# Geologic Hazards and the Built Environment

## Understanding risk and developing resilience

Earthquakes occur on different types of fault systems in Alaska and along the West Coast of the United States. Ground shaking from plate movements have broad reaching effects which can impact communities in many ways.

The "built environment" refers to the human-made physical spaces where we live, recreate and work, which includes buildings, furnishings, open and public spaces, roads, utilities and other infrastructure. Hazards to the built environment may come from geologic factors that cause increased ground motion and shaking due to the nature of underlying soils, liquefaction, landslides, and faulting. Additionally, hazards may be human caused in the way buildings and structures are designed, constructed or have been effectively mitigated to seismically strengthen existing structures.

Damage in Anchorage from the 1964 Mag 9.2 Alaska earthquake.

In this activity, learners conduct collaborative research to better understand various factors that control damage experienced by the built environment of our communities during an earthquake. Learners identify ways to better prepare the built environment for future earthquakes and create more resilient communities.

### Essential Questions:

- Why do some buildings and infrastructure become damaged from an earthquake?
- What particular vulnerabilities exist in the built environment of my community?

### Goals

- Describe how various **factors** (list below) relate to hazards experienced during earthquakes within parts of the built environment (**topics**, list below)
- Identify a community preparedness vulnerability, challenges & constraints, and possible solutions
- Outline how the challenges & constraints impact decision-making and implementation of solutions

### Factors

A. Construction Design & Materials
B. Location site for geologic hazards
C. Zoning Ordinances & Building Codes
D. City & Community Emergency Planning
E. Personal, Family & Neighborhood Planning
F. Emergency Notifications & Communication
G. Vulnerable Populations

### Topics

1. Residential Housing
2. Public Buildings (i.e., schools, stores, hospitals)
3. Infrastructure (i.e., roads, bridges, cell towers)
4. Utilities (i.e., power grid, water & wastewater)
5. Hazardous Materials (i.e., fuel storage)

### Materials

- Included in this PDF: ***Topic & Factor Cards, Student Research Notes Packet, Student Summary Sheet, Rubric***
- ***Slideshow***, ***Resources for Research***, and editable Word versions of handouts and rubric can be accessed at https://serc.carleton.edu/account/loginout.php?return_url=/ANGLE/educational_materials/activities/245161.html
- ***Related IRIS Animation*** - Buildings in Earthquakes: How does construction affect the intensity of shaking that you feel? https://www.youtube.com/watch?v=UVZyYbs76HM

### NGSS Science Standards

- **HS-ESS3-1** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity
- **ESS3.B Natural Hazards**. Natural hazards and other geologic events have shaped the course of human history; they have significantly altered the sizes of human populations and have driven human migrations

# Teacher Background & Instructions

## Implementation Suggestions:

***Pacing***: Suggested time for the full activity is four learning sessions. Options for condensing the activity include skipping the jig saw (don't regroup learners by factor-experts), and skipping the in-class group presentations.

If you only have one learning session, use the slideshow and video to provide an overview of the factors (A-G) and how the factors impact various aspects of the built environment (housing, infrastructure, etc.), then lead a class discussion and/or assign students an independent research task.

***Grouping***: Learners are grouped by topic, but some topics are so large that instructors may choose to create multiple groups for the same topic (i.e., infrastructure could have separate groups on bridges & roads, water & wastewater, and power grids).

***Resource Selection***: Resources for research are provided in regional guides (for Alaska, California, and the Pacific Northwest). Resources vary in their scope and complexity, and not all factors are addressed in each resource. Preview the resources and consider the capabilities of your learners and allotted time frames when making selections. Some resources may be printed, but providing digital access on devices is recommended.

***Connecting Your Classroom***: This activity can be shared using the Community Connection protocol, where learners in one community compare what they have discovered in their region with another group of learners living in earthquake country. The protocol is outlined at https://serc.carleton.edu/ANGLE/educational_materials/activities/246809.html

## Instructional Sequence:

**Step 1**: Engage learners using a recent or impactful historic earthquake event from your region, and/or discuss the active faults in the area.

**Step 2**: Use the slideshow to introduce the factors and topics (see lists on p. 1). Give an overview of how the factors and topics interrelate. Discuss the implications to communities when damage and disruption occurs to the built environment. Consider how awareness and better application of the factors could contribute to increased resilience within communities.

**Step 3:** Create student groups, based on the topics. Each group will research all seven factors. The Topic & Factor Card Deck can be used to communicate topic/factor assignments to learners, and may be helpful for reassigning groups during the jig saw.

Distribute one Research Packet to each group and instruct the groups to distribute the notes pages to each factor expert. Ensure that every learner has one note sheet (if groups are not exactly 7 members, remove or provide extra factor-specific note sheets).

**Step 4**: Provide the resources students will use to conduct their research. Within each Topic group, Factor Experts take notes on the relevant facts & information, challenges & constraints, and possible solutions for taking proactive steps to resolve the identified challenges and constraints.

**Step 5**: Regroup learners to put Factor Experts together (with one expert from each topic group). Factor Experts bring their notes page to share and discuss with each other. This step allows learners to refine and deepen their understanding of the factor, finalizing the constraints and solutions section of their notes page.

**Step 6**: Learners return to the Topic groups. Each Factor Expert provides a summary of their findings. The group discusses the factors, and 1) identifies one primary problem that earthquakes pose to their Topic, 2) defines the main challenges and constraints related to the problem, and 3) chooses one possible solution, or proactive step, that could be taken to mitigate the problem.

**Step 7**: Topic groups create a presentation to summarize the community vulnerability they have identified, and their proposed solution. In their presentation, groups identify and describe the ~3 of the factors that are most critical and relevant to contextualize the problem. In addition, presentations should outline how the challenges and constraints impact decision-making and implementation of solutions (e.g., financial pressures, policy, political will, limitations in knowledge or technology).

**Step 8**: Topic groups present their findings. Distribute the Student Summary Sheet handout to all learners, and instruct them to take notes during the presentation, summarizing key points and ideas.

**Step 9:** Wrap up the activity with a class discussion, using the Student Summary Sheets. Allow students to share their biggest take-aways. What are the greatest vulnerabilities to our community due to earthquakes? What can our community do to become better prepared? Have students keep the summary sheet to use as the engagement exercise if you plan to do the *Geologic Hazards Community Action Plan* capstone project.

When printed 2-sided, card set has
35 unique cards (5 topics, 7 factors)

Create 5 topic groups and distribute one topic card to each group member. Remove selected factor cards for groups that have less than 7 members.

Topic 1 Residential Housing

Topic 1 Residential Housing

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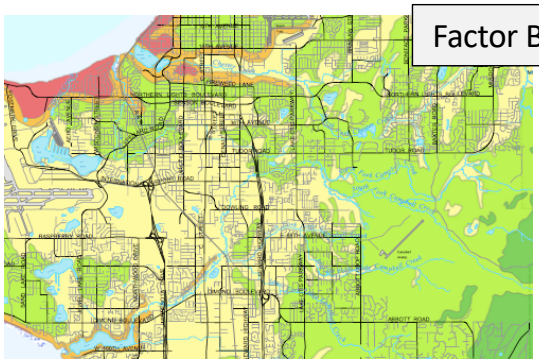
Topic 1 Residential Housing

## Construction Design and Materials

Factor A

## Location Site for Geologic Hazards

Factor B



## Zoning Ordinances / Building Codes

Factor C

## City/Community Emergency Planning

Factor D

## Personal, Family & Neighborhood Emergency Planning

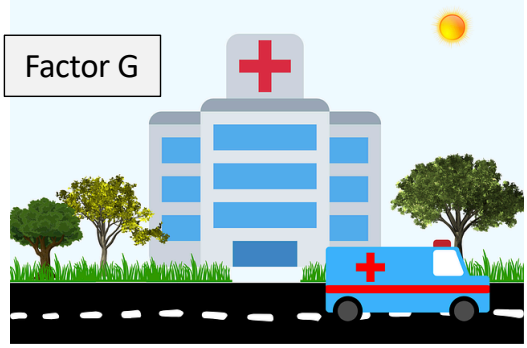
Factor E

## Emergency Notifications & Communication

Factor F

## Vulnerable Populations

Factor G



Topic 2 Public Buildings

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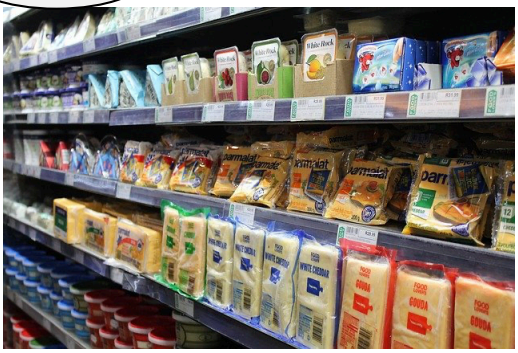

Topic 2 Public Buildings

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## Construction Design and Materials

Factor A

## Location Site for Geologic Hazards

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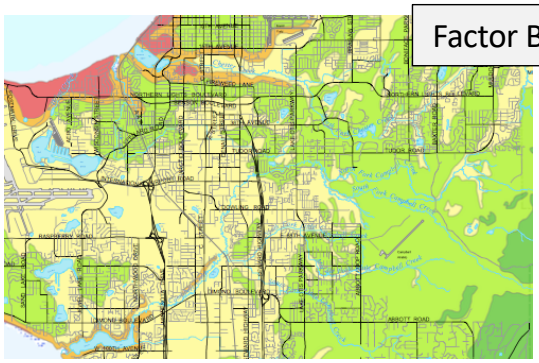

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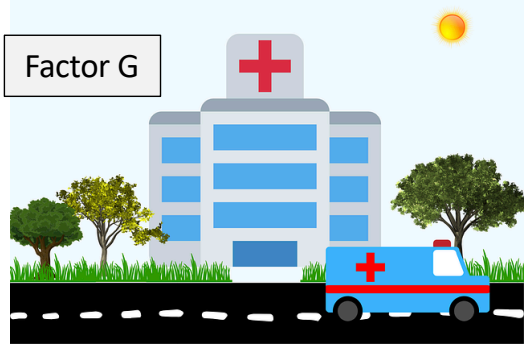
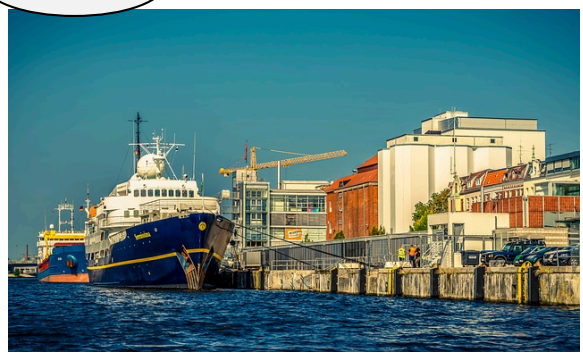


Topic 3 Infrastructure



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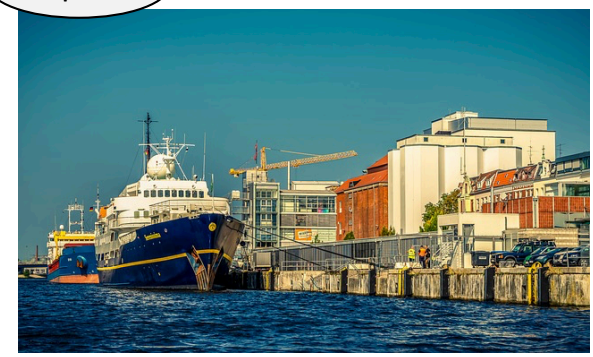

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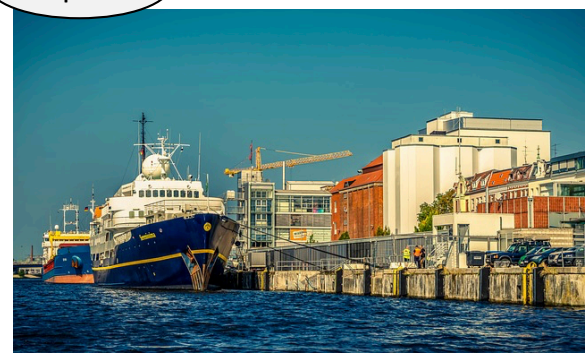

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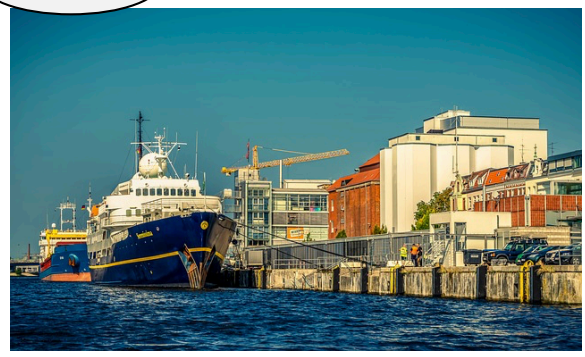

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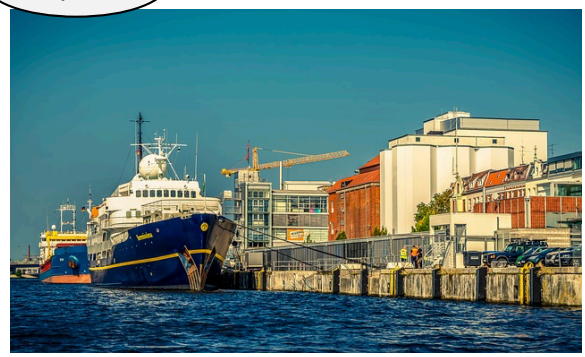

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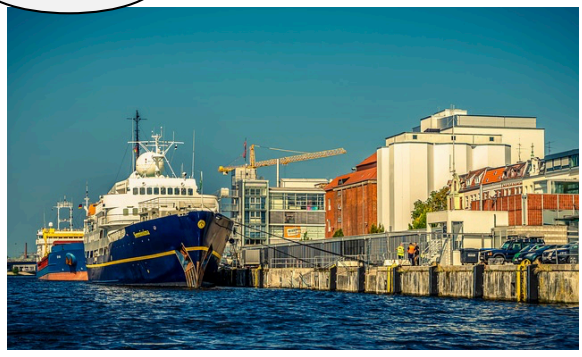

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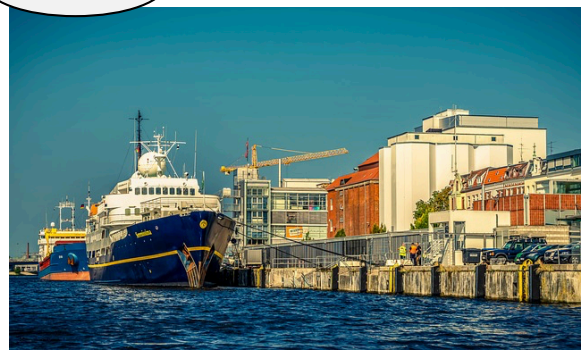
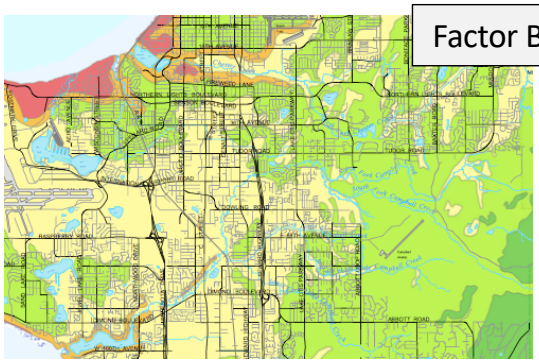


## Construction Design and Materials

Factor A

## Location Site for Geologic Hazards

Factor B



## Zoning Ordinances / Building Codes

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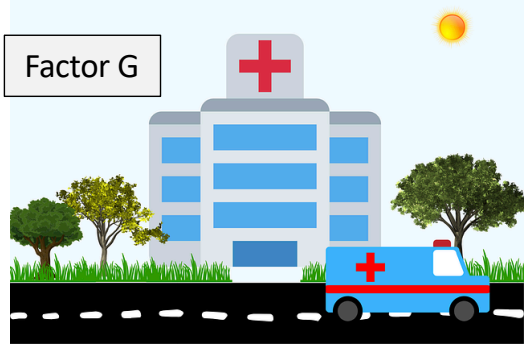
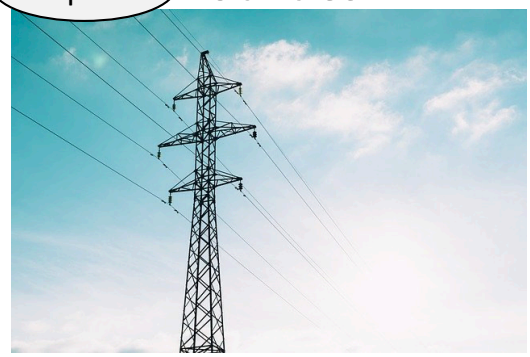


Topic 4 Utilities



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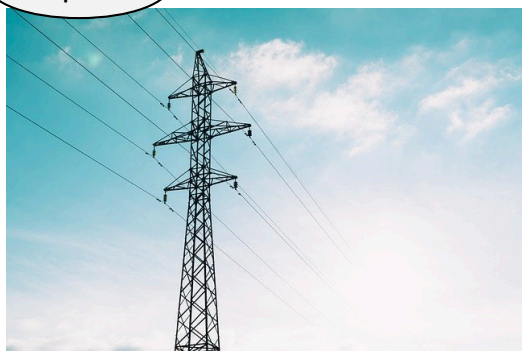

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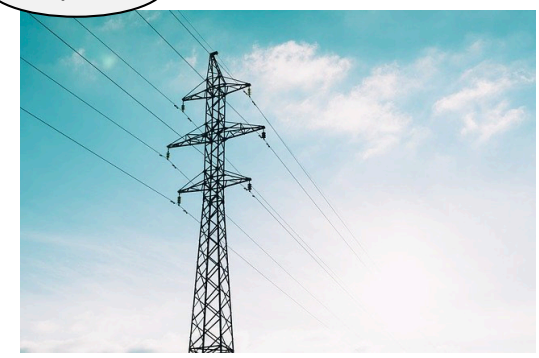

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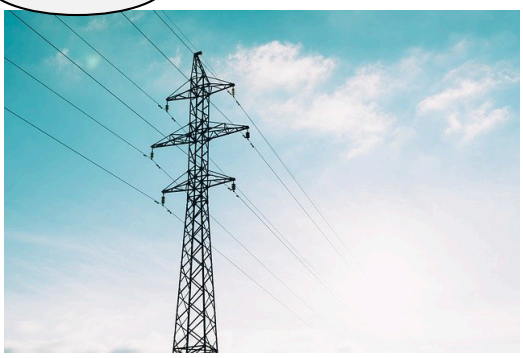

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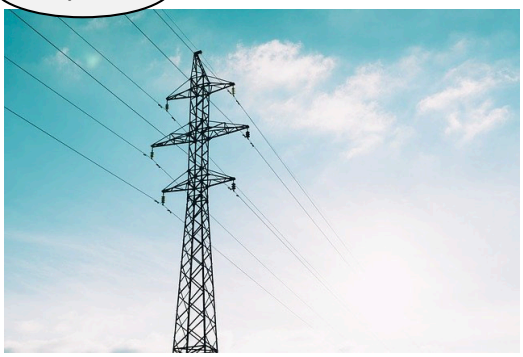

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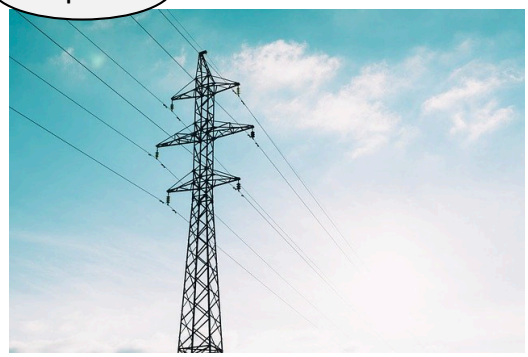

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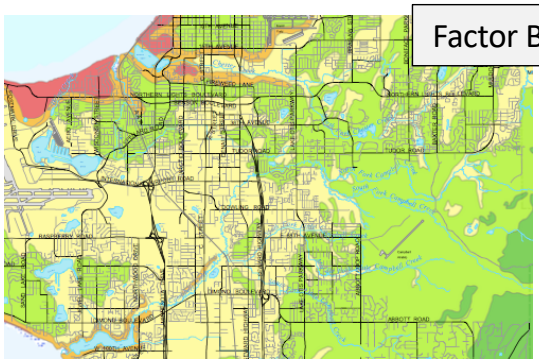

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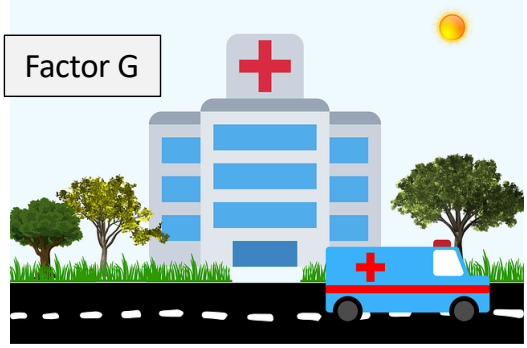

Topic 5 Hazardous Materials

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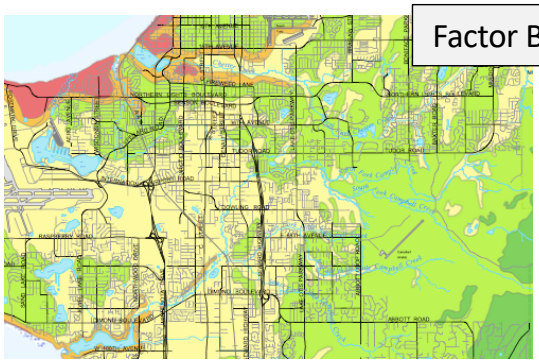

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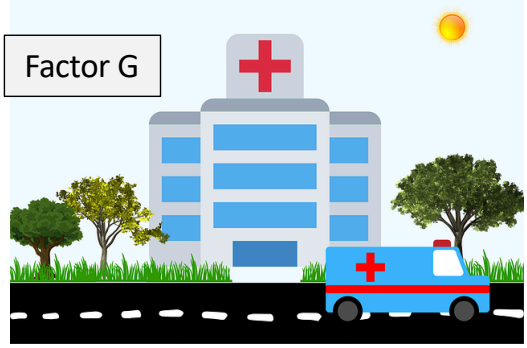

Name _____ Group: ____ Period :____ Date:_____

# Geologic Hazards and the Built Environment

Student Research Notes Packet

In this activity, we will look at hazards that earthquakes pose to the human-made physical spaces where we live including buildings, public spaces, roads, utilities and other infrastructure.

Hazards may come from geologic factors that cause increased ground motion and shaking due to the nature of underlying soils, liquefaction, landslides, and faulting. Hazards may also be caused by the way buildings and structures were designed, and constructed as well as the choice of construction materials used. We will also explore ways to better prepare the built environment for future earthquakes and create more resilient communities.

Your **group** will be assigned one or more **topics** which are part of the built environment in our community. (residential housing, public buildings, infrastructure, utilities, communication, hazardous materials)

**Each group member** will research on of the **factors** that affect your topic(s). (construction design & materials, location site for geologic hazards, zoning ordinances/ building codes, city/community emergency planning, preparedness planning, emergency notifications & communication, vulnerable populations) Resources will be provided for your research.

**Brief instructions for activity:**

- Work as a team to do research - each group member will focus on a different factor, to become the "factor expert."
- Factor experts from all topic groups will meet to share knowledge
- Topic groups reconvene to finalize constraints/solutions
- Topic groups work together to create the final presentation

**Final Presentation:** each group creates a presentation based on their built environment topic which identifies a problem/issue/risk and includes the following elements. Refer to the scoring rubric for more information on how the project will be evaluated.

- State the preparedness issue or problem related to your topic
- Provide a visual presentation related to the problem and topic that includes a minimum of 3 visuals (photos, graphs, etc.)
- Identify and describe ~3 of the factors that are most critical and relevant to contextualize the problem
- Identify challenges and constraints related to the factors
- Cite resources used
- Provide possible solutions for taking proactive steps to resolve the identified challenges within the constraints
- Make an argument about how the challenges and constraints impact decision-making and implementation of solutions (probable themes include: financial, policy/enforcement of building codes/ordinances, political will, knowledge and information available, additional research needed)
- Make sure that teamwork is evident

**Topic**: _____ Group member: _____

**Factor** affecting your topic: **A** - **Construction Design and Construction Materials**

Use the list of resources provided by your instructor. *Cite your sources!*

| | |
|---|---|
| Factor facts<br><br>Relevant facts about factors affecting your topic.<br><br>Cite resource, and page number | |
| Challenges/ constraints for this factor | |
| Suggested resolutions and resources for this factor | |

**Topic**: _____ Group member: _____

**Factor** affecting your topic: **B** - **Location Site for Geologic Hazards**

Use the list of resources provided by your instructor. *Cite your sources!*

| | |
|---|---|
| Factor facts<br><br>Relevant facts about factors affecting your topic.<br><br>Cite resource, and page number | |
| Challenges/ constraints for this factor | |
| Suggested resolutions and resources for this factor | |

**Topic**: _____ Group member: _____

**Factor** affecting your topic: **C - Zoning Ordinances and Building Codes**

Use the list of resources provided by your instructor. *Cite your sources!*

| | |
|---|---|
| Factor facts<br><br>Relevant facts about factors affecting your topic.<br><br>Cite resource, and page number | |
| Challenges/ constraints for this factor | |
| Suggested resolutions and resources for this factor | |

**Topic**: _____ Group member: _____

**Factor** affecting your topic: **D - City and Community Emergency Planning**

Use the list of resources provided by your instructor. *Cite your sources!*

| | |
|---|---|
| Factor facts<br><br>Relevant facts about factors affecting your topic.<br><br>Cite resource, and page number | |
| Challenges/ constraints for this factor | |
| Suggested resolutions and resources for this factor | |

**Topic**: _____ Group member: _____

**Factor** affecting your topic: **E - Personal, Family, and Neighborhood Planning**

Use the list of resources provided by your instructor. *Cite your sources!*

| | |
|---|---|
| Factor facts<br><br>Relevant facts about factors affecting your topic.<br><br>Cite resource, and page number | |
| Challenges/ constraints for this factor | |
| Suggested resolutions and resources for this factor | |

**Topic**: _____ Group member: _____

**Factor** affecting your topic: **F - Emergency Notifications and Communication**

Use the list of resources provided by your instructor. *Cite your sources!*

| | |
|---|---|
| Factor facts<br><br>Relevant facts about factors affecting your topic.<br><br>Cite resource, and page number | |
| Challenges/ constraints for this factor | |
| Suggested resolutions and resources for this factor | |

**Topic**: _____ Group member: _____

**Factor** relating your topic: **G - Vulnerable Populations**

Use the list of resources provided by your instructor. *Cite your sources!*

| | |
|---|---|
| Factor facts<br><br>Relevant facts about factors affecting your topic.<br><br>Cite resource, and page number | |
| Challenges/ constraints for this factor | |
| Suggested resolutions and resources for this factor | |

Name: _____ Period:_____ Date:_____

**Geologic Hazards and the Built Environment – Topic/Factor Student Summary Sheet**
*Community Resilience: How can we prepare our communities for earthquakes?*

**Explain the role each Factor** plays in earthquake preparedness planning:

- A - Construction design and construction materials
- B - Location site for geologic hazards
- C - Zoning ordinances and building codes
- D - City & community emergency planning
- E - Personal, family, and neighborhood planning
- F - Emergency notifications and communication
- G - Vulnerable populations

| Topics | Challenges | Possible Solutions |
|---|---|---|
| **Residential Housing**<br>*Single family homes, condos, apartments, etc.* | | |
| **Public Buildings**<br>*Fire/police, schools, grocery stores, clinics and hospitals.* | | |
| **Infrastructure**<br>*Bridges, roads, cell towers, marine port, airport and rail lines.* | | |
| **Utilities**<br>*Power grid, natural gas, fresh and wastewater.* | | |
| **Hazardous Materials**<br>*Fuel storage, waste, etc.* | | |

**Geologic Hazards and the Built Environment**

Student Project Scoring Rubric

Refer to the Student Research Notes Packet for project requirements.

| Criteria | Points Possible |
|---|---|
| **Content**<br>● Preparedness issue or problem related to topic is identified<br>● Describe ~3 of the factors that are most critical and relevant to contextualize the problem<br>● Identify challenges and constraints related to the factors<br>● Provide possible solutions for taking action to resolve the challenges and constraints<br>● Outline an argument about how the challenges and constraints impact decision-making and implementation of solutions<br>● Notes, oral and visual presentation information is accurate & relevant<br>● Information has been analyzed and synthesized from several sources<br>● Sources are relevant and credible<br>● A good understanding of the topic is evident<br>● Team members all participated | **7** – all criteria met well<br>**6** – all criteria met adequately, and/or one not met<br>5 - most criteria met adequately, and/or two not met<br>4 –some criteria quality is insufficient<br>**3** –some criteria not met, and/or quality is insufficient<br>**2** – many criteria not met<br>**1** – most criteria not met |
| **Written Elements - notes and visual presentation**<br>● Notes provide sufficient relevant information from several sources<br>● Sources are properly cited and referenced<br>● Written portions of the visual presentation are relevant, concise, logical, and informative<br>● Provide group member's name and group and period # for notes<br>● All team members participated | **5** – all criteria met well<br>**4** – all criteria met adequately, and/or one not met<br>**3** –some criteria not met, and/or quality is insufficient<br>**2** – many criteria not met<br>**1** – most criteria not met |

*Continued on the next page*

**Geologic Hazards and the Built Environment**

Student Project Scoring Rubric

*Continued from previous page*

| Criteria | Points Possible |
|---|---|
| **Visual Presentation Elements**<br>● Title clearly identifies topic<br>● Visual presentation is neat and well laid out<br>● Enough visuals were provided to communicate the essential content<br>● Pictures and graphics are relevant to the topic and clarify information<br>● Content is easy to interpret<br>● Written portions of the visual presentation are easy to read by an audience<br>● Provide group member's names and period<br>● All team members participated | **5** – all criteria met well<br>**4** – all criteria met adequately, and/or one not met<br>**3** –some criteria not met, and/or quality is insufficient<br>**2** – many criteria not met<br>**1** – most criteria not met |
| **Oral Presentation Elements**<br>● Presenters make eye contact, stand facing audience and not blocking visual presentation<br>● Presenters speak clearly and loudly enough to be heard<br>● Presenters show energy and enthusiasm for the topic<br>● Presenters explain content at an appropriate scientific level for the audience<br>● Presenters answer questions thoroughly and check for understanding<br>● All team members participated | **5** – all criteria met well<br>**4** – all criteria met adequately, and/or one not met<br>**3** –some criteria not met, and/or quality is insufficient<br>**2** – many criteria not met<br>**1** – most criteria not met |
| **Group Audience Participation**<br>● Shows interest in other presentations<br>● Listens attentively to presenters<br>● Asks thoughtful questions | **3** – all criteria met<br>**2** – some criteria not met<br>**1** – missed one presentation<br>**0.5** – many criteria not met<br>**0** – missed all presentations |
| **Total** | **out of 25** |