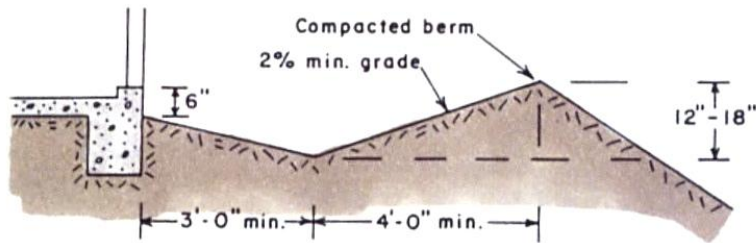
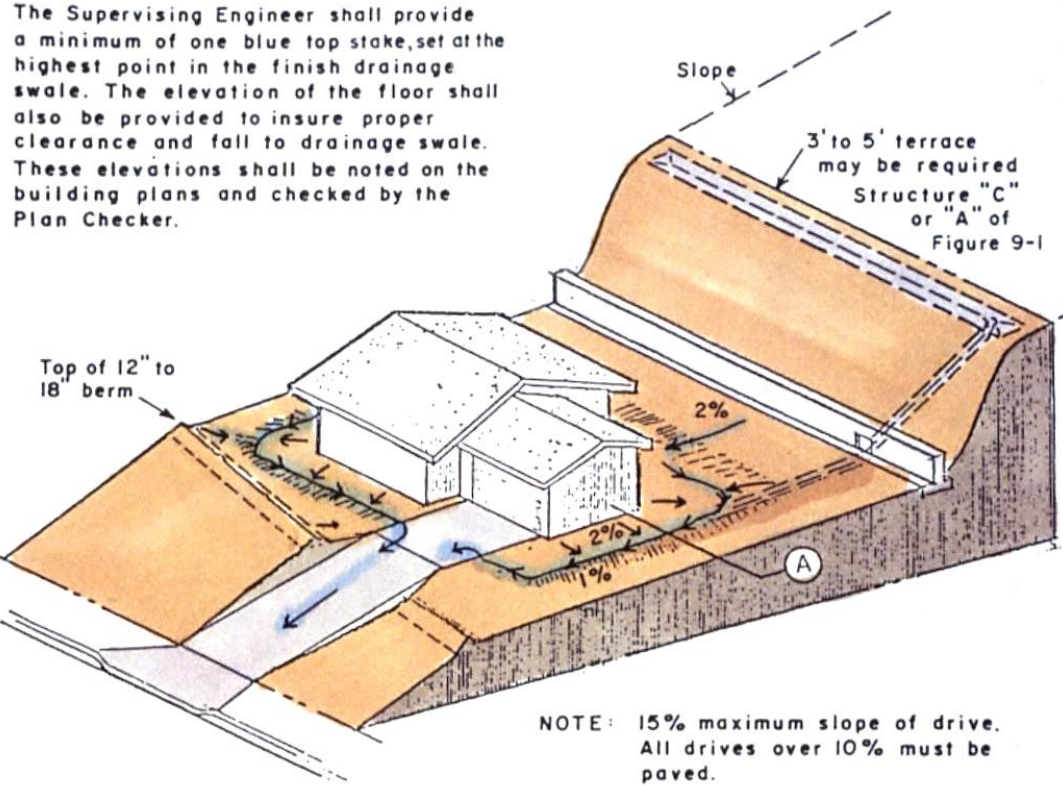


Part 3

**LOT
DRAINAGE**

The Supervising Engineer shall provide a minimum of one blue top stake, set at the highest point in the finish drainage swale. The elevation of the floor shall also be provided to insure proper clearance and fall to drainage swale. These elevations shall be noted on the building plans and checked by the Plan Checker.



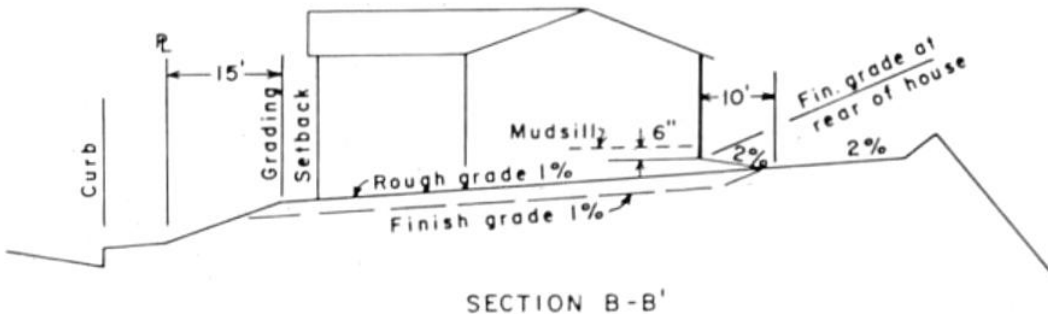
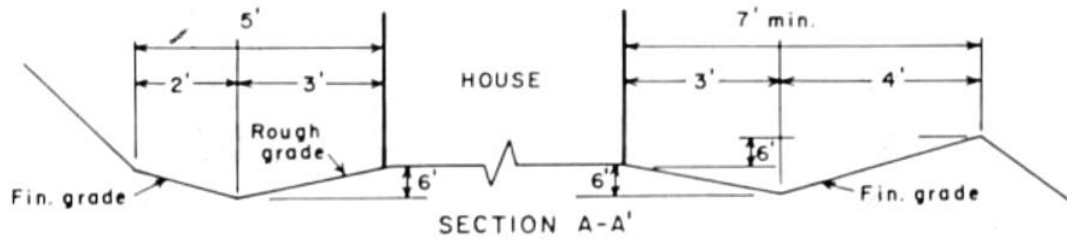
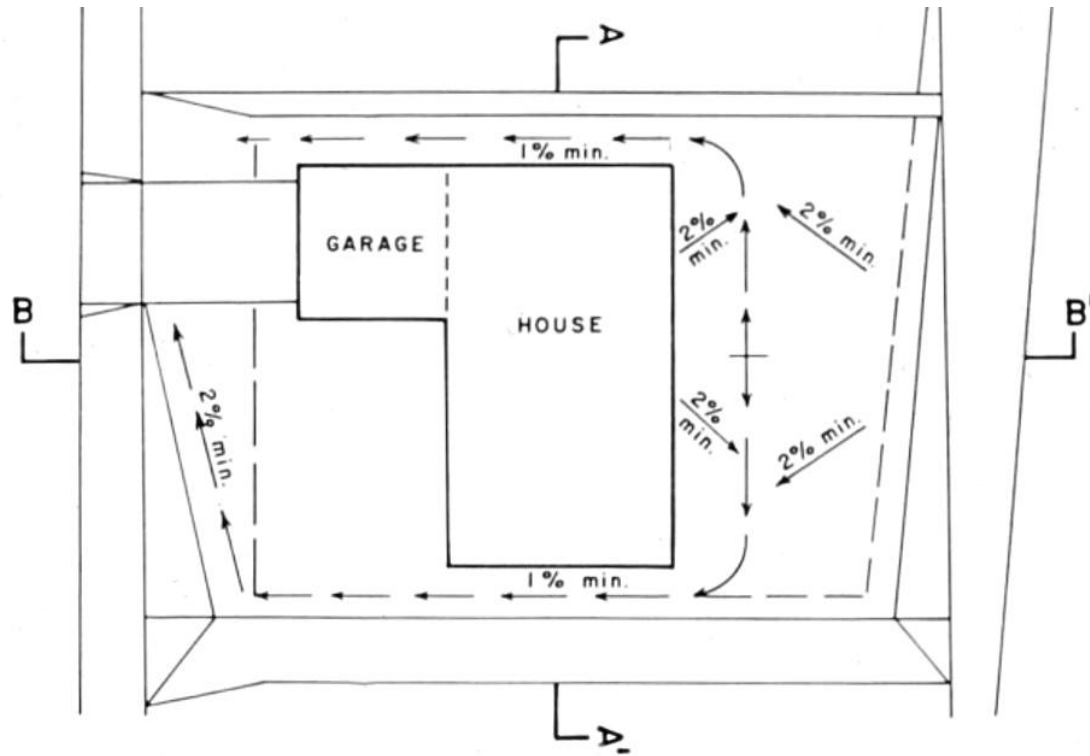
SECTION A-TYPICAL BERM AND SWALE

Where low sideyard area is less than 7' wide, drainage should be conducted to street in an improved device.

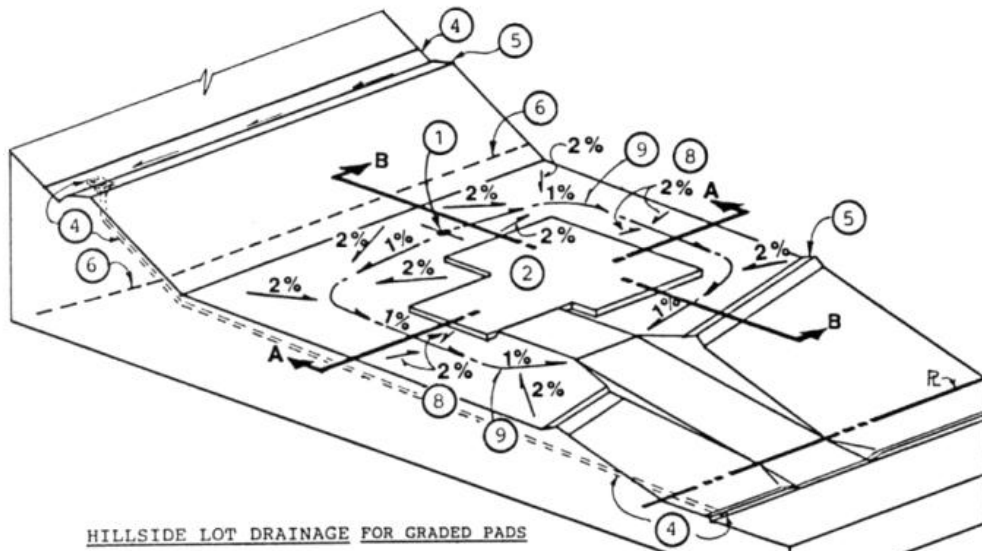
Common drainage swale may be used along sideyard property line where there is less than 1' difference in elevation between the lot pads.

Source: Redrawn from County of Orange, CA.

- **Lot Drainage** refers to the fine grading across a building pad and around structures so as to collect, convey and discharge surface waters in a controlled manner to prevent property damage

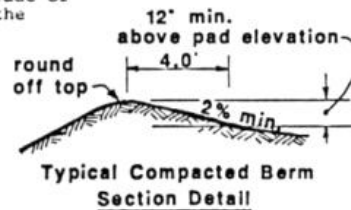


- Lot pads should be sloped at least 2% to promote drainage after grass takes root. Vegetation tends to build up root mats that inhibit runoff after several years, necessitating maintenance



HILLSIDE LOT DRAINAGE FOR GRADED PADS

- ① The Supervising Engineer shall provide a minimum of one blue top stake, set at the highest point in the finish drainage swale, (716-6.006(2)&(3)).
- ② The elevation of the floor shall be provided to insure proper clearance and fall to drainage swale, (U.B.C., sec.2907(a)).
- ③ These elevations, ① & ②, shall be noted on the building plans and checked by the Plan Checker, (716-4.1410(a)).
- ④ A 3' to 5' wide terrace will be required for slopes 25' high or higher, and an approved drainage system to an approved water course (716-8.610).
- ⑤ Provide a 12" to 18" high compacted berm, to protect top of cut or fill slopes, (716-8.610).
- ⑥ If no rear hill slope, provide a "Typical Berm" per detail section, of compacted fill. Finished grade of the top of the berm shall be 12" to 18" above the house pad elevation (716-8.610).



For SIDE YARDS, SECTION A-A, see sheet 2 and 3

For FRONT & REAR YARDS, SECTION B-B, see sheet 4

- Finish grading should address final grades around the structure footprint as well as the lot pad.
- Grades must be steep enough to allow for subsequent landscaping
- Grades of less than 2% should be paved or use piped conveyance



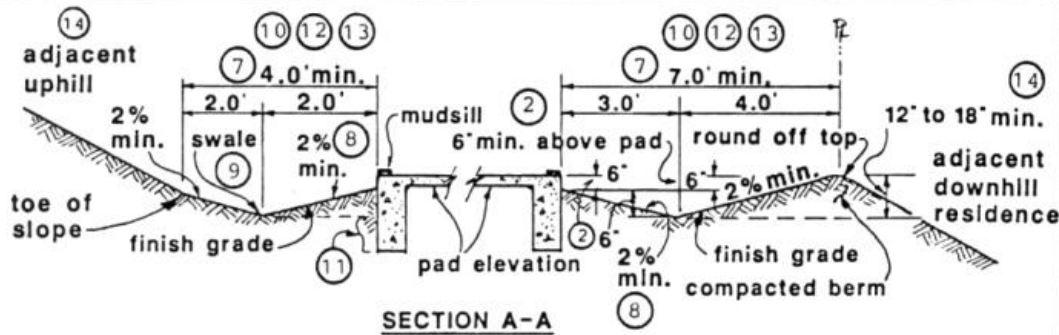
- **Example of offsite drainage leading towards a structure. In such cases substantive drainage improvements are usually needed to collect and convey the imposed discharge**



- **Be wary of situations where structures are placed below the grade of the adjoining street. Below-grade structures are very prone to drainage problems.**



- **When hardened surfaces, like driveways or sidewalks slope towards the structure slotted drains should be installed across the threshold to collect runoff.**



SIDE YARDS:

- 7 All building setbacks from slopes shall be in accordance with Danville Grading Code (716-8.422; 716-8.424):
"Building and Structures shall be set back from excavation or fill slopes a minimum of 4 feet plus one fifth the vertical height of the slope with a maximum of 10 feet" (716-8.422(c)).
- 8 At structure, sloping away from the structure, to be 2% slope minimum, (716-8.606).
- 9 All drainage swales around structure to be 1% min. slope, and drain toward the street (716-8.606).
- 10 Where there is a low side yard area, less than 7 feet wide, drainage should be conducted from backyard to front yard to the street via an improved drainage device (716-8.602).
- 11 In no case shall the flow line (bottom of swale) within 5 feet of a footing, be lower than the bottom of a footing.
- 12 The setback from the toe of a slope maybe reduced to 4' min. if an improved drainage device (i.e., concrete) is used (716-8.602).
- 13 When a stoop, fireplace, or portion of the building extends within the minimum established drainage setbacks, then a paved drainage swale, a catch basin and pipe, or other similar drainage device is required, (716-8.614).
- 14 Be sure all drainage of lot does not drain onto neighboring properties, and all drainage shall be conveyed to a storm drain or approved system (i.e., paved street, or natural creek), (716-8.604).

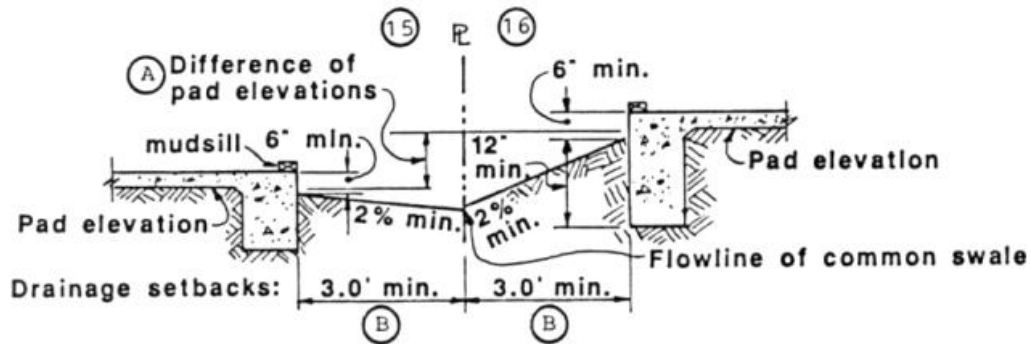
- Drainage swales should be provided adjacent to building foundations, to collect and convey runoff away from the building
- Such swales need to either be paved or maintained in perpetuity



- **Fill slopes should be constructed with crest berms (shown here) or paved interceptor ditches, with the lot pad sloped in the opposite direction (toward the street).**



- **Structural setbacks are important to protect structures from damage associated with normal slope creep and settlement**
- **The minimum structural setback should be 10 feet for slopes 20 or more feet high**



SECTION A-A, Common Swale Option

SPECIAL SIDE YARD CASES:

- 15 Common drainage swale may be used along side yard property line where there is less than one foot difference in elevation between lot pads.

When the difference in pad elevation is:	(A)	then the drainage set back is:	(B)
	0.6'		3.0'
	0.8'		4.0'
	1.0'		5.0'

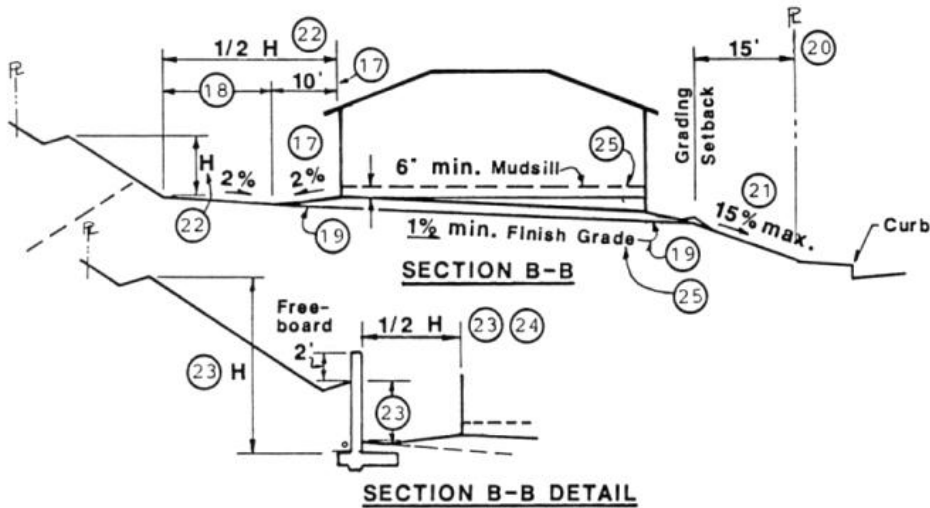
and a common side yard drainage swale may be used.

- 16 When the pad elevations (A) are greater than one foot, then a common side yard drainage swale MAY NOT be used.

- Swales between adjacent structures need to account for differing pad elevations, as shown at left.



- **Example of side yard drainage swale between adjoining lots of differing elevation. Walls and fences may inhibit good drainage along “shared swales”**



Rear Yard:

- (17) Provide 2% grade from 6" below mudsill to 10' behind structure, (716-8.606).
- (18) Provide 2% grade from base of berm or slope, to rear drainage swale, (716-8.606).
- (19) Provide 1% swale to drain rear yard, (716-8.606).

Front Yard:

- (20) Provide 15' min. Grading Setback on front yard, from top of slope berm to Property Line, (716-8.604).
- (21) All driveways steeper than 10% grade must be paved, up to a maximum 15% grade.

Foundations:

- (22) Foundation Setback, from cut, fill, or natural slopes, to be a minimum one half the slope "H" height, with 3'-0" min. setback to a 15'-0" max. setback, Or as recommended by the soil engineer or engineering geologist (U.B.C. 1985, Sec. 7011).
- (23) Where "H" exceeds 20'-0" slope height, provide a 4'-0" high min. designed retaining wall, and provide 2' high freeboard on top of the retaining wall to retain the toe of the slope, if the foundation is to be within 15' of the toe of the slope. (All retaining walls 3' or higher to be engineered, provide dwgs. and calculations).
- (24) Beyond a 15' setback, a wall may not be required, unless recommended by the soil engineer or engineering geologist.
- (25) Foundations for all buildings where the surface of the ground slopes more than 10%, shall be level, and you shall provide a stepped foundation, in order that the floor is level, and the bottom of the footing is placed level, with a minimum horizontal step of 4'-0" (see U.B.C. 1985, Sec. 2907(c)).



- The most common problem with building pads is the promotion of adequate drainage from behind the structure to the street, around the building. Drainage swales need to be created and maintained



- **Homeowners usually infill drainage swales with landscaping, diminishing the intent of fine grading. In this case a remnant of the swale remains, but the grass prevents easy runoff**



- **Concrete flatwork and sidewalks can serve as effective drainage collectors if appropriately sloped away from the structure and towards the point of discharge**



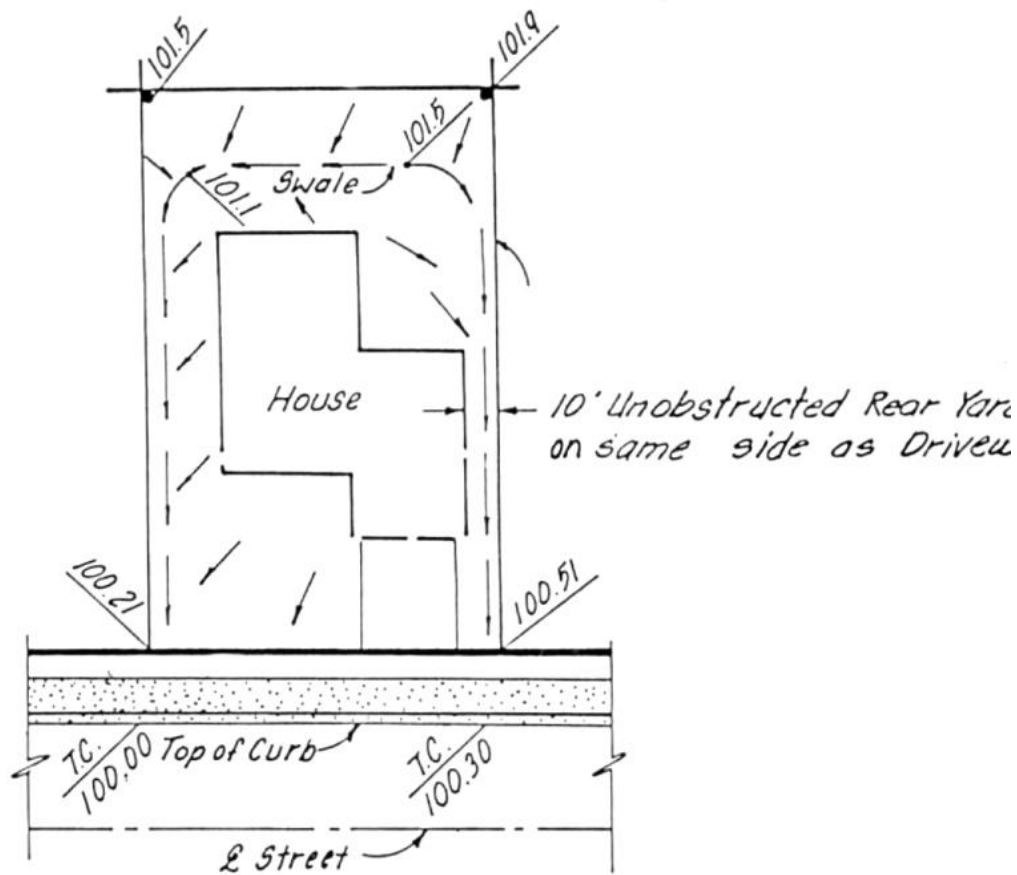
- **Unpaved drainage swales tend to become mollified with time, gradually erasing effective drainage**
- **This shows an old earthen swale that has become infilled and no longer passes runoff to the desired location, causing ponding**



- **Example of poor side yard drainage and absence of maintained drainage swale**
- **Note ponding of water in landscaped area adjacent to the structure**
- **Paved sidewalks or drainage swales are best suited for long-term reliability**



- This lot was equipped with graded side yard drainage swales, leading to drop inlets
- The inlets convey discharge to the street gutter, through a solid pipe, seen in the foreground, which passes through the curb



TYPICAL LOT DRAINAGE PATTERN
 F.H.A. Type "A" Drainage
 No Scale

- In general, runoff should be directed away from the structure, so as not to pond adjacent to foundations or concrete flatwork. Conveyance is usually towards the street



- **This is an example of poor lot drainage, with the ground sloping towards the structure. Water has ponded next to the building and caused the concrete flatwork in the foreground to heave upward, exacerbating the problem.**



- **Drainage pipes should never be turned up (bubble-ups) or discharged against curbs, as shown here**
- **Chronic seepage across walkways creates a potential slip and fall hazard and is in violation of the UBC/IBC**



- **Drainage crossing walkways or driveways needs to be encapsulated in suitable pipes and taken to a suitable point of discharge, such as a gutter**



- **Drop inlets are critical elements of most drainage collection systems**
- **They require perpetual maintenance and upkeep**
- **They may connect to piped conveyances**
- **Piped conveyances carry strict liability for any damages they cause**



- **Drop inlets should be provided with adequate grillage or debris bollards to prevent plugging by oversize debris**



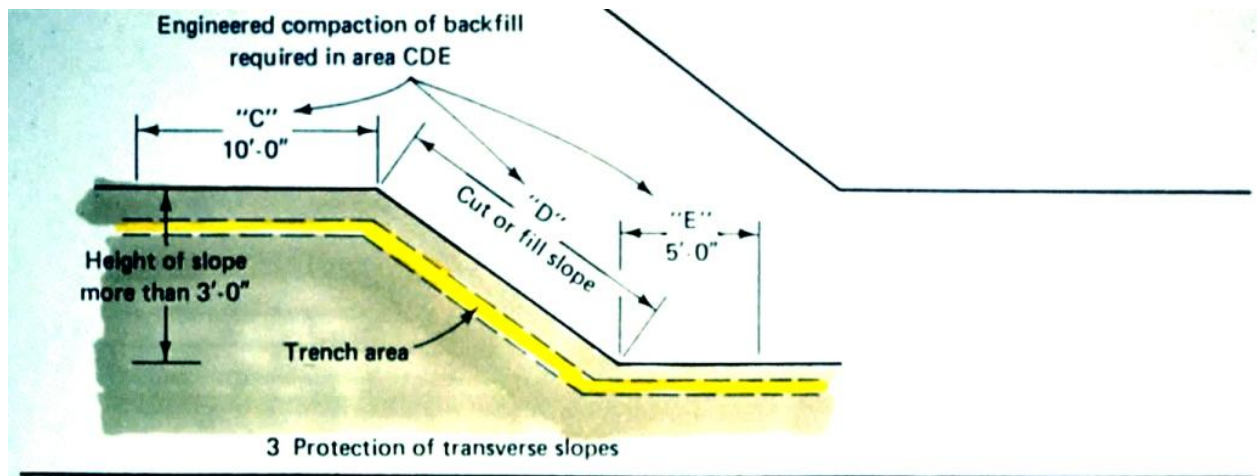
- **Drop inlets that are not maintained pass the runoff onto the next collection point, often overwhelming it**

Part 4

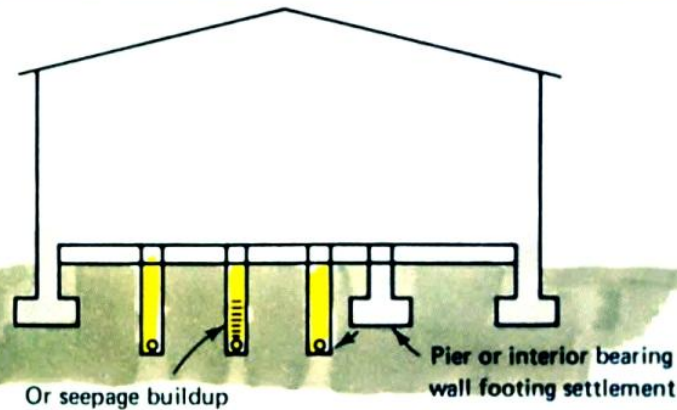
UTILITY TRENCHES



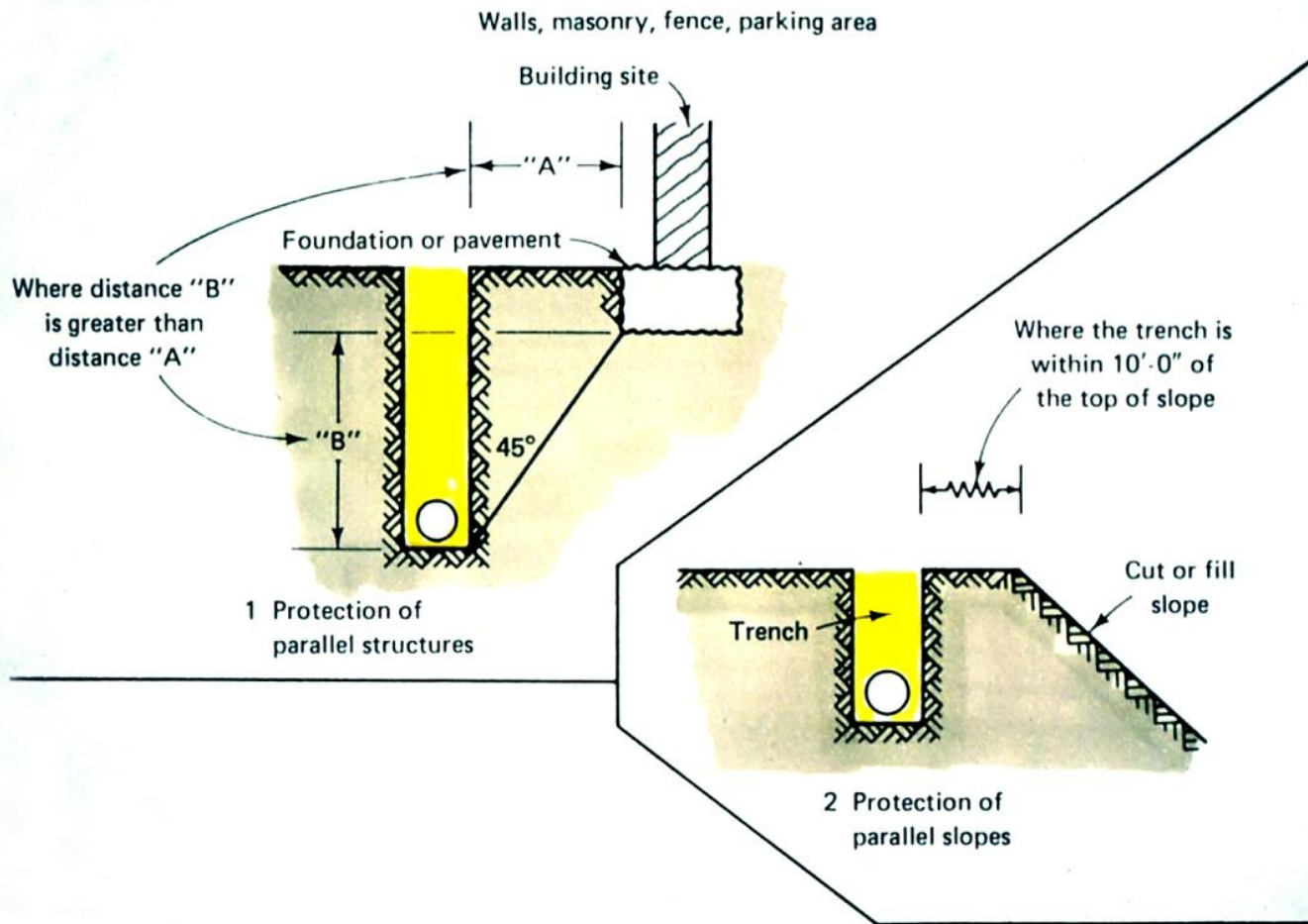
- **Miss-location and under compaction of backfill in utility trenches often lead to unexpected problems, like the erosion depicted here**



Where interior bearing walls settle into utility trenches or water builds up around plumbing fixtures due to loose trench backfills



- **Utility trenches should never be placed directly beneath structures without proper design for bridging of foundation elements**



- **Utility trenches should be located with sufficient offset from slope faces and foundation elements, as shown above**



- **Utility trenches backfill with sand or silt mixtures tend to undergo hydrocompression-induced settlement, as shown here**



- **Example of intersecting utility trenches excavated too close to the building's foundation**

About the Presenter



■ J. David Rogers, Ph.D., P.E., P.G. holds the Karl F. Hasselmann Chair in Geological Engineering at the Missouri University of Science & Technology. He can be contacted at rogersda@mst.edu

- Professor Rogers served as Chair of the Building Codes Committee of the Association of Environmental & Engineering Geologists between 1990-97 and was AEG representative to the International Conference of Building Officials (ICBO) while the 1991, 1994 and 1997 UBC's and 2000 IBC were developed.
- Since 1984 he has taught short courses on grading and excavation codes for ICBO, the University of Wisconsin, University of California, the Association of Bay Area Governments and the City of Los Angeles.