National Renewable Energy Laboratory
Innovation for Our Energy Future

Wind Farm Construction Practices and Considerations

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Presentation Overview

- Land impacts before, during, and after construction
- Typical construction practices

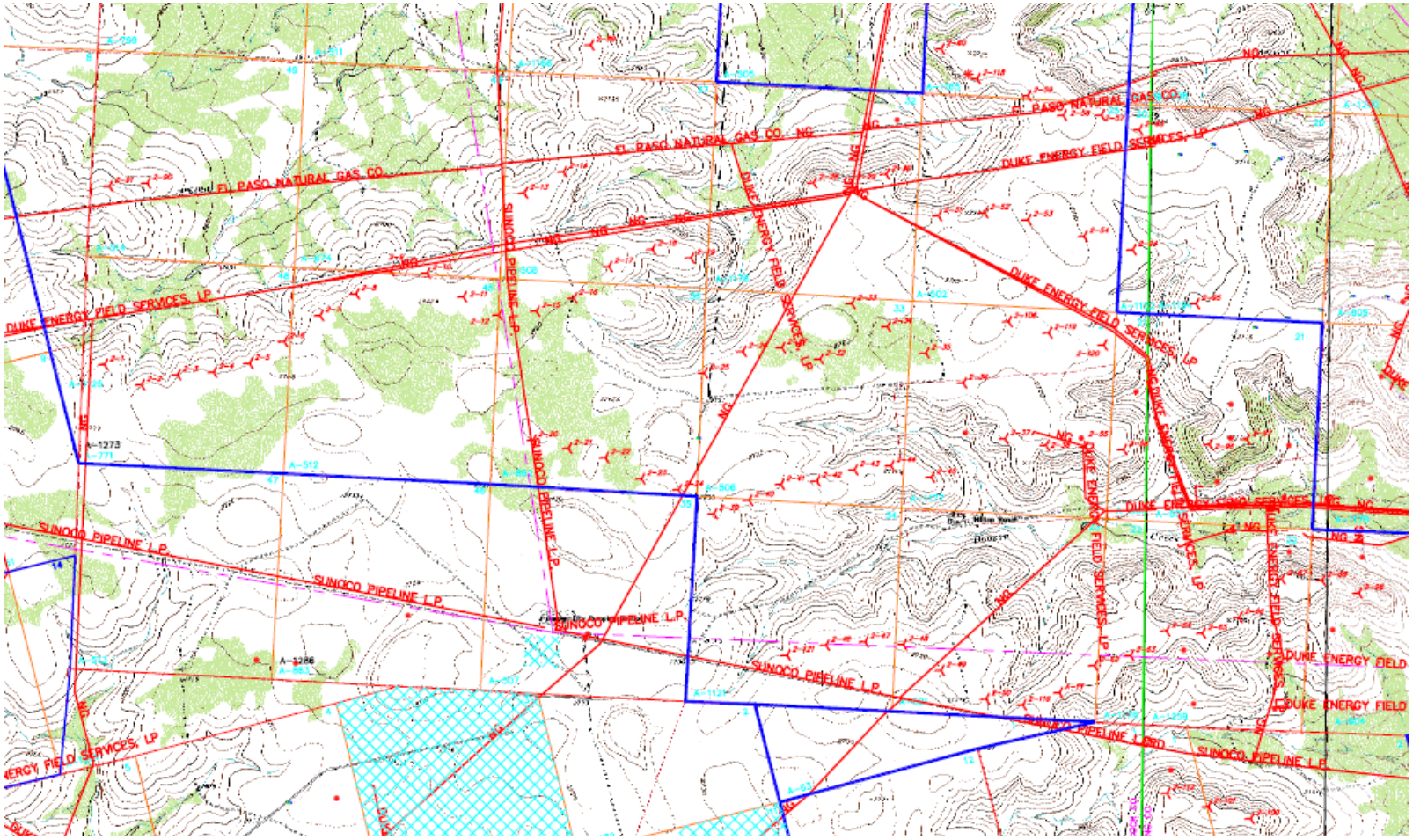
Land Impacts

- Disturbed areas
  - Laydown yard, site prep (geotech and turbine component delivery, road construction, crane paths, borrow pits (quarry), water usage, storm water controls, foundation excavation, blasting, and material stockpiling, large rock disposal,

Existing Uses - Pipelines/Underground Utilities

Existing users

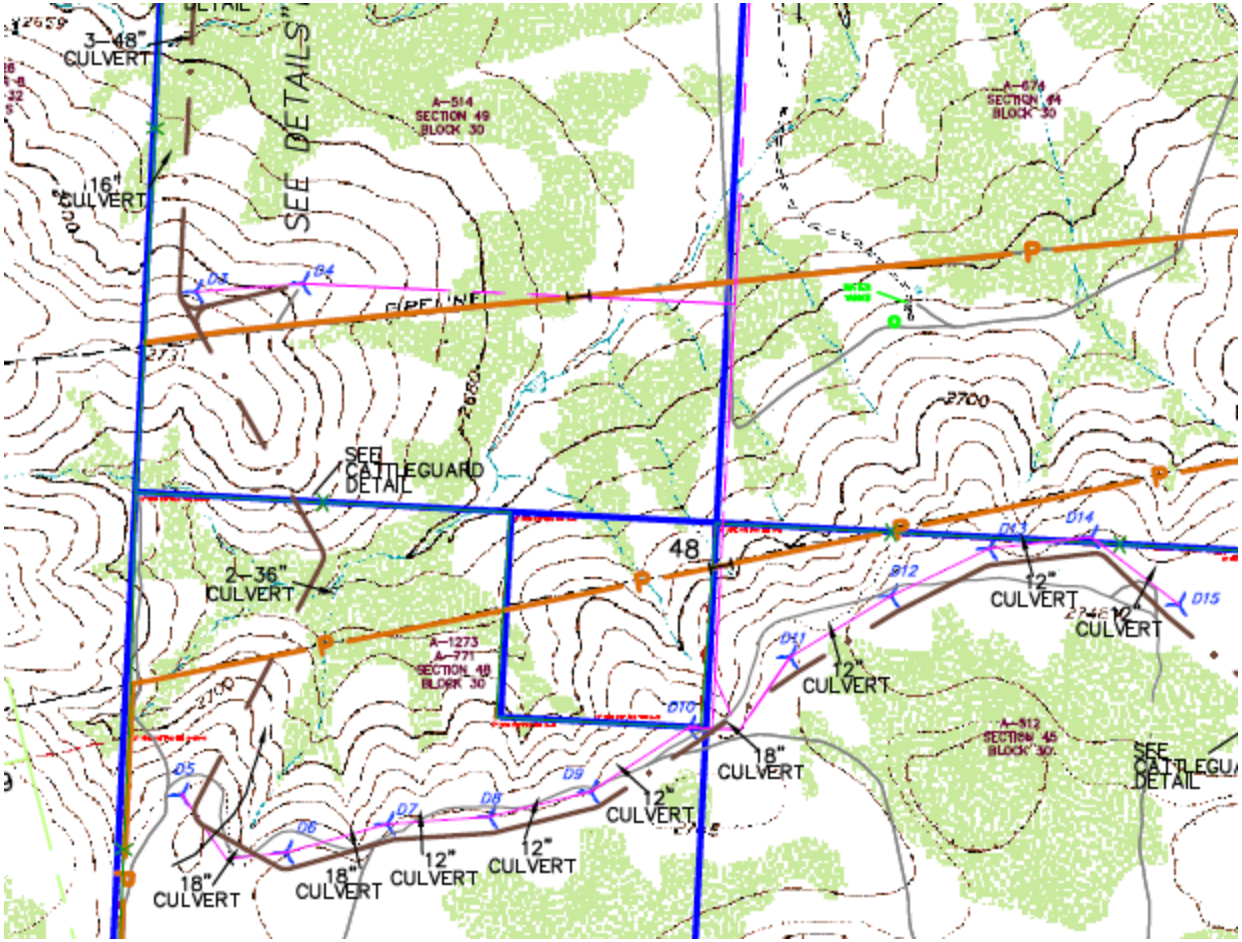
- Mines, pipelines, oil and gas, quarry, etc



Stormwater Pollution Prevention

Water Usage During Construction

- State regulations vary widely as to permitting process



Geotechnical Investigation

What are the subsurface conditions of the rock or soil?

- One hole per foundation, depth depends on foundation design
- Measure rock or soil type, ‘hardness’ of rock or soil, remove core samples and examine to understand how fractured the rock is, ground water level,
- Was the material previously disturbed (mining, reclamation, etc)
- Goal is to determine bearing capacity

Road Construction

Road and Site Preparation

- Clear and grub, subsoil preparation and compaction, road base, maintenance

Site Preparation

Site Preparation

- Clear and grub, subsoil preparation and compaction, road base, maintenance

Foundation Water Usage

Water Usage During Construction

- Dust control, component washing, backfill compaction (foundation backfill and trench backfill), concrete mixing (on site batch plants)

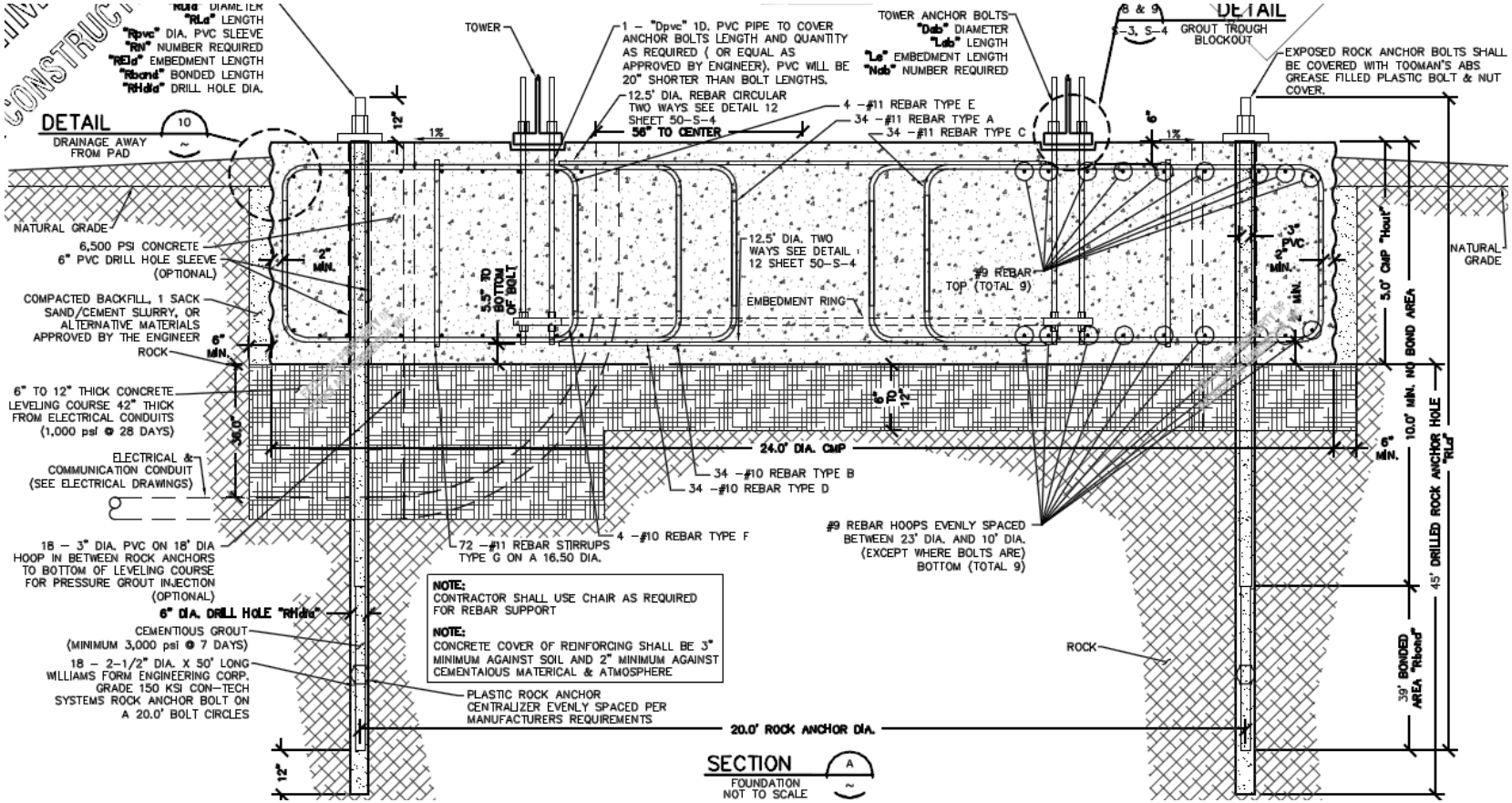
- Rock anchor 1.5MW 80m Hub Height ~3,300 gal/foundation
- Monopier 1.5MW 80m Hub Height ~5,500gal/foundation
- Spreadfoot 1.5MW 80m Hub Height ~6,500 gal/foundation
- Spreadoot 3.0mw 80m Hub Height ~11,000 gal/foundation

- Dust control ~1,500 gal/mile/day during construction depending on location
- Mag chloride is an option, possibly more expensive, some landowners object

Rock Anchor Side View

Rock anchor

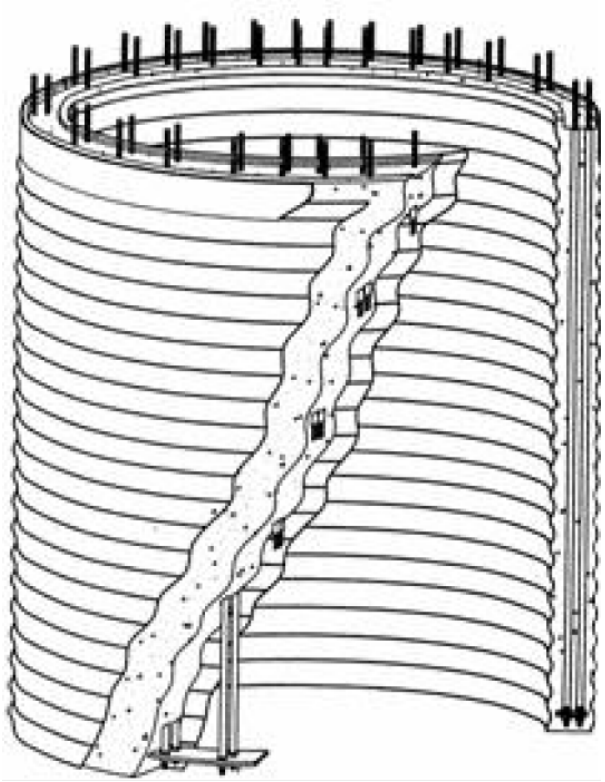
- Needs suitable non highly fractured rock to be cost effective
- More labor intensive
- Fewer commodities (steel, concrete)

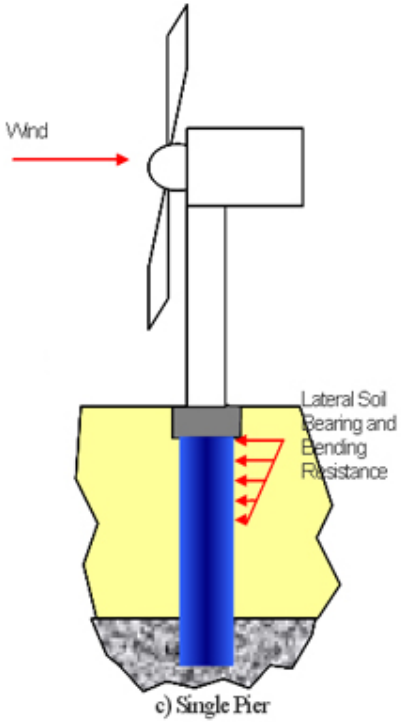


Tensionless Mono-pier

Mono-pier

- Specifically designed for soils, special applications for unstable soils (mine tailings, previously disturbed soil)
- Less concrete and steel than spreadfoot, more labor and equipment costs
- Can be 5-10% cheaper overall than spreadfootings depending on labor and materials costs

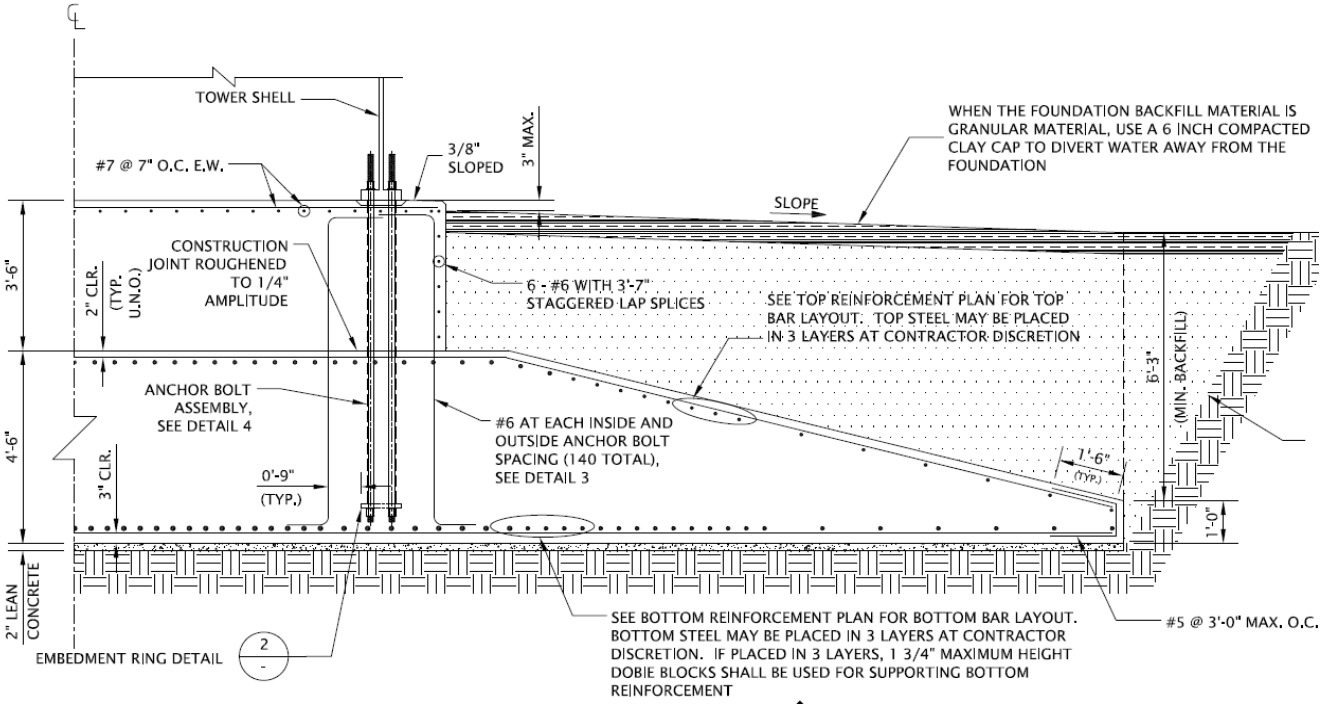


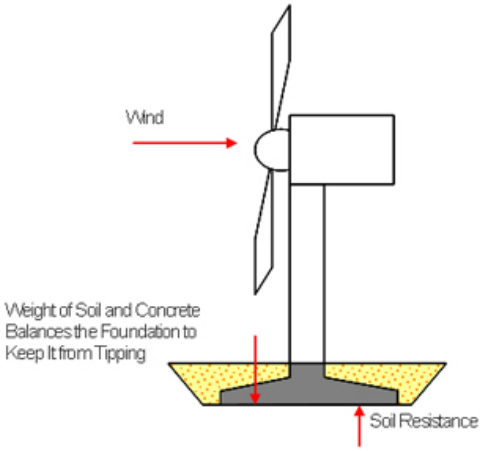


Spreadfooting “T”

Spreadfoot

- Most common
- Typical 1.5MW spreadfoot foundation ~250 yd^3/foundation
- Simple construction, fewer variables than piers, rock anchors

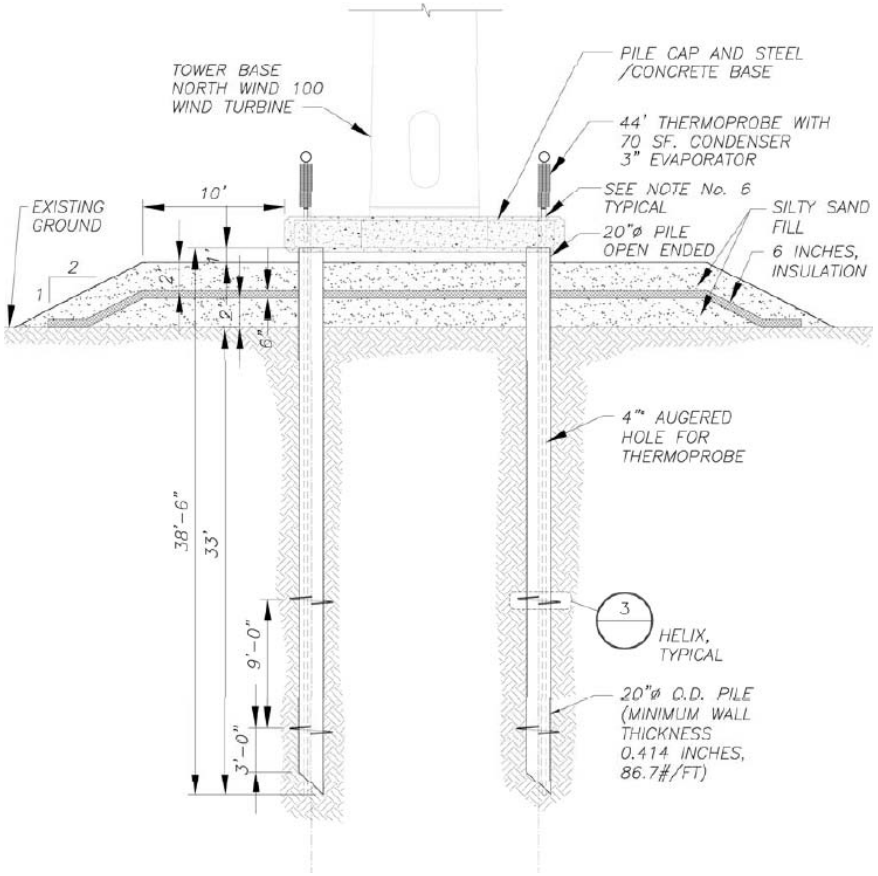




Pile Foundations

Driven Pile

- Applicable in unstable soils
- Much more costly to construct depending on depth to bedrock
- Similar to rock anchor but piles can be placed in compression or tension.
- PA project, 60,000 LF of pile cost $6million for 35 foundations



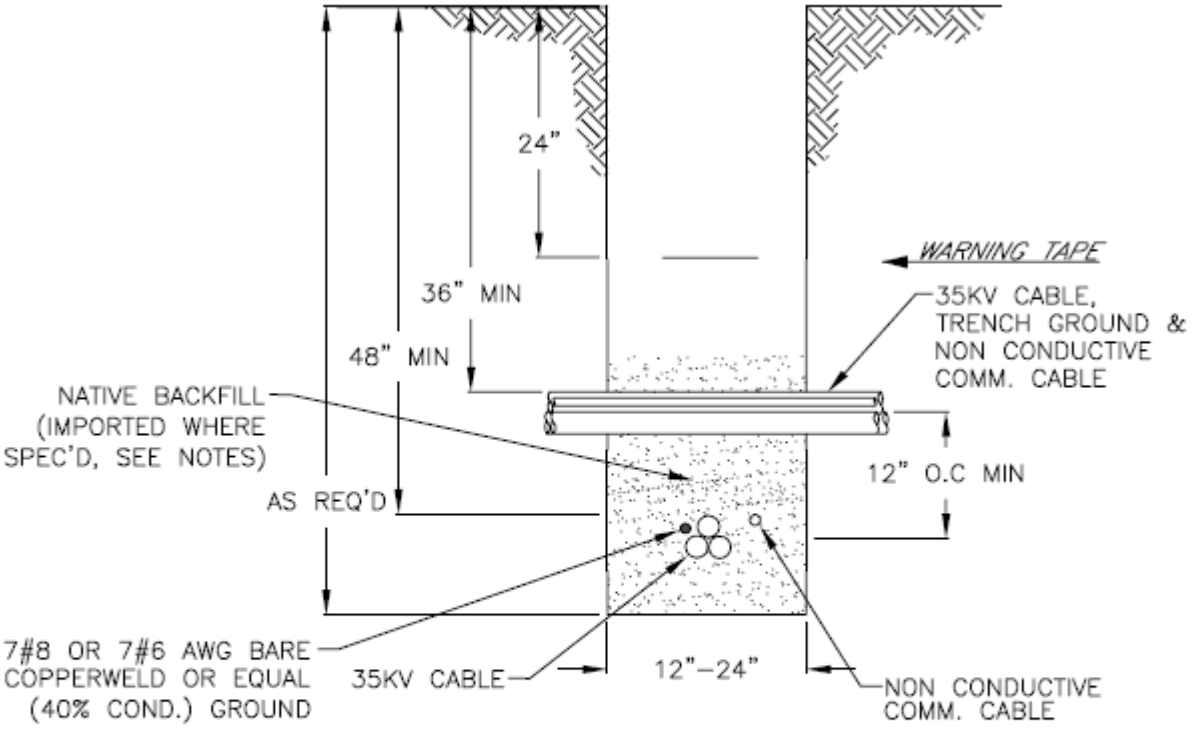
Collection System

Less labor dependence, more material and commodity driven

HIGHLY soil dependant, thermal resistivity drives cable cost

Cable cost can be 40-50% of collection system cost

Collection System – Typical Cable Cross Section



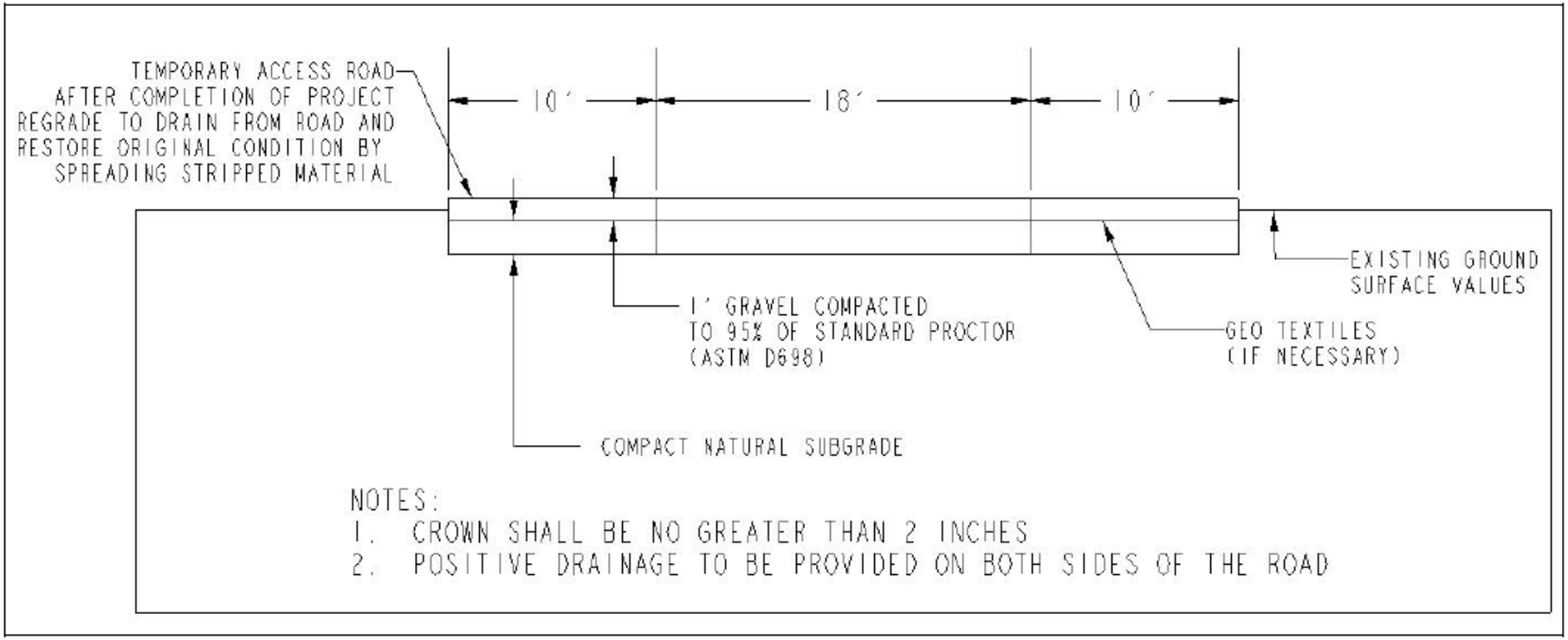
DIRECT BURIAL INSTALLATION

DETAIL G

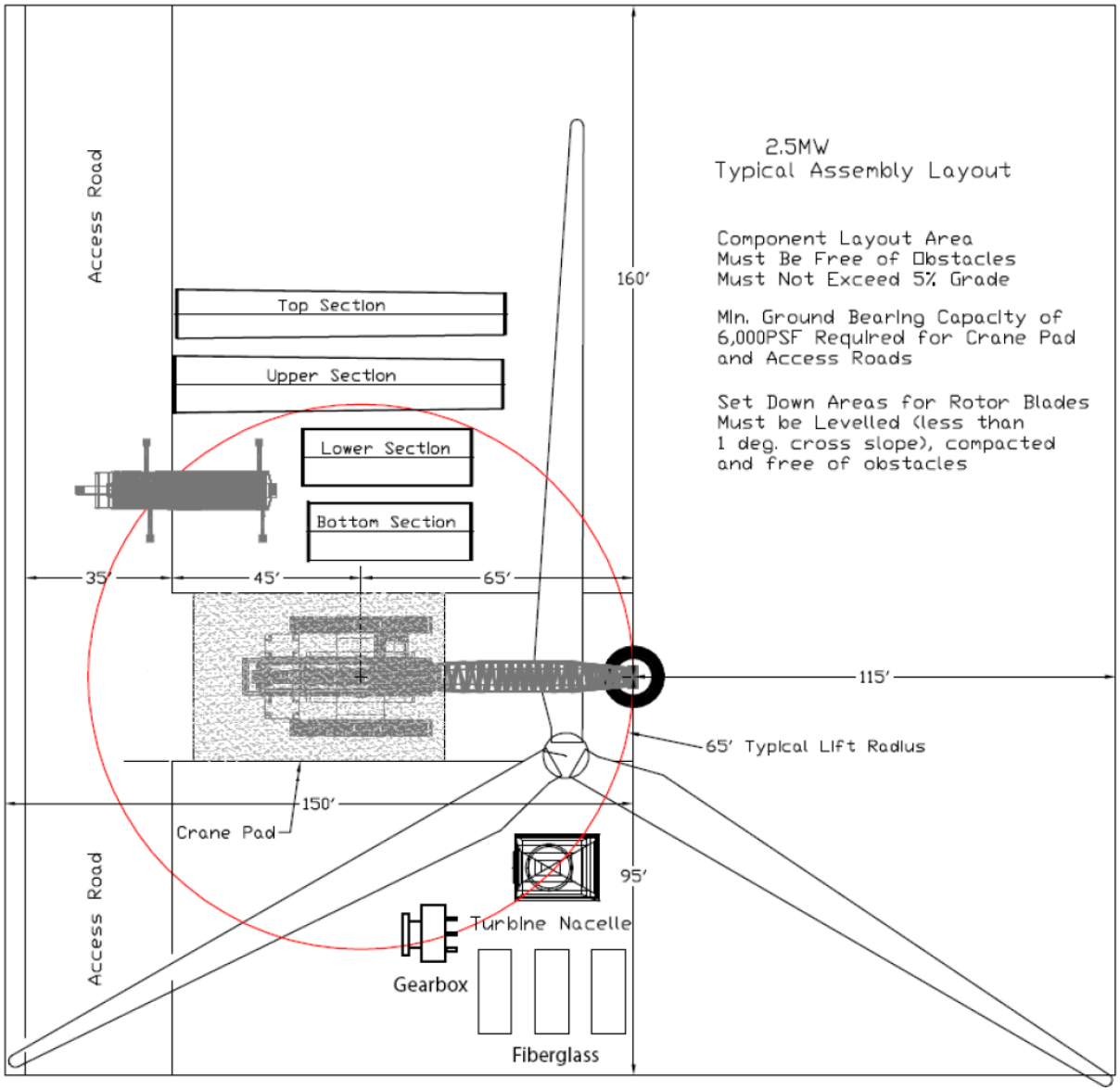
CABLE CROSSING DETAIL

Typical Road Configuration

- Typical 16’ roadway to allow component travel
- Compacted shoulders required for crane travel, testing is critical
- Shoulders can typically be decompacted after the farm enters operation



Typical Turbine Site Configuration



- Note: Single blade erection is possible with most modern turbines which decreases the amount of disturbed area.
- Other options such as delivering each component as needed is a common practice in space constrained sites, but expensive.

Buffalo Mountain, TN

- Note lack of laydown areas, each component delivered as needed to each location
- Compacted shoulders required for crane travel, testing is critical
- Shoulders can typically be decompacted after the farm enters operation

Buffalo Mountain, TN

Photo credit: Barnhart Crane and Rigging

Turbine Installation

Substation

Main Erection

Crane Movement

Component Offload

Component Offload

Erection Sequence

Erection Sequence

Erection Sequence

Erection Sequence

Erection Sequence

Erection Sequence

Questions?