

Geomorphic and Soil Investigations at Joint Experimental Research Complex (JERC) Sites 1& 2, U.S. Army Yuma Proving Ground

The goal was to perform a reconnaissance-level investigation and mapping of the terrain and soil characteristics at the Joint Experimental Research Complex (JERC) sites. The JERC was developed by the U.S. Army Yuma Proving Ground (YPG) to provide a desert-urban environment for testing systems designed to detect improvised explosive devices (IEDs) commonly referred to as “roadside bombs”. This project was conducted because the effectiveness of detecting buried IEDs depends on the soil properties as well as the properties of the IED itself. Understanding how desert soils affect the different mine detection technologies facilitates their effective use and further development. We conducted this project at YPG, AZ and results were reported in 2008. We produced a total of 91 maps for the JERC sites along with detailed information about the mapping units.

Summary of Project Details: We used a combination of satellite imagery, field verification and field and laboratory soils characterization methods to produce terrain property maps for the two JERC sites. We identified a total of 13 geomorphic units across the two sites, which span alluvial plain and fan. We created maps of landform, geomorphology, and the following soil properties: relative salinity, carbonate content, clay content, USCS texture symbol and USCS consistency and density. We analyzed the influence of soil on dielectric permittivity.

Management Implications: Our study was the most detailed characterization of the geomorphology and soils of the JERC sites. We found that there were considerable differences in soil properties of the alluvial plain and fan of the two sites. We recommended that further analyses be conducted, among those being:

- Engage in discussion about how the soil and terrain may impact development and testing of sensors and IED detection techniques.
- Continue to perform site-specific geophysical soil characterizations along roadways where counter IED are tested. Implement other technologies for further characterization.
- Expand the analyses and characterization of disturbed soil.
- Continue assessment of airborne-derived Buckeye (Flight Data Systems Inc) data products, particularly along roadways.
- Establish remote, automated monitoring systems at select soil sites for *in situ* measurements of key variables.
- Develop and apply state of the art soil process models to simulate soil thermal, electrical and moisture flux to enhance understanding of effects of IED detection.

Table E2. Summary of the JERC site soil characteristics to a depth of 4 feet.

Geologic map unit	Trench site	Salinity				Carbonate content				Clay content				USCS texture symbol				USCS Consistency			
		0-1 ft	1-2 ft	2-3 ft	3-4 ft	0-1 ft	1-2 ft	2-3 ft	3-4 ft	0-1 ft	1-2 ft	2-3 ft	3-4 ft	0-1 ft	1-2 ft	2-3 ft	3-4 ft	0-1 ft	1-2 ft	2-3 ft	3-4 ft
Gp3a (alluvial plain)	JS1-1	*	*	*	*	**	**	**	**	**	**	**	**	ML	SM	SM	GM	Soft	Medium Dense	Medium Dense	Medium Dense
Gp3b (alluvial plain)	JS1-8	*	*	*	*	**	**	**	**	**	**	**	**	ML	SM	SM	SM	Soft	Medium Dense	Dense	Very Dense
Qp2 (alluvial plain)	JS1-3	**	**	**	**	**	**	**	**	**	**	**	**	SM	ML	ML	GM	Loose	Stiff	Stiff	Very Dense
Qp1 (alluvial plain)	JS1-2	**	**	**	**	**	**	**	**	**	**	*	*	ML	SM	GP, GW	GP, GW	Loose	Loose	Dense	Loose
Qf6 (alluvial fan)	JS1-9, JS2-1	**	**	**	**	**	**	**	**	**	*	*	*	MU/SM	SM/GM	SM	GM	Very loose	Loose	Medium Dense	Loose
Qf5 (alluvial fan)	JS2-2	**	**	**	**	*	*	*	*	**	**	**	**	GP, GW	GM	SM	GM	Loose	Medium Dense	Medium Dense	Medium Dense
Qf4a (alluvial fan)	JS1-4, -6, -7, JS2-3	**	**	**	**	**	**	**	**	**	*	*	*	ML	SM	SM	SM	Soft	Medium Dense	Dense	Very Dense
Qf4b (alluvial fan)	JS1-5	**	**	**	**	**	**	**	**	**	**	**	**	ML	SM	SM	SM	Soft	Medium Dense	Medium Dense	Dense
Qf3 (alluvial fan)	JS2-4	**	**	**	**	*	*	*	*	**	**	**	**	ML	GP, GW	GM	GM	Loose	Medium Dense	Dense	Dense
Qf2 (alluvial fan)	JS2-5	**	**	**	**	**	**	**	**	**	**	**	**	ML	GP, GW	GP, GW	GP, GW	Soft	Medium Dense	Dense	Dense
Qf1 (alluvial fan)	JS2-6	**	**	**	**	**	**	**	**	**	**	**	**	SM	GP, GW	GP, GW	GP, GW	Loose	Medium Dense	Dense	Dense
QTP (pediment)	N/A**	*	*	*	*	**	**	*	*	**	**	*	*	GP, GW, GM	GP, GW, GM	Rock	Rock	Medium Dense	Dense	Rock	Rock
Bx (bedrock)	N/A**	*	*	*	*	*	*	*	*	*	*	*	*	GP, GW	Rock	Rock	Rock	Medium Dense	Rock	Rock	Rock

Legend		Relative salinity** EC 1.5 (w/v) (dS/m)	Carbonate content Percentage	Clay content Percentage	USCS texture symbol	USCS Consistency Silt/Clay mixtures	Sand/Gravel Mixtures
0.0	0 %	0 %	0 %	ML	Very Soft	Very Loose	
<1.6	1 - 5 %	1 - 5 %	1 - 5 %	SM	Soft	Loose	
1.6 - 5.0	6 - 15 %	6 - 15 %	6 - 10 %	MU/SM	Firm	Medium Dense	
5.0 - 10.0	>15 %	>15 %	>10 %	SM/GM	Stiff	Dense	
>10.0				GM	Very Stiff	Very Dense	
				GP, GW	Hard		

- Excavate additional trenches and install permanent soil monitoring sites with soil sensor arrays.