase in average daily temperature under all emissions scenarios and an increase of 5 - 7 days over 90°F compared to historic averages.

Extreme cold events are not expected to increase, though there are still occasional cold snaps that coincide with winter storms or power outages that threaten vulnerable individuals and can cause damage to infrastructure. Extreme heat has resulted in many adaptation actions, including the increase in installation of air conditioning units or electric heat pumps on the island and in the region in general. These actions could increase the summer electric load, and add a new vulnerability to power loss in the summer if events overlap.

During the summer of 2021, the City opened the Senior Community Center as a cooling center for the first time ever in response to excessive heat warnings. The Senior Center is one of the Community Disaster Hubs, and it has air conditioning and water available for visitors during extreme heat, and rides to the center are provided by volunteers to those who need it. This resource is likely to become more needed with future heat waves unless individuals take initiative to install their own home air conditioning.

Another set of facilities that is likely to be impacted by climate caused extreme temperatures are wastewater treatment plants[34], which already operate less efficiently at very low and very high temperatures[35] and even normal winter icing can interfere with power supply.

Terrorism, Vandalism

Human-caused hazards are important to consider, especially in the context of energy resilience. Attacks can happen on physical infrastructure or software. The threat of terrorism or vandalism was not addressed in the 2016 Bainbridge Island Hazard Identification and Vulnerability Assessment, but is included in the 2020 Kitsap County Comprehensive Emergency Management Plan[36] as an overall moderate risk. Prevention is identified as the main action related to terrorism, including awareness and reporting of suspicious activity.

Assessing the risk of a particular location or infrastructure to a human threat is difficult, especially considering vandalism in addition to terrorism. For this assessment, we consider the most critical locations to be components of

---

[32] https://weatherspark.com/y/936/Average-Weather-in-Bainbridge-Island-Washington-United-States-Year-Round
[33] https://crt-climate-explorer.nemac.org/climate_graphs/?city=Bainbridge+Island%2C+WA&county=Kitsap%2BCounty
[34] Hughes et al. (2021). Impacts and implications of climate change on wastewater systems: A New Zealand perspective. *Climate Risk Management 31*: 100262. DOI: 10.1016/j.crm.2020.100262
[35] Alisawi, H. (2020). Performance of wastewater treatment during variable temperature. *Applied Water Sciences 10*: 89. DOI: 10.1007/s13201-020-1171-x
[36] Kitsap County. (2020). Comprehensive Emergency Management Plan. Available at https://www.kitsapdem.com/wp-content/uploads/2021/08/2020-Kitsap-County-Comprehensive-Emergency- Management-Plan.pdf

the electric grid (PSE transmission lines and substations) due to the widespread impact that an intentional human-caused power disruption could cause. Other locations that are vulnerable to terrorism and vandalism that have fewer impacts from an energy perspective include City facilities, Police/Court Buildings, and schools (though these locations still have impacts from a human life and societal function perspective).

DRAFT

Characterization of Critical Energy Infrastructure

The first step in identifying opportunities to improve energy resilience on Bainbridge Island was selecting the critical energy infrastructure to consider in this study. Critical energy infrastructure is defined as systems or facilities that provide a necessary energy function, and are essential to have operational for normal, day-to-day activities as well as in an emergency or natural disaster. For Bainbridge Island, this infrastructure was identified in some existing emergency management plans and by the Community Disaster Hub program. The ETIPP team also iterated on a list through conversations with the City. The 33 priority locations for critical energy infrastructure considered in this study are shown on Figure 1 and include:

- PSE transmission lines and substations:
    - Port Madison Substation
    - Winslow Substation
    - Murden Cove Substation
    - Winslow Transmission Tap
    - Murden Cove Transmission Tap
    - Murden Cove - Winslow Transmission Line
- 18 Community Disaster Hubs:
    - Bloedel Reserve
    - Seabold United Methodist
    - Island School
    - Grace Episcopal Church
    - Recreation Center
    - Rolling Bay Presbyterian
    - Battle Point Park
    - Sakai Intermediate School
    - Island Center Hall
    - Bethany Lutheran
    - Senior Center (Warming/Cooling Center)
    - Strawberry Hill Park
    - Bainbridge High School (Child Reunification Center)
    - Virginia Mason Medical Center (Disaster Medical Hub)
    - Wing Point Country Club
    - Hyla Middle School
    - Islandwood
    - Fort Ward Community Hall
- City Facilities:
    - Ted Spearman Justice Center (City Emergency Operations Center)
    - Public Works O&M Yard (including charging stations for City fleet EVs)
    - City Hall
    - Winslow Wastewater Treatment Plant
- Kitsap County Sewer District #7 Wastewater Treatment Plant
- Winslow Ferry Terminal
- Fire Stations 21, 22, 23

DRAFT

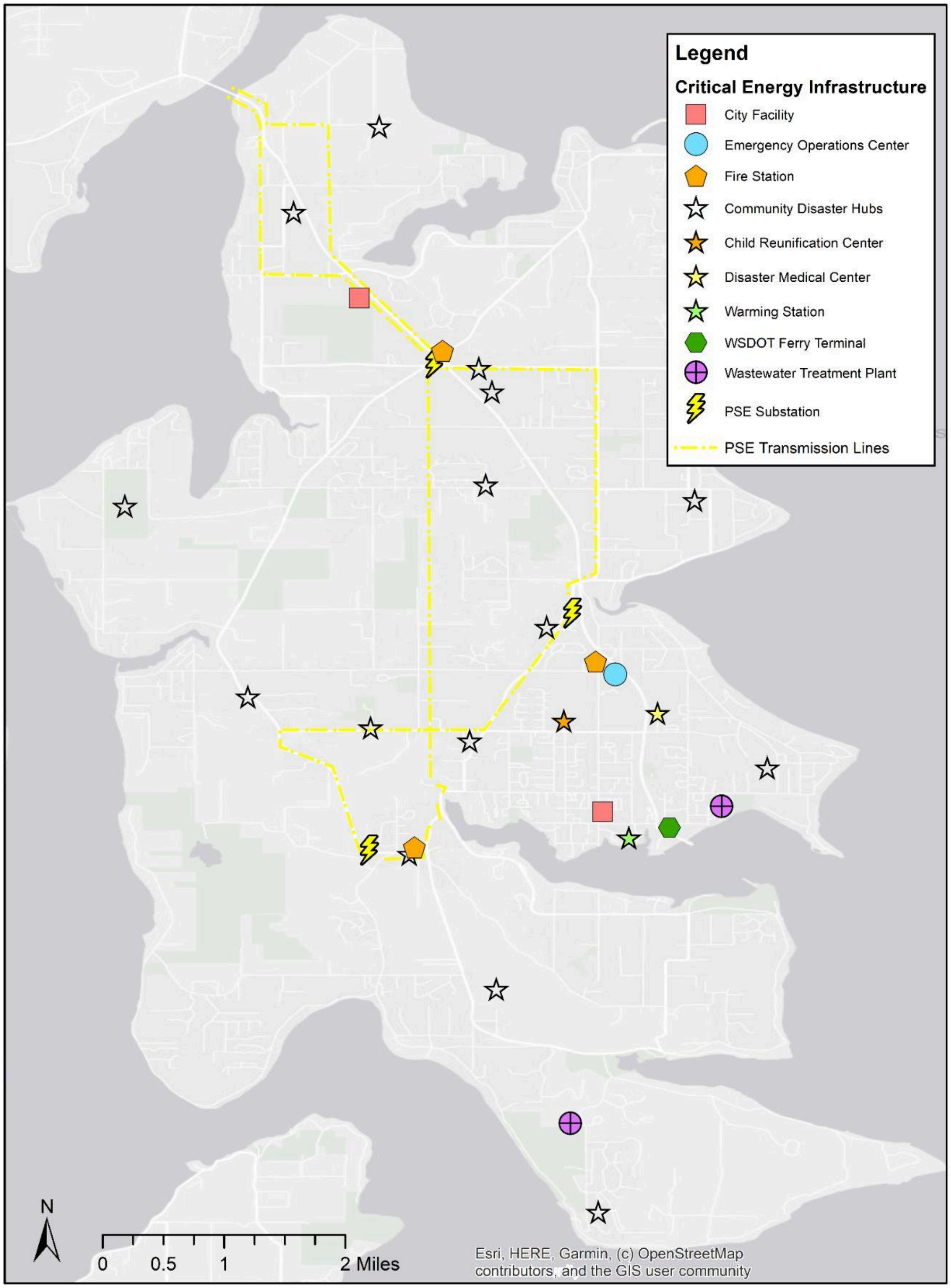


Figure 1. Critical energy infrastructure locations on Bainbridge Island. Data compiled from City sources, Google Maps, and PSE information.

The next step was to characterize the critical energy infrastructure by identifying critical functions and energy requirements (particularly for emergency operations), using the Technical Resilience Navigator[37], the Federal Emergency Management Agency Best Practices report (2014)[38], and the U.S. Department of Energy's Energy Emergency Response Playbook (2022)[39] as guides. PNNL extracted energy system and consumption information from publicly available sources using Google, or collected it from the City and PSE. The City also provided descriptions of energy requirements for community disaster hubs in emergency operation mode. Information for several facilities (senior center, recreation center, Bloedel Reserve, Battle Point Park, the high school, and Hyla Middle School) was provided in the COBI - PV Panel and Battery Storage report by Design West Engineering (2022)[40]. An energy storage planning report commissioned by PSE from Quanta Technology (2019)[41] provides an additional screening of projects for storage and other reliability upgrades for infrastructure operated by PSE. The Bainbridge Island Greenhouse Gas Inventory Report (2019) provides some information on annual consumption for key buildings[42], and updated information on City facilities was provided from their Portfolio Manager tool. A lot of the remaining energy information is not publicly available due to security concerns, and was estimated by PNNL based on a set of assumptions based on industry standards and experience. For instance, the analysis assumes that 50% of normal building power usage is required in emergency operation modes. Additionally, the average annual energy consumption of a commercial building in the U.S. is 22.5 kWh per square foot, which varies greatly by building type and the equipment used for heating, cooling, ventilation, lighting, refrigeration, water heating, and plug loads. PNNL used the Zero Code Energy Calculator[43] to estimate annual consumption for the clinic, schools, and churches without current data, and CalcMaps[44] to estimate square footage of buildings using footprints on Google Maps.

Estimate (kWh/day) = (Annual Electric Consumption (or estimate based on square footage and type), kWh * 0.5) / 365

Following characterization, PNNL compared each of the critical energy infrastructure locations to spatial maps of all hazards to determine the probability, vulnerability, and consequence of occurrence from high, moderate, to low. Definitions for each of these are provided below, and the spatial layers that were used to compile the overlays used in this assessment are available in Appendix A.

- Probability: chance of hazard occurring at location (high, moderate, low). We determined probability for all spatial hazards using the spatial data available in Appendix A (flood, sea level rise, tsunami, earthquake, erosion, and wildfire). Hazards that are not present at a particular location (e.g., sea level rise at inland facilities, extreme temperatures or severe storms that would not affect energy systems) are

[37] https://trn.pnnl.gov/
[38] FEMA. (2014). Emergency Power Systems for Critical Facilities: A Best Practices Approach to Improving Reliability. Available at https://www.wbdg.org/FFC/DHS/femap1019.pdf
[39] U.S. Department of Energy. (2022). Energy Emergency Response Playbook for States and Territories. Available at https://www.energy.gov/ceser/articles/doe-energy-emergency-response-playbook-states-and-territories
[40] Design West. (2022). COBI - PV Panel and Battery Storage: Assessment and preparation of specifications for design build install of PV and BESS systems at six sites. Available at https://bainbridgewa.gov/DocumentCenter/View/17056/Solar-and-Battery-Energy-Storage-at-Community-Disaster-Hubs---2022-Report-?bidId=
[41] Quanta Technology. (2019). Energy Storage Planning to Support Bainbridge Island. Prepared for Puget Sound Energy. Available at https://quanta-technology.com/wp-content/uploads/2020/05/Appendix-E_Energy-Storage-Planning-to-Support-Bainbridge-Island-Final-Report_Quanta-Technology_Apr-23-2019-4a.pdf
[42] Cascadia Consulting Group. (2019). City of Bainbridge Island Greenhouse Gas Emissions Inventory. Available at https://www.bainbridgewa.gov/DocumentCenter/View/12811/Bainbridge_GHG-Inventory-Report_FINAL_20191122
[43] https://zero-code.org/energy-calculator/
[44] https://www.calcmaps.com/map-area/

excluded from further analysis and are not included in results. For non-spatial risks (severe storm, extreme temperatures, terrorism/vandalism), the probability was determined based on the overall frequency of the hazard at an Island-wide scale (see descriptions in Hazards and Threats section).

- Vulnerability: Susceptibility of location to harm/damage from occurrence (high, moderate, low). We determined vulnerability using spatial data in Appendix A for earthquake risk, and building- or site-specific characteristic information where available. Justifications are provided in the results where vulnerability is inferred.
- Consequence: severity of harm/damage (high, moderate, low). We determined the consequence of each hazard for each location of critical infrastructure based on the expected impact on human life, property, and power systems. High consequence was assigned to locations that provide power (PSE infrastructure), or if experiencing a hazard could harm vulnerable populations that regularly utilize the facility (e.g., earthquake and schools, Senior Center, Virginia Mason Medical Center) or interfere with critical operations (e.g., earthquake and Ted Spearman Justice Center, earthquake or extreme temperatures at wastewater treatment plants). Moderate consequence was assigned to locations that are moderately utilized (e.g., earthquake or wildfire and churches). Low consequence was assigned to locations that are relatively lowly utilized or have limited power needs in an emergency (e.g., basic Disaster Hubs).

Following these determinations, the overall risk of each hazard to each location was assigned using Table 2. We discuss these results in light of recommendations to inform resilience for the highest risk locations in subsequent sections.

DRAFT

Table 2. Determination of overall relative risk level based on components: probability, vulnerability, and consequence.

Probability	Vulnerability	Consequence	Overall Risk
High	High	High	High
	High	Moderate	High
	High	Low	Moderate
	Moderate	High	High
	Moderate	Moderate	Moderate
	Moderate	Low	Moderate
	Low	High	Moderate
	Low	Moderate	Moderate
	Low	Low	Low
Moderate	High	High	High
	High	Moderate	High
	High	Low	Moderate
	Moderate	High	High
	Moderate	Moderate	Moderate
	Moderate	Low	Low
	Low	High	Moderate
	Low	Moderate	Moderate
	Low	Low	Low
Low	High	High	Moderate
	High	Moderate	Moderate
	High	Low	Low
	Moderate	High	Moderate
	Moderate	Moderate	Moderate
	Moderate	Low	Low
	Low	High	Moderate
	Low	Moderate	Low
	Low	Low	Low

The results of the critical energy infrastructure characterization and risk assessment is shown in Table 3.

Table 3. Characterization of critical energy infrastructure and assessment of risk from hazards at each location. Locations are listed in order by facility type: PSE infrastructure, community disaster hubs, other City facilities, and public services. Data sources are available in Appendix A.

Location and Energy Needs	Hazard(s)	Probability	Vulnerability	Consequence	Overall Risk
Port Madison Substation Serves 4,140 customers. Originally built in 1954, new transmission line and additional improvements were made in 2000.	Terrorism/ vandalism	Moderate	Low - fenced and currently monitored by PSE	High	Moderate
	Earthquake	High	Low	High	High
	Wildfire	Low	Low	High	Moderate
Winslow Substation Supplies power to 3,960 customers on the south end of the island. Originally built in 1960.	Terrorism/ vandalism	Moderate	Low - fenced and currently monitored by PSE	High	Moderate
	Earthquake	High	Moderate	High	High
	Wildfire	Low	Low	High	Moderate
Murden Cove Substation Location of PSE's new 3.3 MW BESS, which will power peak demand (scheduled for 2025-2026). Serves 4,850 customers, originally built in 1979.	Terrorism/ vandalism	Moderate	Low - fenced and currently monitored by PSE	High	Moderate

Location and Energy Needs	Hazard(s)	Probability	Vulnerability	Consequence	Overall Risk
	Tsunami	Moderate	Moderate - potential inundation to transmission tap or access	High	High
	Earthquake	High	High	High	High
	Wildfire	Low-Moderate	Low	High	Moderate
Winslow Transmission Tap 115kV transmission line, planned for rebuild (originally built in 1960), construction to take place in 2027 with design and permitting in 2026. 4.5 mi long.	Severe storm	High	High	High	High
	Terrorism/ vandalism	Moderate	Low - difficult to access, currently monitored by PSE	High	Moderate
	Tsunami	Moderate	Moderate - some areas under the line could be inundated up to 20ft in Seattle Fault rupture scenario, could cause instability to poles	High	High
	Earthquake	High	Moderate	High	High

Location and Energy Needs	Hazard(s)	Probability	Vulnerability	Consequence	Overall Risk
	Erosion	Moderate	Low - lines cross USGS erosion hazard areas, poles likely sited away from steep slopes	High	Moderate
	Wildfire	Low-Moderate	Moderate	High	Moderate
Murden Cove Transmission Tap 115kV transmission line, connects Murden Cove Substation to Port Madison.	Severe storm	High	High - significant trees	High	High
	Terrorism/ vandalism	Moderate	Low - difficult to access, currently monitored by PSE	High	Moderate
	Earthquake	High	Moderate	High	High
	Erosion	Moderate	Low - lines cross USGS erosion hazard areas, poles likely sited away from steep slopes	High	Moderate
	Wildfire	Low-Moderate	Moderate	High	Moderate

Location and Energy Needs	Hazard(s)	Probability	Vulnerability	Consequence	Overall Risk
Murden Cove - Winslow Transmission Line (scheduled for 2027-2028) New PSE 115kV transmission line, 3.4 miles long that creates a transmission loop for redundancy to support the other substations if one transmission line goes out. Currently still in planning and permitting, though route has been selected and is shown on map.	Severe storm	High	High - significant trees	High	High
	Terrorism/ vandalism	Moderate	Low - difficult to access, currently monitored by PSE	High	Moderate
	Earthquake	High	Moderate	High	High
	Erosion	Moderate	Low - planned route crosses USGS erosion hazard areas, poles will likely be sited away from steep slopes	High	Moderate
	Wildfire	Low-Moderate	Moderate	High	Moderate

Location and Energy Needs	Hazard(s)	Probability	Vulnerability	Consequence	Overall Risk
Bloedel Reserve Several buildings on site: 400 square foot gatehouse building - 33,145kWh annual consumption, 642 square foot floral workshop - 3,050 kWh annual consumption, 2,800 square foot maintenance shed - 14,615 kWh annual consumption. Current power from PSE - 120/240V single phase to each building. Small backup generator at gatehouse. Provides basic disaster hub services. Estimate: 70 kWh/day for emergency operations at all three buildings.	Earthquake	High	Low	Low	Low
	Wildfire	Low-Moderate	Moderate	Low	Moderate
Seabold United Methodist Provides basic disaster hub services (heating, lighting, charging). 1,794 square feet. Estimate: 36 kWh/day for emergency operations.	Earthquake	High	Low	Moderate	Moderate
	Wildfire	Low-Moderate	Moderate	Moderate	Moderate
Island School Provides basic disaster hub services (heating, lighting, charging). ~10,700 square feet. Estimate: 164 kWh/day for emergency operations.	Earthquake	High	Low	Moderate	Moderate
	Wildfire	Low	Moderate	High	Moderate

Location and Energy Needs	Hazard(s)	Probability	Vulnerability	Consequence	Overall Risk
Grace Episcopal Church Provides basic disaster hub services (heating, lighting, charging). ~11,000 square feet. Estimate: 1,237 kWh/day for emergency operations.	Earthquake	High	Low	Moderate	Moderate
	Wildfire	Low-Moderate	Moderate	Moderate	Moderate
Recreation Center 39,000 square foot 2 story building, and a court building with 14,000 additional square feet. Currently served by PSE, 1000 Amps 277/480V 3 phase 4 wire. Large loads include elevator, HVAC and pool equipment, annual load at court building is 438,000 kWhr. No existing backup generator. Provides basic disaster hub services. Estimate: 600 kWh/day for emergency operations at court building.	Earthquake	High	Moderate	Moderate	Moderate
	Wildfire	Low	Moderate	Moderate	Moderate
Rolling Bay Presbyterian Provides basic disaster hub services (heating, lighting, charging). ~24,000 square feet. Estimate: 480 kWh/day for emergency operations.	Earthquake	High	Moderate	Moderate	Moderate
	Wildfire	Low	Moderate	Moderate	Moderate
Battle Point Park 3,100 square foot transmitter building, 5,000 square foot maintenance building - total annual consumption 400 kWh. Both served by PSE (600 Amp 120/240V 3 phase 4	Tsunami	Moderate	Low - site itself not impacted	Moderate - access to site may be impacted by	Moderate

Location and Energy Needs	Hazard(s)	Probability	Vulnerability	Consequence	Overall Risk
wire with stinger leg, fed by underground transformer banks. Maintenance shop has portable generators to use as needed. Provides basic disaster hub services. Estimate: 0.5 kWh/day for emergency operations.				inundation of road, Arrow Point Dr NE	
	Earthquake	High	Moderate	Low	Moderate
	Wildfire	Low	Moderate	Low	Low
Sakai Intermediate School Provides basic disaster hub services (heating, lighting, charging). ~52,000 square feet. Estimate: 796 kWh/day for emergency operations.	Earthquake	High	Moderate	Moderate	Moderate
	Wildfire	Low	Moderate	High	Moderate
Island Center Hall Provides basic disaster hub services (heating, lighting, charging). ~1,700 square feet. Estimate: 34 kWh/day for emergency operations.	Flood - 1% annual chance (FEMA Zone A)	High	Moderate	Moderate	Moderate
	Earthquake	High	Moderate	Moderate	Moderate
	Wildfire	Low-Moderate	Moderate	Moderate	Moderate
Bethany Lutheran Provides basic disaster hub services (heating, lighting, charging). ~11,900 square feet. Estimate:238 kWh/day for emergency operations.	Earthquake	High	High	Moderate	High
	Wildfire	Low-Moderate	Moderate	Moderate	Moderate

Location and Energy Needs	Hazard(s)	Probability	Vulnerability	Consequence	Overall Risk
Senior Center (Warming/Cooling Station) Single story, 6,545 square feet. Power currently provided by PSE, 400 Amps 120/240V 1 phase 3 wire. 2 electrical panels connected to the existing propane backup generator. 5kW PV system was installed on roof in 2014. Serves as warming and cooling station and disaster hub. No data in Design West 2022 on annual consumption, ~75,000 kWh annual consumption in 2018. Estimate: 103 kWh/day for emergency operations.	Extreme Temperatures	Moderate	Low - extreme temps on their own don't cause power outages, but timing is critical	High	Moderate
	Earthquake	High	High	Moderate	High
	Wildfire	Low	Moderate	Moderate	Moderate
Strawberry Hill Park Provides basic disaster hub services (heating, lighting, charging). Gym is 972 square feet. Estimate: 7 kWh/day for emergency operations.	Earthquake	High	Moderate	Low	Moderate
	Wildfire	Low-Moderate	Moderate	Low	Moderate
Bainbridge High School (Child Reunification Center) 36,500 square foot 2 story building. Annual usage estimated 240,000 kWh (Design West 2022). Provides basic disaster hub services (heating, lighting, charging) in addition to serving as connection point for children and guardians. Estimate: 329 kWh/day for emergency operations.	Earthquake	High	High	High	High
	Wildfire	Low	Moderate	High	Moderate

Location and Energy Needs	Hazard(s)	Probability	Vulnerability	Consequence	Overall Risk
Virginia Mason Clinic (Disaster Medical Center) Provides basic disaster hub services (heating, lighting, charging) in addition to serving as primary medical facility. ~30,000 square feet. Has a backup generator on site. Estimate: 1211 kWh/day for emergency operations.	Earthquake	High	Moderate	High	High
	Wildfire	Moderate	Moderate	High	High
Wing Point Country Club Newest hub to be added to network, currently have an MOU signed with the city. Will provide basic disaster hub services (heating, lighting, charging). ~10,800 square feet. Estimate: 216 kWh/day for emergency operations.	Earthquake	High	High	Moderate	Moderate
	Wildfire	Low	Moderate	Low	Low
Hyla Middle School 2,200 square foot Red building - annual consumption 24,600 kWhr, 4,116 square foot Yellow building - annual consumption 23,158 kWhr. Both served by PSE, 200 Amps 120/240V single phase. No backup generator on site. Provides basic disaster hub services (heating, lighting, charging). Estimate: 65 kWh/day total for emergency operations in both buildings.	Earthquake	High	Moderate	High	High
	Wildfire	Low	Moderate	High	Moderate

Location and Energy Needs	Hazard(s)	Probability	Vulnerability	Consequence	Overall Risk
Islandwood Provides basic disaster hub services (heating, lighting, charging). Several buildings, main building ~26,000 square feet. Estimate: 398 kWh/day for emergency operations.	Earthquake	High	Moderate	Moderate	Moderate
	Wildfire	Low	Moderate	Moderate	Moderate
Fort Ward Community Hall Provides basic disaster hub services (heating, lighting, charging) as well as kitchen facilities. ~2,400 square feet. Estimate: 48 kWh/day for emergency operations.	Earthquake	High	Moderate	Moderate	Moderate
	Wildfire	Low-Moderate	Moderate	Low	Low
Ted Spearman Justice Center Site of the City's Emergency Operations Center, a communication hub for emergency radios (ham, city network, CEMNET), Starlink Internet, printer, computer and display equipment. Will have a 150kW diesel generator, 316 gallon capacity. No estimate available for emergency operations.	Earthquake	High	High (due to location alone, though is likely to be built to the highest standards of earthquake code)	High	High
	Wildfire	Low-Moderate	Low - close proximity to fire station	Moderate	Moderate

Location and Energy Needs	Hazard(s)	Probability	Vulnerability	Consequence	Overall Risk
Public Works O&M Yard City of Bainbridge Island maintenance facilities. Charging for electric maintenance equipment batteries. ~241,000 kWh annual consumption in 2023. Shop is currently heated by propane. Estimate: 330 kWh/day for emergency operations.	Earthquake	High	Moderate	Moderate	Moderate
	Wildfire	Low	Low	Moderate	Low
City Hall ~395,000 kWh annual consumption in 2023. Estimate: 541 kWh/day for emergency operations.	Earthquake	High	High	Moderate	High
	Wildfire	Low	Low	Low	Low

DRAFT

Location and Energy Needs	Hazard(s)	Probability	Vulnerability	Consequence	Overall Risk
Winslow Wastewater Treatment Plant Treats 150 million gallons of wastewater per year. All operations required 24/7 and currently supported by an automatically operated 500kW diesel generator located onsite as well as additional generators throughout the infrastructure system. A Wastewater Treatment Facilities Operation and Maintenance Manual (updated in 2020[45]) exists with plans for many hazards. ~920,000kWh annual consumption in 2023. Estimate: minimum 1,260 kWh/day for emergency operations, likely closer to 2,520 kWh/day.	Flood - 1% annual chance (FEMA Zone AE)	High	Moderate	Moderate	Moderate
	Sea Level Rise	High	High (partial inundation with 1ft rise by 2060, very high confidence)	High	High
	Extreme Temperatures	Moderate	Low - already have plans for variable temps, extreme cold not expected to increase significantly	High	Moderate
	Tsunami	High	High - inundation up to 20ft expected with Seattle Fault rupture	High	High
	Earthquake	High	High	High	High
	Wildfire	Low	Low	Low	Low

[45] City of Bainbridge Island and Tetra Tech. 2010, updated in 2020. Wastewater Treatment Facilities Operation and Maintenance Manual. https://apps.ecology.wa.gov/paris/DownloadDocument.aspx?id=311250

Location and Energy Needs	Hazard(s)	Probability	Vulnerability	Consequence	Overall Risk
Kitsap County Sewer District #7 Wastewater Treatment Plant Serves 650 homes, treating ~102 million gallons per year. Estimated annual consumption ~531,440 kWh, based on scale relative to Winslow plant. Estimate: 728 kWh/day for emergency operations.	Extreme Temperatures	Moderate	Low - already have plans for variable temps, extreme cold not expected to increase significantly	High	Moderate
	Earthquake	High	Moderate	High	High
	Wildfire	Low - Moderate	Low	Low	Low
Winslow Ferry Terminal ~21,700 sqft for terminal, walkway, and dock building. Estimated annual consumption ~178,200 kWh. Estimated additional 22,664,000 kWh/year for ferry electrification, beginning in 2026 (per Future Loads Analysis, Arkema et al. 2024). Estimate: 244 kWh/day for emergency operations, not including ferry charging.	Sea Level Rise	High	Low - docks already adjust for tides	Moderate	Moderate
	Tsunami	High	Moderate - inundation (8-12 ft) expected around terminal, docks and marina, could impact planned charging infrastructure depending on siting	Low - ferries are hybrid electric, so have backup power source. Physical damage to infrastructure is more of a concern, restricting transportation.	Moderate
	Earthquake	High	High	High	High

Location and Energy Needs	Hazard(s)	Probability	Vulnerability	Consequence	Overall Risk
	Wildfire	Low	Low	Moderate	Low
Fire Station 21 ~25,200 sqft. Estimated annual consumption 207,000 kWh. Assessed for solar at a high level by Persyn (2019). Estimate: 283 kWh/day for emergency operations.	Earthquake	High	Moderate	High	High
	Wildfire	Low	Low	Low	Low
Fire Station 22 ~11,900 sqft. Estimated annual consumption 97,700 kWh. Estimate: 134 kWh/day for emergency operations.	Earthquake	High	Low	High	Moderate
	Wildfire	Moderate	Low	Low	Low
Fire Station 23 ~14,800 sqft. Estimated annual consumption 121,500 kWh. Estimate: 166 kWh/day for emergency operations.	Earthquake	High	Low	High	Moderate
	Wildfire	Low	Low	Low	Low

DRAFT

Defining Resilience Improvements

The third component of this analysis was to identify recommendations for increasing the resilience of the highest risk locations for critical energy infrastructure on Bainbridge Island. In the following section we introduce the concept of resilience improvements which we used to help inform our recommendations. Then we discuss the existing and planned resilience work led by PSE, Bainbridge Prepares, the City, and other entities on Bainbridge Island. Lastly, we lay out recommendations for the highest priority locations that complement the existing and planned work.

Resilience of a system can be characterized in terms of the following four attributes[46]:

- **Resourcefulness**: the ability to prepare for and manage a disruption, including identifying solutions, training, effective communication, and prioritizing actions to control and mitigate damage
- **Redundancy**: includes back-up resources and islandable onsite generation systems to support primary systems in case of failure
- **Robustness**: the ability to maintain critical operations and functions during a disruptive event
- **Recovery**: the ability to return to normal operating conditions as quickly and efficiently as possible after a disruption

Enhanced resilience reduces unacceptable risk by improving one or more of the resilience attributes. This can be accomplished by reducing a vulnerability, reducing a consequence, or reducing the probability that the hazard or threat (an outage) would occur. In each case, these resilience-enhancing actions reduce risk. More examples of this are shown in Table 4. Typical resilience recommendations can include undergrounding of transmission or distribution lines, installation of earthquake straps or retrofits, purchase of backup diesel or propane generators, relocation of key facilities, addition of solar and/or battery storage, development of building- or campus-scale microgrids, and programs to reduce peak demand or encourage efficiency.

[46] U.S. Department of Homeland Security National Infrastructure Advisory Council. (2009). Critical Infrastructure Resilience: Final Report and Recommendations. Available at https://www.cisa.gov/publication/niac-critical-infrastructure-resilience-final-report

DRAFT

Table 4. Components of risk and relation to resilience attributes. From TRN, Relationship Between Risk and Resilience Resource[47].

	Risk Components: Hazard	Risk Components: Vulnerability	Risk Components: Consequence
Resourcefulness: the ability to skillfully prepare for, respond to, and manage a crisis or disruption as it unfolds	Reduce likelihood of loss of operations through effective business continuity planning, training, supply chain management, and communications.	Training personnel in the use of redundant systems and testing and maintaining those systems on a regular basis to reduce potential for failure of redundant systems during a disruptive event.	Reduce consequences of a disruption through ensuring that response and recovery plans and site-level emergency plans are in place and exercised.
Redundancy: the availability of redundant systems to support the primary source in case of failure	Reduce likelihood of loss of mission capabilities due to a hazard or threat through redundancy in supply infrastructure.	Reduce vulnerability to disruptions in primary supply through implementation of redundant systems and independence of systems.	Reduce consequences of a disruption through enhancing ability to transfer or meet mission critical functions at another site.
Robustness: the ability to maintain critical operations and functions in the face of a crisis	Reduce probability that the hazard will lead to loss of energy and water supply through design of primary infrastructure to withstand relevant hazards and threats.	Reduce vulnerability to relevant hazards and threats through design of redundant systems to withstand those hazards and threats, testing and performing O&M on systems, ensuring redundant system supplies, and training personnel to use redundant systems.	Reduce consequences of a disruption by relocating key operations and functions during emergency situations.
Recovery: the ability to return to and/or reconstitute normal operations as quickly and efficiently as possible after a disruption	Reduce length of utility disruption through utility continuity of operations plans, equipment, and spare parts in place to return to normal operations as quickly as possible.	Reduce vulnerability to relevant hazards and threats through design of redundant systems to have rapid start-up for fast recovery time.	Reduce long-term consequences after a disruption occurs through mutual aid/supply agreements and recovery plans and ensuring that extra equipment and parts are available.

[47] TRN Resource: Relationship Between Risk and Resilience. Available at https://trn.pnnl.gov/resource/TRN%20Relationship%20between%20Risk%20and%20Resilience.docx

Existing or Planned Resilience Work

Several projects have already been proposed, planned, or are currently underway to improve the resilience of the energy systems and existing facilities on Bainbridge Island.

PSE has been planning for resilience upgrades to their systems on Bainbridge, recognizing the frequency of outages and disruptions experienced by customers. Their past and current projects are described on their website[48]. Recent projects have included undergrounding of some distribution lines[49], installation of tree wire to limit interruptions from falling branches, repairs to aging infrastructure, and maintenance tree trimming. Upgrades to all three substations are planned (2023-2028)[50], as well as rebuilding the Winslow Tap transmission line (2026-2027)[51]. A new 115kV transmission line to connect the Murden Cove and Winslow substations is planned for 2027-2028[52], which will create a transmission loop to be able to add redundancy and keep each substation supplied even if one of the main lines goes out.

PSE has also been exploring battery storage solutions and additional renewables on the island to provide support during outages and for peak loads.

- A study was commissioned by Quanta Technology in 2019 to support decision-making around energy storage and transmission upgrade planning, specifically around the decision to build the new Murden Cove - Winslow 115kV transmission line. The report analyzed an optimized storage solution that included five new storage systems to improve reliability and meet peak capacity needs, for a total of 29.3 MW; and a conventional transmission line connecting the Winslow and Murden Cove substations. The conventional solution was selected to move forward, in part due to the costs estimated for development of multiple battery storage systems.
- PSE is planning to install a 3.3MW/5MWh utility scale, lithium-ion battery at the Murden Cove Substation (2025-2026) to provide electricity to meet peak demands[53]. This is part of the hybrid solution that was recommended in the Bainbridge Island Electric Systems Solutions Report (2019) and the Non-Wires Alternatives Report (2019).
- PSE also tested some residential behind-the-meter 6kW/15.5kWh battery units on five homes on Bainbridge in 2019[54]. They found that one battery provided backup power for 26 hours, and that the batteries reduced demand by an average of 2 kW. PSE plans to continue testing batteries as a scalable solution across their services areas.
- PSE has some plans and programs in place to support development of additional renewables on Bainbridge in alignment with the Clean Energy Transformation Act[55]. The Vincent Road site was evaluated in 2022 as a potential site for community solar, but was found to be not viable due to the lack of phase 3 power at the

[48] https://psebainbridge.com/current-projects/
[49] While undergrounding of lines is a possibility that can increase resilience to tree-related outages, it is typically 3-4 times more expensive than traditional overhead lines and the costs are paid for locally instead of by the entire customer base. Undergrounding on Bainbridge is also difficult due to environmental impacts in densely forested areas and wetlands, and as such it is considered as a resilience solution on a case-by-case basis.
[50] https://psebainbridge.com/construction-at-bainbridge-island-substations/
[51] https://psebainbridge.com/winslow-tap-transmission-rebuild/
[52] https://psebainbridge.com/murden-cove-winslow-115-kv-transmission-line/
[53] https://psebainbridge.com/battery-energy-storage-system-bess/
[54] https://psebainbridge.com/bainbridge-island-residential-battery-pilot/
[55] https://www.commerce.wa.gov/growing-the-economy/energy/ceta/

site to connect. They have a goal of one community solar site on Bainbridge by 2024[56], have provided additional guidance on what requirements are needed for candidate sites[57], and are currently developing an online application portal for the Community Solar program (as of February 2023[58]).

In addition to physical or infrastructure upgrades, PSE has also developed several agreements and programs that aim to improve resilience on the island.

- The City and PSE have a Partnership Agreement for 2021-2023[59] and are currently undergoing franchise negotiations. This partnership facilitates communication, data sharing, and collaboration around Community Solar and other distributed energy resources on Bainbridge.
- PSE is also working with the Washington State Department of Transportation to coordinate with the planned electrification of the Bainbridge-Seattle ferry and associated charging infrastructure. PSE obtained an agreement that allows for prioritization of existing customers over ferry charging at peak load times (peak curtailment)[60].
- The Flex Smart+ program[61] has been implemented on Bainbridge since 2022 and allows residential customers to opt in with a smart thermostat to adjust energy consumption at peak times.
- PSE currently has several green energy programs in place for Bainbridge residents: Green Power, Solar Choice, and Customer Connected Solar, and Community Solar (coming soon)[62]. These programs do not directly increase on-island resilience, but contribute to a more resilient energy supply mix overall, considering off-island or regional hazards and volatility.

Significant work has been done around developing the Community Disaster Hub program on Bainbridge to prepare for and respond to emergencies by Bainbridge Prepares[63]. This has included identifying facilities and partners, mapping neighborhoods to hubs, purchasing communication equipment, and practicing emergency operations in the 2022 Cascadia Rising event. Technical analyses have been completed for several hubs to assess potential for installation of solar panels and battery storage to be able to power emergency operations in the event of an extended outage.

Design West (2022) completed an analysis for additional solar installations and addition of battery storage systems at several of these community disaster hubs that are identified as critical energy infrastructure: Bloedel Reserve, Recreation Center, Battle Point Park, Senior Center, Bainbridge Island High School, and Hyla Middle School. Their recommendations are summarized below. Based on these recent assessments and recommendations, we are not pursuing additional analysis at these locations regardless of their overall risk ranking.

- **Bloedel Reserve:** Solar recommended for parking lot areas (carport - 30.5kW DC), and roof of floral workshop and maintenance compound (estimated 6 440 watt modules on floral workshop and 28 440 watt modules on maintenance roof). Also recommended a 120kWh system for battery storage at the

[56] COBI and PSE. (2021). Partnership Agreement (Draft). Available at https://drive.google.com/file/d/1HLKuIe4wpm4gpSpLBK4PEkxZeHeLxJEI/view?usp=drive_link
[57] https://legistarweb-production.s3.amazonaws.com/uploads/attachment/pdf/1792546/PSE_Community_Solar_Site_Considerations.pdf
[58] https://legistarweb-production.s3.amazonaws.com/uploads/attachment/pdf/1792545/PSE_Responses_to_Study_Session_Questions_02.21.23.pdf
[59] COBI and PSE. (2021). Partnership Agreement (Draft). Available at https://drive.google.com/file/d/1HLKuIe4wpm4gpSpLBK4PEkxZeHeLxJEI/view?usp=drive_link
[60] https://psebainbridge.com/ferry-electrification/
[61] https://psebainbridge.com/peak-energy-rewards-is-now-flex-smart/
[62] https://psebainbridge.com/renewable-energy-programs
[63] https://www.bainbridgeprepares.org/hubs

maintenance shed. Installing solar and storage at the maintenance shed was identified as the highest priority project, while the floral workshop was priority #3 and the gate house carport was priority #7.

- **Recreation Center:** The basketball court building was recommended for additional solar (100 440W modules). A small battery storage system was recommended for the court building to provide backup power for basic disaster hub uses (lighting, heating, ventilation) that would have a manual transfer switch to operate as an islanded microgrid, estimated 150-200kWhr system in conjunction with PV. This project was identified as priority #5.
- **Battle Point Park:** None of the buildings were recommended for solar or battery storage due to roof and aging infrastructure limitations.
- **Senior Center:** Additional 5kW solar was proposed. Battery storage was not recommended due to the existing backup generator and complexity of current switch arrangement to consolidate and upgrade panels. This project was identified as priority #4.
- **Bainbridge Island High School:** Due to limited roof space, solar and battery storage are not recommended.
- **Hyla Middle School:** The Yellow building is recommended for 40 440W PV modules and a 190kWhr battery storage system for 3 days of multi-use power (second highest priority project). PV was not recommended for Red Building due to tree shading, but if trees are removed and 40 440W PV modules are added, the building could add a 190kWh battery storage system to provide 3 days of administrative operations (priority #6). Together, the buildings on the Hyla campus could operate as a small microgrid with a transfer switch in island mode.

Persyn (2019), a student at Western Washington University, completed a preliminary solar feasibility and policy analysis at a two additional locations that are considered critical energy infrastructure, Fire Station #21 and Grace Church[64]. Persyn worked with Climate Action Bainbridge and the CCAC to finalize the report.

- **Fire Station #21:** The rooftop was estimated at 400 sq ft, recorded a Total Solar Resource Fraction (TSRF) of 69% measured from ground level (considered not viable below 70%) but likely would be much higher if measured from the actual rooftop location. The rooftop could accommodate approximately 250 standard 300W solar panels with ~21% efficiency to produce 15kW.
- **Grace Church:** TSRF well above industry standard minimums, ample south facing open space for ground-mounted solar. Approximately 187 300W solar panels could be installed with 21% efficiency to produce 11kW. This location scored the highest in Persyn's analysis considering cost effectiveness, technical feasibility, environmental efficacy, legal acceptability, and political acceptability.

As this assessment was fairly preliminary and high level, we are considering additional recommendations at the locations previously assessed by Persyn (2019).

Site-specific Resilience Recommendations

The critical energy infrastructure locations facing the highest overall risks from multiple hazards (in no particular order) are:

[64] Persyn, B. (2019). How can the City of Bainbridge Island effectively accelerate GHG reductions with solar PV projects? Available at https://drive.google.com/file/d/1O0-kcqVeZji0A3Y_QYiSHAW35ZJwPJmR/view?usp=drive_link

- Virginia Mason Medical Center - Earthquake, Wildfire
- Winslow Wastewater Treatment Plant - Sea Level Rise, Tsunami, Earthquake
- Winslow Tap and Murden Cove Tap - Severe Storm, Tsunami, Earthquake
- New Murden Cove - Winslow Tap - Severe Storm, Earthquake

Several additional locations are are facing a single high risk overall from earthquakes:
- Bethany Lutheran
- Senior Center
- Bainbridge High School
- Hyla Middle School
- Ted Spearman Justice Center
- City Hall
- Kitsap Wastewater Treatment Plant
- Winslow Ferry Terminal
- Fire Station 21
- Port Madison, Winslow, and Murden Cove Substations

Each of these locations and the possible resilience upgrades or analyses needed are described in the subsections below. Several locations have had some previous assessments done, and work is described in the Existing or Planned Resilience section.

Virginia Mason Medical Center

The Virginia Mason Medical Center is considered to have overall high wildfire risk (Figure 2), in addition to earthquake risk (addressed in following section on Earthquake Resilience). The site is located in the Wildland-Urban Interface in the Intermix zone[65]. The overall risk to the site is moderated by its proximity to Fire Station 21 (1.0 mi). The primary ways to increase resilience to wildfire are through resourcefulness (see Table 3), which is already a major strength on Bainbridge Island. Many activities to prepare the community for wildfire have occurred, and several plans and codes are in place for wildfire risk assessment (Community Wildfire Protection Plan 2022) and prevention. For example, the City's Comprehensive Plan references municipal codes pertaining to the care of trees, vegetation, and forested areas on Bainbridge Island. Furthermore, in the Wildland-Urban Interface code[66] adopted July 2023, landowners are required to meet defensible space minimums and ignition resistant building materials. Plans also exist for wildfire response, such as the Wildfire Response and Evacuation Annex to the Comprehensive Emergency Management Plan (the Virginia Mason Medical Center is located in Zone 9) and resources from Bainbridge Island Fire Department.

[65] WA DNR, https://wadnr.maps.arcgis.com/apps/View/index.html?appid=21683af70ece4bd495c319915f7a9232
[66] https://www.bainbridgewa.gov/1444/WUI

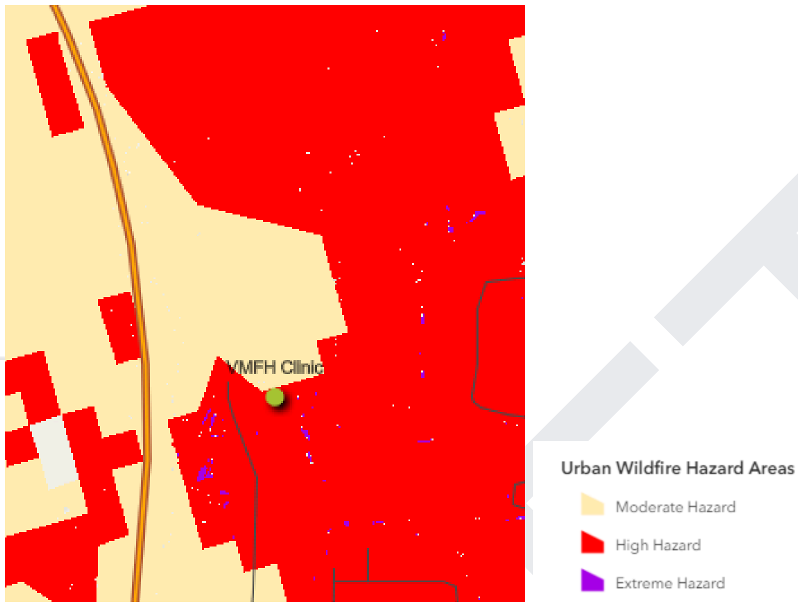


Figure 2. Wildfire risk to the Virginia Mason Medical Center (denoted on the map as VMFH Clinic [Virginia Mason Franscican Health]). Data from WA DNR, accessed through the COBI GIS Portal.

The Wildfire Urban Interface code is scheduled to become effective on March 15, 2024. As such, we recommend a more robust assessment of the Virginia Mason site for wildfire risk mitigation in partnership with Bainbridge Island Fire Department. Prior to a full assessment, additional risk mitigation activities could take place in alignment with existing codes, such as:

- Tree assessment and removal to create defensible space (in accordance with other municipal codes)[67]
- Material upgrades or replacements (for roofs, siding, etc.) under 2021 limited provisions of the International Wildland-Urban Interface Code[68]
- Consideration of flammability in landscaping selections[69]
- Expansion of fire protection water supply infrastructure, such as hydrants. Significant portions of Bainbridge Island are located greater than 1000 ft from a hydrant[70]

There are several programs that may assist with wildfire mitigation actions, including PSE's wildfire mitigation and response program[71] and the Firewise USA[72] program (which is already being leveraged by BIFD)[73].

DRAFT

[67] COBI. (2023). Understanding WUI Defensible Space. Available at https://bainbridgewa.gov/DocumentCenter/View/17488/WUI_Defensible-Space
[68] International Wildland-Urban Interface Code. (2021). https://codes.iccsafe.org/content/IWUIC2021P1/preface
[69] BIFD. (n.d.). Bainbridge Island Fire-Resistant Landscaping Guide. Available at https://www.bainbridgewa.gov/DocumentCenter/View/17554/Fire-Resistant-Landscaping
[70] BIFD. (2010). Bainbridge Island Community Wildfire Protection Plan. Available at https://www.dnr.wa.gov/publications/rp_burn_cwpp_bainbridgeIsland.pdf
[71] https://www.bifd.org/pdfs/PSE_Vegetation-management-and-wildfire-risk-fact-sheet.pdf
[72] https://www.nfpa.org/education-and-research/wildfire/firewise-usa
[73] https://www.bifd.org/firewise

Winslow Wastewater Treatment Plant

The Winslow Wastewater Treatment Plant is considered to have overall high risk from sea level rise and tsunami (Figure 3). The site was first identified as potentially vulnerable to sea level rise in the 2019 Sea Level Rise Assessment[74]. Partial to full inundation from tsunami is possible with either a Cascadia or Seattle Fault rupture. According to the 2019 Sea Level Rise Assessment for Bainbridge Island[75], the most likely projections indicate that Bainbridge Island will experience one foot of sea level rise by the year 2060[76]. The combination of water hazards over the long term as well as at specific times (e.g., co-occurrence with king tides or heavy rainfall) poses significant risk to the wastewater treatment plant.

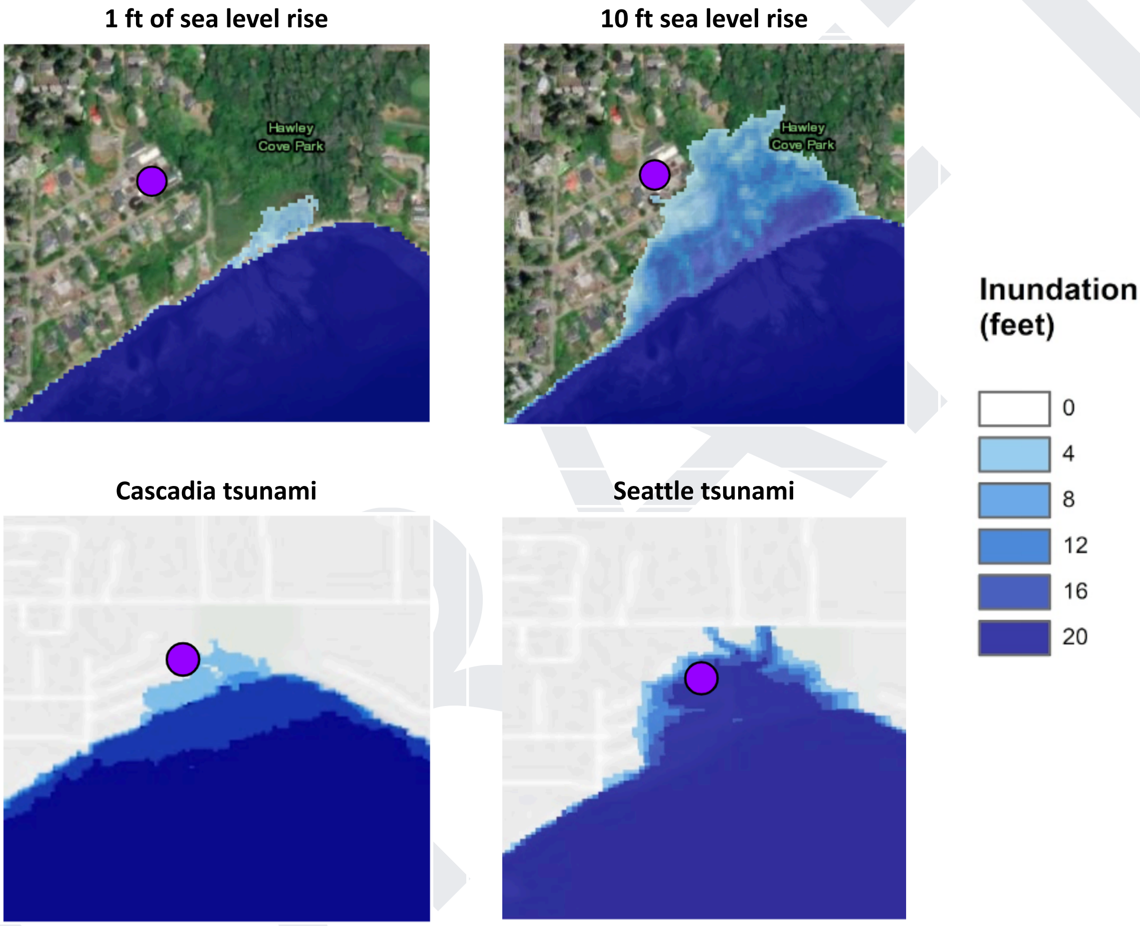


Figure 3. Inundation of the area around the Winslow Wastewater Treatment Plant due to sea level rise scenarios and tsunami events. Data from NOAA's Sea Level Rise Viewer[77] and WA DNR Tsunami Maps[78,79].

[74] Climate Change Advisory Committee. (2019). Sea Level Rise on Bainbridge Island: A Preliminary Assessment. Available at https://www.bainbridgewa.gov/DocumentCenter/View/12893/Sea-Level-Rise-Assessment-October-24-2019

[75] Climate Change Advisory Committee. (2019). Sea Level Rise on Bainbridge Island: A Preliminary Assessment. Available at https://www.bainbridgewa.gov/DocumentCenter/View/12893/Sea-Level-Rise-Assessment-October-24-2019

[76] National Oceanic and Atmospheric Administration's Sea Level Rise Viewer: https://coast.noaa.gov/slr/#/layer/slr/

[77] National Oceanic and Atmospheric Administration's Sea Level Rise Viewer: https://coast.noaa.gov/slr/#/layer/slr/

[78] https://www.bainbridgewa.gov/DocumentCenter/View/16345/Tsunami-Bainbridge-Map-Cascadia-SZ?bidId=

[79] https://www.bainbridgewa.gov/DocumentCenter/View/16344/Tsunami-Bainbridge-Submersion-Map-Seattle-Fault?bidId=

The City authorized an updated Sea Level Rise Flood Vulnerability and Risk Assessment that is starting up as part of the 2024 Comprehensive Plan update[80]. Environmental Science Associates has been selected as the consultant and the work is funded by the City and a grant from Ecology, and the analysis is expected to result in improved assessments of inundation across the island. The findings should be available later in 2024.

The current Winslow Wastewater Treatment Plant operations have multiple redundant backup systems for other types of power outages (including a 500kW diesel generator onsite). Several other upgrades and improvements are underway, including upgrades to plant capacity to support future customers and handle additional organic load[81], relocation of the outfall at Wing Point[82], and nearby improvements, including relocation of the Wing Point Sewer Pump Station[83]. However, it is unclear how current planning efforts and operations will respond to persistent inundation with seawater and limited information on flooding is included in the Operation and Maintenance Manual[84].

Many communities across the U.S. and the world are planning for sea level rise impacts on wastewater infrastructure in coastal areas. King County identified vulnerable facilities beginning in 2008[85], based on some early projections of sea level rise and focusing on the risks of flooding and adaptation strategies. Hummel et al. (2018) assessed exposure of wastewater treatment plants across the U.S. using national level spatial data and projections. Zhao & Hawken (2023) review the literature on effects of sea level rise on wastewater treatment plants and find that potential impacts could include:

- induction of land subsidence and altered topography, increasing risk of sewer overflow and rupture of pipelines and utilities;
- increased groundwater levels and resulting saltwater intrusion into aquifers, potentially corroding sewer pipes and infrastructure;
- uplift forces on pipelines and utilities, altering flows and causing rupture;
- additional need for desalination, increasing maintenance costs;
- excessive water overwhelming the plant, resulting in backup and flooding in nearby areas;
- structural damage due to weight of floodwaters, resulting in release of untreated wastewater;
- areal flooding due to rising groundwater tables;
- debris blocking pipe inlets, outlets, and pipelines; and
- inflow through surface apertures following a flooding event.

Generic recommendations for adapting to sea level rise are numerous, but must be applied to specific locations and coupled with detailed vulnerability analyses to identify and recommend the most relevant actions for a particular

[80] https://cityofbainbridgeisland.civilspace.io/en/projects/2024-comprehensive-plan-periodic-update
[81] TetraTech. (2023). Presentation to COBI City Council at November 21, 2023 meeting. Slide deck available at https://d3n9y02raazwpg.cloudfront.net/bainbridgewa/2253096f-719c-11ed-9024-0050569183fa-1288c45d-5d3e-46ae-af61-2e888e37b46d-1700265059.pdf
[82] https://www.bainbridgewa.gov/1471/Wastewater-Treatment-Plant-Outfall-Reloc
[83] COBI City Council. (2022). Regular Business Meeting Agenda Bill. Available at https://d2kbkoa27fdvtw.cloudfront.net/bainbridgewa/3f190a7c319c8b7ecad9e4a1cd2aee500.pdf
[84] COBI. (2010, revised 2020). Wastewater Treatment Facilities Operation and Maintenance Manual. Available to download from https://apps.ecology.wa.gov/paris/DownloadDocument.aspx?id=311250
[85] King County. (2008). Vulnerability of Major Wastewater Facilities to Flooding from Sea-Level Rise. Available at https://your.kingcounty.gov/dnrp/library/archive-documents/wtd/csi/csi-docs/0807_slr_vf_tm.pdf

DRAFT

wastewater treatment plant. Azevedo de Almeida & Mostafavi (2016)[86] review the literature and summarize adaptation measures for sea level rise impacts on water infrastructure by 1) protection, 2) accommodation, and 3) retreat. Protection actions include installation of dams, dikes, seawalls, or nature-based solutions. Accommodation includes increasing pumping capacity, addition of bioswales/wetlands or rain gardens, or artificial aquifer recharge (in the event of groundwater intrusion). Retreat includes elevating facilities or relocating completely.

We compiled and synthesized several examples of what other communities are doing to plan for and respond to sea level rise at wastewater treatment plants, especially where relocation of facilities is not a feasible option. The California Coastal Commission has developed guidance (2021)[87] for sea level rise planning that considers critical infrastructure and may be useful to consider in future planning efforts on Bainbridge Island. Table 5 summarizes a few examples that may be helpful in guiding future planning efforts.

Table 5. Examples of planning for sea level rise impacts on wastewater treatment plants.

Reference	Location	Description and Recommended Planning Actions
Zhao & Hawken. (2023). Climate-Related Sea Level Rise and Coastal Wastewater Treatment Infrastructure Futures: Landscape Planning Scenarios for Negotiating Risks and Opportunities in Australian Urban Areas. *Sustainability 15(11)*: 8977. DOI: 10.3390/su15118977	Adelaide, Australia	Inundation scenarios are assessed at three wastewater treatment plants, including assessment of cost of infrastructure reconstruction and coastal ecosystem values. Scenarios include protection, retreat, and accommodation that include new conceptual designs, with physical and green infrastructures to be discussed with community planners.
LOTT Clean Water Alliance. (2022). Preparing for Sea Level Rise: LOTT's Budd Inlet Treatment Plant. Available at https://www.lottcleanwater.org/wp-content/uploads/2022/11/preparing-for-sea-level-rise.pdf	Olympia, WA, USA	The City of Olympia has been planning for sea level rise since 2018, including specific plans to protect the Budd Inlet Treatment Plant located in the downtown area. The primary impacts of concern are increased street flooding and stormwater drainage, which would increase the number of bypass events; as well as overland flooding of the buildings, pumps and backup generators as well as the adjacent PSE substation that powers the plant. Physical barriers along the shoreline are planned to reduce overland flooding as well as the installation of additional pumping capacity, as well as elevating key structures by several feet and adding watertight connections.
Threndyle et al. (2022). Future inundation of coastal on-site wastewater treatment systems in a region with pronounced sea-level rise. *Journal of Hydrology* 614(B):	Nova Scotia, Canada	Subsurface inundation and flooding of wastewater treatment plants is assessed in a densely populated rural community in Nova Scotia under various sea level rise scenarios. Recommendations are made for installation regulations at wastewater treatment plants, including alternative designs for treatment to protect long term water quality.

[86] Azevedo de Almeida & Mostafavi. (2016). Resilience of Infrastructure Systems to Sea-Level Rise in Coastal Areas: Impacts, Adaptation Measures, and Implementation Challenges. *Sustainability 8(11)*: 1115. DOI: 10.3390/su8111115
[87] California Coastal Commission. (2021). Critical Infrastructure at Risk: Sea Level Rise Planning Guidance for California's Coastal Zone. Available at https://www.coastal.ca.gov/climate/slr/vulnerability-adaptation/infrastructure/

Reference	Location	Description and Recommended Planning Actions
128548. DOI: 10.1016/j.jhydrol.2022.128548		
Cao et al. (2020). Adapting wastewater treatment plants to sea level rise: learning from land subsidence in Tohoku, Japan. *Natural Hazards 103*: 885-902. DOI: 10.1007/s11069-020-04017-5	Tohoku, Japan	Interviews were conducted with wastewater treatment plant staff to develop adaptation plans for various sea level rise scenarios based on current design parameters related to coastal flooding, discharge flooding, and groundwater inundation. Their plans include which types of flooding to deal with first, based on incremental rise, land subsidence, and existing facility structures.
Ogunquit Sewer District. (2019). Sea Level Rise Adaptation. https://www.ogunquitsewerdistrict.org/sealevelrise	Ogunquit, ME, USA	The Ogunquit Sewer District has been planning for adaptation to sea level rise since 2012, and has added second story office spaces, moved electrical controls into elevated towers with a footbridge, installed submersible pumps, and flood-proofed the aeration tanks and control buildings with wall reinforcements.
Allen et al. (2018). Linking Water Infrastructure, Public Health, and Sea Level Rise: Integrated Assessment of Flood Resilience in Coastal Cities. *Public Works Management & Policy 24(1).* DOI: 10.1177/1087724X18798380	Charleston, SC, USA Morehead City, NC, USA	Impacts to human health risk and resilience are assessed using scenarios and participatory community activities to map risk. The analysis resulted in identification and prioritization of remaining locations at risk and the need for high-level preparedness actions to respond to storms that co-occur with sea level rise, combining water infrastructure planning and emergency management.
Hummel et al. (2018). Sea Level Rise Impacts on Wastewater Treatment Systems Along the U.S. Coasts. *Earth's Future 6(4)*: 622-633. DOI: 10.1002/2017mEF000805	San Francisco Bay, CA, USA	Groundwater and marine flooding induced by sea level rise in the San Francisco Bay region was assessed. Costs considered include frequent pumping to keep components dry, as well as shorter timeframes for replacement parts due to brackish water exposure. Adaptation actions are recommended for specific locations, including installation of a treatment wetland with native vegetation, additional shoreline protections. Assessing the tradeoffs in cost between protection and relocation for each plant in particular is needed, especially considering the impacts of both groundwater and marine flooding which vary by location.

PSE Facilities and Infrastructure

Several components of the PSE electric grid were identified as high risk for multiple hazards:

- Winslow Tap and Murden Cove Tap - Severe Storm, Tsunami, Earthquake
- New Murden Cove - Winslow Tap - Severe Storm, Earthquake
- Murden Cove Substation - Tsunami, Earthquake

As PSE is currently developing the Murden Cove - Winslow Tap as well as making other resilience and reliability upgrades (see Existing or Planned Resilience Work), these locations are not the focus of our further recommendations. A more comprehensive future analysis could include scenario development of which critical energy infrastructure locations are supplied by which substations and transmission lines, and explore additional options to increase resilience from storm-related outages. However, this work is out of scope of the ETIPP project at present and will require significant engagement with PSE to develop and analyze specific scenarios.

In addition to the new connecting tap line, PSE has been planning for installation of a 3.3MW battery for peak shaving. At present, the battery is not intended to fulfill any additional resilience functions, or provide energy in the case of a power outage, but these scenarios could be explored in a further analysis in partnership with PSE as these components of the electric system are outside of the City's jurisdiction. As the battery designs and siting move forward, it will be important to consider site specific attributes of the Murden Cove Substation location and its high risk for tsunami and earthquake to be able to position and install the battery in such a way to minimize risk from hazards.

Earthquake Resilience

Several buildings were identified as high risk for earthquakes. This includes:

- Disaster Hubs: Bethany Lutheran, Senior Center, High School, Hyla Middle School, Medical Center
- City Facilities: TSJC, City Hall
- PSE Substations: Port Madison, Winslow, Murden Cove
- Other: Fire Station 21, Winslow Ferry Terminal, Kitsap Wastewater Treatment Plant

As the overall risk ranking depends on a combination of data layers for probability, vulnerability, and severity, it is important that each of the input layers are as detailed as possible. For this assessment, the vulnerability of each building was determined by a layer from WA DNR for the number of damaged buildings, which is a fairly rough estimate (Figure 4). Vulnerability of a location to earthquakes, in terms of building damage sustained, is dependent on building design factors, including age of the building, structural codes to which it is built and maintained, as well as the power connections. This information is not currently available for buildings on the critical energy infrastructure list with enough specificity to select or recommend buildings for earthquake resilience upgrades.

DRAFT

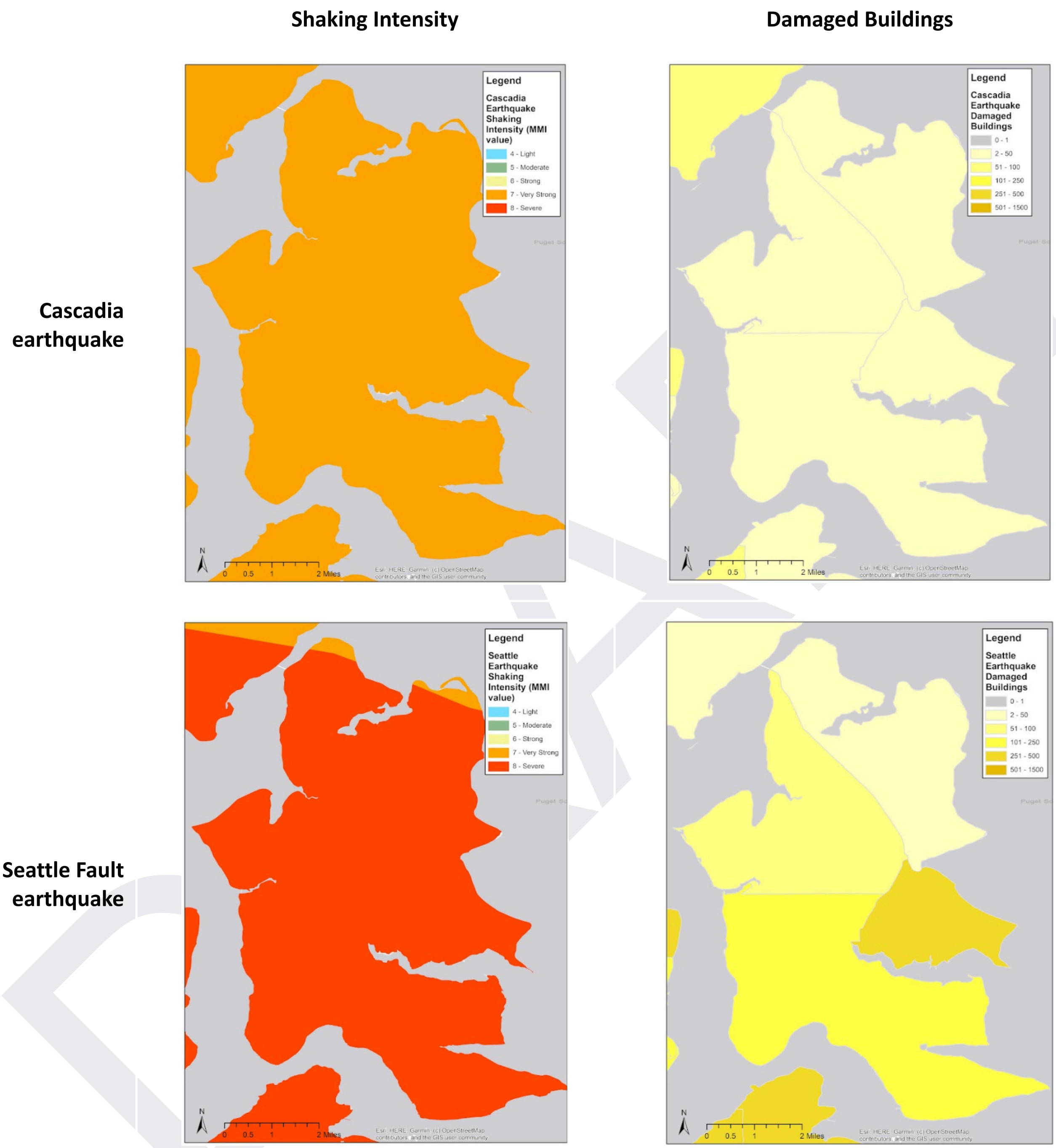


Figure 4. Spatial data used for assessing probability (shaking intensity) and vulnerability (damaged buildings) to earthquakes on Bainbridge Island, from WA DNR[88]. High resolution maps available in Appendix A.

[88] https://www.dnr.wa.gov/seismic-scenarios

We recommend a more focused earthquake assessment for the buildings currently rated high risk to be able to refine the level of risk based on vulnerability to earthquakes and identify specific needs. For example, the new TSJC is expected to be built according to the most current earthquake codes, especially as an emergency operations center with a focus on a Cascadia event, while older buildings such as churches may not be as up to date on structural codes.

Opportunities for Solar + Storage

In addition to identifying critical energy infrastructure that is at risk from multiple hazards, we also identified locations that could potentially increase resilience to power outages in general with the addition of solar and battery storage. This analysis looks only at single buildings or campuses as characterized in Table 3, not neighborhood- or island-scale microgrids. More information on solar and storage for resilience is available from Oak Ridge National Laboratory's Distributed Generation Resilience Guide, under Solar + Energy Storage 101[89] and Microgrids 101[90].

This solar and battery storage analysis utilized NREL's Renewable Energy Integration & Optimization (REopt) tool to estimate the most cost-effective combination of solar PV and battery storage (BESS) to sustain a critical load for each site during a 3-day outage. Because the analysis used typical daily energy use instead of measured electrical load data, as well as high-level estimates of solar PV potential for each site, the results should be considered as preliminary. These preliminary results should be used to gain a clearer understanding of the solar PV and battery storage requirements to sustain critical loads during a 3-day outage and are not to be considered as design or sizing recommendations from PNNL. The results of the analysis are shown in Table 6 and described below. Additional information on the methodology and assumptions for this preliminary analysis is available in Appendix B.

From this analysis, the locations that emerged as having further potential for solar + storage to be explored in more detail in future work include:

- Island School
- Rolling Bay Presbyterian
- Bethany Lutheran
- Wing Point Country Club
- Virginia Mason Medical Center
- Grace Church
- Sakai Intermediate School
- Public Works O&M Yard
- Winslow Ferry Terminal
- Fire Station 21
- Fire Station 22
- Fire Station 23

Additional factors to consider for determining the feasibility of any of these locations for solar + storage include actual solar PV potential, battery cost, electrical interconnection, and area available for a BESS. For the locations identified in the list above, the next steps for the City to consider are to obtain the actual building load data from

[89] https://dg.resilienceguide.ornl.gov/solar
[90] https://dg.resilienceguide.ornl.gov/microgrids

PSE, complete a more detailed solar feasibility analysis for each building, and complete a follow-up feasibility assessment with REopt with the site-specific load and solar information.

Table 6. Summary of opportunities for solar PV and battery storage (BESS) for resilience at critical energy infrastructure locations. Full table with additional assumptions is documented in Appendix B. The sources for this assessment include the high level REopt assessment, previous studies, and Arkema et al. (2024).

Critical Energy Infrastructure	Solar + Storage Assessment(s)	Findings / Recommendations
PSE Infrastructure	Not considered	NA
Bloedel Reserve Estimate: 70 kWh/day for emergency operations at all three buildings.	Already assessed (Design West 2022, see Existing or Planned Resilience Work)	No additional recommendations from the ETIPP technical assistance team.
Seabold United Methodist Estimate: 36 kWh/day for emergency operations.	High-level REopt assessment	Location appears quite shaded, and might not be a good location for solar PV. REopt recommends a 3 kW / 108kWh BESS.
Island School Estimate: 164 kWh/day for emergency operations.	High-level REopt assessment	Location is relatively shaded, and may not be an optimal location for solar PV. REopt recommends 8.5 kW of solar PV and a 19 kW / 900 kWh BESS.
Grace Episcopal Church Estimate: 1,237 kWh/day for emergency operations.	Already assessed in Persyn (2019) Rooftop - Assessed in Pathways Report High-level REopt assessment	Persyn's assessment is very high level - recommend using Pathways assessment values. REopt recommends 160 kW of solar PV and a 75 kW / 3,794 kWh BESS.
Recreation Center Estimate: 600 kWh/day for emergency operations at court building.	Already assessed (Design West 2022, see Existing or Planned Resilience Work) Rooftop - Assessed in Pathways Report	No additional recommendations from the ETIPP technical assistance team.
Rolling Bay Presbyterian Estimate: 480 kWh/day for emergency operations.	High-level REopt assessment	REopt recommends 146 kW of solar PV and a 34 kW / 1144 kWh BESS.

Critical Energy Infrastructure	Solar + Storage Assessment(s)	Findings / Recommendations
Battle Point Park Estimate: 0.5 kWh/day for emergency operations.	Already assessed (Design West 2022, see Existing or Planned Resilience Work) Carport - Assessed in Pathways Report	No additional recommendations from the ETIPP technical assistance team.
Sakai Intermediate School Estimate: 796 kWh/day for emergency operations.	Rooftop - Assessed in Pathways Report High-level REopt assessment	REopt recommends 146 kW of solar PV and a 34 kW / 1144 kWh BESS.
Island Center Hall Estimate: 34 kWh/day for emergency operations.	High-level REopt assessment	Location appears relatively shaded, and might not be an optimal location for solar PV. REopt recommends 332 kW of solar PV and a 74 kW / 1,526 kWh BESS.
Bethany Lutheran Estimate:238 kWh/day for emergency operations.	High-level REopt assessment	Location has rooftop and parking space available for solar PV. REopt recommends 71 kW of solar PV and a 17 kW / 569 kWh BESS.
Senior Center (Warming/Cooling Station) Estimate: 103 kWh/day for emergency operations.	Already assessed (Design West 2022, see Existing or Planned Resilience Work)	No additional recommendations from the ETIPP technical assistance team.
Strawberry Hill Park Estimate: 7 kWh/day for emergency operations.	High-level REopt assessment	Location is relatively shaded, and may not be an optimal location for solar PV. REopt recommends 2 kW of solar PV and a 1 kW / 17 kWh BESS.
Bainbridge High School (Child Reunification Center) Estimate: 329 kWh/day for emergency operations.	Already assessed (Design West 2022, see Existing or Planned Resilience Work) Rooftop - Assessed in Pathways Report	No additional recommendations from the ETIPP technical assistance team.
Virginia Mason Medical Center (Disaster Medical Center) Estimate: 1211 kWh/day for emergency operations.	High-level REopt assessment	Location has rooftop and parking space available for solar PV. REopt recommends 350 kW of solar PV and a 96 kW / 5455 kWh BESS.
Wing Point Country Club Estimate: 216 kWh/day for emergency operations.	High-level REopt assessment	Location has rooftop and parking space available for solar PV. REopt recommends 114 kW of solar PV and a 30 kW / 256 kWh BESS.

Critical Energy Infrastructure	Solar + Storage Assessment(s)	Findings / Recommendations
Hyla Middle School Estimate: 65 kWh/day total for emergency operations in both buildings.	Already assessed (Design West 2022, see Existing or Planned Resilience Work), projects underway	Continue moving forward with current projects. No additional recommendations from ETIPP technical assistance.
Islandwood Estimate: 398 kWh/day for emergency operations.	High-level REopt assessment	Location is relatively shaded, and may not be an optimal location for solar PV. REopt recommends 252 kW of solar PV and a 58 kW / 440 kWh BESS.
Fort Ward Community Hall Estimate: 48 kWh/day for emergency operations.	High-level REopt assessment	REopt recommends 14 kW of solar PV and a 3 kW / 115 kWh BESS.
Ted Spearman Justice Center (Emergency Operations Center) No estimate available for emergency operations.	Carport - Assessed in Pathways Report	No data available to estimate load, solar, or BESS. Already has a 150kW, 316 gallon capacity diesel generator.
Public Works O&M Yard City of Bainbridge Island maintenance facilities. Charging for electric maintenance equipment batteries. ~241,000 kWh annual consumption in 2023. Shop is currently heated by propane. Estimate: 330 kWh/day for emergency operations.	Rooftop - Assessed in Pathways Report High-level REopt assessment	REopt recommends 129 kW of solar PV and a 33 kW / 1,333 kWh BESS.
City Hall Estimate: 541 kWh/day for emergency operations.	Already has solar	No additional recommendations from the ETIPP technical assistance team.
Winslow Wastewater Treatment Plant Estimate: minimum 1,260 kWh/day for emergency operations, likely closer to 2,520 kWh/day.	High-level REopt assessment	REopt recommends 102 kW of solar PV and a 105 kW / 9,649 kWh BESS.

Critical Energy Infrastructure	Solar + Storage Assessment(s)	Findings / Recommendations
Kitsap County Sewer District #7 Wastewater Treatment Plant Estimate: 728 kWh/day for emergency operations.	High-level REopt assessment	REopt recommends 60 kW of solar PV and a 30 kW / 2,692 kWh BESS.
Winslow Ferry Terminal Estimate: 244 kWh/day for emergency operations, not including ferry charging.	Parking Lot Carport - Assessed in Pathways Report High-level REopt assessment	REopt recommends 73 kW of solar PV and a 17 kW / 583 kWh BESS.
Fire Station 21 Estimate: 283 kWh/day for emergency operations.	Already assessed in Persyn (2019) Rooftop - Assessed in Pathways Report High-level REopt assessment	Persyn's assessment very high level - recommend using Pathways assessment values. REopt recommends 86 kW of solar PV and a 23 kW / 1,104 kWh BESS.
Fire Station 22 Estimate: 134 kWh/day for emergency operations.	Rooftop - Assessed in Pathways Report High-level REopt assessment	REopt recommends 41 kW of solar PV and a 11 kW / 523 kWh BESS.
Fire Station 23 Estimate: 166 kWh/day for emergency operations.	Rooftop - Assessed in Pathways Report High-level REopt assessment	REopt recommends 51 kW of solar PV and a 13 kW / 648 kWh BESS.

Resilience and Renewables for Future Loads

In addition to increasing resilience of existing infrastructure to hazards, there is a need to consider the implications of adding more renewable energy generation to the Bainbridge Island grid, and the risks to those new installations as potentially critical infrastructure. To avoid generating new vulnerabilities, the hazard levels identified in this report (Table 3 and Appendix A) can be used to assess site specific risks when siting renewable energy projects, as well as other electric infrastructure like EV charging stations.

Rooftop solar panels are unlikely to be affected by all but the most extreme earthquakes when installed properly on suitable roofs[91]. Some areas have restrictions on where arrays of ground mount or carport solar can be installed to avoid earthquake fault lines[92]. Wildfires can destroy solar panels along with buildings, but otherwise light cleaning

[91] Atlantic Key Energy. (2021). What Happens to My Solar During Natural Disasters or Inclement Weather. Available at https://atlantickeyenergy.com/what-happens-to-my-solar-during-natural-disasters-or-inclement-weather/

[92] Finnegan & Holland. (2011). Green building: Solar panels and earthquake faults don't mix. https://www.latimes.com/archives/blogs/greenspace/story/2011-03-13/green-building-solar-panels-and-earthquake-faults-dont-mix

will remove any effects of ash fall after a fire has passed[93]. Wind turbines are engineered to withstand a variety of harsh weather conditions, including severe storms with high winds. In the event of too high of winds for turbine ratings, the power generation would need to be curtailed, which would reduce the power available for connected users. Marine energy devices are also designed with moorings to withstand storm intensity waves, though at this point in time not much is known about the survivability of devices in extreme events.

Conclusions and Implications for City Priorities

Various natural hazards exist on Bainbridge Island that need to be considered in planning for resilience and siting new renewables. We have assessed risk to critical energy infrastructure considering probability of hazards, vulnerability at locations, and consequences of occurrence. Our recommendations to mitigate the highest risks include conducting a more thorough assessment of wildfire risk at the Virginia Mason Medical Center, planning for sea level rise specifically at the Winslow Wastewater Treatment Plant, and adding building-specific vulnerabilities to a comprehensive earthquake risk assessment.

We also conducted a high level, preliminary feasibility analysis to identify critical energy infrastructure that would benefit from solar and battery storage for increased resilience. We provided rough estimates of solar potential and battery size to prioritize efforts. In addition to increasing resilience of existing infrastructure to hazards, there is a need to consider the implications of adding more renewable energy generation to the Bainbridge Island grid, and the risks to those new installations from hazards and threats. We recommend using the hazard levels and site specific risks from this report to aid in siting additional renewable energy as well as other electric infrastructure such as EV charging stations.

The City of Bainbridge Island has the most influence on resilience activities at City facilities, public buildings, and community disaster hubs. We recommend pursuing partnerships to help increase the resilience of the Disaster Hubs that are at the greatest risk from hazards and to explore the locations where installation of solar plus battery storage could increase resilience to power outages. Continuing to partner with PSE to address grid disruptions and to support the development of additional distributed resources and battery storage will be critical to advancing the resilience of Bainbridge Island's critical energy infrastructure.

[93] Atlantic Key Energy. (2021). What Happens to My Solar During Natural Disasters or Inclement Weather. Available at https://atlantickeyenergy.com/what-happens-to-my-solar-during-natural-disasters-or-inclement-weather/

DRAFT

References

Allen et al. (2018). Linking Water Infrastructure, Public Health, and Sea Level Rise: Integrated Assessment of Flood Resilience in Coastal Cities. *Public Works Management & Policy 24(1)*. DOI: 10.1177/1087724X18798380

Alisawi, H. (2020). Performance of wastewater treatment during variable temperature. *Applied Water Sciences 10*: 89. DOI: 10.1007/s13201-020-1171-x

Atlantic Key Energy. (2021). What Happens to My Solar During Natural Disasters or Inclement Weather. Available at https://atlantickeyenergy.com/what-happens-to-my-solar-during-natural-disasters-or-inclement-weather/

Arkema, K.; Rose, D.; Moncheur de Rieudotte, M.; Sheridan, L.; Caruso, O.; Solana, A.; Piazza, A.; Grear, M.; Devine, M.; Esterly, S.; Salamnack, A. (2024). ETIPP Report: Bainbridge Island Pathways to 100% Renewable Energy. PNNL-35643.

Azevedo de Almeida & Mostafavi. (2016). Resilience of Infrastructure Systems to Sea-Level Rise in Coastal Areas: Impacts, Adaptation Measures, and Implementation Challenges. *Sustainability 8(11)*: 1115. DOI: 10.3390/su8111115

BIFD. (2010). Bainbridge Island Community Wildfire Protection Plan. Available at https://www.dnr.wa.gov/publications/rp_burn_cwpp_bainbridgeIsland.pdf

BIFD. (2022). Bainbridge Island Community Wildfire Protection Plan. Available at https://www.bifd.org/pdfs/FINAL_CWPP_UPDATE_101322.pdf

BIFD. (n.d.). Bainbridge Island Fire-Resistant Landscaping Guide. Available at https://www.bainbridgewa.gov/DocumentCenter/View/17554/Fire-Resistant-Landscaping

BIFD and Western Washington University. (2012). Bainbridge Island Hazard Identification and Vulnerability Assessment. Available at https://www.bifd.org/hazard-identification-and-vulnerability-assessment

California Coastal Commission. (2021). Critical Infrastructure at Risk: Sea Level Rise Planning Guidance for California's Coastal Zone. Available at https://www.coastal.ca.gov/climate/slr/vulnerability-adaptation/infrastructure/

Cascadia Consulting Group. (2019). City of Bainbridge Island Greenhouse Gas Emissions Inventory. Available at https://www.bainbridgewa.gov/DocumentCenter/View/12811/Bainbridge_GHG-Inventory-Report_FINAL_20191122

Cao et al. (2020). Adapting wastewater treatment plants to sea level rise: learning from land subsidence in Tohoku, Japan. *Natural Hazards 103*: 885-902. DOI: 10.1007/s11069-020-04017-5

Climate Change Advisory Committee. (2019). Sea Level Rise on Bainbridge Island: A Preliminary Assessment. Available at https://www.bainbridgewa.gov/DocumentCenter/View/12893/Sea-Level-Rise-Assessment-October-24-2019

DRAFT

COBI. (2010, revised 2020). Wastewater Treatment Facilities Operation and Maintenance Manual. Available to download from https://apps.ecology.wa.gov/paris/DownloadDocument.aspx?id=311250

COBI. 2020. Climate Action Plan: A Plan for Mitigating and Adapting to Climate Change on Bainbridge Island. https://www.bainbridgewa.gov/DocumentCenter/View/14354/Final-Bainbridge-Island-Climate-Action-Plan-November-12th-2020

COBI. (2022). Comprehensive Emergency Management PLan: Hazard Specific Annex - Wildfire Response and Evacuation Plan. Available at https://www.bainbridgewa.gov/DocumentCenter/View/12163/Wildfire-Response-and-Evacuation-Plan---Hazard-Specific-Annex-?bidId=

COBI. (2023). Understanding WUI Defensible Space. Available at https://bainbridgewa.gov/DocumentCenter/View/17488/WUI_Defensible-Space

COBI and PSE. (2021). Partnership Agreement (Draft). Available at https://drive.google.com/file/d/1HLKuIe4wpm4gpSpLBK4PEkxZeHeLxJEI/view?usp=drive_link

COBI City Council. (2022). Regular Business Meeting Agenda Bill. Available at https://d2kbkoa27fdvtw.cloudfront.net/bainbridgewa/3f190a7c319c8b7ecad9e4a1cd2aee500.pdf

Design West. (2022). COBI - PV Panel and Battery Storage: Assessment and preparation of specifications for design build install of PV and BESS systems at six sites. Available at https://bainbridgewa.gov/DocumentCenter/View/17056/Solar-and-Battery-Energy-Storage-at-Community-Disaster-Hubs ---2022-Report-?bidId=

EcoAdapt. (2016). Bainbridge Island Climate Impact Assessment. Available at https://www.bainbridgewa.gov/DocumentCenter/View/12544/BICIA-Final-28-July-2016?bidId=

EcoAdapt. (2023). Bainbridge Island Sea Level Rise: Community Survey and Adaptation Support. Available at https://ecoadapt.org/projects/6/Bainbridge-Island-Community-Sea-Level-Rise-Survey

FEMA. (2014). Emergency Power Systems for Critical Facilities: A Best Practices Approach to Improving Reliability. Available at https://www.wbdg.org/FFC/DHS/femap1019.pdf

FEMA. (2015). Kitsap County Risk Report. Available at https://www.kitsap.gov/dcd/Kitsap_climate_assessment/Risk%20Report%20-%20Kitsap%20County%20-%20Final.pdf

Finnegan & Holland. (2011). Green building: Solar panels and earthquake faults don't mix. https://www.latimes.com/archives/blogs/greenspace/story/2011-03-13/green-building-solar-panels-and-earthquake-faults-dont-mix

Hughes et al. (2021). Impacts and implications of climate change on wastewater systems: A New Zealand perspective. *Climate Risk Management 31*: 100262. DOI: 10.1016/j.crm.2020.100262

Hummel et al. (2018). Sea Level Rise Impacts on Wastewater Treatment Systems Along the U.S. Coasts. *Earth's Future 6(4)*: 622-633. DOI: 10.1002/2017mEF000805

DRAFT

Kitsap County (2008). Hazard Identification and Vulnerability Assessment. Available at https://www.bainbridgewa.gov/DocumentCenter/View/8572/HIVA-2008-Final?bidId=

Kitsap County. (2013). Multi-Hazard Mitigation Plan. Available at https://www.bainbridgewa.gov/DocumentCenter/View/8573/2013-Mitigation-Plan?bidId=

Kitsap County. (2019). Multi-Hazard Mitigation Plan. Available at https://www.kitsapdem.com/wp-content/uploads/2021/08/2019-multi-hazard-mitigation-plan-for-Kitsap-County-WA.pdf

Kitsap County. (2020a). Climate Change Resiliency Assessment. Available at https://www.kitsap.gov/dcd/Kitsap_climate_assessment/KitsapCountyClimateAssessment_June2020%20-%202%20Full%20Assessment%20LowRes.pdf

Kitsap County. (2020b). Comprehensive Emergency Management Plan. Available at https://www.kitsapdem.com/wp-content/uploads/2021/08/2020-Kitsap-County-Comprehensive-Emergency-Management-Plan.pdf

King County. (2008). Vulnerability of Major Wastewater Facilities to Flooding from Sea-Level Rise. Available at https://your.kingcounty.gov/dnrp/library/archive-documents/wtd/csi/csi-docs/0807_slr_vf_tm.pdf 2

LOTT Clean Water Alliance. (2022). Preparing for Sea Level Rise: LOTT's Budd Inlet Treatment Plant. Available at https://www.lottcleanwater.org/wp-content/uploads/2022/11/preparing-for-sea-level-rise.pdf

Mauger et al. (2015). State of Knowledge: Climate Change in Puget Sound. Available at https://cig.uw.edu/projects/climate-change-in-puget-sound-state-of-knowledge/

Miller et al. (2018). Projected Sea Level Rise for Washington State – A 2018 Assessment. Available at https://cig.uw.edu/projects/projected-sea-level-rise-for-washington-state-a-2018-assessment/

Miller et al. (2019). Extreme Coastal Water Level in Washington State: Guidelines to Support Sea Level Rise Planning. Available at https://cig.uw.edu/publications/extreme-coastal-water-level-in-washington-state-guidelines-to-support-sea-level-rise-planning/

Morgan et al. (2019). Managing Washington Wildfire Risk in a Changing Climate. Workshop summary report prepared by the Northwest Climate Adaptation Science Center and the Climate Impacts Group, University of Washington, Seattle. Available at https://cig.uw.edu/wp-content/uploads/sites/2/2019/12/Managing-Western-Washington-Wildfire-Risk-in-a-Changing-Climate.pdf

Navigant Consulting. (2019). Bainbridge Island Non-Wires Alternative Analysis. Prepared for PSE. Available at https://oohpsebainbridgefall2019.blob.core.windows.net/media/Default/documents/Appendix%20D_Bainbridge%20Island%20Non-Wires%20Alternative%20Analysis_Navigant%20Consulting_July_9_2019.pdf

Ogunquit Sewer District. (2019). Sea Level Rise Adaptation. https://www.ogunquitsewerdistrict.org/sealevelrise

DRAFT

Persyn, B. (2019). How can the City of Bainbridge Island effectively accelerate GHG reductions with solar PV projects? Available at https://drive.google.com/file/d/1O0-kcqVeZji0A3Y_QYiSHAW35ZJwPJmR/view?usp=drive_link

PSE. (2019a). Bainbridge Island Electric System Needs Assessment. Available at https://psebainbridge.blob.core.windows.net/media/Default/images/Bainbridge_Island_Electric_System_Needs_Assessment_Final_July%202017.pdf

PSE. (2019b). Bainbridge Island Electric System Solutions Report. Available at https://psebainbridge.blob.core.windows.net/media/Default/images/Bainbridge_Island%20Solutions_Final_July_2019.pdf

Quanta Technology. (2019). Energy Storage Planning to Support Bainbridge Island. Prepared for Puget Sound Energy. Available at https://quanta-technology.com/wp-content/uploads/2020/05/Appendix-E_Energy-Storage-Planning-to-Support-Bainbridge-Island-Final-Report_Quanta-Technology_Apr-23-2019-4a.pdf

TetraTech. (2023). Presentation to COBI City Council at November 21, 2023 meeting. Slide deck available at https://d3n9y02raazwpg.cloudfront.net/bainbridgewa/2253096f-719c-11ed-9024-0050569183fa-1288c45d-5d3e-46ae-af61-2e888e37b46d-1700265059.pdf

Threndyle et al. (2022). Future inundation of coastal on-site wastewater treatment systems in a region with pronounced sea-level rise. *Journal of Hydrology* 614(B): 128548. DOI: 10.1016/j.jhydrol.2022.128548

U.S. Department of Energy. (2021). Energy Sector Risk Profile for Washington State. Available at https://www.energy.gov/sites/default/files/2021-09/State%20of%20Washington%20Energy%20Sector%20Risk%20Profile.pdf

U.S. Department of Energy. (2022). Energy Emergency Response Playbook for States and Territories. Available at https://www.energy.gov/ceser/articles/doe-energy-emergency-response-playbook-states-and-territories

U.S. Department of Homeland Security National Infrastructure Advisory Council. (2009). Critical Infrastructure Resilience: Final Report and Recommendations.Available at https://www.cisa.gov/publication/niac-critical-infrastructure-resilience-final-report

Zhou & Hawken. (2023). Climate-Related Sea Level Rise and Coastal Wastewater Treatment Infrastructure Futures: Landscape Planning Scenarios for Negotiating Risks and Opportunities in Australian Urban Areas. *Sustainability 15(11)*: 8977. DOI: 10.3390/su15118977

DRAFT

Appendix A - Spatial Data

The spatial data sources for the probability and risk assessment are available to download as an ArcGIS Map Package File and as individual PDFs from Google Drive - https://tinyurl.com/56txyutd.

Spatial data sources for each hazard are shown in Table A1.

Table A1. Data layers for characterization of critical energy infrastructure in relation to hazards.

Hazard	Source(s)	Layer Name and Symbology
Flood	FEMA Flood Insurance Rate Designations from 2016, from COBI Critical Areas Web Application.	FEMA Flood Insurance Rate Designations A - 1% annual flooding AE - base 100 year floodplain VE - 1% annual coastal flooding
Sea Level Rise	https://coast.noaa.gov/slrdata/, Kitsap County Sea Level Rise	Inundation from 1 foot of Sea Level Rise (feet) High : 15.7297 Low : 0
Tsunami	Data from WA DNR ● Cascadia Fault Scenario ● Seattle Fault Scenario	Tsunami - Cascadia/Seattle Fault Scenario Inundation (feet) 0 4 8 12 16 20
Earthquake	Data from WA DNR ● Cascadia Earthquake ● Seattle Earthquake	Shaking Intensity Shaking Intensity 4 - Light 5 - Moderate 6 - Strong 7 - Very Strong 8 - Severe Damaged Buildings (used to assess vulnerability) Number of Damaged Buildings (by tract) 0 - 1 2 - 50 51 - 100 101 - 250 251 - 500 501 - 1500

		Waste Water Facility Damage (used to assess vulnerability) WW Low WW Moderate WW High Fire Station Damage (used to assess vulnerability) F Low F Moderate F High
Erosion, Landslide	USGS Mapped Landslides and Erosion Hazards, from [COBI Critical Areas Web Application]().	USGS Mapped Landslides USGS Mapped Landslides USGS Erosion Hazard USGS Erosion Hazard
Wildfire	• LANDFIRE Fire Behavior Fuel Models, shared by COBI • Bainbridge Island Community Wildfire Protection Plan - Overall Wildfire Risk from Figure 25. Not included in Map Package File due to availability, but compared for reference for probability of risk. • Urban Wildfire Hazard Layers from COBI GIS, https://cityofbi.maps.arcgis.com/apps/instant/basic/index.html?appid=0ca00857acb34cb888fb6f6fa37a7110. Not included in Map Package File due to availability, but compared for reference for probability of risk.	Fire Behavior Fuel Model 40 Low Moderate High Non-Burnable

Other layers are included in the Map Package File and are described in Table A2.

Table A2. Additional spatial data layers included in Map Package File.

Data Type	Source(s)	Layer Name and Symbology
Critical Energy Infrastructure	Identified from conversations with COBI. Locations determined using Google Maps and information from PSE.	Critical Energy Infrastructure City Facility Emergency Operations Center Fire Station Community Disaster Hubs Child Reunification Center Disaster Medical Center Warming Station WSDOT Ferry Terminal Wastewater Treatment Plant PSE Substation PSE Transmission Lines
Streets	[COBI Critical Areas Web Application]()	City of Bainbridge Island Streets <all other values> Collector Secondary Arterial
Shoreline Designations	[COBI Critical Areas Web Application]()	Official Shoreline Designations Shoreline Residential Conservancy Shoreline Residential Island Conservancy Natural Urban
Marine Energy Resource	[Marine Energy Atlas]()	Tidal Current Speed (m/s) Annual- and depth-averaged 0 - 0.3 0.3 - 0.5 0.5 - 0.77 0.77 - 1.13 1.13 - 2
Wind Energy Resource	[Global Wind Atlas 3]()	Mean Wind Speed at 50m (m/s) High : 10 Low : 0

Appendix B - Preliminary Solar + Storage Analysis

Inputs to the Preliminary Solar + Storage analysis include daily critical loads and theoretical capacity for rooftop and carport solar PV based on land availability. Each site was assigned a typical electric load profile that best matched the building type. Four 72-hour outages were simulated in REopt, centered around the seasonal load peaks. The system recommended by REopt was optimized to sustain loads for the seasonal outage requiring the largest amount of solar PV and battery storage. In other words, a 3-day outage in July, when the solar resource is plentiful and electricity demand tends to be low, will require a smaller solar PV array to meet the load than a 3-day outage in December, when there is less sun and higher loads due to, for example, increased space heating loads.

This analysis is considered preliminary because it uses typical electric load profiles that best match building type, rather than measured electrical load data for each site. It also utilizes preliminary estimates of solar PV for each site, which do not include shading losses. REopt estimates the combination of solar PV and BESS to sustain a critical load for each site, but does not match the output to commercially available technologies for battery storage. For example, most commercially available Lithium-Ion systems are 2-hour or 4-hour batteries that have the capacity to discharge at their maximum rate for 2 or 4 hours, respectively. A 1kW / 2kWh BESS would be a 2-hour battery. However, REopt simply estimates the battery storage that would meet the given load during an outage of a specified duration, resulting in much greater battery-hour systems. Planning for shorter outages (e.g., 12 hour, 24 hour) would require smaller batteries.

Approach and Assumptions:

1. Estimated total annual energy use by multiplying daily use by 365
    - Daily use estimates from Characterization of Critical Energy Infrastructure (Table 3).
2. Estimated theoretical maximum solar available using square footage, and noted if more space was available due to large parking lots
    - For Seabold United Methodist, it was assumed that no solar was available due to shading on the roof
3. Ran REopt to size the amount of PV and battery storage (BESS) to provide power for a **3 day outage**.
    - Assumed that daily energy need for emergency operations already accounted for the 50% critical load factor
    - Assumed specific load shapes for each hub. Some are obvious (schools modeled as schools, and the wastewater treatment plant as a 24/7 flat load), but there does not exist a generic load profile for churches, for example. The supermarket load shape was used for most other buildings, since it was assumed these buildings would have pretty consistent occupation throughout the course of every day of the week during an emergency. The Wing Point Country Club was modeled as a restaurant because there is a relatively constant load every day of the week, including evenings.
    - The size of PV available was capped by the theoretical max solar available from square footage. Where not already available, square footage was estimated using satellite imagery.
    - This also assumes no shading, and all panels facing due South

Table B1. Preliminary analysis results using REopt for critical energy infrastructure locations.

DRAFT

Location	Square Footage	Annual Emergency Load (kWh)	Load Profile Used	Solar (kW)	BESS for 3 day outage (kW / kWh)	Notes
Seabold United Methodist	1794	13140	supermarket	0	3 / 108	very shaded, likely not good location for solar PV
Island School	10700	59860	school - secondary	8.5	19 / 900	-
Rolling Bay Presbyterian	24000	175200	supermarket	146	34 / 1144	-
Island Center Hall	1700	12410	supermarket	10	2 / 81	relatively shaded, may not be optimal location for solar PV
Bethany Lutheran	11900	86870	supermarket	71	17 / 569	rooftop + parking lot available
Strawberry Hill Park	972	2555	supermarket	2	1 / 17	relatively shaded, may not be optimal location for solar PV
Wing Point Country Club	10800	78840	restaurant	114	30 / 256	rooftop + parking lot available
Islandwood	26000	145270	school - secondary	252	58 / 440	relatively shaded, may not be optimal location for solar PV
Fort Ward Community Hall	2400	17520	supermarket	14	3 / 115	not much space available for PV
Winslow Wastewater Treatment Plant	6800	919800	24/7 flat load	102	105 / 9649	not much space available for PV
Kitsap County Sewer District #7 Wastewater Treatment Plant	4000	265720	24/7 flat load	60	30 / 2692	not much space available for PV
Virginia Mason	30000	442015	outpatient health care	350	96 / 5455	rooftop + parking lot available
Grace Episcopal Church	11000	451505	supermarket	160	75 / 3794	-
Sakai Intermediate School	52000	290540	school - secondary	332	74 / 1526	-
Public Works O&M Yard	18363	120450	warehouse	129	33 / 1333	-

Location	Square Footage	Annual Emergency Load (kWh)	Load Profile Used	Solar (kW)	BESS for 3 day outage (kW / kWh)	Notes
Winslow Ferry Terminal	21700	89060	supermarket	73	17 / 583	-
Fire Station 21	25200	103295	hospital	86	23 / 1104	-
Fire Station 22	14800	48910	hospital	41	11 / 523	-
Fire Station 23	11900	60590	hospital	51	13 / 648	-

DRAFT

ENERGY
TRANSITIONS
INITIATIVE
U.S. Department of Energy

Partnership Project

Bainbridge Island

March 20th, 2024

Presentation to Climate Change Advisory Committee

Pacific Northwest
NATIONAL LABORATORY

Spark Northwest

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Overview + Goals

- Brief presentation on resilience findings, as detailed in report that was shared
- Discussion of Resilience Report
  - Confirm Key Takeaways
- Discuss next steps post-ETIPP

Resilience

- Bainbridge Island has longer and more frequent outages than other PSE customers in Kitsap County, often due to tree-related events
  - Primarily a reliability issue

- Resilience goals feature strongly in the Climate Action Plan, especially around emergency or disaster response to natural hazards
  - Energy self-sufficiency for emergency preparedness as an island
  - Energy infrastructure reliability in a changing climate
  - Solar and storage at community disaster hubs

Photos from May 31 ETIPP team site visit

Approach

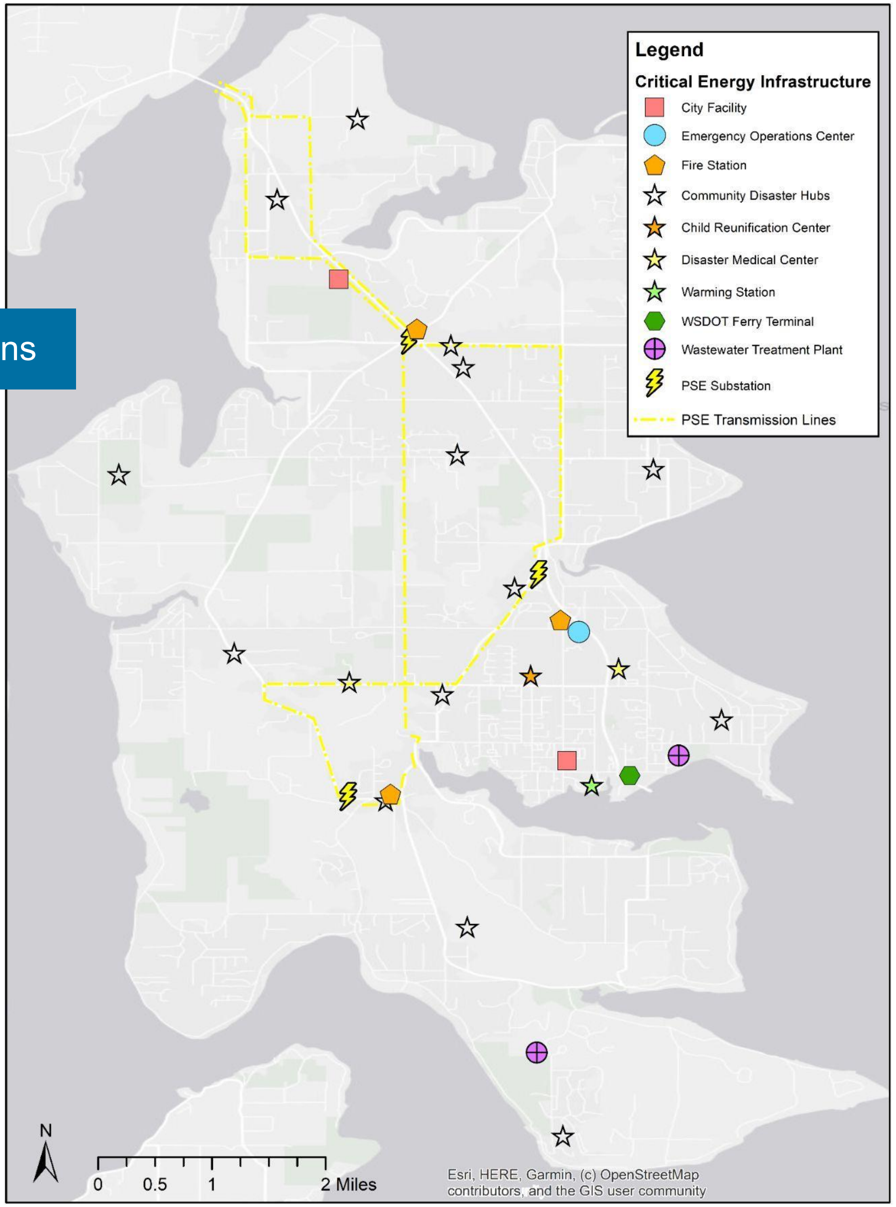
1. Identify critical energy infrastructure locations and characterize energy needs

Total: 33 locations

- PSE Substations and Transmission Lines
- All Community Disaster Hubs
- Ted Spearman Justice Center (Emergency Operations Center)
- Public Works O&M Yard
- City Hall
- Winslow Wastewater Treatment Plant
- Kitsap County Sewer District #7 Wastewater Treatment Plant
- Winslow Ferry Terminal
- Fire Stations 21, 22, 23

2. Spatial overlap with hazards

3. Assess risk
4. Identify priority sites
5. Make recommendations



Findings

High Risk Locations for Multiple Hazards:

Virginia Mason Medical Center

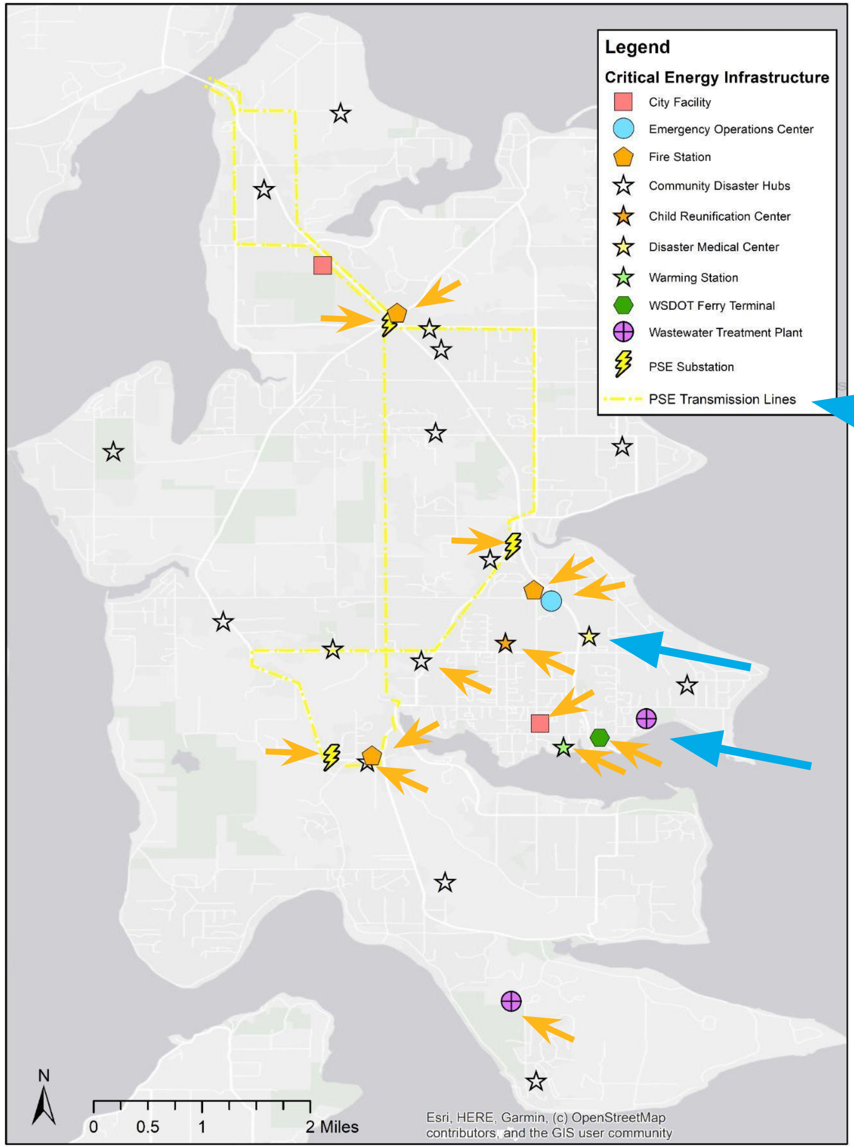
Winslow Wastewater Treatment Plant

PSE Transmission Lines

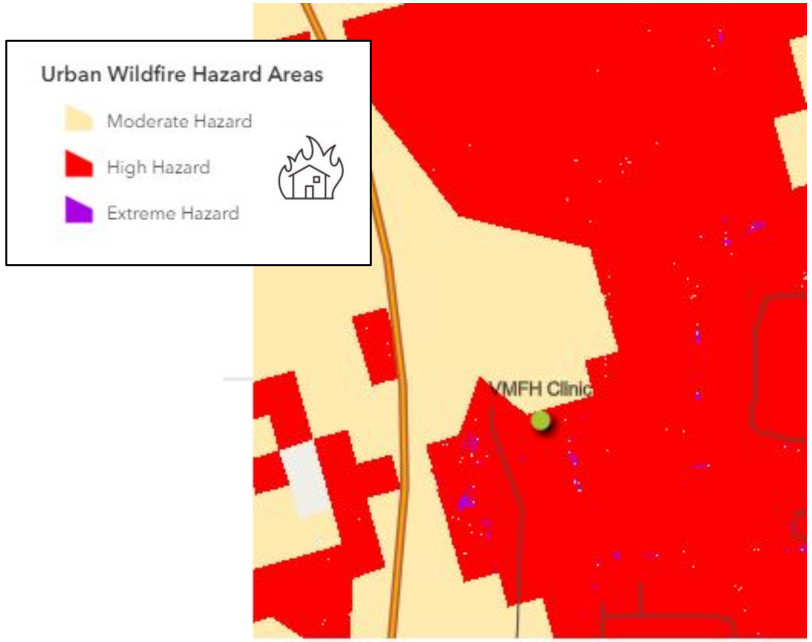
Many locations have a single high risk for earthquake

Installed renewables can become critical energy infrastructure:

Solar: Wind: Marine: Biodigester:



Virginia Mason Medical Center



Data from WA DNR, accessed through the [COBI GIS Portal]

Risks:

- Located in the Wildland-Urban Interface
- Overall risk to the site is moderated by its proximity to Fire Station 21 (1.0 mi)

Resilience:

Many activities to prepare the community for wildfire have occurred, and several plans and codes are in place for wildfire risk assessment, prevention and response.

Recommendations:

More robust assessment of the Virginia Mason site for wildfire risk mitigation in partnership with Bainbridge Island Fire Department. Prior to a full assessment, additional risk mitigation activities could take place with engaged partner in alignment with existing codes, such as:

- Tree assessment and removal to create defensible space (in accordance with other municipal codes)
- Material upgrades or replacements (for roofs, siding, etc.) under 2021 limited provisions of the International Wildland-Urban Interface Code
- Consideration of flammability in landscaping selections
- Expansion of fire protection water supply infrastructure, such as hydrants

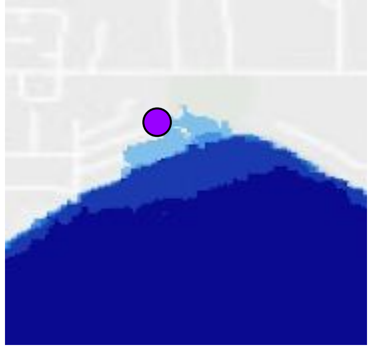
Winslow Wastewater Treatment Plant

1 ft of SLR (MHHW)

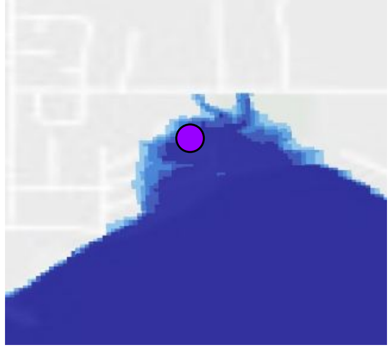
10 ft of SLR (MHHW)

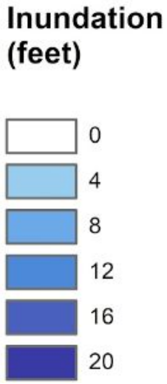
The most likely projections indicate that Bainbridge Island will experience **one foot** of sea level rise by the year 2060.

Cascadia Tsunami



Seattle Tsunami





Risks:

- Identified as potentially vulnerable to sea level rise in 2019 assessment
- Tsunami inundation possible for both Cascadia and Seattle fault ruptures

Resilience:

- Many communities across the U.S. and the world are planning for sea level rise impacts on wastewater infrastructure in coastal areas.
- COBI authorized an updated Sea Level Rise Flood Vulnerability and Risk Assessment that is starting up (Environmental Science Associates) as part of the 2024 Comprehensive Plan update.
- Current wastewater treatment plant operations have redundant backup systems for other types of power outages (numerous generators) but unclear how planning to respond to persistent inundation with seawater.

Recommendations:

- We compile and synthesize several examples of what other communities are doing, especially where relocation isn't a feasible option to provide guidance.

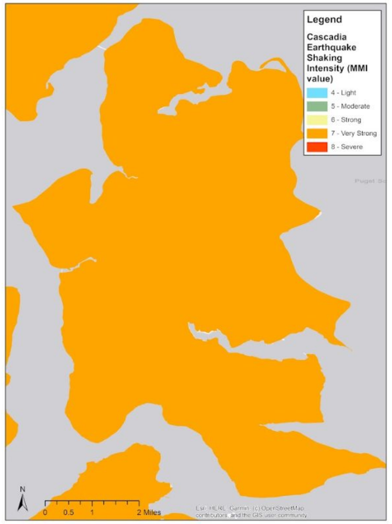
PSE Infrastructure

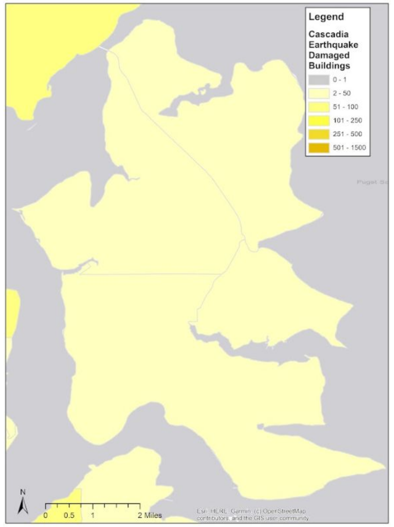
- Severe storms already cause power outages on Bainbridge
- Plans to add Murden Cove - Winslow Tap should increase redundancy.
  - A more comprehensive future analysis could include scenario development of mapping which critical energy infrastructure locations are supplied by which substations and transmission lines, and explore additional options to increase resilience from storm-related outages.
- Siting of new PSE battery at Murden Cove will need to consider earthquake.
  - Resilience scenarios could be explored in a further analysis in partnership with PSE (outside of City jurisdiction).

Earthquake Resilience

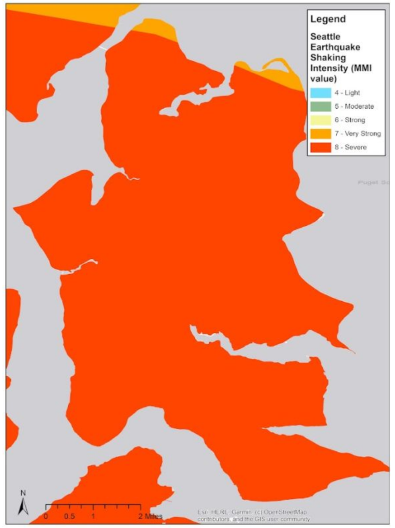
Shaking Intensity | **Damaged Buildings**

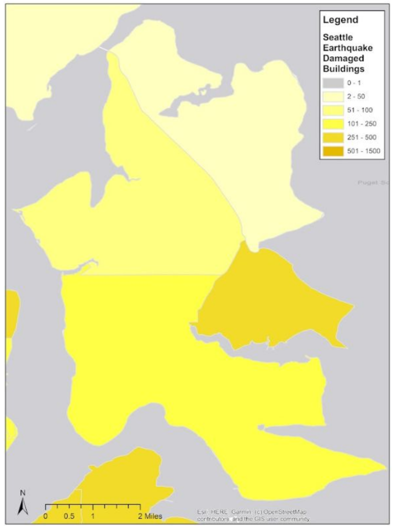
Cascadia:





Seattle:





Locations considered high risk: Bethany Lutheran, Senior Center, High School, Hyla Middle School, Medical Center, TSJC, City Hall, Fire Station 21, Winslow Ferry Terminal, Kitsap Wastewater Treatment Plant

- Vulnerability is dependent on building design factors, including age of the building, structural codes to which it is built and maintained, as well as the power connections.
  - This information is not currently available for buildings on the critical energy infrastructure list. Data on the left (used in analysis) is regional estimates from WA DNR.
- We recommend a more focused earthquake assessment for the buildings currently rated high risk to be able to refine the level of risk based on vulnerability to earthquakes and identify specific needs.

Solar + Storage for Resilience

Approach

- Preliminary feasibility analysis using ReOpt and several assumptions to estimate solar generation potential at remaining sites on critical energy infrastructure list (building on Pathways solar analysis)
- Estimated theoretical battery size needed for a 3-day outage

Findings:

The following locations emerged as having further potential for solar + storage to be explored in future work.

- Island School
- Rolling Bay Presbyterian
- Bethany Lutheran
- Wing Point Country Club
- Virginia Mason Medical Center
- Grace Church
- Sakai Intermediate School
- Public Works O&M Yard
- Winslow Ferry Terminal
- Fire Station 21
- Fire Station 22
- Fire Station 23

Key Takeaways

- Various natural hazards exist on Bainbridge Island that need to be considered in planning for energy resilience and siting new renewable energy infrastructure. In particular, sea-level rise, extreme heat, and extreme cold were not considered in past assessments, should be considered in future planning.
- Risk is assessed considering probability of hazards, vulnerability at locations, and consequences of occurrence.
- The most at-risk critical energy infrastructure on Bainbridge Island based on this analysis includes **existing and planned transmission lines**, the **Virginia Mason Medical Center**, and the **Winslow Wastewater Treatment Plant**. Several other locations may be at high risk due to earthquakes.
- Resilience actions to address these risks include:
  - A more thorough assessment of wildfire risk at the Virginia Mason Medical Center
  - Planning for sea level rise specifically at the Winslow Wastewater Treatment Plant
  - Adding building-specific vulnerabilities to a comprehensive earthquake risk assessment
- Based on our high-level analysis, several critical energy infrastructure locations could increase resilience to power outages in general with the installation of solar and battery storage. These locations include the **Island School**, **Rolling Bay Presbyterian**, **Bethany Lutheran**, **Wing Point Country Club**, **Virginia Mason Medical Center**, **Grace Church**, **Sakai Intermediate School**, the **Public Works O&M Yard**, the **Winslow Ferry Terminal**, and **Fire Stations 21, 22**, and **23**. More detailed analysis for each site is needed for project design.

Questions / Discussion

- Do the results for the highest risk locations of critical energy infrastructure resonate with your experience?
- Are there partners that may be particularly interested in the results from the solar plus battery storage analysis?
- How can the City partner with other institutions (public + private) to continue to take action without having direct control over facilities?
- Do the key takeaways reflect the messages that you think are important to emphasize from this work?

Next Steps for ETIPP and CCAC

- How can CCAC members help to foster relationships with particular partners, including PSE, that can help the City implement the pathways to 100% renewable energy and resilience recommendations?

- Are there future opportunities for sharing ETIPP results with the broader community and original project partners (e.g., Earth Day, monthly topic sessions, website/newsletter communications)?

- Are there opportunities for integrating ETIPP results into future plans and assessments (e.g., Pathways into the Comprehensive Plan, Resilience results into the next HIVA)?

- Are there funding opportunities that Spark Northwest could help to support through grant applications?

ENERGY
TRANSITIONS
INITIATIVE
U.S. Department of Energy

Partnership Project

Thank you!

Contact:
katie.arkema@pnnl.gov
deborah.rose@pnnl.gov

BI CAP Dashboard (3/12/24)

Goal: Foster public transparency by developing clear, concise, and easy to use information that tells a story and enables the City Council, City Staff, and Community to evaluate the progress in meeting the goals of the BI Climate Action Plan.

Audience: There are multiple audiences for the dashboard (e.g., City Council, public, CCAC members, and City Staff).

Proposed Process for Developing Dashboard

1. Form three subgroups. Each subgroup selects 1-3 goals using the criteria below with a goal of 5-7 total goals (finalize at the March 20th CCAC meeting).

- Energy/Buildings/Transportation (Steve, Derik, Sanjay, Jens)
- Transportation/Waste/Natural Environment (Ray, Michael K., Mike C.)
- Engagement/Implementation (Julie, Kevin)
- GHG emissions will be completed as part of the GHG inventory process.

2. Develop criteria for evaluating which goals to consider for each area (finalize at the March 20th CCAC meeting).

- Tells a Story: Does the goal tell a story that is easy to understand and relatable for the public?
- Assists in Decision Making: Would it assist in decision making for the City Council and City Staff and help to evaluate and explain progress in meeting the CAP goals? Would it help the CCAC provide advice to the Council?
- Data is accessible of high quality and low cost: Is the data available and easily accessible? Is the data of high quality (e.g., QA/QC has been conducted)? Is there a cost for obtaining the data and what is the cost?
- Staff Effort: What is the level of effort for staff to track and update the goal?

3. Subgroups meet and develop goals to be discussed at the May 15th CCAC meeting.

4. CCAC discusses what platform to use at the April 17th CCAC meeting.

- Tableau: Headwaters Economics has created an interactive tool in Tableau that helps city planners and leaders prioritize adaptation strategies through the lens of equity. Tableau was widely used during COVID-19 to present and track the state of the pandemic.

- Power BI, Microsoft's product, is likely a lower cost option for dashboards and is also widely used by governments to visualize their data. It lacks some of the elegance of Tableau but it may be easier for City staff to administer. The WA DOH is using it for reporting on respiratory illness statewide. It also may be included in the City's subscription to Office 365 (depending on plan level).

- Infogram is a low-cost data visualization service that is used widely and is optimized for mobile devices. It does not require any training to use quickly, unlike Tableau and Power BI.

5. CCAC discusses at the May 15th CCAC meeting who is responsible for creating the dashboard and collecting, managing, and maintaining database?

- City staff or a contractor could be responsible for collecting, managing, and maintaining the database.
- The CCAC could help develop the database or could be more involved in data collection and management.

6. Discuss draft Dashboard at July 17th CCAC meeting.

7. Do we engage the public in selecting the goals and providing advice on the Dashboard?

- Mixed.
- Some say yes and others say no that the dashboard will be reviewed by the City Council and City Staff so could ask for public input during that process but not necessarily separately.

Committee Annual Report and Work Plan

Climate Change Advisory Committee

Annual Report and Workplan for 2024

Report on 2023 Activities (please format to describe your work and includes how this work aligns with Council requests and/or policy priorities.)

- Energy Transitions Initiative Partnership Project (ETIPP) – Supported staff and participated in multi-partner meetings related to technical assistance about energy resilience and vulnerability assessments for the Island.
- Community Heat Pump Installation Program - Supported the development of a community pilot heat pump program for the Island which addresses priorities related to reduction of greenhouse gas emissions stated by Council in the Climate Action Plan; with an emphasis on equity and income-qualification in the application process it also supports values of equity and inclusion.
- Worked with the staff and the Utility Advisory Committee to develop a Memorandum of Understanding with Puget Sound Energy concurrently with the City's Franchise Agreement.
- Proposed Climate Lens for Outreach Activities in Support of the Comprehensive Plan Periodic Review and Winslow Subarea Plan Update.
- Staffed Climate Smart booths at five (5) community events to support Climate Action Plan Implementation.
- Completed analysis and participated in development of Request for Proposals for solar projects by other public agencies to provide options for offset to the carbon emissions of the Ted Spearman Justice Center.
- Sponsored the Electric Vehicle Expo, held at Woodward Middle School on May 20th.
- Participation in Groundwater Management Plan development subcommittee with members of the Utility Advisory Committee and Environmental Technical Advisory Committee.
- Reviewed and provided comments on the draft and final Fehr and Peers sustainable transportation report.
- Recruitment and onboarding of new members.

2024 Workplan Priorities (please format to describe your work and includes how this work aligns with Council requests and/or policy priorities.)

- ETIPP - Continue participation in the ETIPP started in 2023 by reviewing final report and providing suggestions and support of next steps.
- Community Heat Pump Installation Program – Continue to provide support to the pilot hear pump program.
- Comprehensive Plan and Winslow Subarea Plan Support – Review and provide Committee feedback on draft plans, as requested by the Council and staff.

- Electric Vehicle (EV) Chargers – Assist with gathering data, providing input on program development, and encouraging community participation.
- Greenhouse Gas Emissions Update – Respond to staff requests as needed to gather data; review draft inventory and public-facing educational materials.
- Support the Bainbridge Island Environmental Conference and Electrification Expo.
- Develop Dashboard that will foster transparency by developing clear, concise, and easy to use information that tells a story and enables the City Council, City Staff, and Community to evaluate the progress in meeting the goals of the Climate Action Plan.