Soil Dynamics

…….So when is the concrete being delivered?

How important is soil type?

Video illustrating the dynamic nature of soil

- **Provided by the Society of Civil Engineers:**
- https://www.youtube.com/watch?v=

WHY we need to analyze soil conditions:

- 150 lbs per cu ft of "dead" Weight of Concrete when cured – **excluding** rebar, tower, antenna, rotor and wiring;
- Tower concrete footings and piers are meant to act as an anchoring point for the tower/antenna dynamic reaction to the wind along with accommodating the dead weight.
- Rule out subsurface "Unknowns";
- Tower structure stability is determined by what type of soil it will be placed on- keeping the Tower structure upright and level is critical;
- Adverse weather conditions can also expedite severe soil shifting conditions.
- ADD to this scenario : a Tower adjoining another structure!!

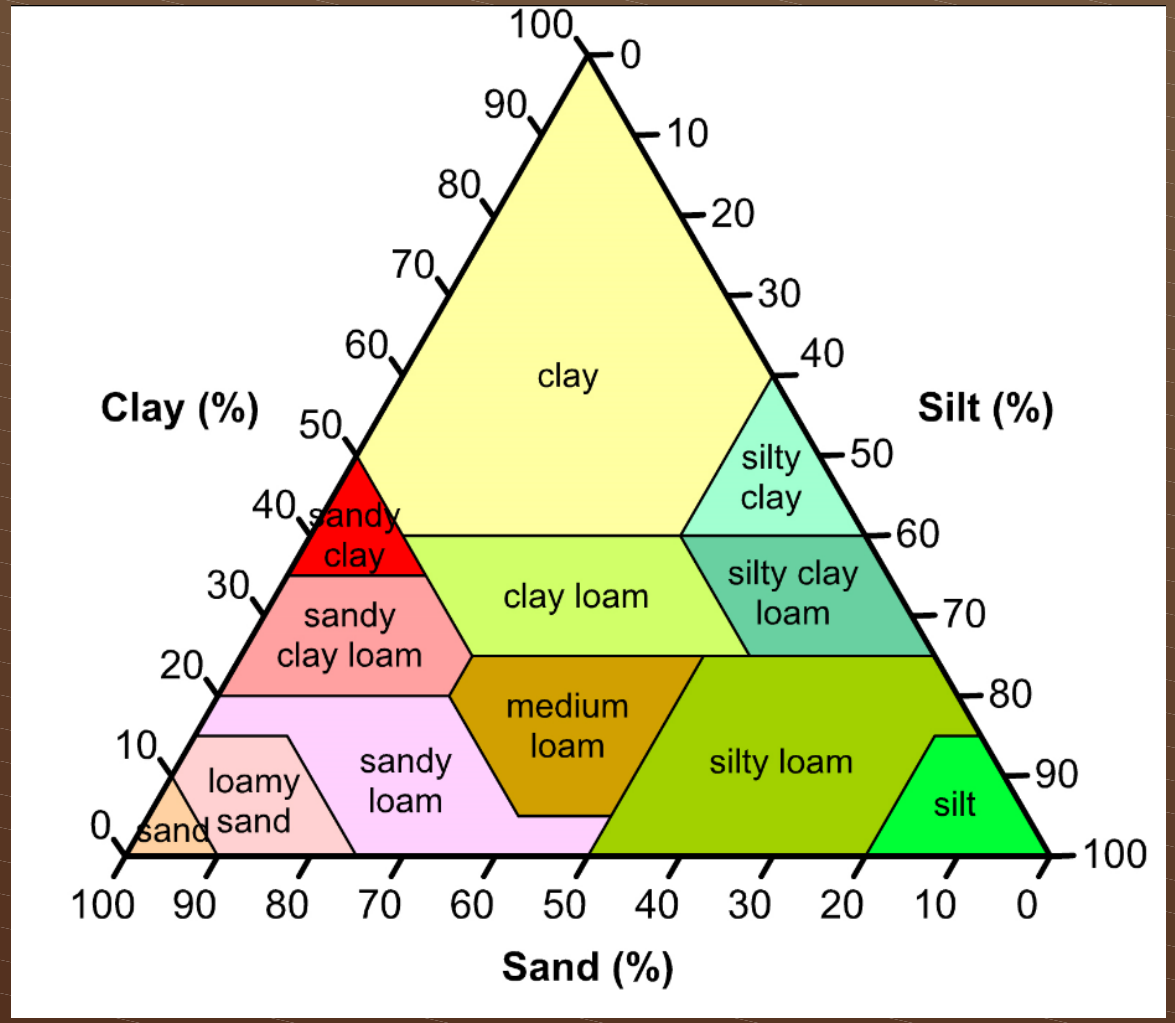
<u>Wish list of every Ham</u>:

-We all want a tower that's tall enough to clear tree tops >55 ft;

-We all want a multi-banded "**MONSTER" directional** Antenna with A LOT of gain;

-We expect it to be *functional all the time* and to survive "Pocono weather" patterns- a.k.a. frequent high winds, snow/ice and heavy rains;

What above equates to is a "structural system" that can support ANTENNA system components that will not fail because of unknown conditions!!



Different Soil conditions

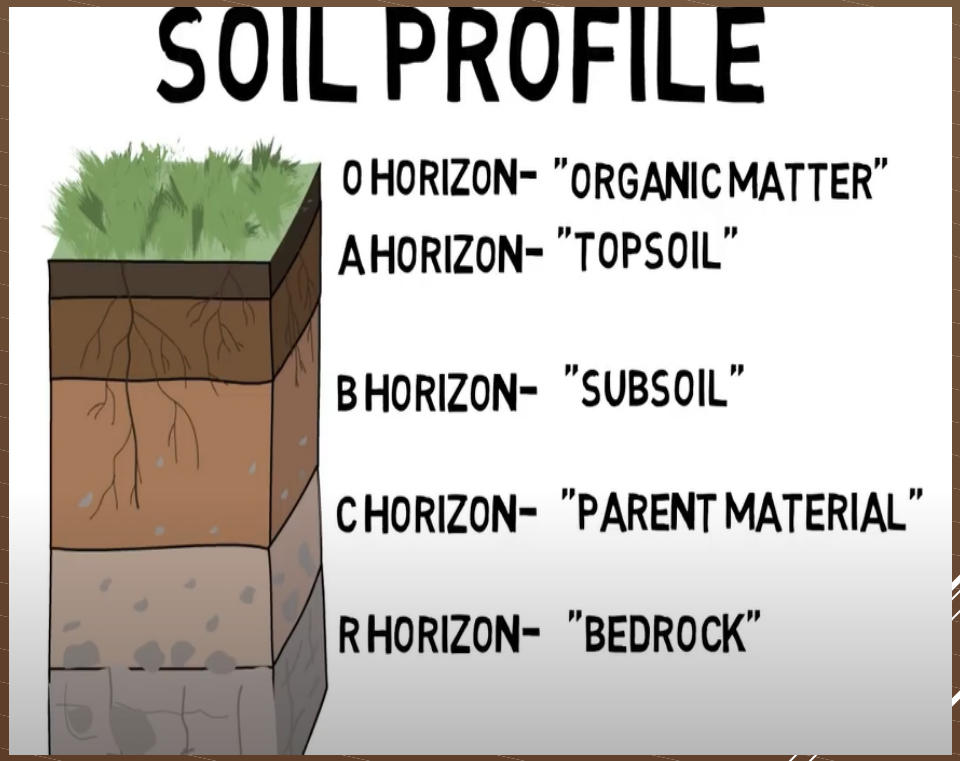
- Depending on the existing soils at the tower location will determine the appropriate engineered solution to carry the combined loads of the assembled tower and antenna.

- **Definitions according to USDA Guidelines…..**

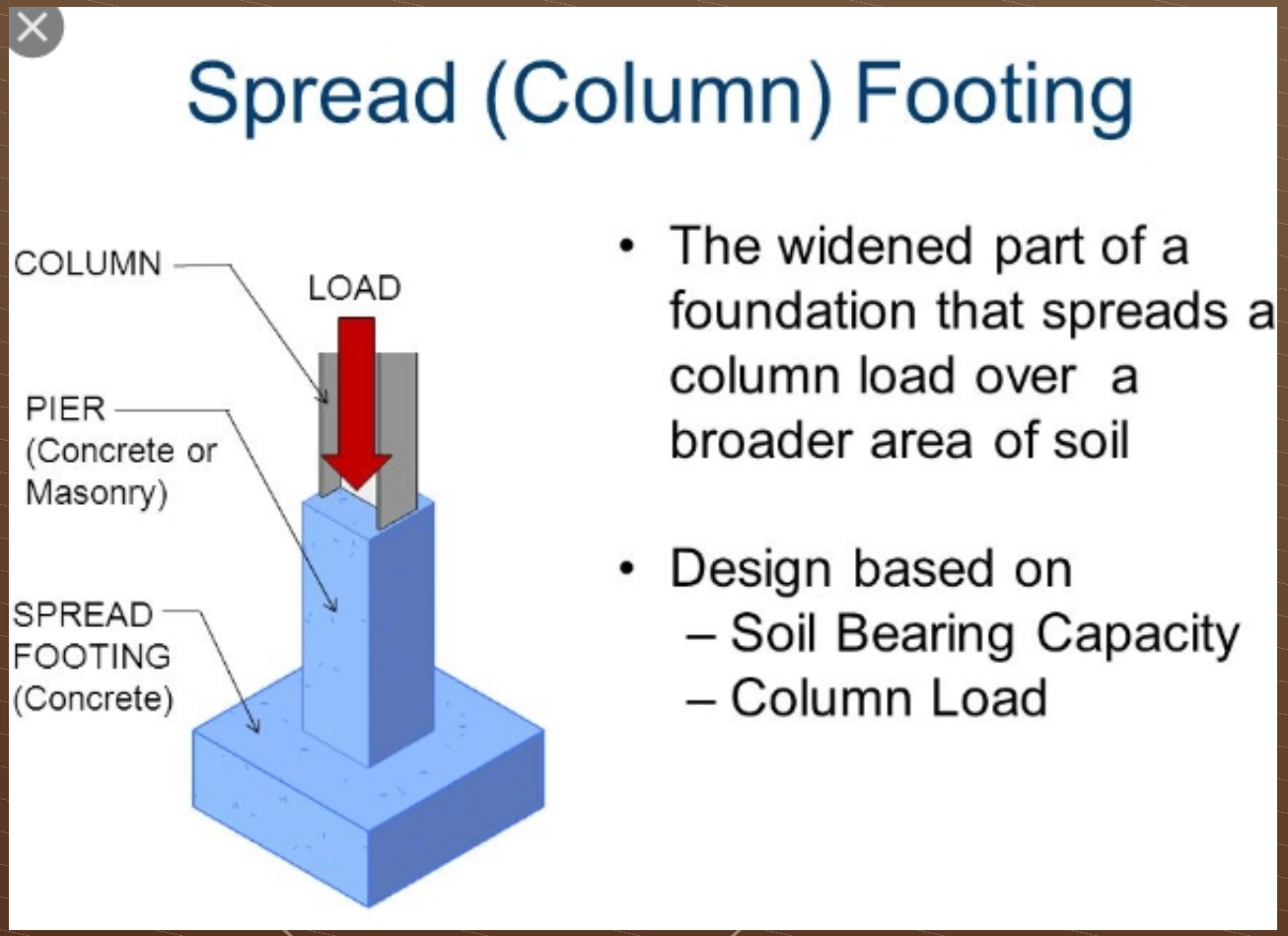
Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

- But where and How low?



GET to Know your sub surface Composition !



Proper Soil Analysis to support Tower Manufacturer installation recommendations

- **Particularly if the area in question had soil brought in as "fill"; A professional determination is needed….**
- **if the current soil characteristics fit any of the known technical classifications and deemed "adequate" for construction.**

GUESS HOW Heavy a 6ft x 6ft x 6ft solid concrete base weighs?

- **HINT: Weighs more than the Tower, Antenna and appurtenances….**

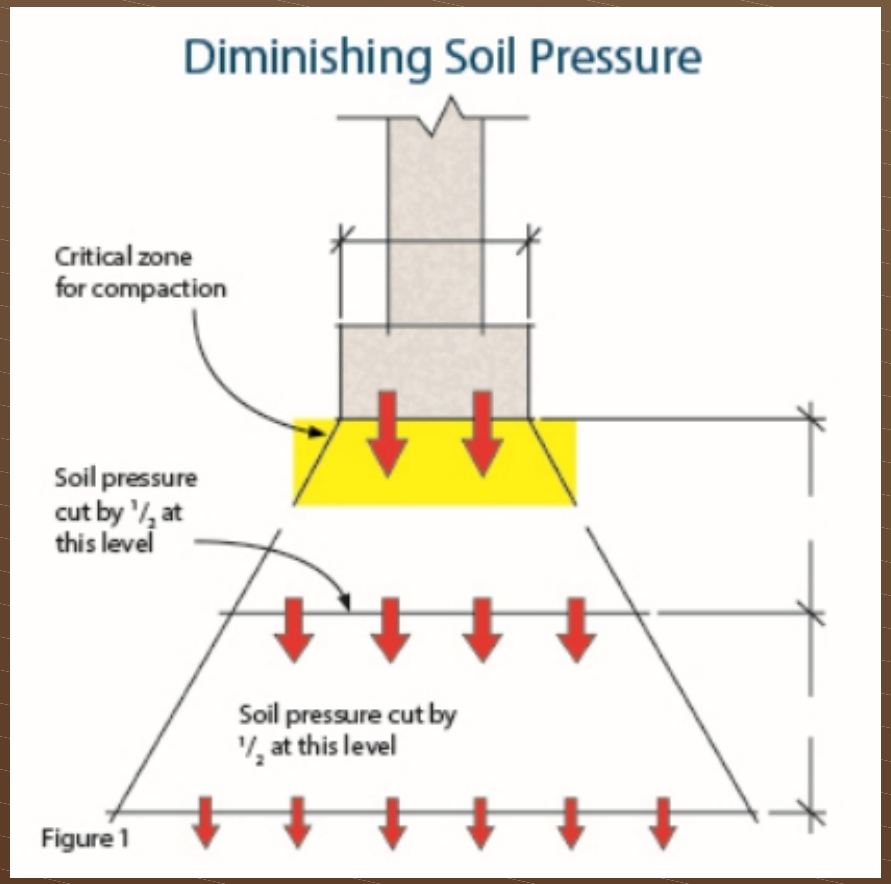
Answer:

- 32,400 LBS!
- Image all this weight concentrated in one spot. The soils reaction to this pressure must be able to withstand this 900 Lb /sq ft surface bearing force over time.
- NOTE: If soil conditions are not “idea” it cannot support dead-loading condition then resulting consequences which my be severe!

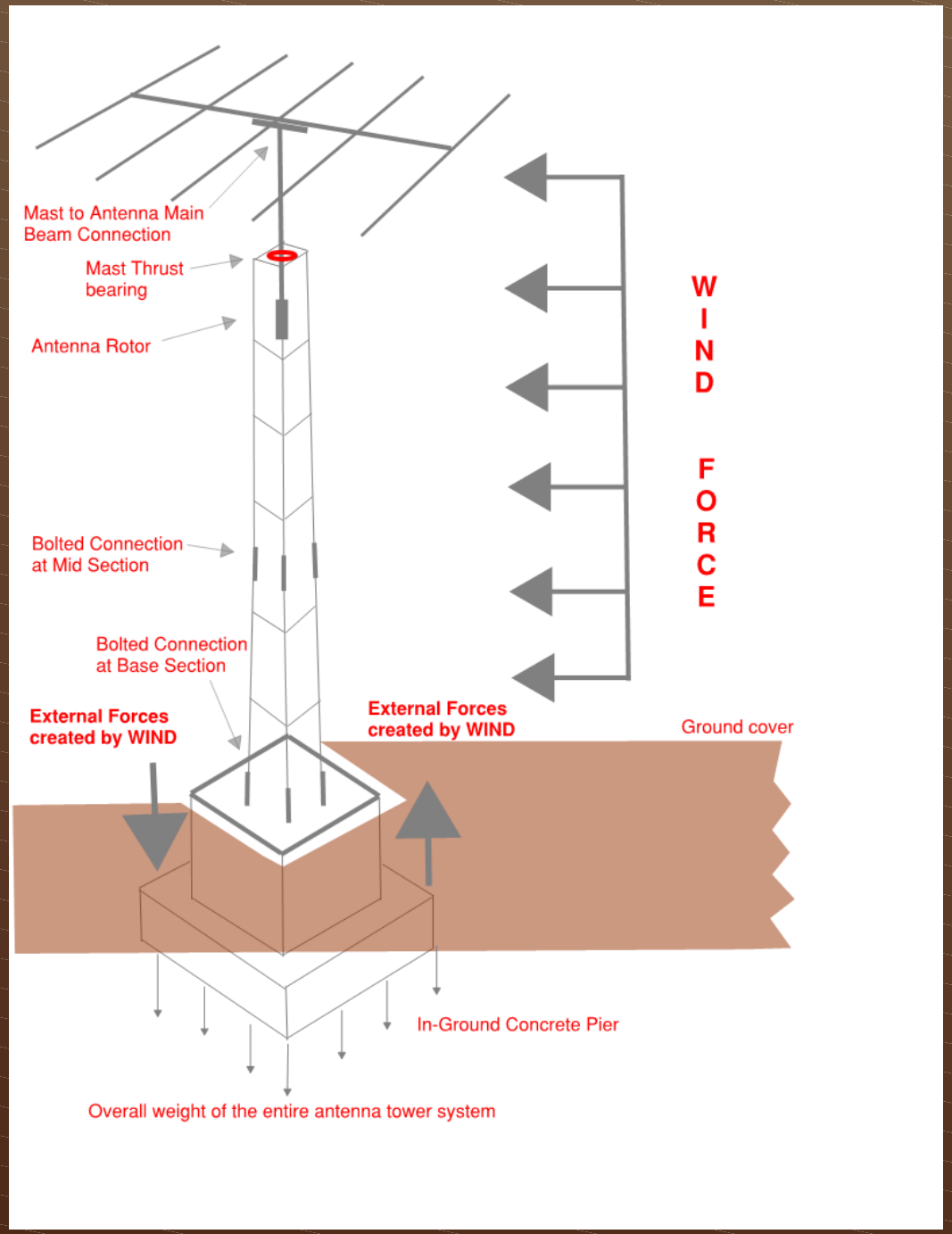
Huge Tower Bases for HAMS – Not Uncommon!!

- **Special thanks to Bill/W3MJ for these pictures:**
- **A 6ft X 6ft X 6ft concrete base was installed at his QTH to support his antenna and tower. The concrete is also anchored to in ground undisturbed rocks at the bottom.**

If IN DOUBT… Plan FOR THE WORST CASE S !



- Immediate area under the concrete footing will be subject to immense downward pressure and spread to the surrounding area. The underlying soil must have the correct composition to withstand this over time.



NOW Consider the entire Antenna tower as a "*SYSTEM*"

- The tower is comprised of multiple assembly points where each mechanical connection introduces a stress point.
- All the combined weights of all mounted devices contribute to the overall load of the tower.
- Imagine a wind force great enough that's capable of toppling it over, think of this as a likely scenario.
- All of the individual components are a factor for resisting opposing forces such as wind shear:
- -"Sleek" Antenna design to reduce wind loading;
- -Antenna mast thrust bearing at rated loads;
- -Tower rung patterns and overall leg diameters;
- -Multiple guyed connections maybe required.
- VISIT EACH TOWER MANUFACTURES WEBSITE to COMPARE HOW THESE PARAMETERS DIFFER. Differences may save you work in the long run!

A State Licensed Professional will:

- Examine soil conditions;
- Research local area historical weather patterns and propose any modifications for the tower installation;
- Determine concrete and all tower anchoring details;
- Tower system analysis for all mechanical connections and loading;
- Provide a drawing to appease any local municipality requirements.

CONSULT with A Professional Engineer!

KWWL, Rowley, Iowa	November 28, 1983	Guyed steel lattice mast	610	Ice
Bielstein, Germany	January 15, 1985	Guyed steel tube mast	298	Ice
San Francisco, CA, US - Candlestick Hill	February 14, 1986	Self-supporting tower	137	High wind.
Caroline 558 and Radio Monique mast, aboard MV Ross Revenge, off English coast	November 25, 1987	Lattice steel tower	92	Force 8 storm
KTUL Tower Coweta, OK	December 26, 1987	Lattice steel guyed tower	582	Ice storm
Vännäs TV Tower, Vännäs, Sweden	1988	Guyed mast on top of a concrete tower.	323	Icing
KTVO-TV Tower, Colony, Missouri	June 2, 1988	Guyed steel lattice mast	610	During repairs
KGO (AM) towers Newark, California	October 17, 1989	?	91	Earthquake
WRAL-TV & WPTF-TV towers, Auburn	December 1989	Two guyed steel tube framework masts	609	Ice
RÚV long wave radio mast, Vatnsendahæð, Reykjavik, Iceland	February 3, 1991	Guyed steel lattice mast		Storm
WDIO-TV Duluth, Minnesota, US	March 23, 1991	Guyed steel triangular tower	259	Ice and high wind

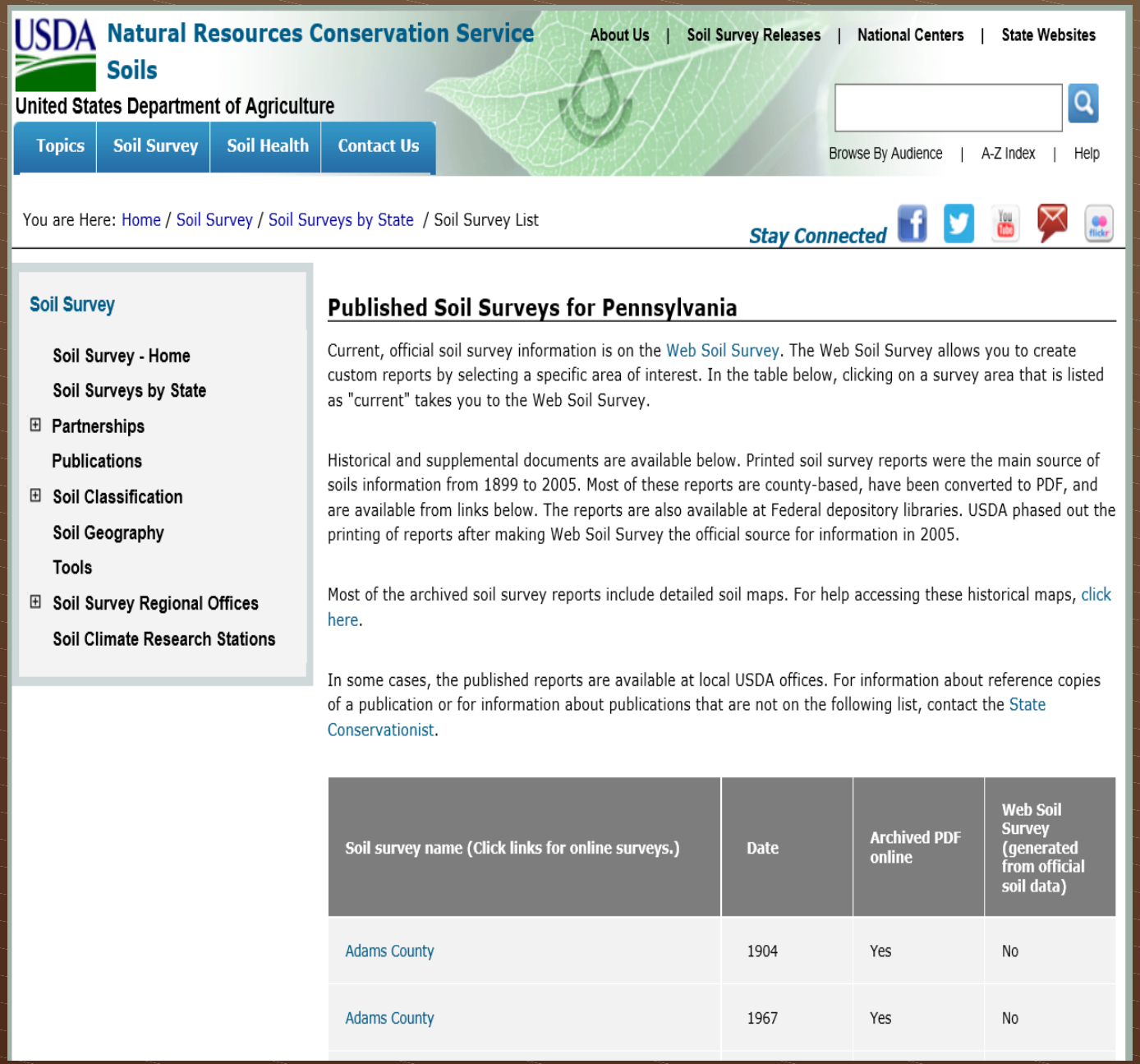
WDIO-TV Duluth, Minnesota, US	March 23, 1991	Guyed steel triangular tower	259	Ice and high wind
Warsaw radio mast, Konstantynów, Poland	August 8, 1991	Guyed steel tube framework mast	648	Maintenance
WCIX TV Tower Homestead, Florida	August 25, 1992	Guyed steel tower	549	Hurricane Andrew
COMMSTA Miami	1992	Guyed mast (insulated)	91	Hurricane Andrew
Cape Race LORAN-C transmitter, Cape Race, Canada	February 2, 1993	Guyed steel lattice mast	411	Material fault
LORAN-C transmitter Kargaburan, Kargaburan, Turkey	February 25, 1993	Guyed steel lattice mast	191	Snowstorm
WCOV-TV Tower, Montgomery, Alabama, US	1996	?	242	Tornado
Langenberg, Germany	September 2, 1996	Guyed steel lattice mast	160	Maintenance
KXTX-TV Tower Cedar Hill, Texas	October 12, 1996	Guyed steel tower	468	Maintenance for DTV install
Grigoriopol transmitter, Moldova	1997	Guyed steel lattice mast	350	Icing
Grigoriopol transmitter, Moldova	1997	Guyed steel lattice mast	250	Icing
KXJB-TV mast, North Dakota, US	April 6, 1997	Guyed steel lattice mast	628	Ice

Common Causes of commercial tower failures

Hurricane Andrew WCIX Tower - FLA

Tips on Excavating

- Limit the excavator equipment for gross area being dug out. The ideal is to disturb the least amount of area with heavy equipment;
- “Fine Tune” the cut by removing remaining areas by hand;
- Leave very large stones in the cut unless it prohibits anchoring the new concrete effectively;
- When back filling area, use vibratory machines and compact every foot when proceeding- we call this “Lifts”;
- And…Don’t forget the electrical grounding loop for the tower to be buried as well!



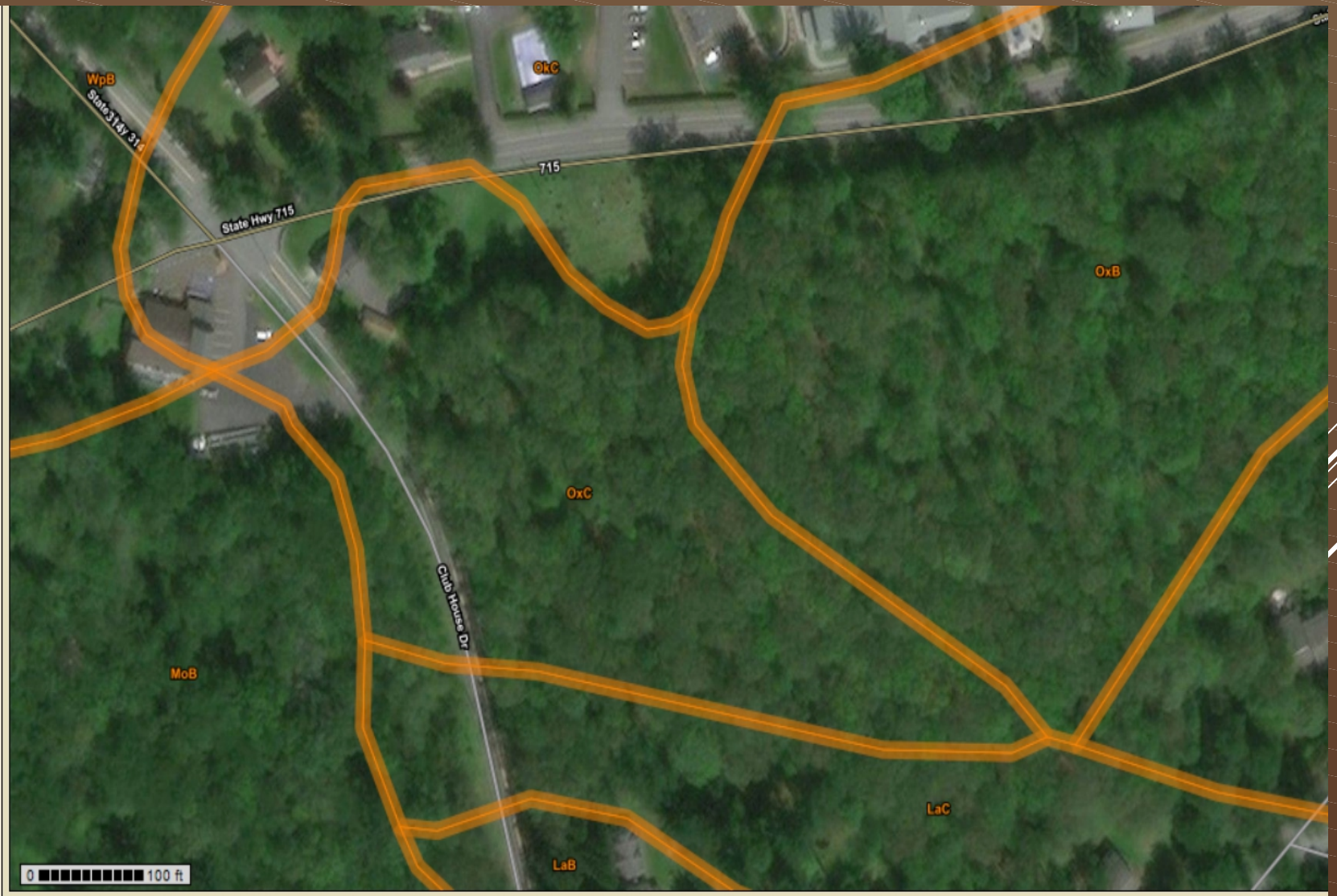
What is your soil type? .....USDA Resource aids:

- Historical Data but must be considered only for known undisturbed areas

Digging further: USDA WEBSITE APP - "AOI"

ap Unit Legend

	slopes		
)xB	Oquaga-Lackawanna complex, 0 to 8 percent slopes, extremely stony	8,320.6	2.1%
)xC	Oquaga-Lackawanna complex, 8 to 25 percent slopes, extremely stony	17,197.4	4.4%
h	Philo silt loam	2,027.3	0.5%
o	Pope silt loam	1,887.1	0.5%
p	Pope silt loam, high bottom	1,720.5	0.4%



Warning: Soil Map may not be valid at this scale.

TABLE 4--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ad	Alden mucky silt loam	799	0.2
AnA	Allenwood gravelly silt loam, 0 to 3 percent slopes	444	0.1
AnB	Allenwood gravelly silt loam, 3 to 8 percent slopes	670	0.2
AnC	Allenwood gravelly silt loam, 8 to 20 percent slopes	197	0.1
As	Alluvial land	2,771	0.7
AvB	Alvira gravelly silt loam, 3 to 8 percent slopes	348	0.1
AwB	Alvira and Watson very stony loams, 0 to 12 percent slopes	784	0.2
BaB	Bath channery silt loam, 3 to 8 percent slopes	817	0.2
BaC	Bath channery silt loam, 8 to 15 percent slopes	866	0.2
BaD	Bath channery silt loam, 15 to 25 percent slopes	279	0.1
BbB	Bath very stony silt loam, 0 to 8 percent slopes	518	0.1
BbC	Bath very stony silt loam, 8 to 25 percent slopes	402	0.1
BeB	Benson-Rock outcrop complex, 0 to 8 percent slopes	1,763	0.5
BeC	Benson-Rock outcrop complex, 8 to 25 percent slopes	5,761	1.5
BeF	Benson-Rock outcrop complex, 25 to 70 percent slopes	5,600	1.4
BrA	Braceville gravelly loam, 0 to 3 percent slopes	1,066	0.3
BrB	Braceville gravelly loam, 3 to 8 percent slopes	1,404	0.4
BuB	Buchanan loam, 3 to 8 percent slopes	822	0.2
BxB	Buchanan extremely stony loam, 0 to 8 percent slopes	3,242	0.8
BxC	Buchanan extremely stony loam, 8 to 25 percent slopes	407	0.1
ChA	Chenango gravelly loam, 0 to 3 percent slopes	1,273	0.3
ChB	Chenango gravelly loam, 3 to 8 percent slopes	1,539	0.4
ChC	Chenango gravelly loam, 8 to 15 percent slopes	775	0.2
CmA	Chippewa and Norwich silt loams, 0 to 5 percent slopes	850	0.2
CnB	Chippewa and Norwich extremely stony soils, 0 to 8 percent slopes	18,797	4.8
CpA	Clymer loam, 0 to 3 percent slopes	1,491	0.4
CpB	Clymer loam, 3 to 8 percent slopes	1,048	0.3
CpC	Clymer loam, 8 to 15 percent slopes	653	0.2
CxB	Clymer extremely stony loam, 0 to 8 percent slopes	8,372	2.1
CxC	Clymer extremely stony loam, 8 to 25 percent slopes	1,251	0.3
Cy	Cut and fill land	4,248	1.1
DxB	Dekalb extremely stony loam, 0 to 8 percent slopes	3,110	0.8
DxC	Dekalb extremely stony loam, 8 to 25 percent slopes	3,293	0.8
DxE	Dekalb extremely stony loam, 25 to 60 percent slopes	3,634	0.9
ExB	Empeyville extremely stony sandy loam, 0 to 8 percent slopes	5,668	1.4
HaB	Hartleton channery silt loam, 2 to 8 percent slopes	2,680	0.7
HaC	Hartleton channery silt loam, 8 to 20 percent slopes	1,232	0.3
HxB	Hazleton extremely stony sandy loam, 0 to 8 percent slopes	775	0.2
HxC	Hazleton extremely stony sandy loam, 8 to 25 percent slopes	2,366	0.6
Hy	Holly silt loam	3,220	0.8
KaB	Kedron silt loam, 2 to 8 percent slopes	1,203	0.3
KaC	Kedron silt loam, 8 to 15 percent slopes	192	(1)
KdB	Kedron very stony loam, 0 to 8 percent slopes	1,375	0.4
KvB	Klinesville channery silt loam, 3 to 8 percent slopes	688	0.2
KvC	Klinesville channery silt loam, 8 to 15 percent slopes	712	0.2
KvD	Klinesville channery silt loam, 15 to 25 percent slopes	488	0.1
LaB	Lackawanna channery loam, 2 to 8 percent slopes	2,921	0.7
LaC	Lackawanna channery loam, 8 to 15 percent slopes	1,527	0.4
LaD	Lackawanna channery loam, 15 to 25 percent slopes	698	0.2
LbB	Lackawanna extremely stony loam, 0 to 8 percent slopes	13,291	3.4

TABLE 4--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
MeB	Meckesville gravelly loam, 3 to 8 percent slopes	2,059	0.5
MeC	Meckesville gravelly loam, 8 to 15 percent slopes	791	0.2
MfB	Meckesville very stony loam, 0 to 8 percent slopes	2,230	0.6
MfC	Meckesville very stony loam, 8 to 25 percent slopes	1,427	0.4
MgB	Morris channery silt loam, 2 to 10 percent slopes	1,413	0.4
MoB	Morris extremely stony silt loam, 0 to 8 percent slopes	13,875	3.5
MoC	Morris extremely stony silt loam, 8 to 20 percent slopes	758	0.2
Mp	Mucky peat, deep	4,322	1.1
Ms	Mucky peat, shallow	5,630	1.4
OkB	Oquaga-Lackawanna channery loams, 3 to 8 percent slopes	1,904	0.5
OkC	Oquaga-Lackawanna channery loams, 8 to 15 percent slopes	2,226	0.6
OkD	Oquaga-Lackawanna channery loams, 15 to 25 percent slopes	995	0.3
OxB	Oquaga-Lackawanna extremely stony loams, 0 to 8 percent slopes	9,068	2.3
OxC	Oquaga-Lackawanna extremely stony loams, 8 to 25 percent slopes	17,143	4.3
Ph	Philo silt loam	1,936	0.5
Po	Pope silt loam	1,871	0.5
Pp	Pope silt loam, high bottom	1,770	0.5
ReA	Rexford gravelly silt loam, 0 to 3 percent slopes	1,454	0.4
ReB	Rexford gravelly silt loam, 3 to 8 percent slopes	311	0.1
RuC	Rushtown shaly silt loam, 5 to 15 percent slopes	672	0.2
RuD	Rushtown shaly silt loam, 15 to 30 percent slopes	270	0.1
Sh	Sheffield silt loam	1,530	0.4
SmA	Shelmadine silt loam, 0 to 3 percent slopes	460	0.1
SpB	Shelmadine very stony silt loam, 0 to 8 percent slopes	732	0.2
SwB	Swartswood channery sandy loam, 3 to 8 percent slopes	757	0.2
SwC	Swartswood channery sandy loam, 8 to 15 percent slopes	481	0.1
SxB	Swartswood extremely stony sandy loam, 0 to 8 percent slopes	12,803	3.3
SxC	Swartswood extremely stony sandy loam, 8 to 25 percent slopes	4,837	1.2
VaC	Very stony land and Rock outcrops, sloping	2,757	0.7
VaE	Very stony land and Rock outcrops, steep	2,631	0.7
VoA	Volusia gravelly silt loam, 0 to 3 percent slopes	287	0.1
VoB	Volusia gravelly silt loam, 3 to 8 percent slopes	824	0.2
VxB	Volusia extremely stony silt loam, 0 to 8 percent slopes	27,097	6.8
WaB	Watson silt loam, 2 to 8 percent slopes	1,099	0.3
Wb	Wayland silty clay loam	2,241	0.6
WeB3	Weikert channery silt loam, 3 to 8 percent slopes, eroded	476	0.1
WeC3	Weikert channery silt loam, 8 to 15 percent slopes, eroded	649	0.2
WeD3	Weikert channery silt loam, 15 to 25 percent slopes, eroded	888	0.2
WhB	Weikert-Hartleton channery silt loams, 3 to 8 percent slopes	2,795	0.7
WhC	Weikert-Hartleton channery silt loams, 8 to 15 percent slopes	2,855	0.7
WhD	Weikert-Hartleton channery silt loams, 15 to 25 percent slopes	983	0.3
WKE	Weikert and Klinesville soils, steep	4,235	1.1
WmB	Wellsboro channery loam, 3 to 8 percent slopes	3,265	0.8
WmC	Wellsboro channery loam, 8 to 15 percent slopes	1,057	0.3
WpB	Wellsboro extremely stony loam, 0 to 8 percent slopes	19,422	4.9
WpC	Wellsboro extremely stony loam, 8 to 25 percent slopes	5,015	1.3
WrB	Worth extremely stony sandy loam, 0 to 8 percent slopes	2,240	0.6
WrC	Worth extremely stony sandy loam, 8 to 25 percent slopes	1,322	0.3
WsB	Wurtsboro channery loam, 2 to 12 percent slopes	903	0.2
WxB	Wurtsboro extremely stony loam, 0 to 8 percent slopes	17,202	4.3
WxC	Wurtsboro extremely stony loam, 8 to 25 percent slopes	2,573	0.7
WyA	Wyoming gravelly sandy loam, 0 to 3 percent slopes	1,833	0.5
WyB	Wyoming gravelly sandy loam, 3 to 8 percent slopes	4,157	1.1
WyC	Wyoming gravelly sandy loam, 8 to 15 percent slopes	5,196	1.3
WyD	Wyoming gravelly sandy loam, 15 to 25 percent slopes	2,002	0.5
WyE	Wyoming gravelly sandy loam, 25 to 70 percent slopes	2,607	0.7
	Gravel pit	778	0.2
	Water	1,337	0.3
	Total	391,040	100.0

[1]Less than 0.1 percent.

Many different soil types are Native to the Pocono region

Remember to call national “800” dig if you are within a community

- Underground utilities need to be marked out:
- >>Gas
- >>Electric
- >>Cable/Fiber
- >>Sanitary Sewer

Lets Get digging! Thank You!