## 38-2 Potential Hazards.

### A. Surface-Fault Ruptures

Surface faulting has been identified as a potential hazard in Weber County. Maps have been produced delineating the known area where a hazard may exist from surface fault ruptures. Broad subsidence of the valleys accompanying surface faulting may affect areas several miles away from the fault. These effects are not considered here, but are covered below in Subsection B.

Studies along the Wasatch fault have indicated that during a "characteristic" earthquake which produces surface faulting, offsets of six (6) feet or more may occur on the main trace of the fault zone. This offset will result in formation of a near-vertical scarp, generally in unconsolidated surficial deposits, that begins to ravel and erode back to the material's angle of repose (33-35 degrees) soon after formation. Antithetic faults west of the main trace may also form, generally exhibiting a lesser amount of offset, but sometimes as much as several feet. The zone between these two faults may be complexly faulted and tilted with offset along minor faults of several inches or more.
Based upon this data, it is difficult, both technically and economically, to design a structure to withstand six (6) feet or more of offset through its foundation. Thus, avoidance of the main traces of the fault is the principal risk reduction technique that can be reasonably taken.

No critical facility or structure for human occupancy shall be built astride an active fault. In some areas adjacent to the main trace but still within the zone of deformation, avoidance may not be necessary. Less damaging (smaller) offsets of less than 4 inches, and tilting may occur and structural measures may be taken to reduce casualties and damage. However, structural damage may still be great, and buildings in the zone of deformation may not be safe for occupants following a large earthquake.

Due to the scale used to map these zones, there is not enough detail to delineate all fault traces and zones of deformation at a particular location, therefore, site specific plans and studies shall be required for development in or adjacent to the delineated areas.

Upon submittal, review and Planning Commission approval of site specific plans and studies with recommendations, produced by a qualified engineering geologist, setbacks shall be a minimum of 50 feet from an active fault trace. A reduction in the setback will be considered if the report presents evidence to justify a reduction acceptable to the Planning Commission.

### B. Landslide/Tectonic Subsidence

#### 1. Landslide:

Landslides, historically, have been one of the most damaging geologic processes occurring in Weber County. Most active landslides, and most older slides, have been mapped and are shown on the Sensitive Lands Overlay District maps. These designations serve as an indication of unstable ground. The maps designate areas of landslides and slopes which are potentially unstable under static (non-earthquake) conditions, and are especially vulnerable under conditions of high to abnormally high precipitation. Landslides can damage structures, roads, railroads and power lines. Furthermore, landslides may rupture canals, aqueducts, sewers and water mains, all of which can add water to the slide plane and promote further movement. Flooding may also be caused.

Many methods have been developed for reducing landslide hazards. Proper planning and avoidance is the least expensive measure, if landslide-prone areas are identified early in the planning and development process. Care in site grading with proper compaction of fills and engineering of cut slopes is a necessary follow-up to good land use planning. Where avoidance is not feasible, various engineering techniques are available to stabilize slopes, including de-watering (draining), retaining structures, piles, bridging, weighting or buttressing slopes with compacted earth fills and drainage diversion. Since every landslide and unstable slope has differing characteristics, any development proposed within a designated landslide hazard area, as delineated on the

Sensitive Lands Overlay District maps, shall require the submittal, review and approval by the Planning Commission, of specific site studies, including grading plans, cut/fill, and plans produced by a qualified engineering geologist and a Utah licensed Geotechnical Engineer. The site specific study shall address slope stability (including natural or proposed cut slopes), evaluate slope-failure potential, effects of development and recommendations for mitigative measures. Slope stability analysis shall include potential for movement under static, development-induced and earthquake-induced conditions as well as likely ground water conditions.

**2. Tectonic Subsidence**

Tectonic subsidence, also called seismic tilting, is the warping, lowering and tilting of a valley floor that accompanies surface-faulting earthquakes on normal (dip slip) faults such as the Wasatch fault zone. Inundation along the shores of lakes and reservoirs and the ponding of water in areas with a shallow water table may be caused by tectonic subsidence. Certain structures which require gentle gradients or horizontal floors, particularly wastewater treatment facilities and sewer lines may be adversely affected.

Because subsidence may occur over large areas (tens of square miles), it is generally not practical to avoid the use of potentially affected land except in narrow areas of hazard due to lake shoreline flooding. For gravity-flow structures such as wastewater treatment facilities that are within areas of possible subsidence, it is advisable to consider the tolerance of such structures to slight changes in gradient. Some structures may have to be releveled after a large-magnitude earthquake. Critical facilities which contain dangerous substances should have safety features to protect the structure, its occupants and the environment from both tilting and flooding.

Flooding problems along lakes from tectonic subsidence shall be reduced using standard techniques such as raising structures above expected flood levels and dikes can be built. Development adjacent to lakes or reservoirs shall be prohibited within 3 feet of elevation above projected lake levels to protect against natural rises from wet periods, storm waves and earthquake induced seiching, as well as hazards associated with tectonic subsidence.

Rises in the water table accompanying tectonic subsidence may cause water to pond, flood basements and disrupt buried facilities in areas of shallow ground water adjacent to the fault on the down dropped side.

The principal application of the identified tectonic subsidence areas is to make the public aware of the hazard and to indicate those areas where further study may be necessary. Site specific Tectonic Subsidence Studies are recommended only for critical facilities in areas of potential lake-margin and ponded shallow ground water flooding. However, certain vulnerable facilities such as high cost wastewater treatment plants and hazardous waste facilities should also consider potential tilting.

**C. Rock Fall**

Rock falls are a naturally occurring erosional process in mountain areas in Weber County. As development advances higher onto the bench areas and into the canyons the risk from falling rocks becomes greater. A primary mechanism responsible for triggering rock falls is water in outcrop discontinuities. Rock falls present a hazard because of the potential damage a large rock mass, traveling at a relatively high velocity, could cause to structures and personal safety. Buildings shall be located so that structures are not positioned in an area susceptible to rock falls. When new developments cannot be designed around a rock fall path, and hazard reduction measures must be considered, a site specific plan and hazard study, with recommendations for mitigation, shall be produced by a qualified engineering geologist, submitted for review and approval by the Planning Commission. Mitigation may require design by a Utah licensed geotechnical engineer, and may include rock stabilization techniques such as bolting, cable lashing, burying, and grouting discontinuities, removal or break-up of potential rock clasts, as well as deflection berms, slope benches, and rock catch fences to stop or at least slow down falling rocks. Strengthening a structure to withstand impact is an example of modifying what is at risk. Mitigation problems can arise when rock source areas are located on land not owned by the developer.

In areas where the rock fall hazard is present but very low, disclosures of potential hazards to land owners and residents with an acknowledgment of risk and willingness to accept liability may be an acceptable alternative to avoidance or mitigation for single family residences.

**D. Debris Flows**

Debris flows are mixtures of water, rock, soil and organic material (70-90 % solids by weight) that form a muddy slurry much like wet concrete and flow down slope, commonly in surges or pulses, due to gravity. They generally remain confined to stream channels in mountainous areas, but may reach and deposit debris over large areas on alluvial fans at and beyond canyon mouths.

The Weber County Debris Flow Hazard Maps were constructed from the boundaries of active alluvial fans and areas with slopes steeper than 30 percent. Any proposed development in areas identified as debris flow hazard areas shall be evaluated prior to approval of the proposed development.

1. A study shall be prepared by an Engineering Geologist for any development proposed in or adjacent to a Debris Flow Hazard area and shall include:

   a. An analysis of the past history of debris flow at the site based on subsurface exploration to determine the nature and thickness of debris flow and related alluvial fan deposits.

   b. An analysis of the drainage basin's potential to produce debris flows based on the presence of debris slides and colluvium-filled slope concavities, and an estimate of the largest probable volumes likely to be produced during a single

   c. An analysis of the stream channel to determine if the channel will supply additional debris, impede flow, or contain debris flows in the area of the proposed development.

   d. An analysis of man-made structures upstream that may divert or deflect debris flows.

   e. Recommendations concerning any channel improvements, flow modifications and catchment structures, direct protection structures or flood proofing measures, if necessary, in order to protect the development.

   f. Upon approval of the County Engineer, the report shall be presented to the Planning Commission along with review comments for recommendation of approval by the County Commission.

**E. Liquefaction Areas**

Earthquake ground shaking causes a variety of phenomena which can damage structures and threaten lives. One of these is termed soil liquefaction. Ground shaking tends to increase the pressure in the pore water between soil grains, which decreases the stresses between the grains. The loss of intergranular stress can cause the strength of some soils to decrease nearly to zero. When this occurs, the soil behaves like a liquid. When liquefaction occurs, foundations may crack, buildings may tip, buoyant buried structures such as septic tanks and storage tanks may rise, and even gentle slopes may fail as liquefied soils and overlying materials move down slope.

Areas of potential liquefaction have been delineated and the following regulations and mitigation measures have been adopted in order to reduce the hazard and consequences. Areas of moderate to high liquefaction potential need not be avoided. Structural measures and site modification techniques are available to reduce hazards.

1. A site specific liquefaction study shall be required to be prepared, and shall be prepared by an engineering geologist and/or a Utah licensed geotechnical engineer.

   a. Standard soil foundation study, for the proposed development, shall include liquefaction potential evaluation based upon depth to groundwater, soil types and ground failure hazard.

   b. If liquefiable soils are present, standard penetration tests and/or cone penetration tests shall be required to determine critical accelerations needed to induce liquefaction.

   c. Report shall include accurate maps of the area showing any proposed development, the location of bore holes and/or test pits, the site geology, and location and depths of any liquefiable soils noted, along with the probability of critical accelerations needed to induce liquefaction in these soils being exceeded for appropriate time periods.

   d. The report shall include recommendations for hazard reduction techniques.

   e. The County Engineer shall concur with the scope of the report, techniques and methodology to be used in the preparation of the report and shall have input as to the specific types of information to be included in the report.

**F. Flood (See also Chapter 33, Flood Plain Overlay Zone FP-1)**

1. The flood plain standards are written to minimize the loss of life and property when floods do occur, not to ban development outright from the flood plain. The Federal Emergency Management Agency (FEMA) has produced official flood plain maps, depicting areas of potential stream flooding for major drainages in Weber County. FEMA recommends that no new development be permitted in the 100 year flood plain unless:

   a. Detailed Engineering studies, prepared by a Utah-licensed engineer , show that the proposed development will not increase the flood hazard to other property in the area. Recommendations shall be made for flood proofing or other mitigation techniques for development within flood hazard areas. (Site investigations for proposed development in lake-flooding areas near Great Salt Lake need only indicate the site elevation. Development proposals in areas with elevations less than 4,218 feet will be reviewed with respect to lake-flooding potential and compatibility of proposed use)

   b. The proposed development is elevated above the 100-year flood base elevation.

   c. For federally-insured loans, flood insurance is purchased from a company participating with the Federal Insurance Administration or a like private carrier.

   d. Upon approval of the County Engineer, the report shall be presented to the Planning Commission along with review comments for recommendation of approval by the County Commission.

2. Alluvial fan flooding, which is not mapped under the FEMA program, may be a hazard on all active alluvial fans designated on the debris flow hazard maps. The hazard from such flooding shall be addressed and appropriate hazard reduction measures taken. 2001-16

3. Sheet flow. Certain areas of the Ogden Valley have been identified and mapped as areas of sheet flow flooding. The hazard from such flooding shall be addressed and appropriate hazard reduction measures taken. 2001-16

**G. Other Hazardous Areas**

As in many counties in the Western United States, development in Weber County is constrained by the presence of natural and man-made hazards. These hazards include avalanche, slope movement, soils categorized as having severe building limitations and slopes exceeding thirty percent (30%).

Not all hazardous sites and conditions have been identified in Weber County; however, development on those identified sites shall be permitted when projects are studied and designed by a qualified engineering geologist and a Utah Licenced civil engineer, architect and/or an engineering geologist and certified to withstand the potential hazard for which it is designed, and that the site is buildable and that the site is safe. This allows development on hazardous sites with the full acknowledgment of the property owner. The use of hazardous sites for open space is encouraged.