MODIFICATION OF LA DOTD SPECIFICATION ON HIGHWAY CROSS-DRAIN TRENCH BACKFILL

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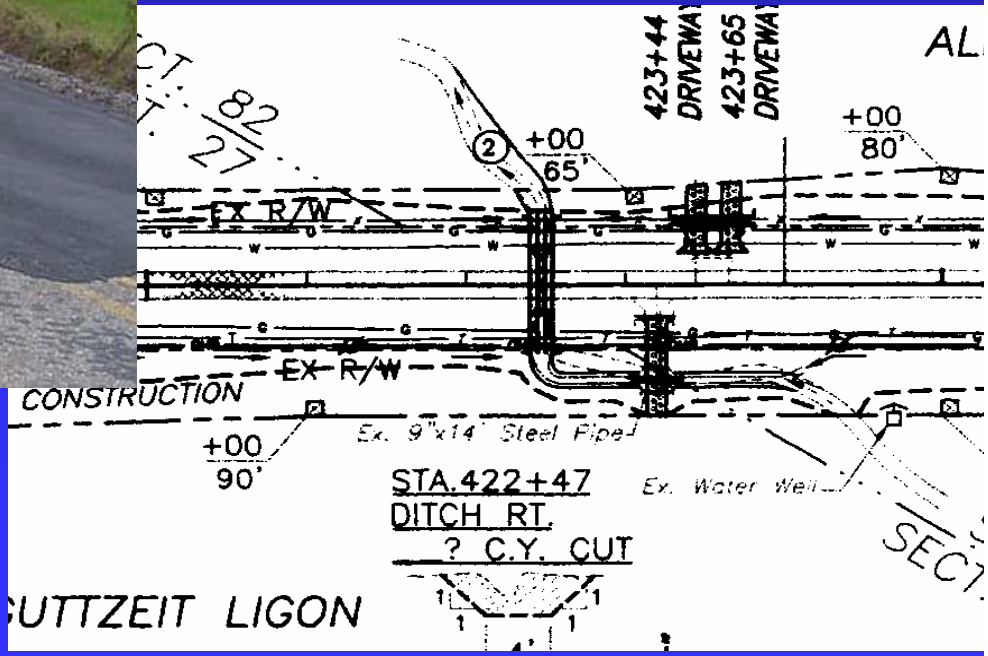
LTRC

Louisiana Transportation Research Center

Problem

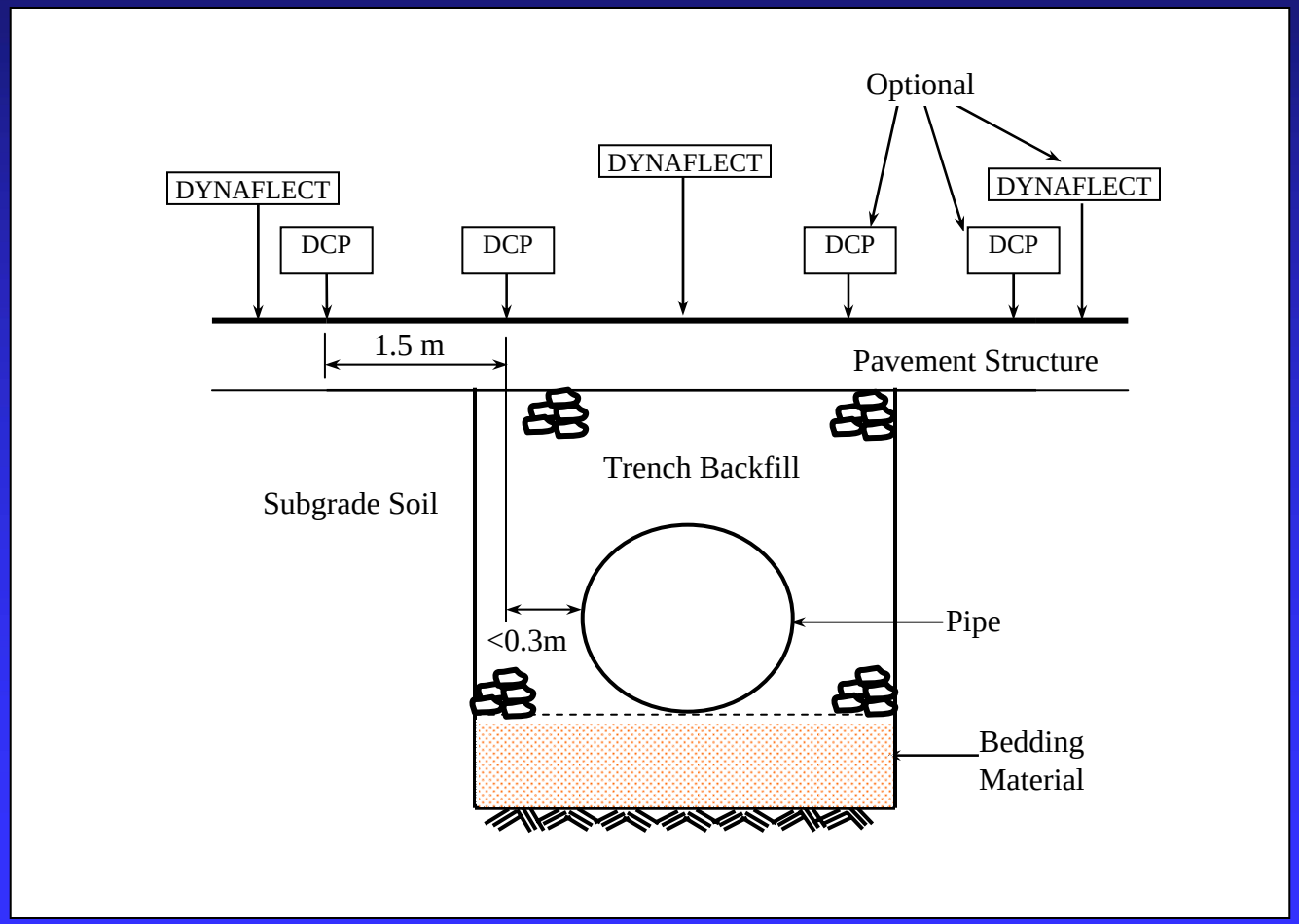
Unexpected pavement surface dips at highway cross-drain sites



Field Investigation Indicates

Pavement surface “dips” at highway cross-drain locations are mainly due to weak trench backfill compared to adjacent subgrade

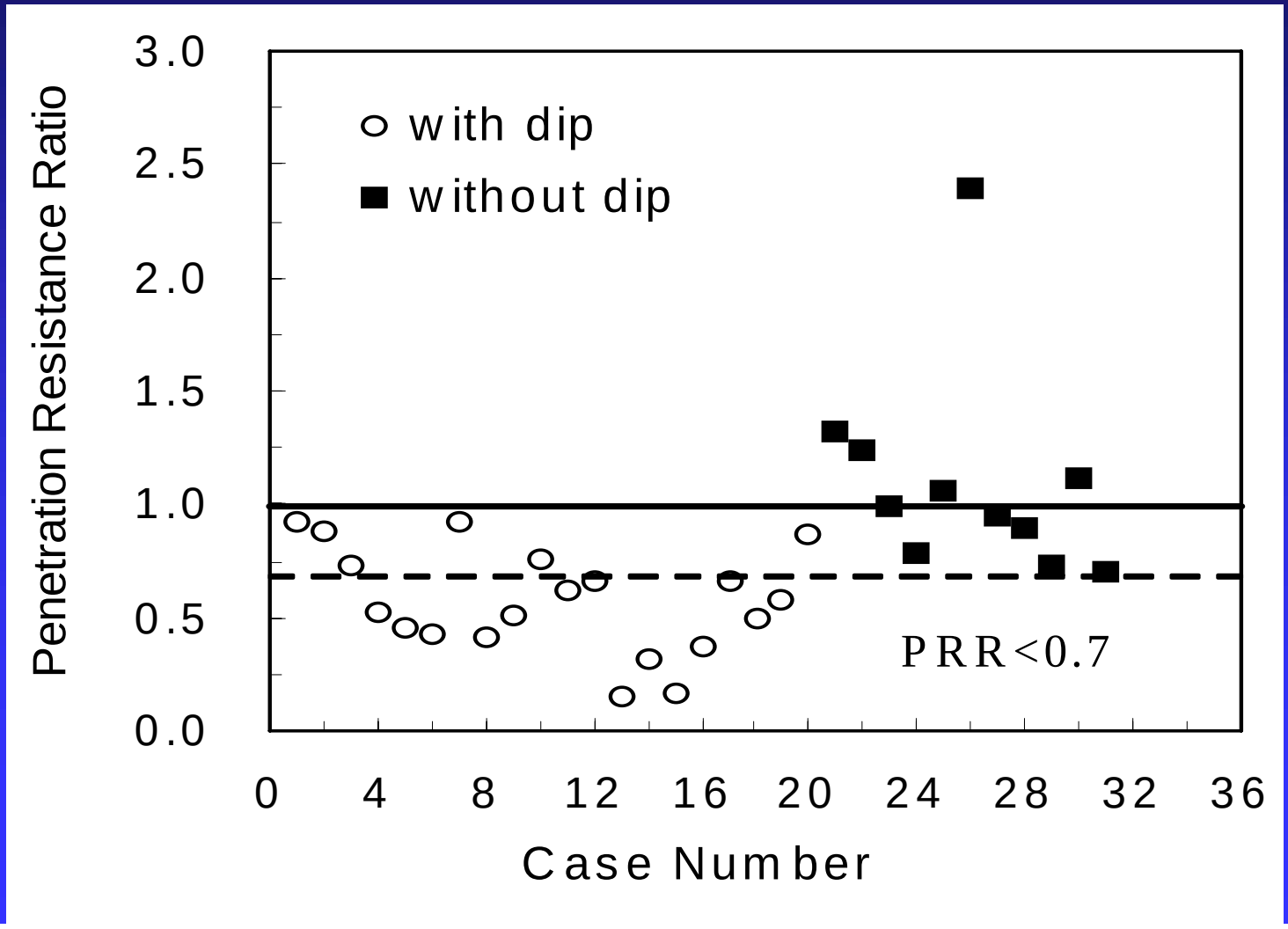
Field Testing Scheme



Penetration Resistance Ratio (PRR)

$$PRR = \frac{\text{Penetration Resistance in Trench}}{\text{Penetration Resistance out of Trench}}$$

PRR with or without surface “dip”



Prevention of Pavement Dips

To prevent pavement surface “dips” at highway cross-drains, we should make trench backfill stronger than adjacent subgrade soils

Backfilling

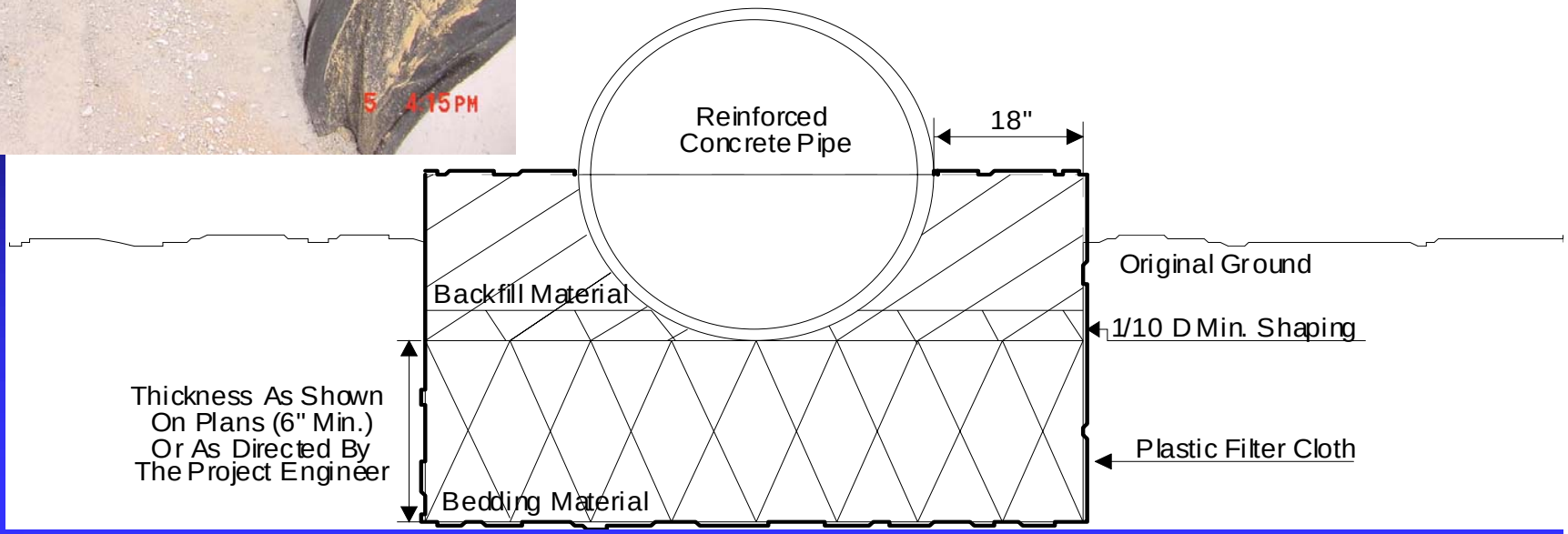
- Type A backfill material

  Stone, recycled Portland cement concrete, or flowable fill
- Type B backfill material

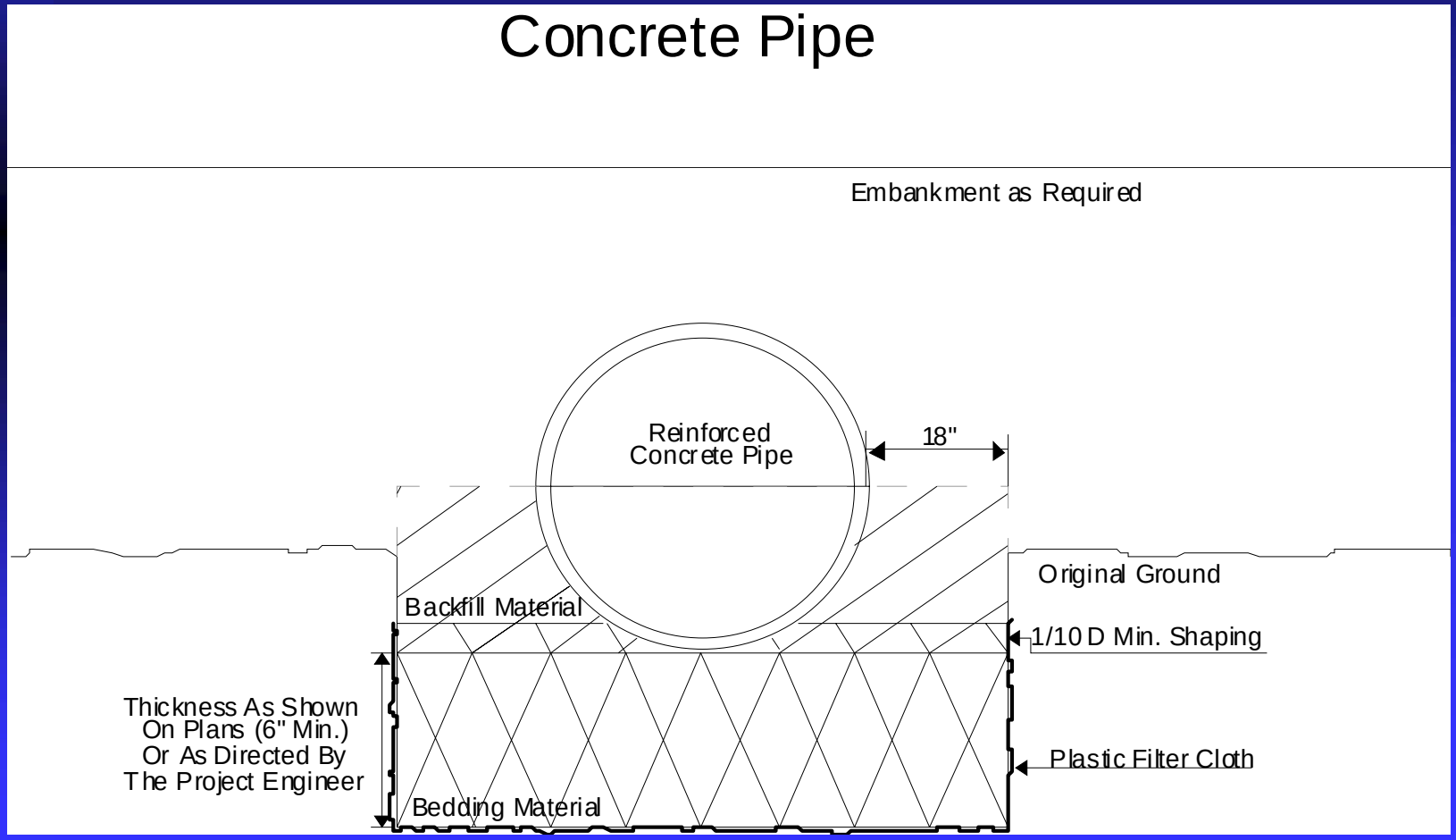
  Stone, recycled Portland cement concrete, flowable fill, selected soils, or granular material
- Type A for pipes/trenches subject to traffic; Type B for others
- More details

BM-01 Detail
– Type A Backfill

Concrete Pipe

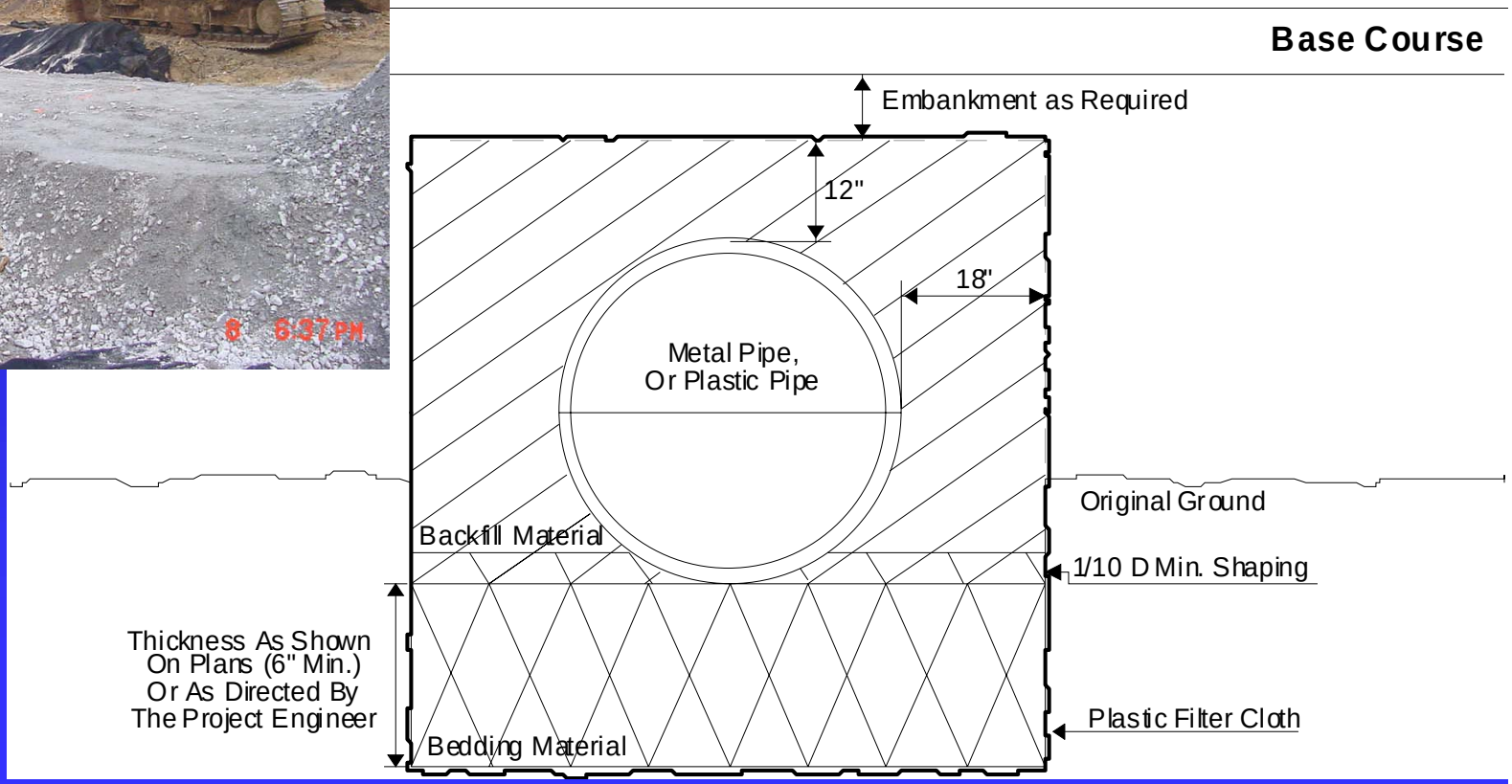


BM-01 Detail (cont.) – Type B Backfill

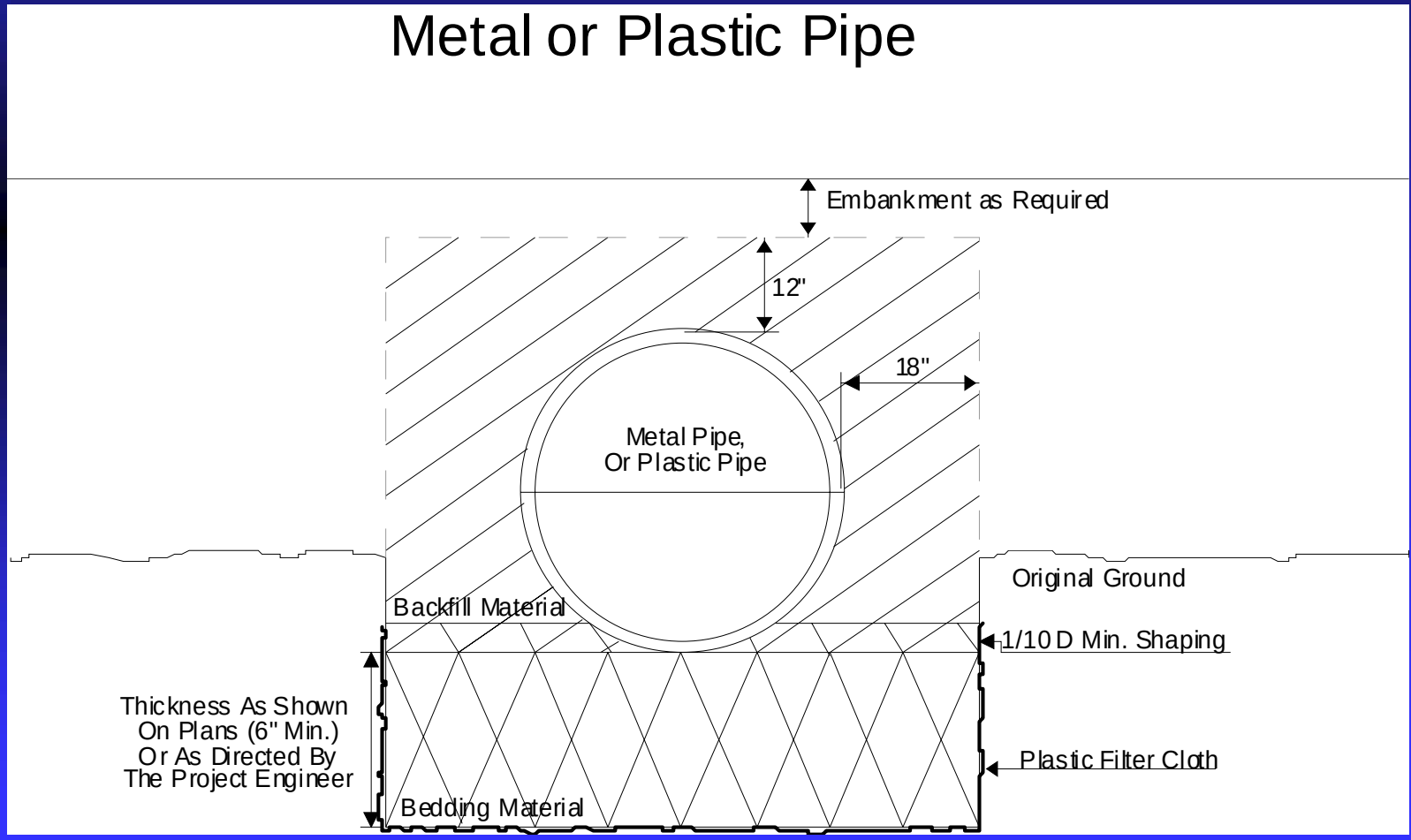


BM-01 Detail (cont.) – Type A Backfill

Metal or Plastic Pipe

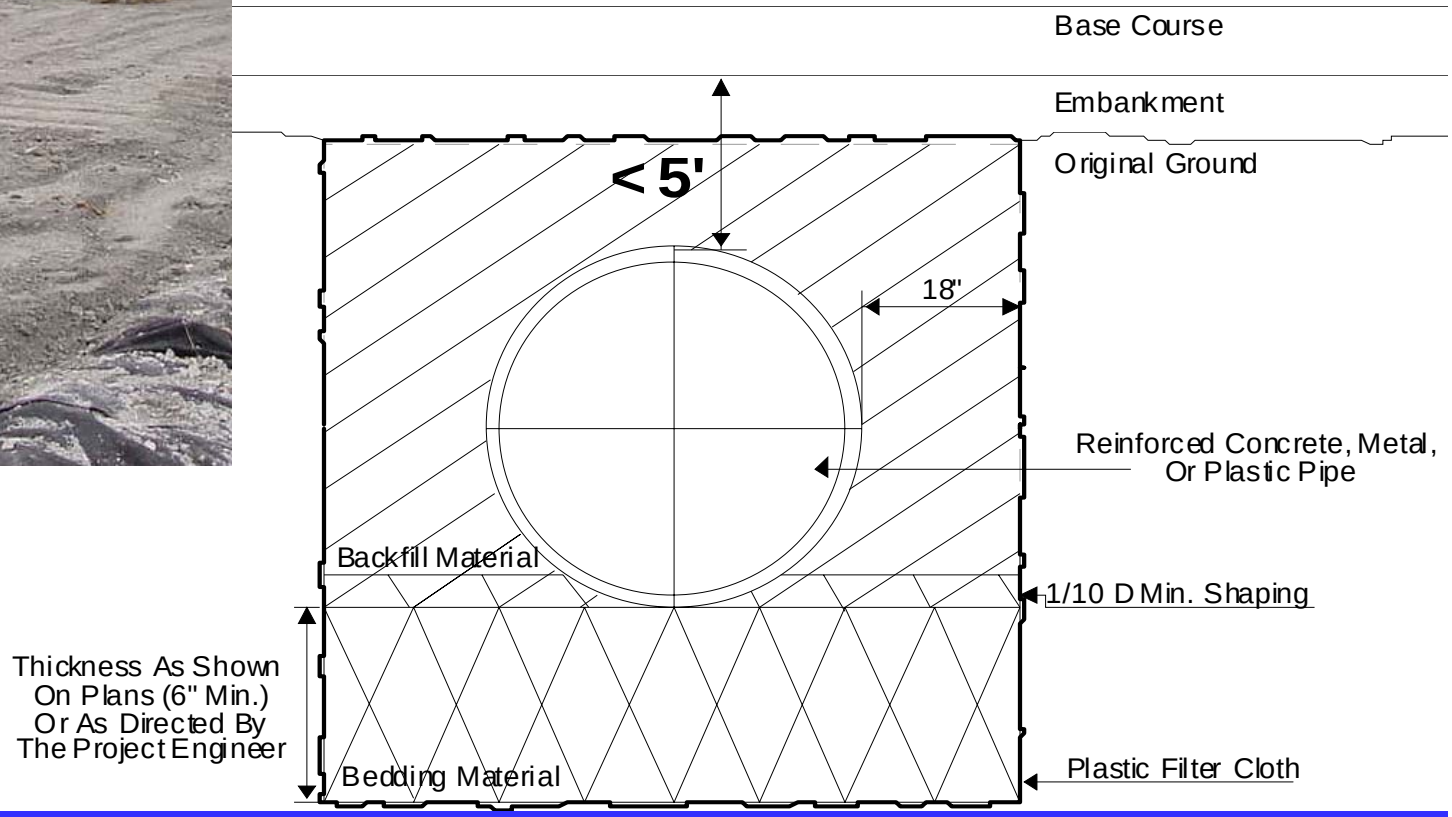


BM-01 Detail (cont.) – Type B Backfill

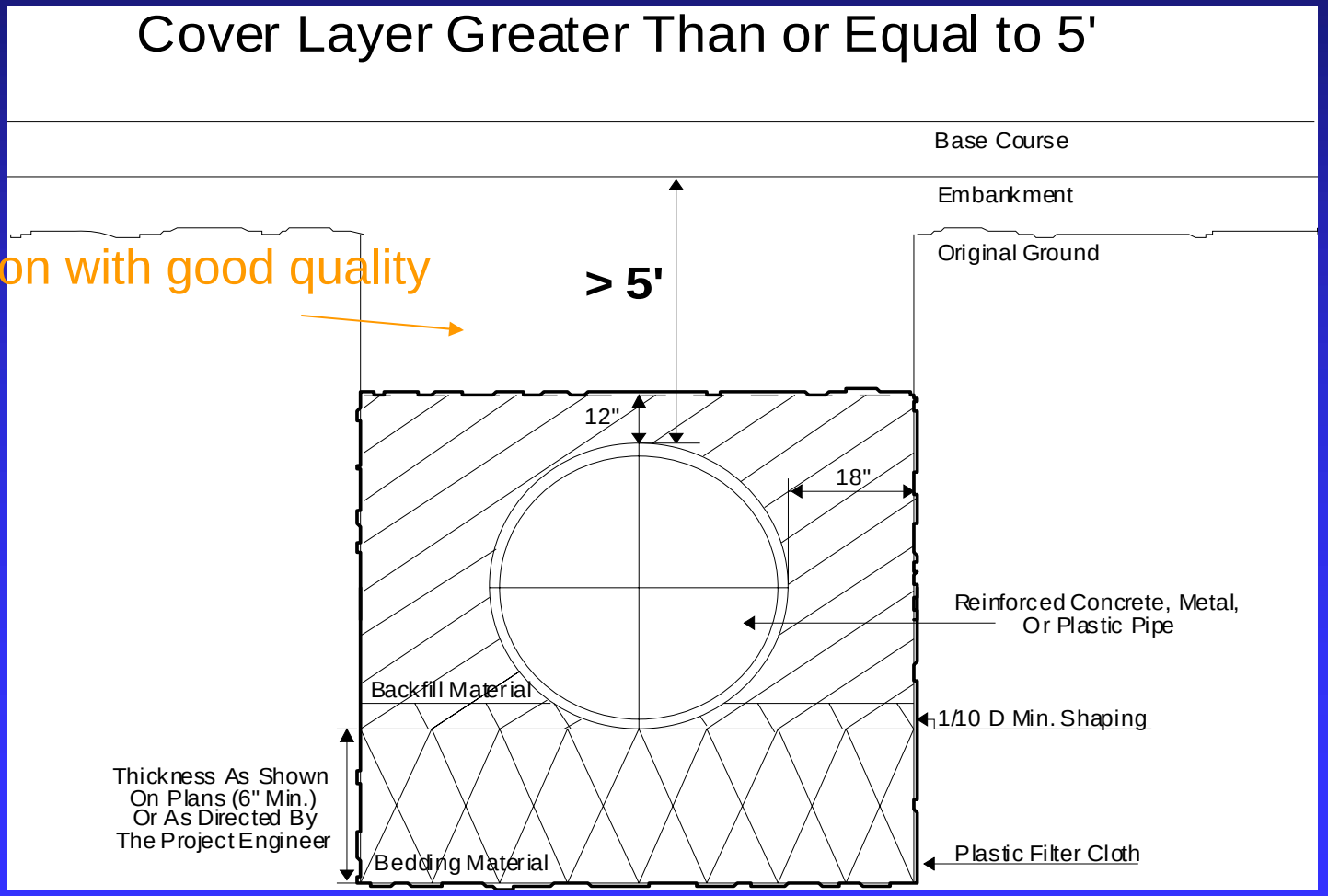


BM-01 Detail (cont.) – Type A Backfill

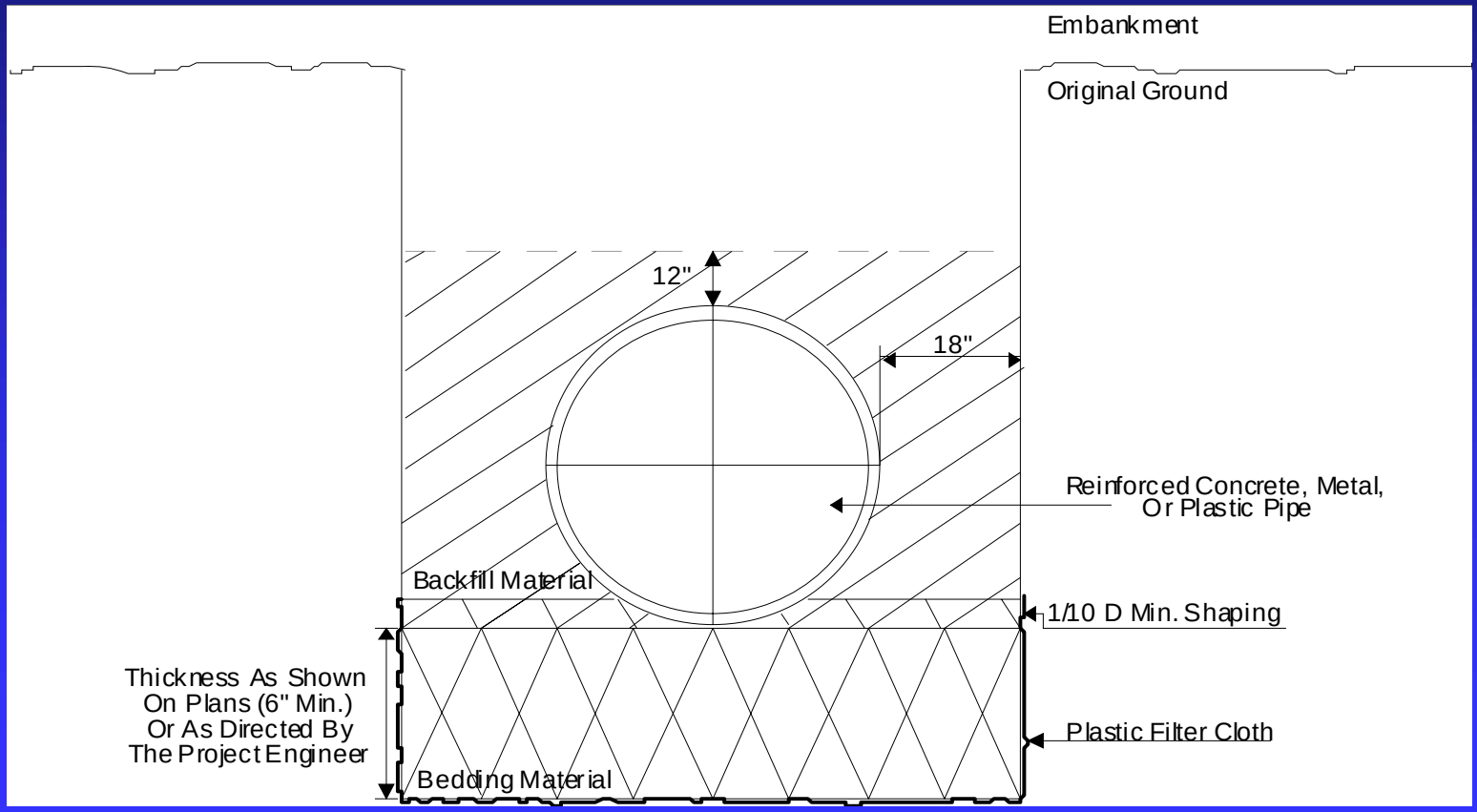
Cover Layer Less Than 5'



BM-01 Detail (cont.) – Type A Backfill



BM-01 Detail (cont.) – Type B Backfill



RAP – Type A Backfill

- Not in the new specs, but can be tried on a project basis
- To be added to the new spec
- Equipment:
  Wacker packer compactor
- Lift thickness:
  8 inches (200 mm) - 12 inches (300 mm) compacted thickness

RAP – Type A Backfill

- Quality control
  - Start with 8 coverage passes

    Can be reduced to, but not less than 6 passes
  - Dry density probably be 90 to 92% of the maximum dry density (102 to 104 pcf)

    DCP tests should be conducted for every 3 foot backfill
  - Below the springline of pipe: 12 mm/blow

    Above the springline of pipe: 10 mm/blow
- Pay attention to the compaction quality of layers that cover the pipes because that is the location for the settlement of backfill to occur

Field Testing - Program

- Number of Trenches: 19
- Pipe size and type: 36” – 54”, concrete
- Backfill Materials:

  Sand, Kentucky/Mexican crushed limestone, RAP, sand gravel mixture, and Selected soil
- Compaction Equipment

  Vibratory Plate, Vibratory Roller, and Wacker Packer Compactors

Field Testing - Results

Poor backfill was related to

- Construction conditions
- Workmanship and inspection
- Backfill material and compaction

Construction Conditions

Conditions that make it difficult to compact backfill include

- Tight schedule
- Under traffic
- Poor weather
- Wrong moisture
- Poor drainage
- Confined construction space
- etc.

Tight Construction Schedule

What Weather Can Do

Work under Traffic

Too Much Moisture

In summary, creating and maintaining a good construction environment is important to the quality control of trench backfills at highway cross-drains

Workmanship & Inspection

- Is the most important factor in quality control
- Most contractors are experienced
- Tension can build in the field when under pressure due to construction delays, under traffic, bad weather, wrong moisture content of backfill, poor drainage conditions
- Communication and cooperation are very important
- All should share the consequences of their construction products, good or bad

Backfill Material

- *Material Compaction*

  Moisture Adjustment

  Seepage Stability

Field Compaction Equipment

Wacker Packer

Vibratory Roller

Vibratory Plate

Summary of Compaction – Standard Proctor

Material	Maximum Dry Density pcf	Working Moisture Range, %	Compaction in field
Sand	105 - 107	4 – 7	Difficult
Kentucky limestone	135 - 139	5 – 7	Very easy
Mexican limestone	116 -121	8 – 12	Very easy
Bedding (Sand gravel)	125 - 128	5 – 8	Better than sand
RAP	102 - 104	5 – 9	Easy
Selected soil	106 - 109	15 – 18	Not easy

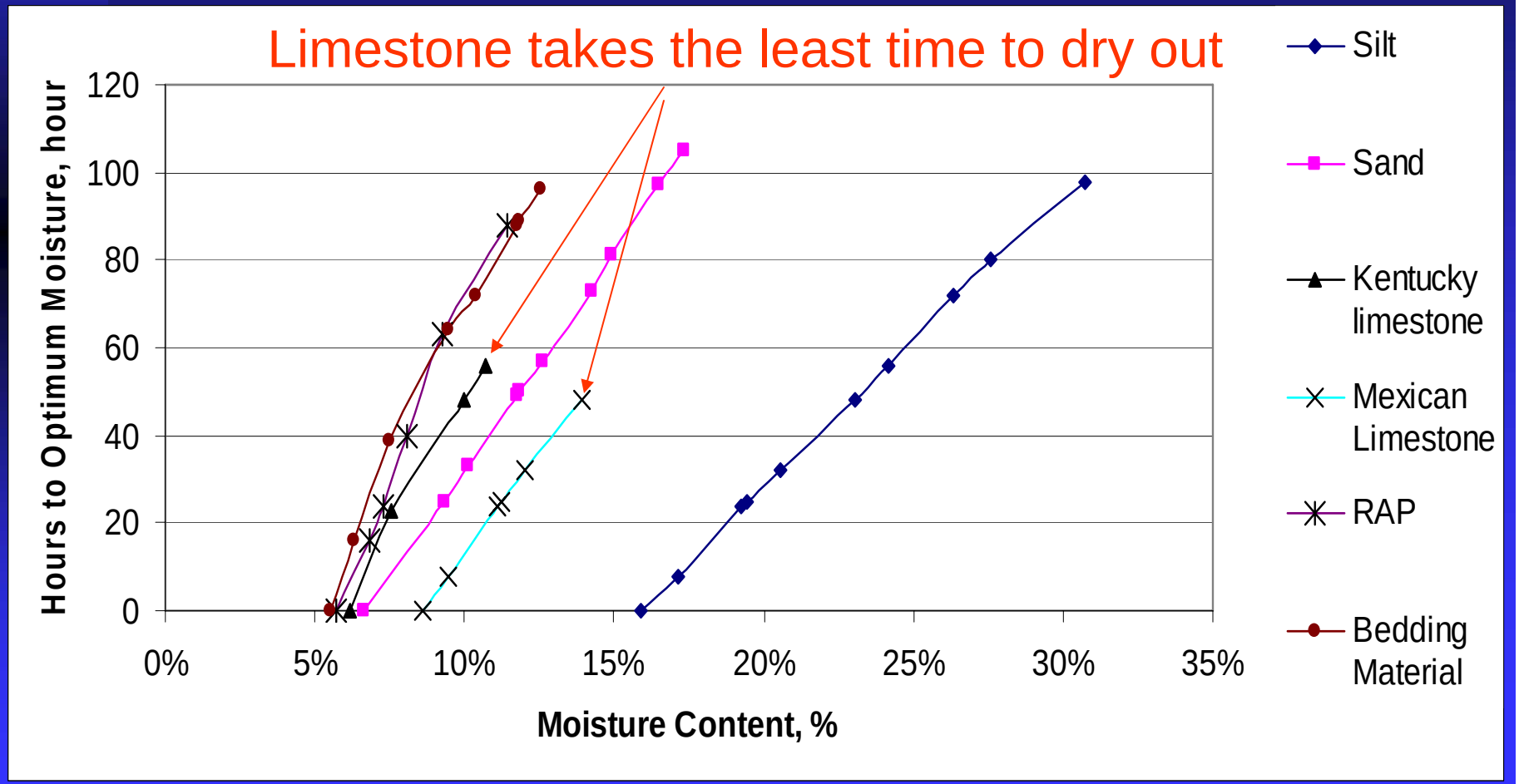
Backfill Material

- *Material Compaction*
- *Moisture Adjustment*
- *Seepage Stability*

Moisture Adjustment

- How fast a backfill material can be dried out in the field
- Laboratory dry-out test

Laboratory Dry-Out Test Results



Backfill Material

Material Compaction

Moisture Adjustment

- *Seepage Stability*

Seepage Stability

- Resistance to erosion caused by the water that leaks out from the joints or cracks of cross-drain pipes
  - Backfill dry density
  - Material cohesion or particle interlock

- Material comparison

	Density	Strength
Kentucky limestone:	*high*	*high*
Mexican limestone:	*medium*	*medium*
RAP:	*low*	*high*
Bedding:	*medium*	*medium*
Selected soil:	*low*	*low*
Sand:	*low*	*low*

Summary for Backfill Material

- Kentucky limestone: The best choice
  - Easy to compact to a high dry density and stiffness
  - Narrow moisture range to deal with in the field
  - Strong particle interlock with good seepage stability
- Followed by Mexican limestone, RAP, bedding material (sand gravel mixture), Selected soil, and sand

Field Testing - Results

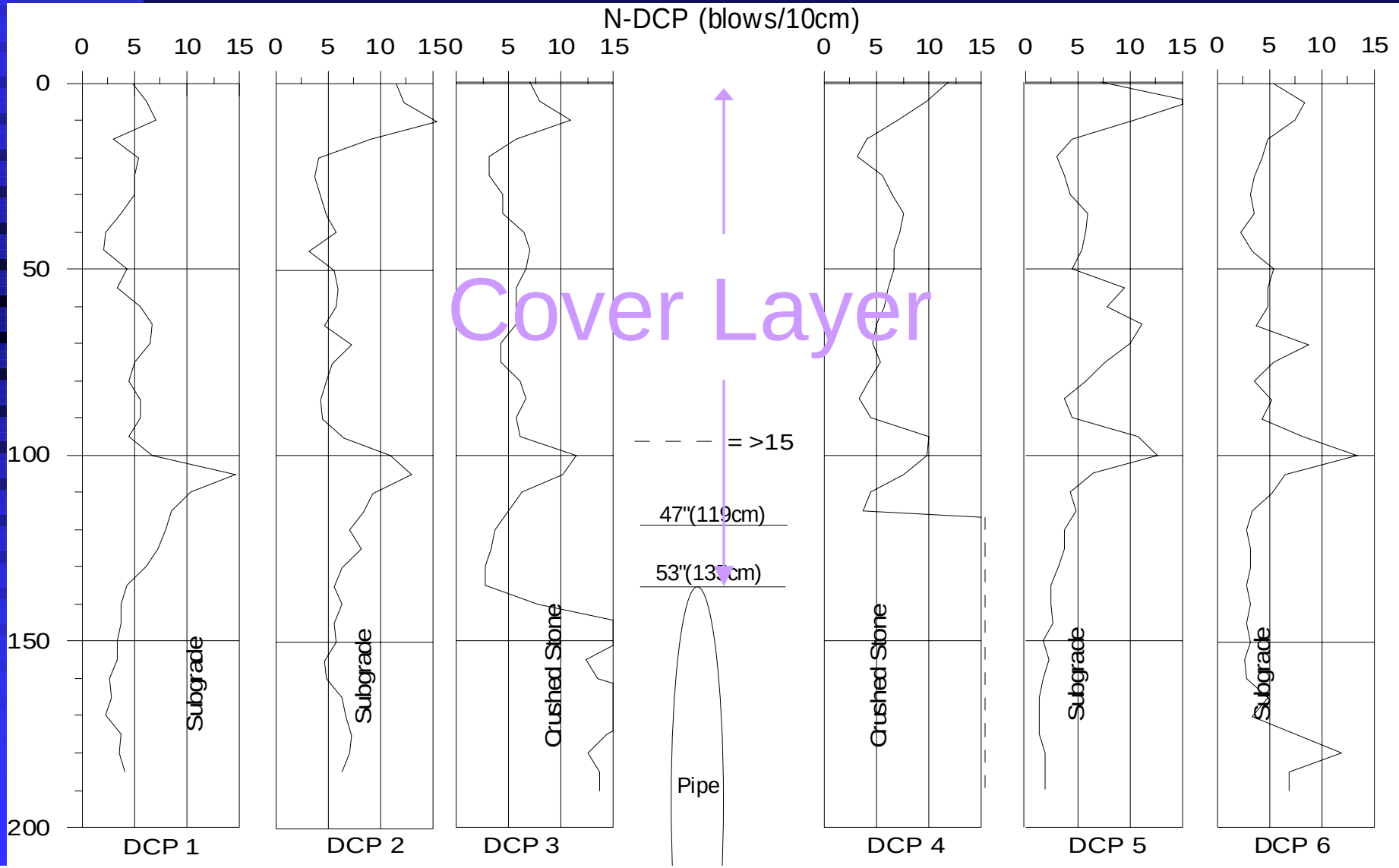
Other factors for the occurrence of pavement surface dips

- Pipe cover layer
- Configuration of cross-drain trench

Pipe Cover Layer

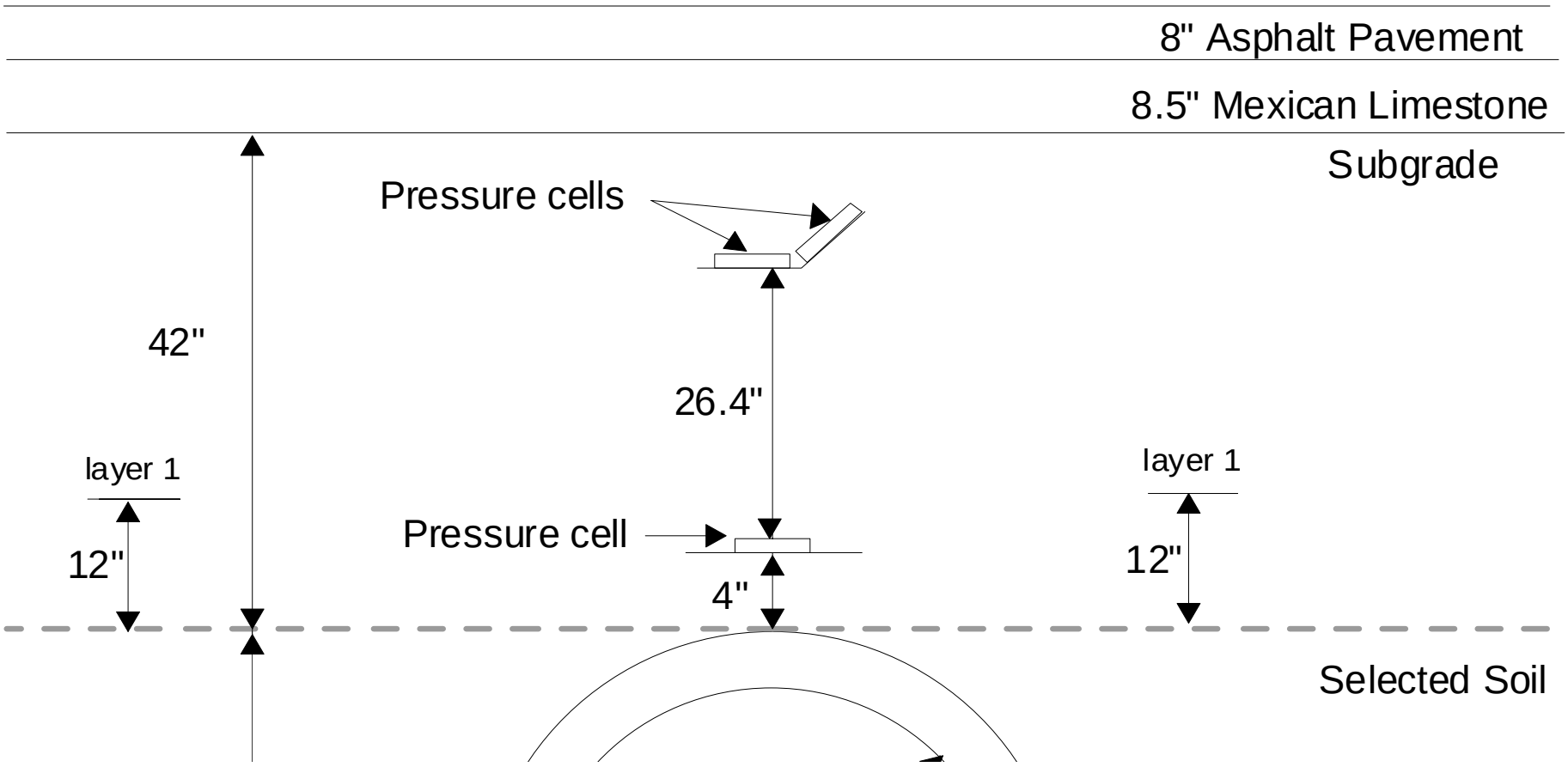
- Refers to the subgrade soil over pipes
- It is a buffer zone between a pavement structure and pipes for construction and traffic loading
- A thick and well compacted cover layer will spread traffic loading well over trench area

Pipe Cover Layer – 4.4 feet

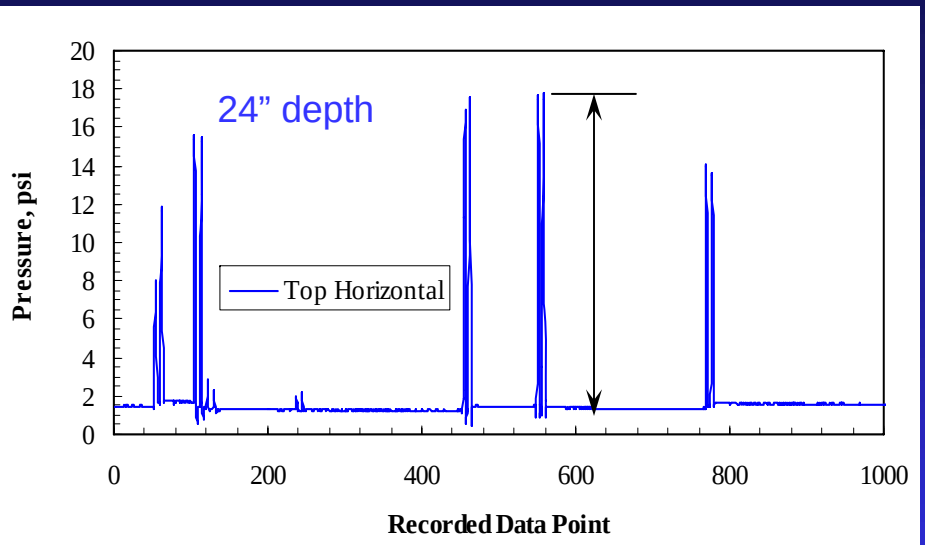


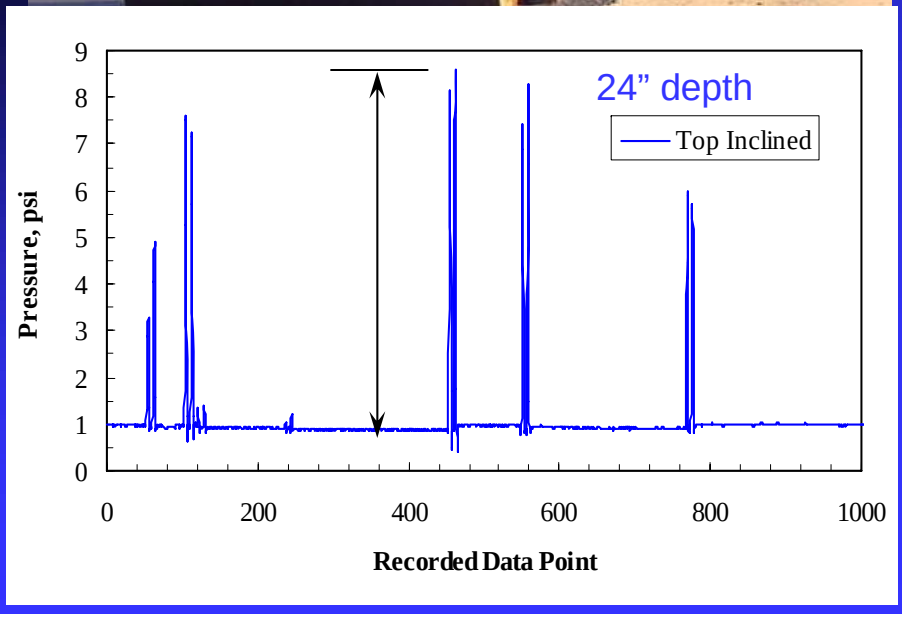
Cover Layer Spread Traffic Loading

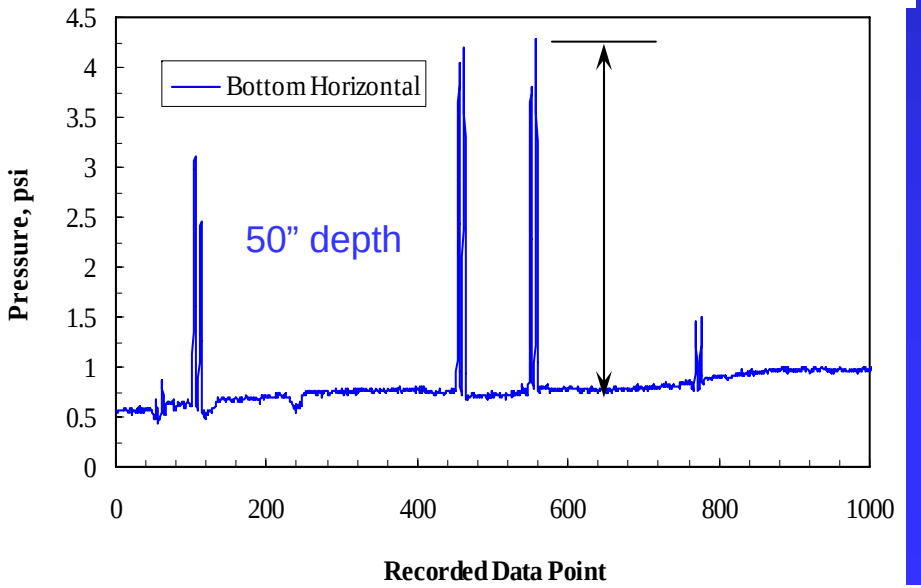
– Embedded pressure cells



Construction Loading – on Binder







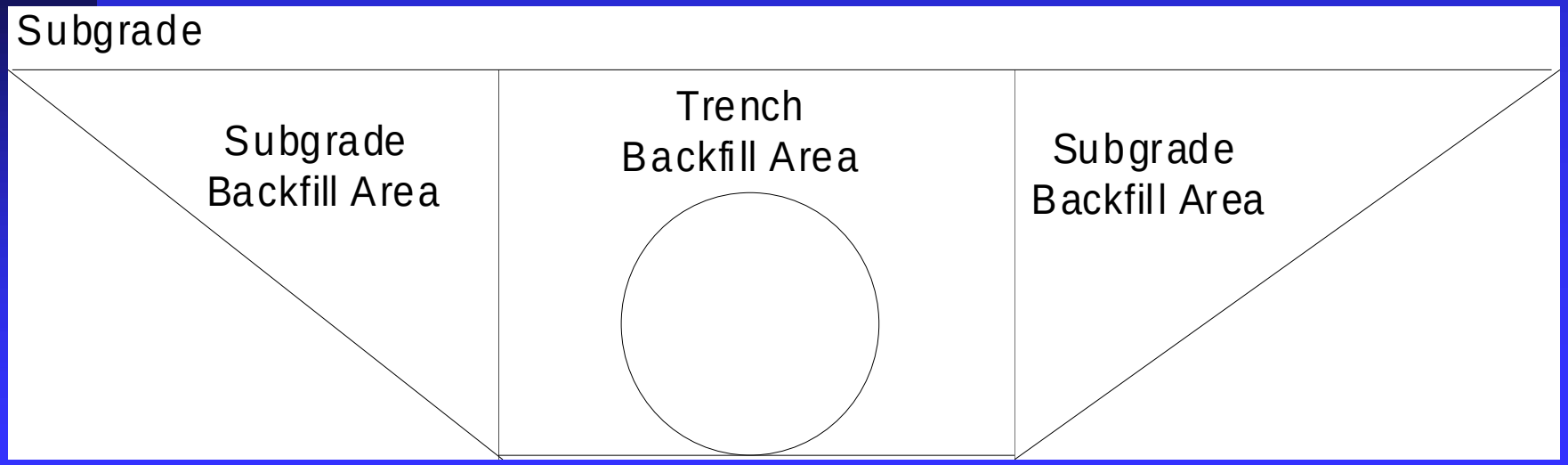
Summary for Pipe Cover Layer

A well compacted thick cover layer will “bridge” traffic loading over trench area and prevent overloading cross-drain pipes and backfill

Configuration of Cross-Drain Trench

Compaction in subgrade backfill area is important

- If properly compacted, it can provide a smooth transition in stiffness
- Otherwise, it can be a weak area causing pavement surface dips



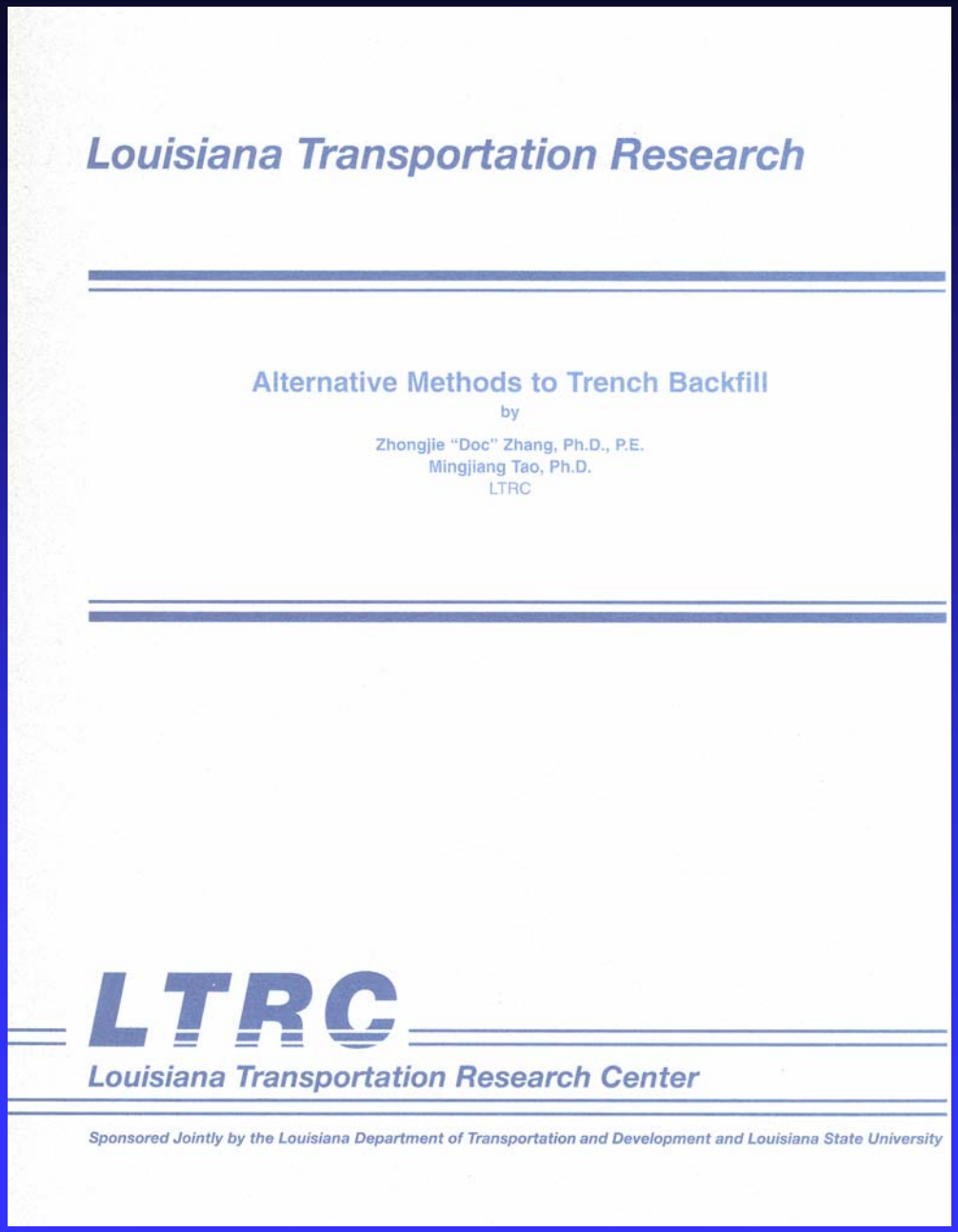
Field Example of Subgrade Backfill Area

Conclusion

- Field experience indicates that we will have to build highway cross-drains under different (good and bad) conditions
- We need to make backfill stronger than adjacent subgrade soils to prevent pavement surface dips at highway cross-drains

Conclusions (cont.)

- To prevent pavement surface dips
  - Use backfill materials that can be properly compacted under different construction conditions
  - Try to avoid bad construction conditions that affect construction quality
  - Have good project inspections


Louisiana Transportation Research
Alternative Methods to Trench Backfill
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Questions?