85-677

WATER FACT SHEET

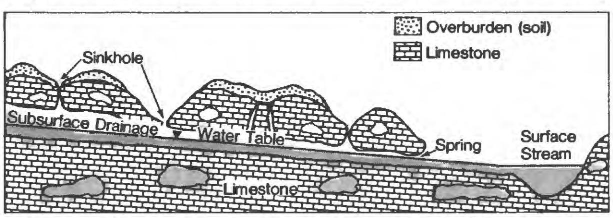
U.S. GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR

HYDROLOGIC HAZARDS IN KARST TERRAIN

NOTE: Figures on this Fact Sheet are two-dimensional and appear to show rocks and surficial material floating on cave streams. This was done to emphasize the concept of an open flow system. In reality, the third dimension would show the material above and below the cave streams to be connected in places.

WHAT IS KARST?

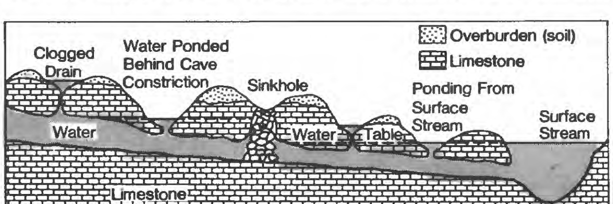
Karst or karst terrain refers to a type of topography formed in limestone, dolomite, or gypsum by dissolution of these rocks by rain and underground water, and is characterized by closed depressions or sinkholes, and underground drainage. During the formation of karst terrain, water percolating underground enlarges subsurface flow paths by dissolving the rock. As some subsurface flow paths are enlarged over time, water movement in the aquifer changes character from one where ground-water flow was initially through small, scattered openings in the rock to one where most flow is concentrated in a few well-developed conduits. As the flow paths continue to enlarge, caves may be formed and the ground-water table may drop below the level of surface streams; surface streams may then begin to lose water to the subsurface. As more of the surface water is diverted undergound, surface streams and stream valleys become a less conspicuous feature of the land surface, and are replaced by closed basins. Funnels or circular depressions called sinkholes often develop at some places in the low points of these closed basins.



SINKHOLE FLOODING

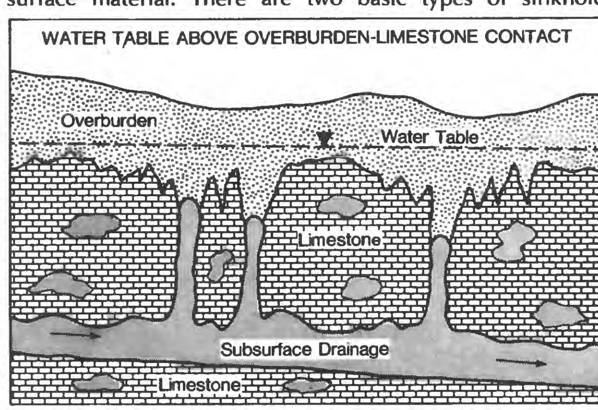
Ponding in sinkholes of surface runoff from storms is a part of the natural hydrologic system in karst regions. Ponding occurs during periods of intense rainfall when the rate of storm water runoff exceeds the drainage capacity of sinkholes. Water in underground conduits can back up into sinkholes when the rate of storm water inflow exceeds the drainage capacity of either the cave stream or the receiving surface stream.

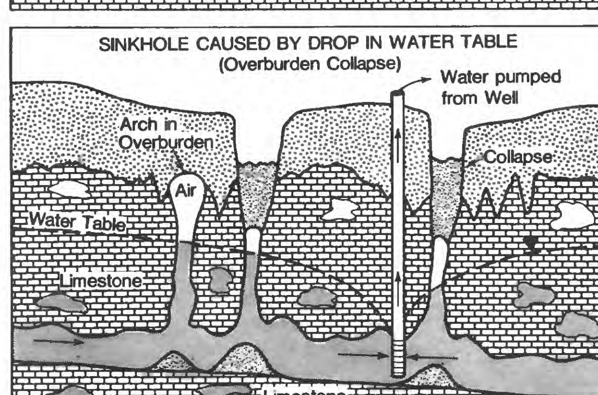
Urban structures are often built near sinkholes where flooding problems may be aggravated by (1) increased rates of runoff from impervious roofed or paved areas, (2) decreased storage due to sinkhole grading and filling, and (3) clogging of sinkhole drains by debris and silt.



HOW DO SINKHOLES DEVELOP?

Sinkholes develop as a result of the collapse of surface or near-surface material. There are two basic types of sinkhole-

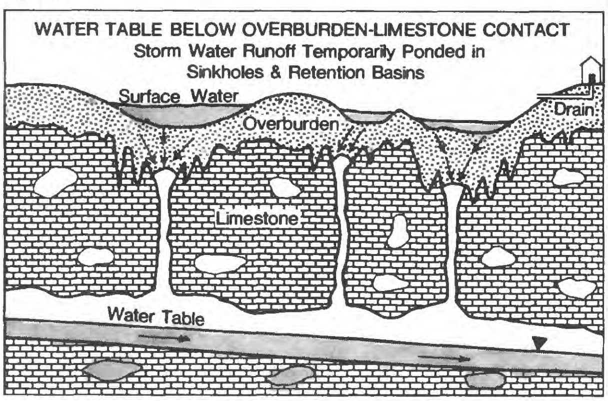


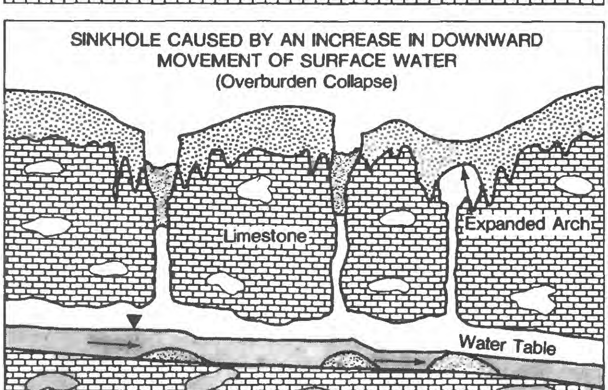


forming collapses: (1) limestone collapses and (2) overburden collapses into underlying limestone cavities. Limestone collapses generally occur due to the enlargement of cave passages in limestone. The enlargement causes the roofs above the passages to weaken and eventually collapse to create sinkholes. Overburden collapses are more common than limestone collapses and generally result in overburden slumping into openings or cavities in the underlying limestone.

In areas where the water table is usually above the overburden-limestone contact, collapses often occur when the water table drops below the overburden-limestone contact, either during droughts or during high-volume pumping. Phys- ically the collapses in this case are caused by loss of buoyant support for the overburden arches over openings in the limestone. Collapses are also caused by sloughing of saturated overburden down the opening, enlarging the arch, and eventually causing collapse at the land surface. When the water table fluctuates above and below the overburden-limestone contact, collapse may result from repeated wetting (swelling) and drying (shrinking) of material supporting overburden arches.

Overburden collapses also may occur in situations where the water table is usually below the overburden-limestone contact. Construction and land use changes that concentrate surface runoff in drains and impoundments may locally increase the downward movement of water resulting in slumping of saturated overburden into openings in the limestone. Loading of the surface by structures or ponded water, or vibrating the surface by blasting may also occasionally cause the collapse of overburden arches.





Although sinkhole-forming collapses occur naturally, many are induced by pumping or by constructing facilities that alter surface drainage. Collapses cause millions of dollars in damages each year to reservoirs, roads, buildings, and homes. In most States, losses are not usually covered by homeowners insurance policies.

GROUND-WATER CONTAMINATION

Shallow aquifers in karst terrains are extremely vulnerable to contamination. The aquifers receive water either by percolation through the soil or by concentrated flow directly into the aquifer from sinkholes and disappearing streams. In many karst areas, subsurface streams are simply surface streams that, after disappearing underground, flow through subsurface conduits to reappear at springs where they become surface streams again. Because these underground streams flow at velocities commonly between 0.1 and 5 miles per day, contaminants may move in a shorter period of time than contaminants in aquifers that are unaffected by karst development.

Contaminants associated with agricultural activities, such as fertilizers, nitrate and bacteria from livestock waste, or organic compounds from pesticides, are potential problems in karst terrains. Contaminants associated with urban storm water runoff, such as lead, chromium, oil and grease, and bacteria from pet-animal wastes, may be a threat to people using water supplies in karst terrains and to cave aquatic life. Dye-tracing techniques have shown that septic tank effluent can travel through the thin soils that are characteristic of most karst terrains into the aquifer and to springs in only a few hours. Water samples collected at some springs following heavy rains contain bacteria that probably are derived from human wastes, indicating that recharge water flushes effluents from septic tank drain fields into the shallow limestone aquifer.

Contamination problems are aggravated in karst terrains by the common practice of disposing of soil and liquid wastes in sinkholes where they may be washed directly into the aquifer. The development and widespread use of hazardous materials has increased the threat from this practice.

Leaks, spills, or deliberate dumping of toxic or explosive chemicals are a particularly serious hazard for karst terrains. Chemicals that leak from buried tanks may be carried into conduits or caves below by percolating water following heavy rains. Most conduits or caves become completely water-filled at some downstream point forming natural traps for floating chemicals that accumulate against the ceiling. Not only are these materials a threat to water supplies and cave aquatic life, but, upon vaporizing, they may become highly concentrated in the cave atmosphere and rise through fractures in the overlying lime-stone to enter inhabited structures on the surface. Occasionally homes in urban areas must be evacuated because fumes in base-ments reach explosive levels.

The degree of contamination of shallow aquifers in karst terrain depends primarily upon whether these aquifers receive distributed or concentrated recharge, and upon the proximity and types of sources of contamination. Springs and water wells in karst terrain, if supplied entirely by distributed recharge through thick overburden or from sources distant from contaminated areas, may be free of contaminants and therefore excellent sources of potable water. However, many springs and water wells in karst terrain receive concentrated recharge from a nearby area where sources of contamination are present.

For additional information write to:

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