Grouting
Bentonite, and Cements

Mark Whittle
Baroid IDP

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Grouting Techniques

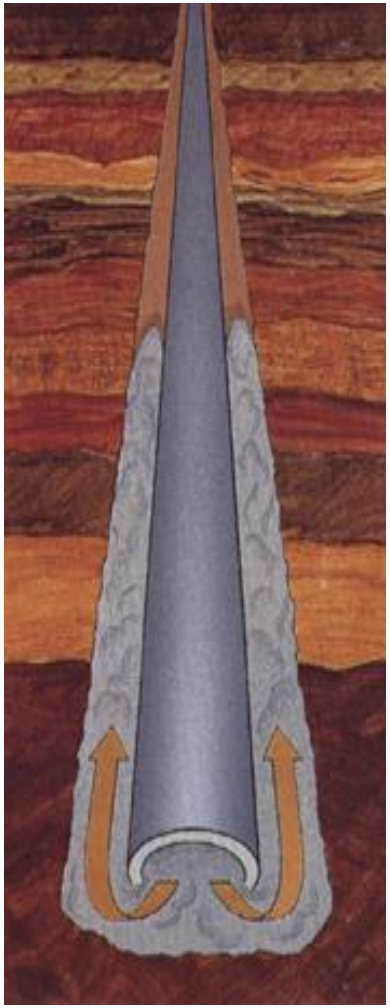
- Free Pouring in Borehole
- Pouring through Tremie Pipe
- Pumping through Casing
- Pumping through Tremie

Issues to Consider

- Requirements for an effective annular seal
  1. Effective Pre-Planning
  2. Effective Drilling Phase
  3. Effective Casing Set
  4. Effective Sealing Phase
- Key Factor to Remember
  - ☑ ***A Successful Seal Starts With The First Turn of The Bit***

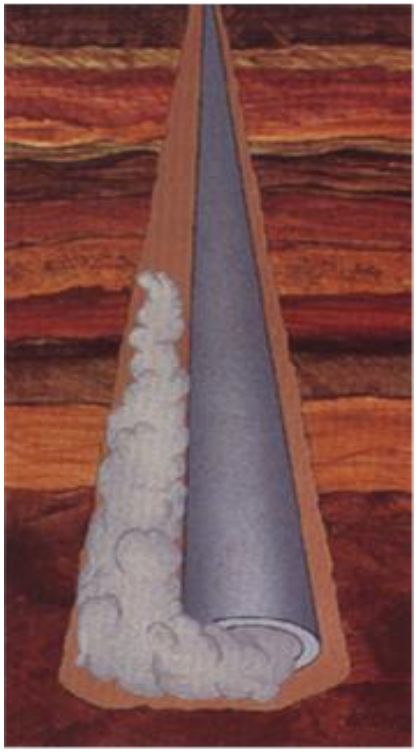
Displacement Factors

- Volume
- Pipe movement
- Pumping Rate
- Density
- Centralization
- Drilling Fluid Condition
- Deviation

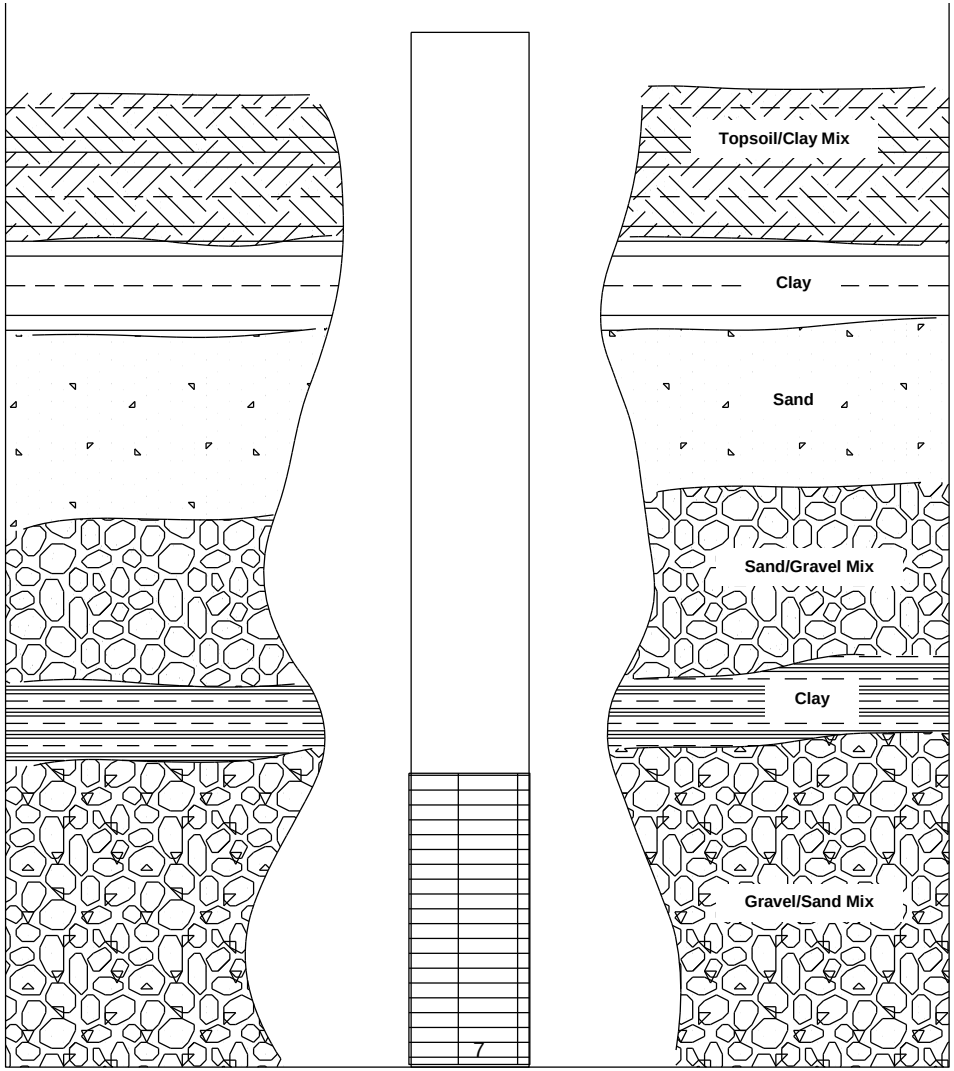


Mud Displacement

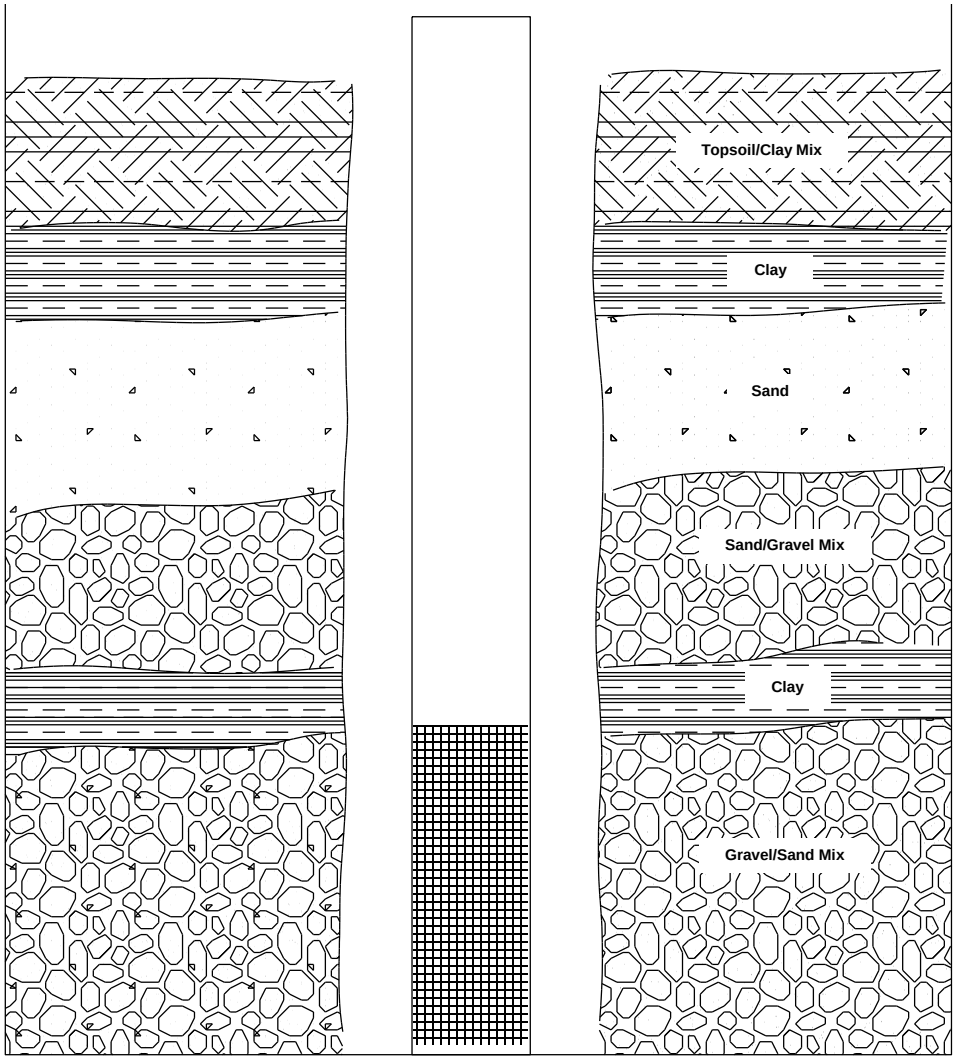
- Drilling fluid needs to be removed for cement/bentonite to bond to surfaces properly.
- This will include:
  - Drilling Fluid
  - Filtercake
  - LC Material



Impact of Washouts



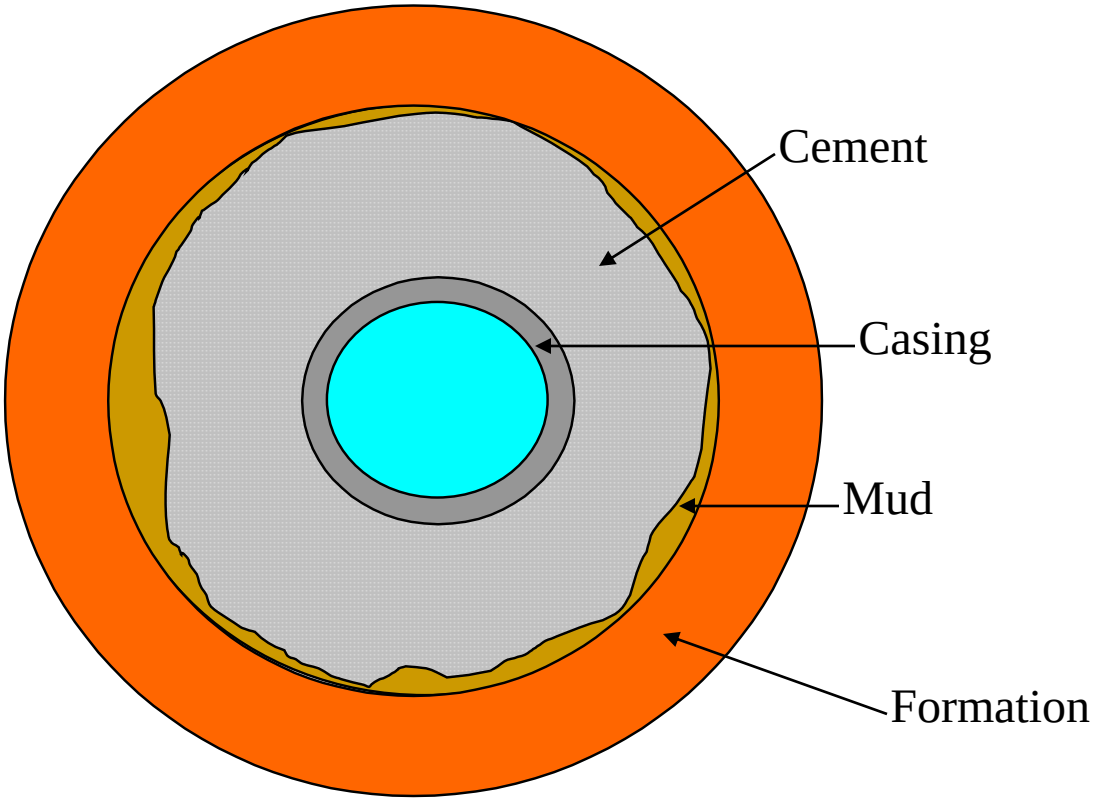
Benefits of a Gauge Borehole



Displacement Efficiency

200 gpm vs 20 gpm

$$\text{Displacement Efficiency} = \frac{\text{Cemented Area}}{\text{Annular Area}}$$



Cement or Bentonite are <u>One</u> of Many Tools for Contractors to Use

- ***While versatile, they can't fit every application!!!***
- ***The question of the day…….***
- ***Is the tool currently performing as we think it is??***
- ***How can we utilize the tool most effectively?***

Cement Grouts

- Neat Cement
- Bentonite-Cement Grouts
- Cement, Plus Additives

False Rumors

- Cement *melted* my Casing
- The Cement *flash set* in my tremie pipe or the borehole
- I need more water added
- Too thick to pump with my pump
- High Yield Bentonite can be added to cement to improve bonding and reduce shrinkage

Cement plus Bentonite

- Selected for reducing slurry density and increasing slurry volume
- Normal bentonite additions range from 1 to 12 percent by weight of cement (bwoc)
- For every 1% bentonite bwoc added the water content must be increased 0.65 gallons (assumes dry blending)
- Bentonite reduces resistance of cement to chemical attacks from formation water

Bentonite for use with Cement

- The proper material for addition to cement is **untreated, 200 mesh Bentonite, API 90 bbl/ton**
  - Polymer treated Bentonites alter bulk viscosity of cement and negatively impact set
- Granular Bentonite should not be used
  - Particle size variation, non-uniform distribution

Bentonite In Cement Slurry

Class “A” Cement with Bentonite				
Bentonite	Water	Slurry weight	Slurry volume	Pressure gradient
%	gal/sack	lb/gal	gal/sack	psi/ft
0	5.2	15.6	8.8	.811
2	6.5	14.7	10.2	.764
4	7.8	14.1	11.6	.733
6	9.1	13.5	12.9	.702
8	10.4	13.1	14.4	.681
12	13.0	12.5	17.1	.650

Notes: From Durham Geo - Slope Indicator

It is not really practical to try to match the strength of the grout to the strength of the soil, since the properties of grout and soil are so different. The cement-water ratio controls the strength of the grout. To decrease the strength of the grout, add more water.

Drillers are accustomed to mixing water and bentonite first, but this will not allow you to control the water-cement ratio. Mix water and cement first. Then add bentonite. There is no particular amount of bentonite that you must add. The thickness(viscosity) of the grout varies with water, temperature, and agitation, so the amount of bentonite required will vary.

Cement Failures

- Shrinkage
- Cracks
- Slumps
- Formation Loss

This is a “No Shovel Mixing Zone”

Cement Mixer???

This is not a Grouter!

Cement Should Be Pumped
To Facilitate Effective Displacement

Bentonite Grout Material

- Bentonite Chips
- 2-Step Inhibited Bentonite Grouts
- Dispersed Bentonite Grouts
- 1-Step Inhibited Bentonite Grouts
- Geothermal Grouts

Bentonite Chips

- Chips first used in seismic work, noticed that the chip Bentonite stayed in place after shot charge detonated.
- Saw the benefit of sealing casing in borehole.
- Used for Borehole Abandonments.

Bentonite Chips

- Best choice to seal Vadose Zone
- Excellent In-Situ swelling capabilities
- Will Pour though drilling fluids and Groundwater
- Requires adequate annular space and proper installation methods
- Recommended for above filter pack or to initiate casing seal

Granular Bentonite with Polymer

- First Developed by Sam Geffen and Carl Mason (Baroid IDP) during Late 1960's-early 1970's.
- Used in the field by Carl Mason.
- Frank Cannon, Joe Dobry, Carl Mason and others helped develop the grouter used to mix and pump the material.

Inhibited Bentonite Grouts

- 2 Part Inhibited Pumpable Bentonite Grouts
- Granular Bentonite with Polymer Coating

Granular Bentonite with Polymer

- 16.6% - 20% Total Active Solids by changing amount of water used
- Polymer slows down the Hydration of Bentonite to allow you to pump material down hole
- Polymer must be mixed and Hydrated first before addition of Bentonite

Fabricated Grouting Machine

Dispersed Bentonite Grouts

- Developed during the 1980's to have a bentonite grout that can be pumped more easily
- Developed for the Environmental and Water Well industries
- Used for bore hole sealing and abandonment.
- Needed a pumpable grout without the use of polymers (additives)
- Needed a high Solids Content

Dispersed Bentonite Grouts

- 20% Solids Dispersed Bentonite Grouts
- 30% Solids Dispersed Bentonite Grouts

20% Solids Dispersed Bentonite Grout

- 20% Total Active Solids (Base on 24 gallons of water)
- Utilize for Monitor & Water Well completions and abandonment
- Do not over mix or shear too much
- Do Not Use With Centrifugal Pumps

30% Solids Dispersed Bentonite Grout

- 30% Total Active Solids (Based on 14 Gallons of water)
- Totally inorganic additives
- Designed for sealing annular spaces in monitor and water well applications
- Do Not over mix or Shear too much
- Do Not Use With Centrifugal Pumps

Inhibited Bentonite Grouts

- The Industry Wanted Easier 1 Step, One Bag, not multiple products
- 1 Step Inhibited Pumpable Bentonite Grouts
- Coated Granular Bentonite

Inhibited Bentonite Grouts

- Andrew Liao (Baroid IDP) developed a way to coat the Bentonite Granular chips with a polymer coating to delay the hydration once the coating dissolved in the water.

Coated Granular Bentonite Grout

- Effective with Total Active Solids of 16.6%, 20%, 23% by changing amount of water used
- Must stir long enough to disperse the polymer coating
- DO NOT RECIRCULATE WITH PUMP
- Do Not Use With Centrifugal Pumps

Conclusions

- All Grouts failed in some way in the Vadose Zone
- All Bentonite Grouts passed in the Saturated Zone
- Bentonite Chips (+60% solids) the best in the Vadose Zone
- Cement had micro annular spaces between casing and grout in all zones
- The addition of sand to Bentonite Grouts or Cement helped

Conclusions

- Grouting deeper than the clays within the saturated zone is the best way to seal the bore hole
- How can we Improve?
- We must be willing to change
- Stop the “Do I have to”
- But I’ve done it this way for “Years”

Questions

Question from the field

- When grouting to 20', the only bentonite allowed in our local rules is 20% solids grout, as we fear that the contractors may not always have a clear annular space to 20'. If there was a difference of opinion, then there would be a "discussion" about what defines a "clear" annular space.

Question from the field

- Some of our well contractors work in other counties. One of these contractors pumps 20% solids and the REHS in another county remarked that most of his contractors used Holeplug or a similar product. This contractor, being somewhat knowledgeable about bentonite products, asked “How many bags do they use?”. The REHS replied “Two or three”. Using the Baroid calculator, I see that a 20’ grout hole with a 11.5” diameter and 6.9” OD PVC casing will require approximately 13 bags.

Question from the field

- When abandoning wells, sometimes the static water level is near the bottom of the well. If the contractor is using Holeplug or a similar product, not only does he need to pour the chips at a slow rate, we have been requiring that he add water to insure that the bentonite chips fall into water and start the hydration process. Is this a good idea?

Question from the field

- Baroid recommends two minutes to pour a bag of Holeplug. Does anyone follow directions?

Question from the field

- . Some contractors have abandoned wells by pumping 20% solids grout. Placing the bottom of the tremie pipe a few feet off the bottom and pumping grout until it is full seems to work well. The tremie can be raised as the grout is pumped but shall remain submerged in grout during the entire application. We had one contractor place a 100' tremie in a 400' well. This was not a good idea. Unfortunately, there is no easy way to correct the situation after it has occurred. Any recommendations for Environmental Health people?

Question from the field

- Most or our contractors that pump 20% solids complete the top three feet of their grout with Holeplug or a similar product. Typically, they will do this when they set the pump. Some even pour the chips as soon as they are done pumping the 20% solids grout. When we do the Well Final Inspection and collect samples, there are dry bentonite chips under the well cover. When we run the water for several minutes, it flows between the chips until they are hydrated. Is this an acceptable method of grouting the top three feet? If we advise them to use five gallons of water, they will probably pour it into the space and then dump the chips in. Meanwhile, the water has moved into the formation. Should they maintain water in the space until all the chips are placed and have started hydrating?

Question from the field

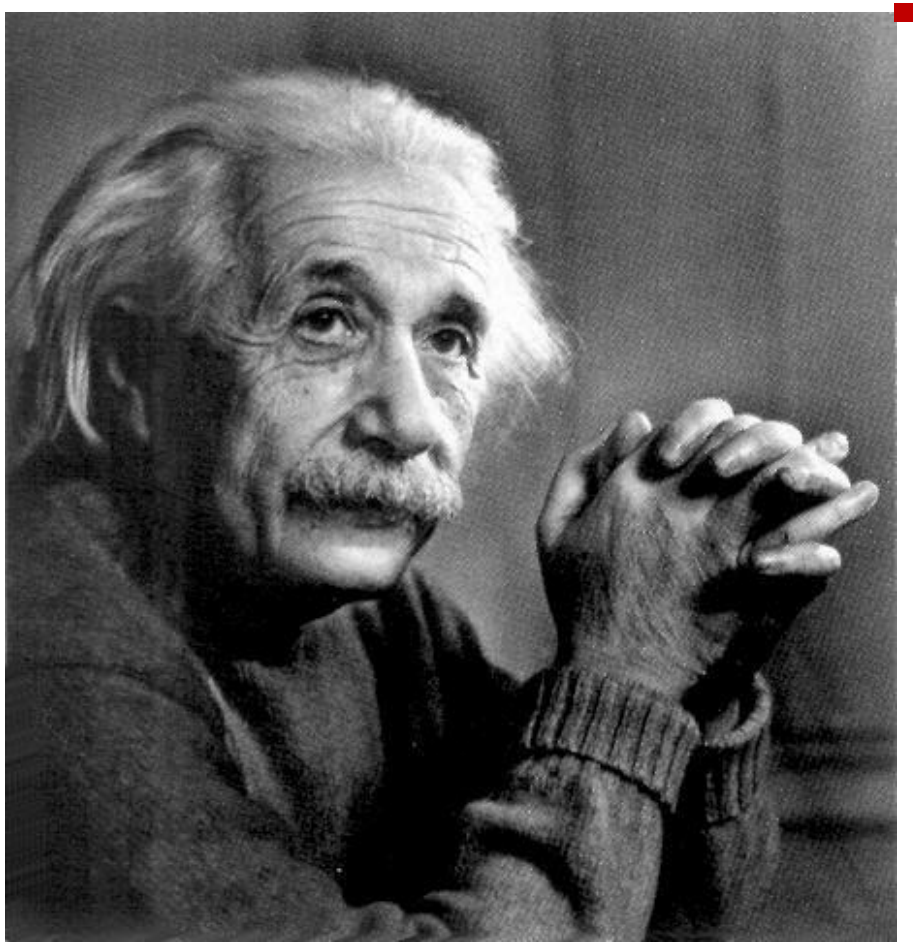
- Over the past few years, we have noted problems with some of the wells grouted with 20% solids. Various contractors using various name-brand products (Baroid, Wyo-Ben, DSI) have had “grout” settle long after drilling was complete and the Final Inspection had been performed.

Question from the field

Before I take Questions

Something to think about

Definition of Insanity



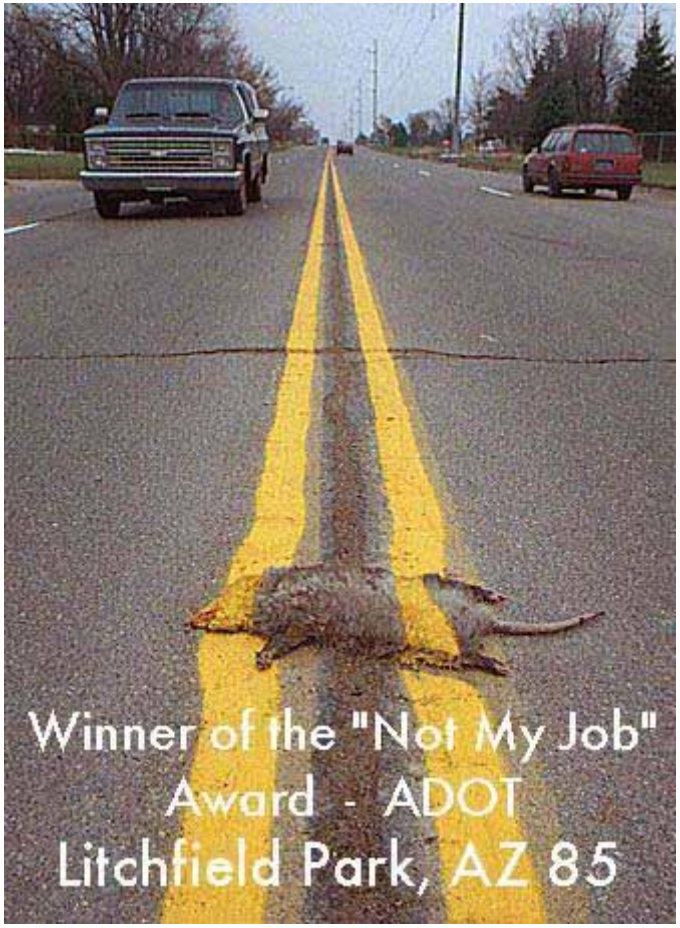
- Albert Einstein once said "The definition of insanity is doing the same thing over and over again and expecting different results". Think about this quote for a second and ask yourself, does this quote apply to the way you do your job?

Definition of Stupidity

- If the definition of insanity is doing the same thing over and over again and expecting different results". Then Stupidity is doing the same thing over and over again with the same result and Not Doing anything about it or changing how we do things.

Questions

It’s Not My Job!



Thank You!!!
Remember, We Make House calls