Integrating Resilience into a Sustainability Program: Process, Guidelines, and Tools

Liz Kutschke, Research Fellow, Center for Sustainable Building Research

Richard Graves, Director, Center for Sustainable Building Research

Definitions

Sustainability: The ability (of a building and its occupants) to impact or benefit the environment, social and economics of its construction and operations.

Resilience: The ability (of a building and its occupants) to respond, absorb, adapt to, and recover from a disruptive event.

Disruptive events may be natural or human-made disasters, with potential to damage or interrupt one or more critical services to the building including electricity, potable water, or transportation and access.

Integrating Resilience into Sustainability Guidelines

- 2018 study funded by Minnesota Pollution Control Agency
- Investigated regenerative design as basis for sustainable and resilient design
- Developed high performance prototype buildings with enhanced resilience features
  - Library
  - Multifamily Housing
  - Single Family Home

Existing Resilience in B3 – Sustainability with Benefits

- Site and Water
  - S.1- Human System Connections
    - Human System Connections –Connections to bike paths, walking paths, water trails, and direct connection to existing or planned transit stops within half a mile. (Required)
  - S.2- Site Water Quality and Efficiency
    - Manage site water cycle – including runoff and stormwater quality to manage large rain events on site and avoid overloading municipal systems, while also protecting the building from water intrusion. (Required)
    - Follow FEMA flood protection requirements if building in flood plain, and building in floodplain is prohibited unless essential to the project (Required)
    - Reduce potable water use in project from baseline established by 1992 Energy Policy Act. This decreases the need for potable water required for non-consumptive uses, therefore extending potable water reserves while utilizing recycled water for non-consumptive purposes. (50% Required, 70% Recommended)
  - S.3- Soil
    - Soil management and erosion control to maintain the stability of the site in increasingly intense rain events and other weather events (Required)
  - S.4- Sustainable Vegetation Design
    - Biodiverse and non-invasive planting practices contribute to soil stability, stormwater management, and provide habitat and sustenance to other species (Required)
    - Site albedo at least 0.25 (Required) / 0.3 (Recommended). A low site albedo decreases the contribution to urban heat island effect and increases the resilience of the larger area by mitigating some extreme day time and overnight temperatures.

Existing Resilience in B3 – Sustainability with Benefits

- Energy and Atmosphere
  - E.1- Energy Efficiency
    - Meet MN SB 2030 Energy Standards to ensure the building uses energy in the most efficient way, and that electrical loads critical to the resilient goals can be supported by renewable energy and battery storage (Required)
  - E.2- Renewable Energy
    - Provide 2% of energy needs with onsite renewables which could support critical electrical loads in the event of a grid power disruption. (Required)
    - Design and construct project to be renewable-energy ready so new or additional on-site renewable energy generation can be easily installed at a later date. (Required)
    - Resilient power infrastructure installation for one of three options: electrical grid disconnection and renewables with battery storage, grid disconnection and permanently installed generator and fuel storage, or grid disconnection and use of a portable generator. (Recommended)
  - E.3-Efficient Equipment and Appliances
    - Select new equipment and appliances that meet energy star criteria to decrease the overall electrical demand, and increase the amount of equipment and appliance able to function in a critical load scenario. (Required)

Existing Resilience in B3 – Sustainability with Benefits

- Indoor Environmental Quality
  - I.2- Moisture and Water Control
    - Control bulk water on site to direct water away from building to protect the enclosure construction and prevent water intrusion. (Required)
    - Design building envelope to manage moisture flow and maintain safe moisture levels to ensure structural stability, and to deter mold and mildew growth. (Required)
    - Construct building to control air leakage to maximize energy efficiency of heating, cooling, and ventilation systems, and to contribute to the overall moisture-safe envelope (Required)
  - I.4- Thermal Comfort
    - Passive thermal comfort – avoid high solar heat gain, avoid radiant temperature asymmetry, and utilize natural ventilation to provide comfortable conditions with the lowest amount of energy possible (Required)
  - I.5- Lighting and Daylighting
    - Demonstrate useful daylighting for program to maximize energy-free lighting, and to allow solar gain when it is useful to contribute to passive solar heating. (Required)
    - High reflectance interior surfaces to increase daylight utilization and promote daylight penetration further from exterior walls. (Recommended)
  - I.8- Ergonomics and Physical Activity
    - Provide showers, changing facilities, and lockers for both day-to-day use, and for use in the event of the building sheltering occupants for an extended period of time during a disaster event. (Recommended)
    - Select site located maximum 1/3 mile from at least five basic services to allow human powered transportation and connection in the event of a transportation network disruption. (Recommended)
  - I.9- Wayfinding and Universal Access
    - Interior wayfinding should be easily understood by regular and occasional users of the building to ensure safe and efficient evacuations or to direct occupants to shelter spaces (Required)
    - Universal design principles should be implemented in any building with a goal of sheltering people during a disaster event to safely accommodate occupants of all abilities (Required)

Existing Resilience in B3 – Sustainability with Benefits

- Materials and Waste
  - M.3- Waste Reduction and Management
    - Select materials with appropriate durability for service life to ensure building materials do not fail due to weather events, and are repairable if damaged (Required)
    - Address partial and total deconstruction in the event the building is damaged beyond repair, consider which materials and components may be salvaged and reused or recycled to contribute to a more resilient materials economy (Required)
  - M.4- Health
    - Demonstrate reduction of likely hazardous materials to protect occupant health in the event of extended habitation of a space, possibly in conditions that exceed the design parameters (over-crowded, longer operational hours, etc.) and that will not harm human or environmental health if exposed to the elements during a disaster event. (Required)

B3 Resilience Tool

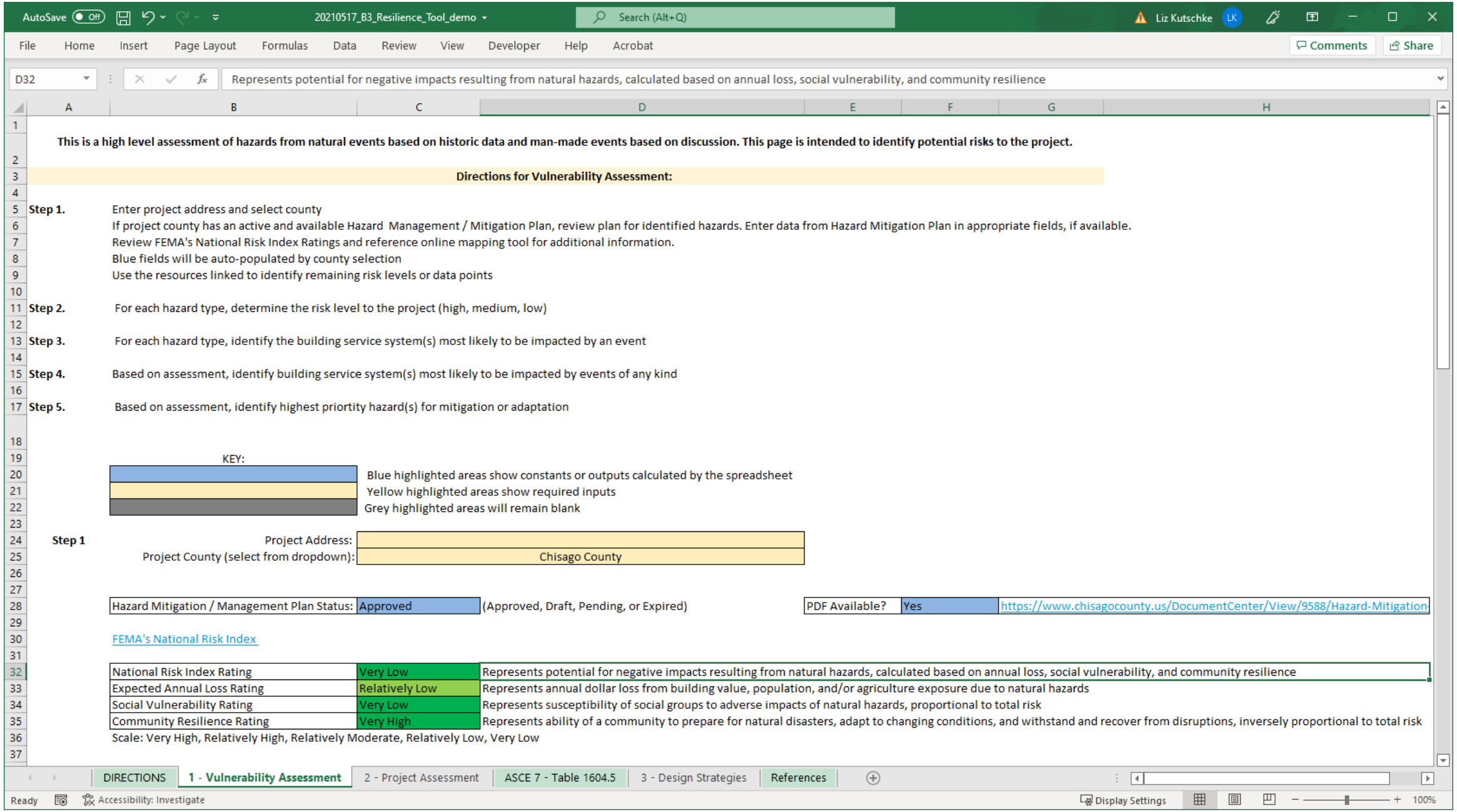
Vulnerability Assessment

Natural Hazards

- Reference local and national resources and maps to identify historic weather-based hazards at county-level
- Project stakeholders contribute site-specific knowledge
- Pre-loaded information from 2019 Minnesota State Hazard Mitigation plan and FEMA National Risk Index for each county
- Determine relative risk and consider building services and systems that may be impacted by each hazard type

Human-made Hazards

- This type of risk harder to quantify
- Assessment includes developing indicators for each hazard, based on local and site knowledge



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D32: Represents potential for negative impacts resulting from natural hazards, calculated based on annual loss, social vulnerability, and community resilience

This is a high level assessment of hazards from natural events based on historic data and man-made events based on discussion. This page is intended to identify potential risks to the project.

Directions for Vulnerability Assessment:

Step 1. Enter project address and select county
If project county has an active and available Hazard Management / Mitigation Plan, review plan for identified hazards. Enter data from Hazard Mitigation Plan in appropriate fields, if available.
Review FEMA's National Risk Index Ratings and reference online mapping tool for additional information.
Blue fields will be auto-populated by county selection
Use the resources linked to identify remaining risk levels or data points

Step 2. For each hazard type, determine the risk level to the project (high, medium, low)

Step 3. For each hazard type, identify the building service system(s) most likely to be impacted by an event

Step 4. Based on assessment, identify building service system(s) most likely to be impacted by events of any kind

Step 5. Based on assessment, identify highest priortity hazard(s) for mitigation or adaptation

KEY:

	Blue highlighted areas show constants or outputs calculated by the spreadsheet
	Yellow highlighted areas show required inputs
	Grey highlighted areas will remain blank

Step 1

Project Address:	
Project County (select from dropdown):	Chisago County

Hazard Mitigation / Management Plan Status:	Approved	(Approved, Draft, Pending, or Expired)	PDF Available? Yes	https://www.chisagocounty.us/DocumentCenter/View/9588/Hazard-Mitigation-

FEMA's National Risk Index

National Risk Index Rating	Very Low	Represents potential for negative impacts resulting from natural hazards, calculated based on annual loss, social vulnerability, and community resilience
Expected Annual Loss Rating	Relatively Low	Represents annual dollar loss from building value, population, and/or agriculture exposure due to natural hazards
Social Vulnerability Rating	Very Low	Represents susceptibility of social groups to adverse impacts of natural hazards, proportional to total risk
Community Resilience Rating	Very High	Represents ability of a community to prepare for natural disasters, adapt to changing conditions, and withstand and recover from disruptions, inversely proportional to total risk

Scale: Very High, Relatively High, Relatively Moderate, Relatively Low, Very Low

DIRECTIONS | 1 - Vulnerability Assessment | 2 - Project Assessment | ASCE 7 - Table 1604.5 | 3 - Design Strategies | References

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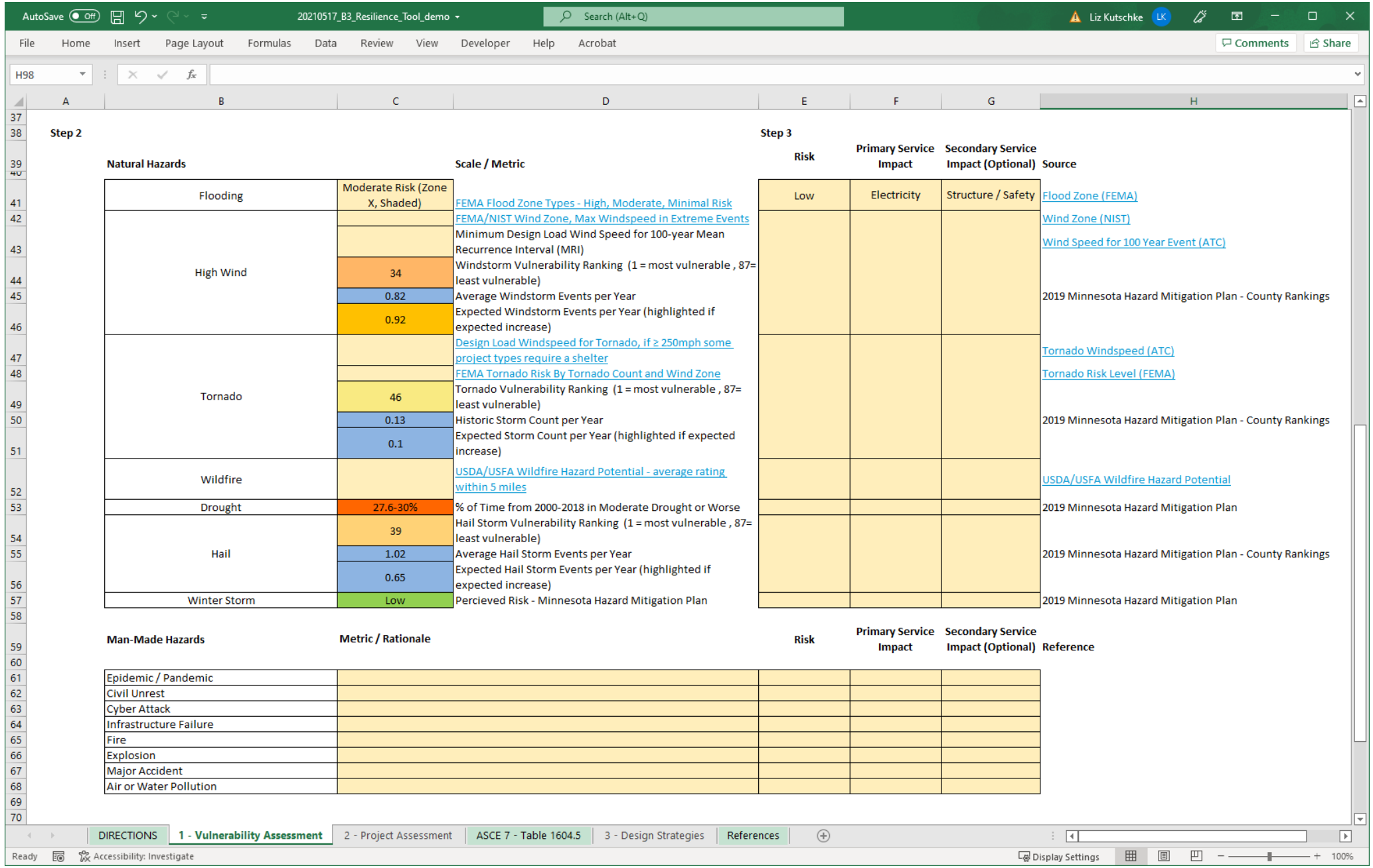

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Step 2

Natural Hazards		Scale / Metric
Flooding	Moderate Risk (Zone X, Shaded)	FEMA Flood Zone Types - High, Moderate, Minimal Risk
High Wind		FEMA/NIST Wind Zone, Max Windspeed in Extreme Events
		Minimum Design Load Wind Speed for 100-year Mean Recurrence Interval (MRI)
	34	Windstorm Vulnerability Ranking (1 = most vulnerable , 87= least vulnerable)
	0.82	Average Windstorm Events per Year
	0.92	Expected Windstorm Events per Year (highlighted if expected increase)
Tornado		Design Load Windspeed for Tornado, if ≥ 250mph some project types require a shelter
		FEMA Tornado Risk By Tornado Count and Wind Zone
	46	Tornado Vulnerability Ranking (1 = most vulnerable , 87= least vulnerable)
	0.13	Historic Storm Count per Year
	0.1	Expected Storm Count per Year (highlighted if expected increase)
Wildfire		USDA/USFA Wildfire Hazard Potential - average rating within 5 miles
Drought	27.6-30%	% of Time from 2000-2018 in Moderate Drought or Worse
Hail	39	Hail Storm Vulnerability Ranking (1 = most vulnerable , 87= least vulnerable)
	1.02	Average Hail Storm Events per Year
	0.65	Expected Hail Storm Events per Year (highlighted if expected increase)
Winter Storm	Low	Percieved Risk - Minnesota Hazard Mitigation Plan

Step 3

Risk	Primary Service Impact	Secondary Service Impact (Optional)	Source
Low	Electricity	Structure / Safety	Flood Zone (FEMA)
			Wind Zone (NIST)
			Wind Speed for 100 Year Event (ATC)
			2019 Minnesota Hazard Mitigation Plan - County Rankings
			Tornado Windspeed (ATC)
			Tornado Risk Level (FEMA)
			2019 Minnesota Hazard Mitigation Plan - County Rankings
			USDA/USFA Wildfire Hazard Potential
			2019 Minnesota Hazard Mitigation Plan
			2019 Minnesota Hazard Mitigation Plan - County Rankings
			2019 Minnesota Hazard Mitigation Plan

Man-Made Hazards	Metric / Rationale	Risk	Primary Service Impact	Secondary Service Impact (Optional)	Reference
Epidemic / Pandemic					
Civil Unrest					
Cyber Attack					
Infrastructure Failure					
Fire					
Explosion					
Major Accident					
Air or Water Pollution					

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Expanding Resilience in B3

Energy and Atmosphere

- Downscale future weather file data for use in Minnesota
- Future weather file use in energy modeling

Indoor Environmental Quality

- Design for passive survivability - maintaining thermally safe conditions during a power outage that lasts four days

Materials and Waste

- Integrate Fortified Standards for Increased Resistance to Severe Weather
- Specify products that meet impact resistance standards and security standards
    - ASTM E1996 – Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes
    - ASTM E2395 - Standard Specification for Voluntary Security Performance of Window and Door Assemblies with Glazing Impact
- Consider expanding range of termites and design strategies to resist pests

Challenges and Constraints

Authority

- Current statutes authorize ‘Sustainable’ building design, does not include resilience

Cost Implications and Budget

- Resilience measures do not fit neatly into a cost-effective payback model from energy efficiency. Return on investment if from potential insurance savings and/or bond rating.
- Human and environmental health impacts, other non-monetary potential benefits