Part 8

COMMMON PROBLEMS

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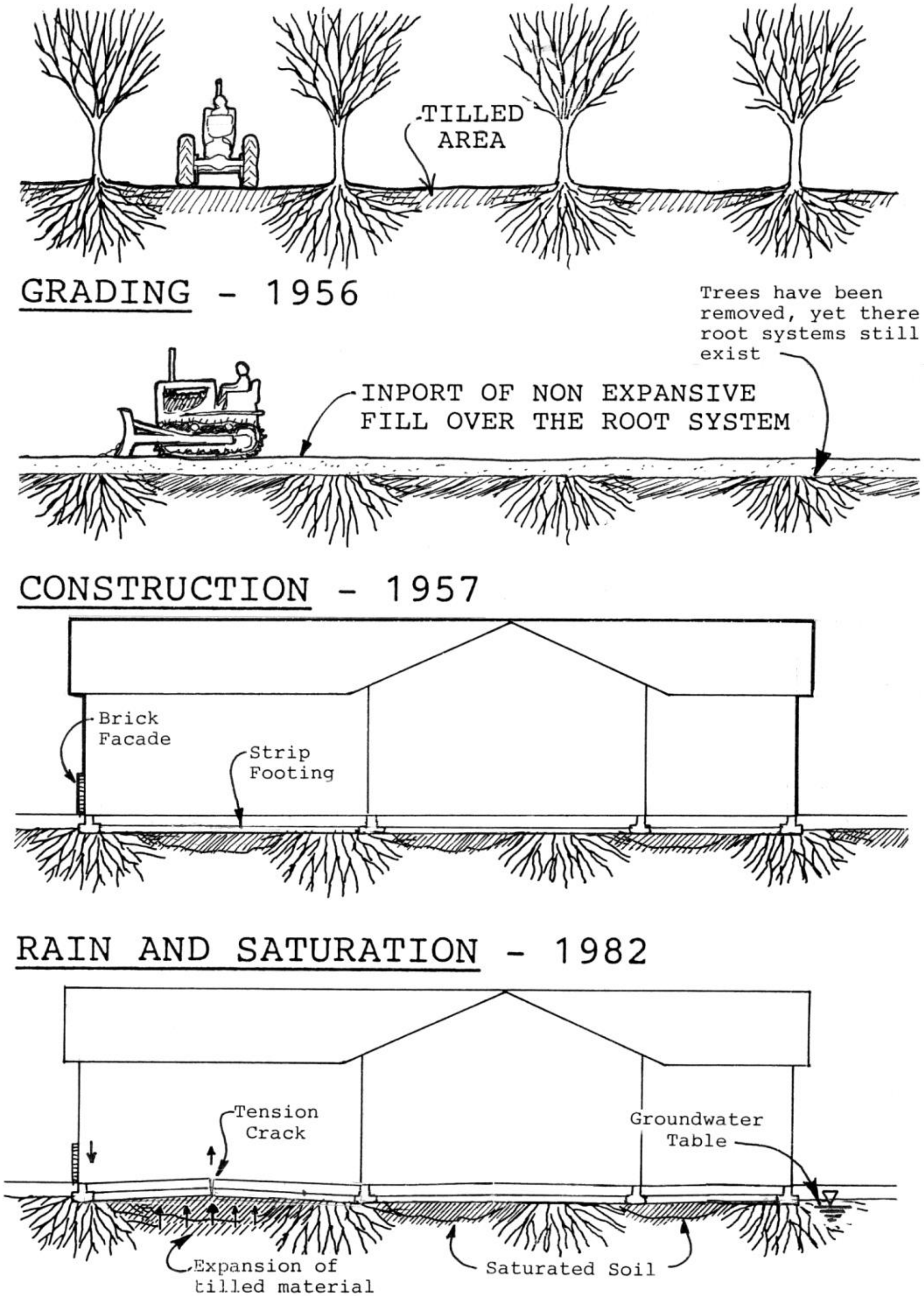
INSUFFICIENT GRUBBING

- **Established compaction standards limit inclusion of organic debris to *no more than 2% by volume* if less than 2-inches diameter, and zero percent for debris > 2 inches in diameter (Mike Scullin in photo)**



ENTRAINED ORGANICS

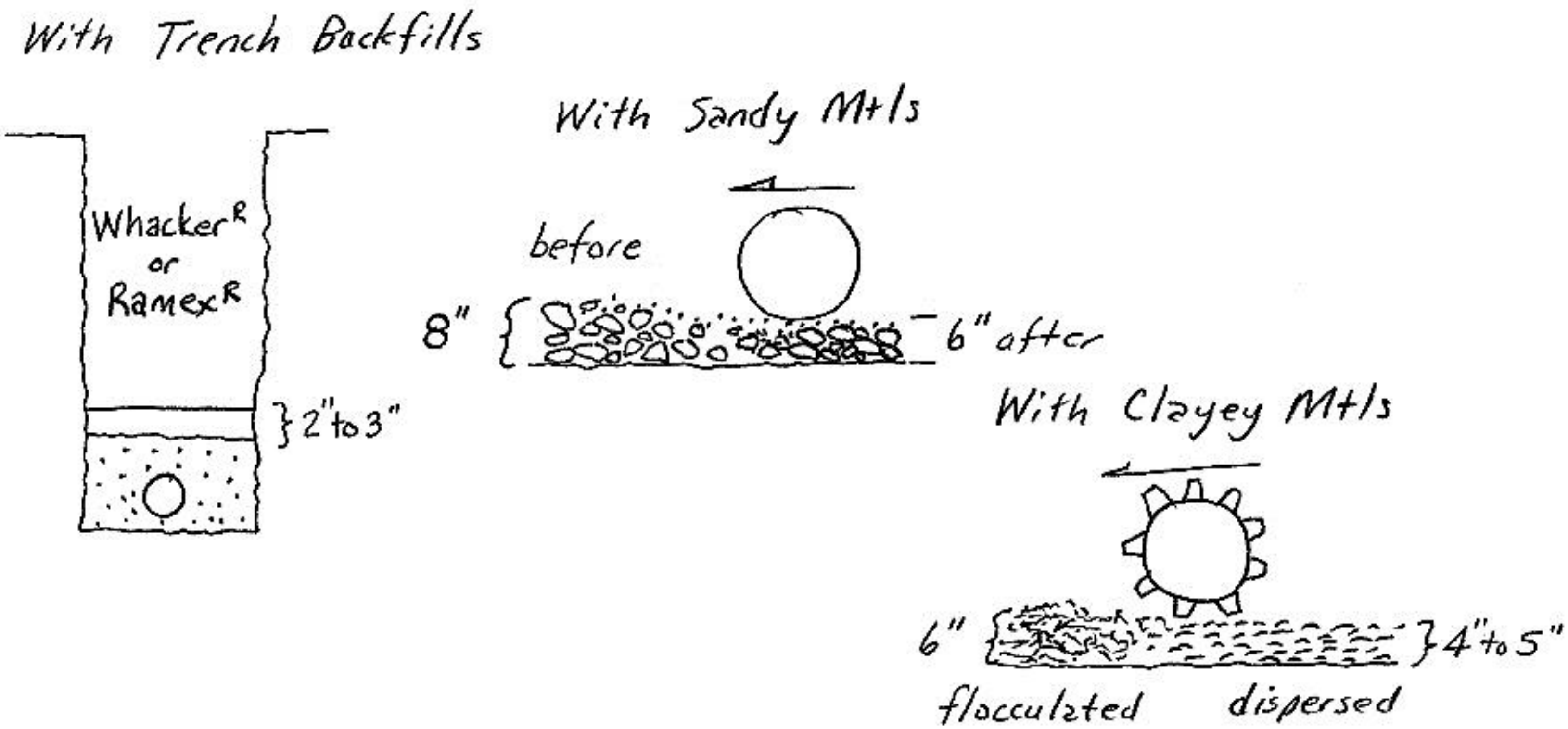
- **Root balls left in the ground usually rot within 5 to 10 years, leaving noticeable pockets of settlement or sinks structures if the voids collapse**
- **In this case the tilled furrows between the root balls heaved upward, breaking the lightly reinforced house slabs**

Always try to employ the

Observational Method

- **Common sense** and the **observational method** are crucial components of soils testing. If you see a lot of dust blowing during grading, chances are the fill is being placed well dry of optimum moisture level.

WATCH FILL LIFT THICKNESS



- **Lifts between 6 and 8 inches are typical when using standard size compactors. This thickness must be reduced if using smaller hand-operated machines, as is often required in trench excavations.**

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Speed vs lift thickness

- The faster the scrapper moves during fill placement, the thinner the lift of soil that is laid down. This can be advantageous if the soil is near optimum moisture content and can be rolled between passes. Note how dry the working pad is in this image, and the slightly dusty nature of the fill being loosed upon this dry surface. Both these factors would lead to lower-than-optimum placement.

BEWARE OF DOUBLE DUMPING

- **These scrappers are dumping thick lifts of fill one behind the other. This is known as "*double dumping*" and should be prohibited when placing engineered fill.**

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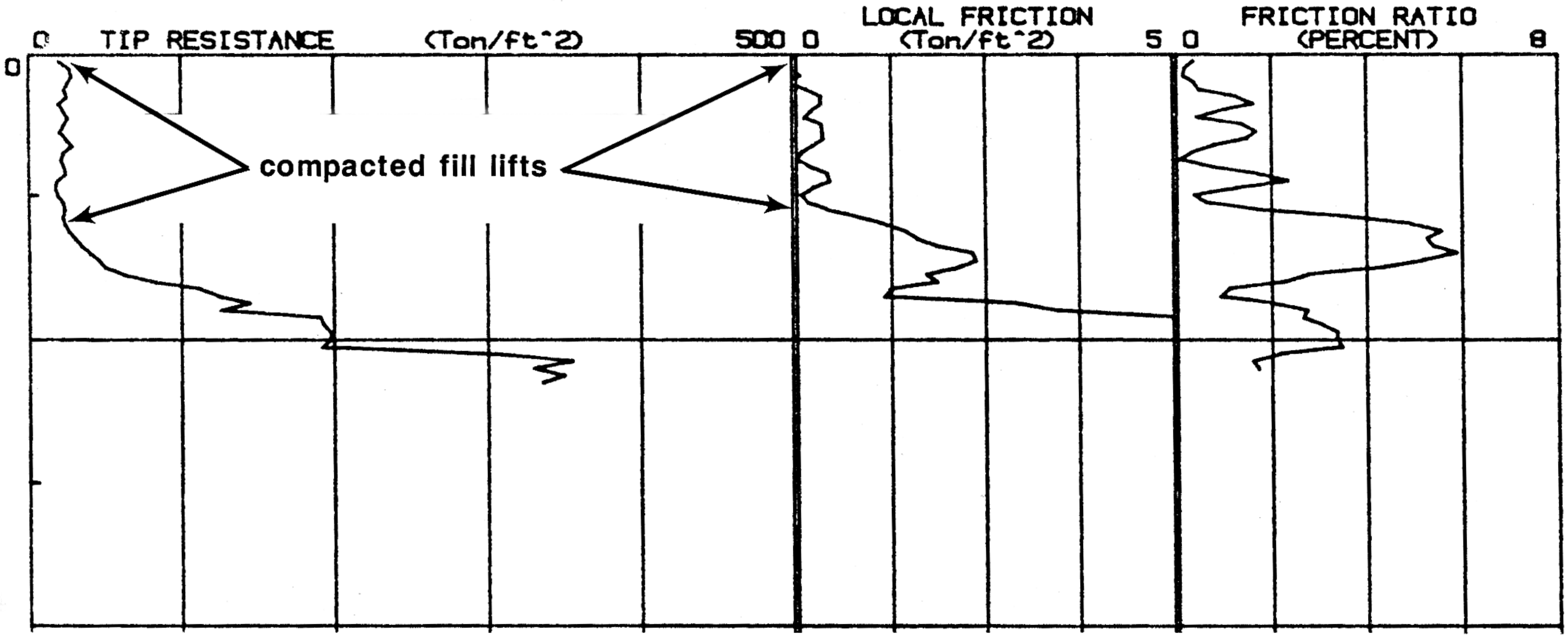

- **Fill lift thickness can be detected as cyclic variances in *sleeve friction ratio* of Cone Penetrometer Soundings made shortly after compaction, before the fill has absorbed noticeable volume of water** (from J. D. Rogers, 1992, Long Term Behavior of Urban Fill Embankments: Stability and Performance of Slopes and Embankments II: ASCE *Geotechnical Special Publication 31*, Vol. 2, pp. 1258-1273).

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Failure to compact keyway margins and/or subdrains

- **CAT 825 series pad compactor spreading a lift of fill in a keyway using its blade. Fill lifts should be between 4 and 8 inches thick with a minimum of two passes by the compactor before placing more fill.**

MOISTURE CONTROL

- **Moisture control** is of paramount importance when compacting cohesive soils, especially expansive soils. **Low humidity wind** is a bigger problem than ambient air temperature.

The wetter the better for structures

- When compacting expansive soils to support structures (not roads), care should be exercised to compact the soil 2% to 5% *over* optimum moisture content, if possible.

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- **When compacting expansive soils *wet of their optimum moisture content*, some sacrifice may need to be made. In situations with high plasticity clays (PI > 25) it may be advisable to employ a reduced density in the upper 5 to 10 ft of the fill prism, to reduce the potential for post-construction heave (Seed & Chan, 1959).**

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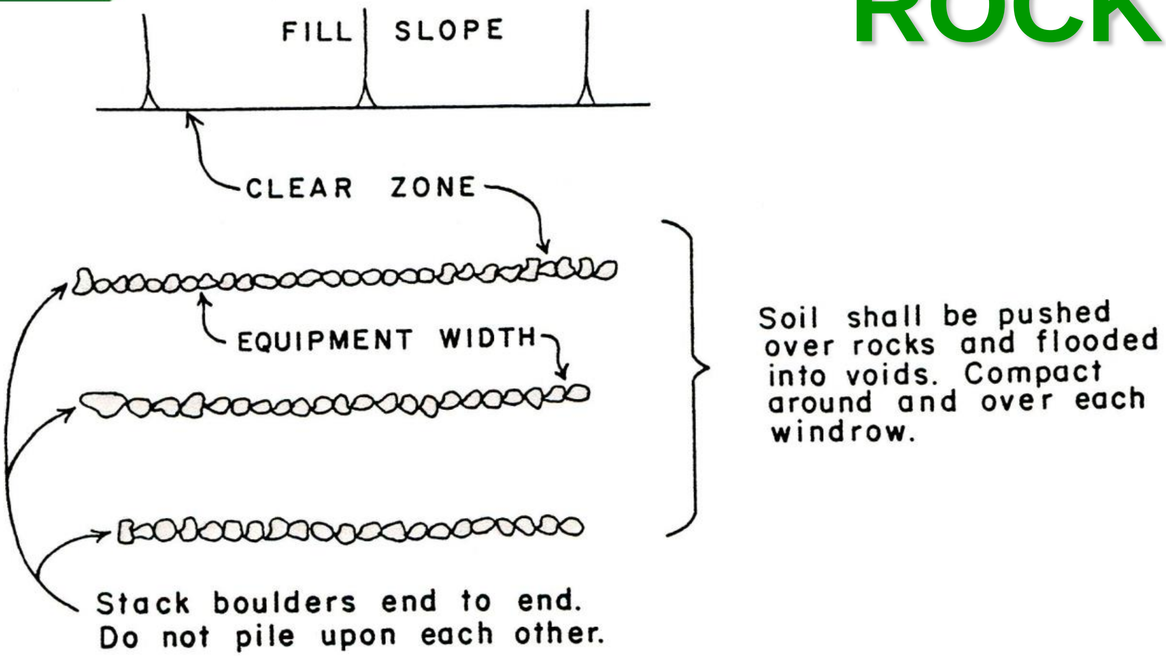
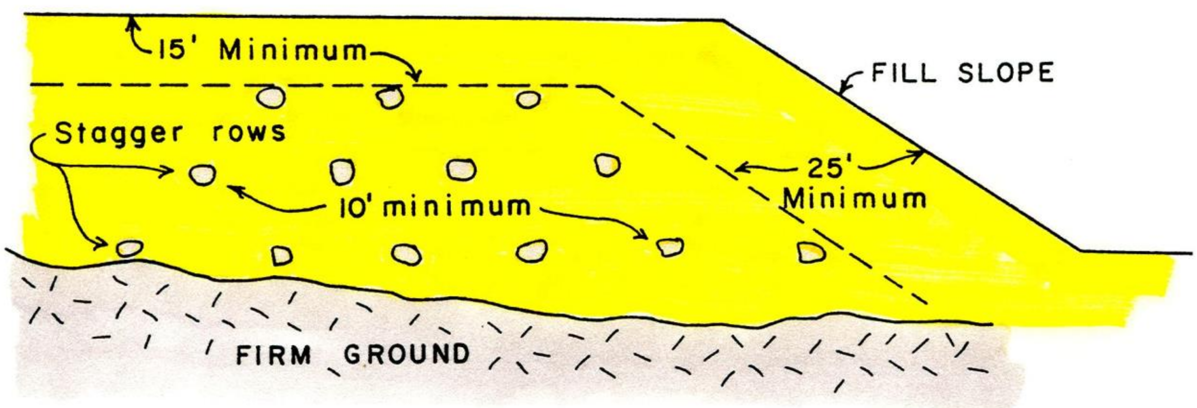
- **Oversize rock** can be included in engineered fill, provided proper precautions are taken to provide filtration between voids. This is usually accomplished by jetting a well-graded gravel mix (such as Cedergren's Class II permeable mixture) into the interstices between the blocks.

ROCK WINDROWS

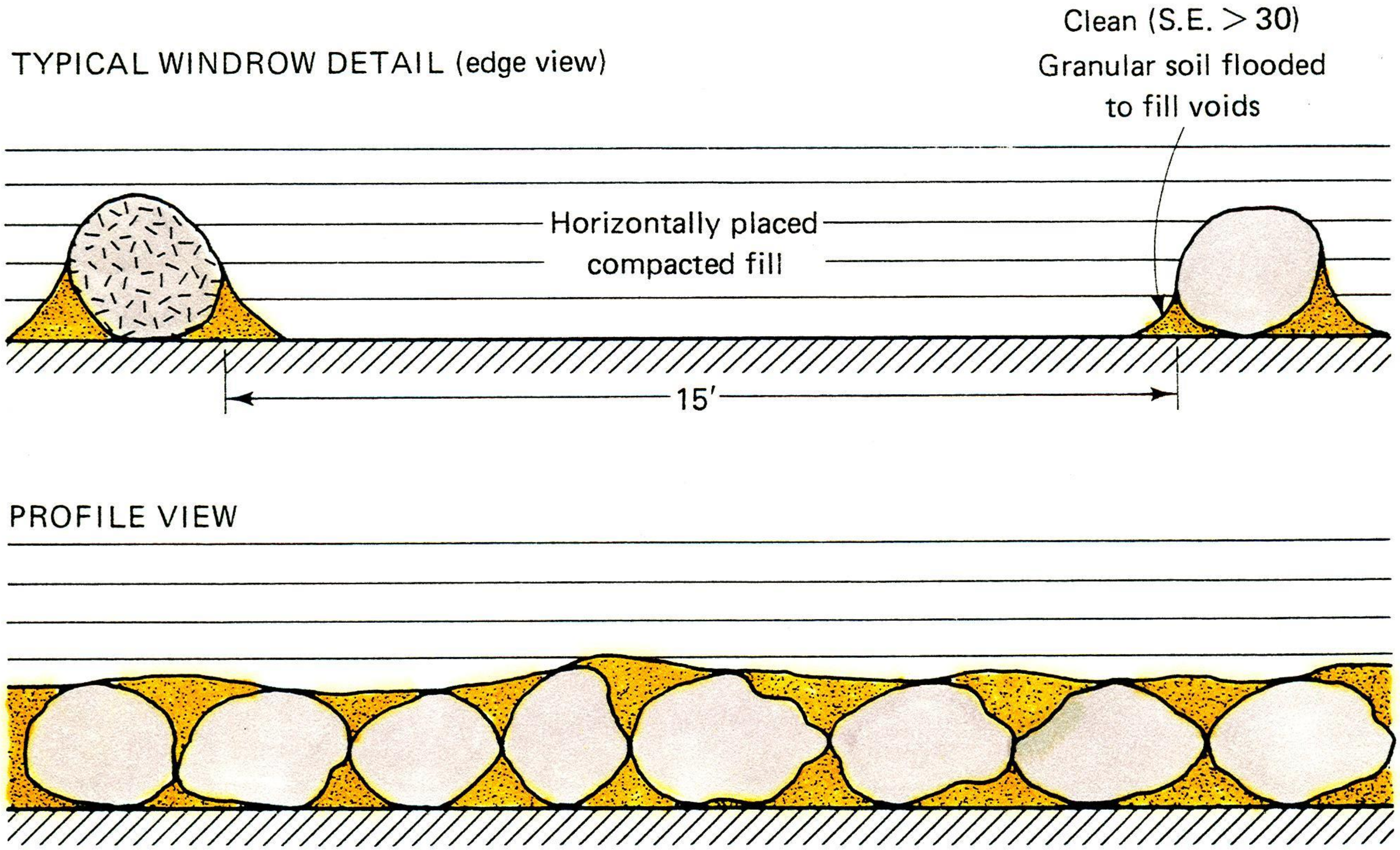


PLAN VIEW



SECTION VIEW

- Rock windrows are used to bury oversize rock
- Rocks are lined up in rows
- Rows are typically buried >15 feet below finished grade and >25 feet behind sloping face



- **Windrows** are usually sluiced with jetted sand and gravel mixtures, to infill voids beneath and between blocks, as sketched here. Sluicing is important because it is impossible to compact beneath the rounded, irregular blocks.

Sluicing well graded granular backfill

- ***Well-graded mixtures*** **of sand, gravel, and rock can be hydraulically sluiced by hoses and vibrated to generate sufficient compaction and interlocking, as shown at left. Target water contents are around 10% moisture**
- **This shows the backfilling of a reinforced concrete power conduit for the Bureau of Reclamation**

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Compacting Culvert Inverts

Above: Prior to the 1930s most culverts were constructed of masonry, like this one

Below: Corrugated steel culverts were introduced in 1896. Segmented galvanized circular steel culverts (shown below) began to dominate practice in the 1930s

Little or no attempt was made in the early days to mechanically compact beneath the lower hemisphere of the circular culverts

- **The lack of compaction** beneath the lower hemisphere of the circular culverts led to numerous hydraulic piping failures, especially with cohesionless backfill.

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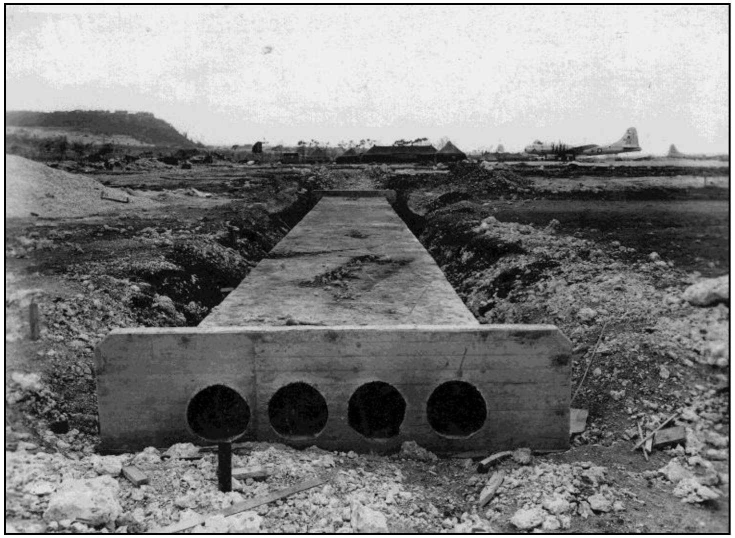
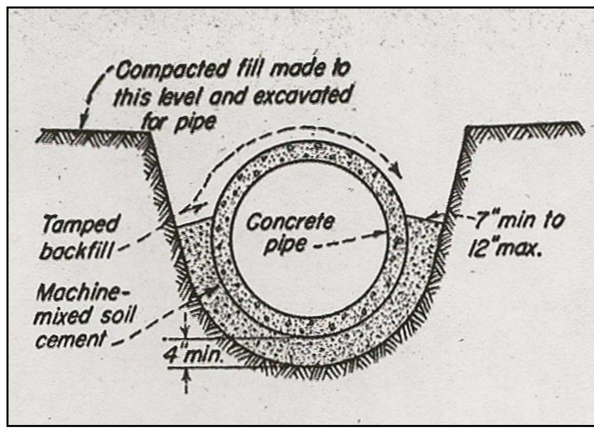
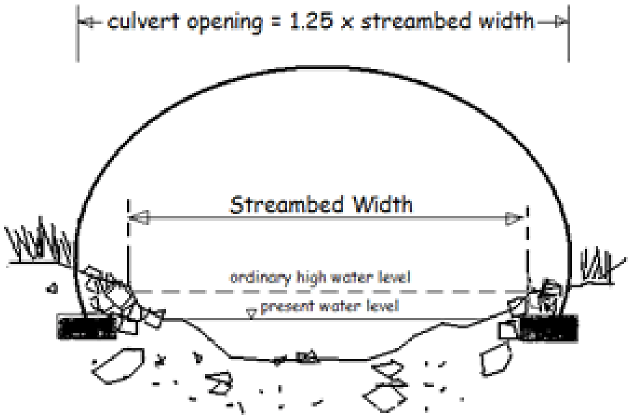
Early Solutions – 1940s





- **In the 1940s the problem was often solved by employing rectangular concrete footings, concrete boxes, slush grouting, and placing soil-cement backfill.**

Creative Solutions



Correctly installed open-bottom arch culvert with footings

Above left: Clear spanning the channel with parabolic shell on strip footings

Middle: mechanical compaction can be accomplished next to rectangular culverts

Lower left: Tamping well-graded backfill in thin lifts using Whackers

Upper right: Infilling the culvert hemispheres with crushed rock (OK for low head applications)

Parabolic Culverts

Parabolic culverts are manufactured in CMP, aluminum, and HDPE. The difficulty in compacting lower hemisphere backfill depends on their curvature, as seen in the upper left versus upper right images.

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