GROUND PENETRATING RADAR SURVEY OF THE NATHAN ANDERSON
CEMETERY, RINGGOLD, GA

Prepared for:

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Introduction/Scope of Work
Bigman Geophysical, LLC was contracted by Marshall Bandy to evaluate the presence or absence of unmarked burials in an area approximately one acre in size at the Nathan Anderson Cemetery located in Ringgold, GA. An assessment of this plot with ground penetrating radar (GPR) indicated that 140 possible unmarked burials were present in the workspace.

GPR Method
This survey utilized GPR to image the subsurface and evaluate the presence or absence of possible unmarked historic graves. GPR sends electromagnetic pulses to a transmitting antenna at the ground surface which produces a radio wave that travels through the subsurface (Koppenjan 2009). Wave speed depends on the ability of a given medium to transfer energy (Annan 2009, Conyers 2004). When an approaching wave encounters a discontinuity in the dielectric constant, often the result of a change in material substance, some of the wave front's energy is reflected back toward the ground surface (Annan 2009). The two-way travel time (usually recorded in nanoseconds) and the amplitude of the reflection are recorded at the surface by a receiver antenna. Each traverse with the GPR provides a two-dimensional profile of the subsurface.

GPR is a popular and often successful technique for mapping cemeteries and locating unmarked burials. Numerous cemetery case studies document the success of the technique in historic contexts (Bevan 1991; Bigman 2014; Conyers 2006; Davenport 2001; Dionne et al. 2010; Fiedler et al. 2009; Gleason et al. 2011; Honerkamp and Crook 2012; Hunter 2012; Jones 2008; Shaaban et al. 2009; Sjostrom et al. 2009; Tarver and Bigman 2013; Torgashov and Anderson 2012). Several researchers developed accurate expectations of various burial anomalies by dragging antennas over wood caskets, metal caskets, and grave shafts (Conyers 2006; Fiedler et al. 2009; Sutton and Conyers 2013). While wood and metal caskets create a clear high-amplitude reflective signature; burial pits, grave shafts, or deteriorated wooden caskets are more difficult to detect. Grave shafts or burial pits can produce lower amplitude reflections at the ground surface since the top of the grave shaft is less compact than the surrounding, undisturbed ground surface (Bigman 2014). However, under conditions where the ground surface has been systematically unconsolidated, such as through plowing, it is difficult to identify graves in this manner. The bottom of burial pits or grave shafts may still contrast with the soil matrix at depth, but historic burials often homogenize with the soil matrix through time. Thus the signature for identifying historic burial pits can be limited to low amplitude hyperbolic reflections from the bottom of the pit.

Data Collection and Processing Procedures
This survey was carried out using a SIR-4000 GPR with a 400 MHz antenna manufactured by GSSI (Figure 1). The antenna was pushed along the ground surface with a three wheeled survey cart. All data were processed using RADAN v.7 software developed by GSSI. Profiles were compared following each processing step to ensure that reflections of interest were not removed and that artificial anomalies were not introduced. Each possible burial was marked with an orange survey marking flag at the approximate center of the burial (Figure 1). Bigman Geophysical, LLC then collected GPS coordinates for the locations of each possible burial using a Trimble GPS unit with the capability of sub-foot accuracy after post-processing.

Figure 1. Photograph of Anderson Cemetery survey showing GPR unit and marking flags.

Results/Interpretations

The survey detected 140 possible unmarked graves in the northern portion of the Anderson Cemetery (Figure 2) (See appendix A for a list of GPS coordinates). Preservation of graves and/or the interment method varied across the workspace. It appeared that some burials were still intact (possibly with remains of coffins), while others have homogenized into the surrounding soil, leaving a low amplitude signature (For examples see Figures 3 and 4). Overall, the possible unmarked graves identified in the eastern portion of the survey area were dispersed throughout the marked burials. The density was greater in the western portion of the cemetery, where few markers remain. The survey recorded approximately seven rows of burials, separated from each other similar distances, and with a generally consistent pattern running east/west across rows.
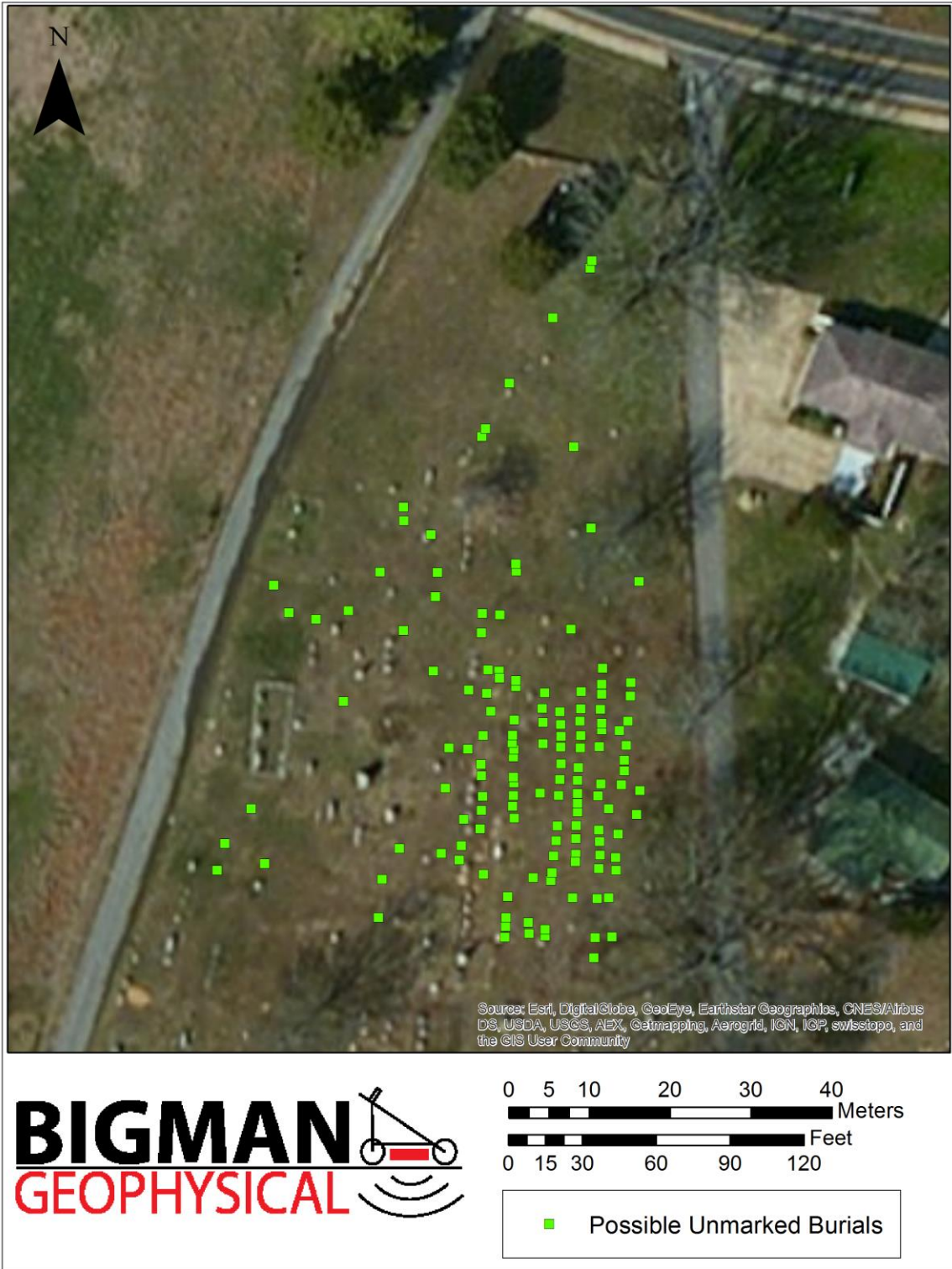
Figure 2. Locations of possible unmarked burials identified at Anderson Cemetery
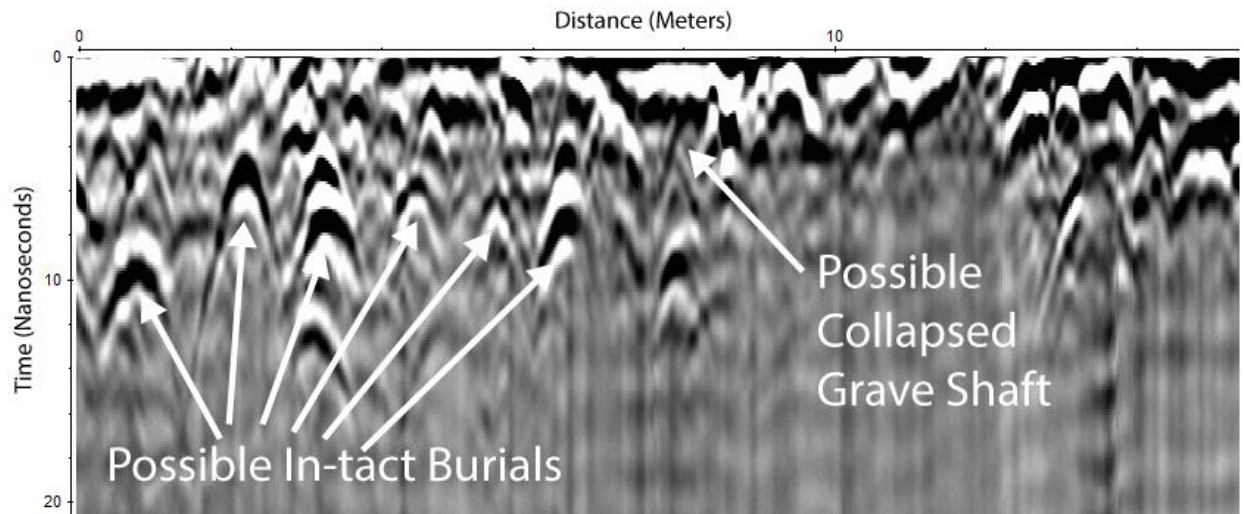
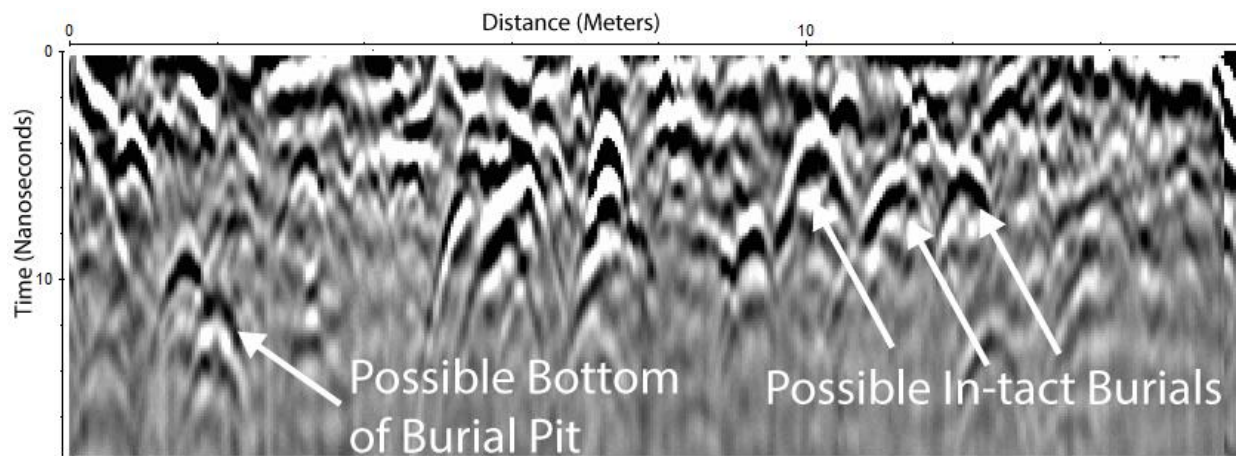Figure 3. Example of GPR data collected during survey.

Figure 4. Example of GPR data collected during survey.

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Appendix A: GPS coordinates of possible unmarked burials (State Plane, Georgia West)

Target #	Latitude	Longitude	Precision
1	34.9113860274066	-85.1222857704781	1
2	34.9114183491674	-85.1222838224174	0.6
3	34.9113970723866	-85.1222379864648	0.7
4	34.9114464728642	-85.1222547282363	0.4
5	34.9116272820577	-85.1222112866414	0.4
6	34.9116475240182	-85.1222326761209	0.5
7	34.9116175165476	-85.1221835608278	0.5
8	34.9116253344804	-85.1221477876682	0.5
9	34.9115439167576	-85.1221537884093	0.5
10	34.9113456989669	-85.1221148172864	0.4
11	34.9113770770962	-85.1221072902417	0.4
12	34.9116572429960	-85.1221100777871	0.4
13	34.9117166006086	-85.1220845532803	0.4
14	34.9117051235210	-85.1220849394805	0.4
15	34.9116057422722	-85.1220842534089	0.4
16	34.9114041625864	-85.1220871461689	0.6
17	34.9113988633080	-85.1220404779471	0.5
18	34.9114593742308	-85.1220367093853	0.5
19	34.9114950632141	-85.1220102674357	0.4
20	34.9115681244732	-85.1220522092799	0.4
21	34.9116351032286	-85.1220479700739	0.4
22	34.9116584263817	-85.1220449124460	0.4
23	34.9116919615052	-85.1220519319718	0.4
24	34.9114979680655	-85.1220302050978	0.4
25	34.9113958220803	-85.1220197140652	0.5
26	34.9114080492574	-85.1220166868619	0.5
27	34.9114318234423	-85.1220141502856	0.4
28	34.9115506952800	-85.1220104705537	0.6
29	34.9116192820832	-85.1219945536712	0.5
30	34.9116021997542	-85.1219954905260	0.5
31	34.9116167270681	-85.1219713933926	0.4
32	34.9115686450898	-85.1219872366839	0.4
33	34.9115670434018	-85.1219740530168	0.5

34	34.9115609295792	-85.1219755269943	0.4
35	34.9115477985267	-85.1219896989021	0.4
36	34.9115313878289	-85.1219860232122	0.4
37	34.9115101306695	-85.1219947980934	0.4
38	34.9114829882804	-85.1219969468162	0.4
39	34.9114726621054	-85.1219965490980	0.4
40	34.9114543977299	-85.1219945120070	0.5
41	34.9114412785910	-85.1219963436091	0.4
42	34.9114248399489	-85.1219972133980	0.4
43	34.9113821690582	-85.1219937982458	0.5
44	34.9113237605449	-85.1219706944773	0.5
45	34.9113335834784	-85.1219692845416	0.4
46	34.9113413194996	-85.1219680090157	0.4
47	34.9113604212349	-85.1219657943204	0.5
48	34.9114330508924	-85.1219588754369	0.5
49	34.9114437532733	-85.1219605562069	0.4
50	34.9114538726094	-85.1219596165660	0.4
51	34.9114660057188	-85.1219589748730	0.4
52	34.9114713685465	-85.1219596194464	0.4
53	34.9114894619054	-85.1219601839178	0.4
54	34.9114970173203	-85.1219601999884	0.4
55	34.9115028720398	-85.1219614849180	0.4
56	34.9115092507689	-85.1219609673567	0.4
57	34.9115243056524	-85.1219593789110	0.4
58	34.9115534388910	-85.1219577788443	0.4
59	34.9115593144679	-85.1219579021619	0.4
60	34.9116582125556	-85.1219574559440	0.4
61	34.9116644961572	-85.1219577371665	0.4
62	34.9115473971155	-85.1219251087994	0.4
63	34.9115347013792	-85.1219286062553	0.4
64	34.9115211802782	-85.1219272504766	0.4
65	34.9115018078209	-85.1219270156502	0.4
66	34.9114569780402	-85.1219308920353	0.4
67	34.9113802044311	-85.1219393060114	0.4
68	34.9113399826721	-85.1219452021283	0.4
69	34.9113283430622	-85.1219446707577	0.4
70	34.9113259630879	-85.1219255880880	0.4
71	34.9113320575985	-85.1219247855568	0.4
72	34.9113757236749	-85.1219175717311	0.4

73	34.9113833175817	-85.1219161952347	0.4
74	34.9113992733245	-85.1219154114450	0.4
75	34.9114132135117	-85.1219125092514	0.4
76	34.9114269396623	-85.1219111956058	0.4
77	34.9114540353334	-85.1219087306138	0.4
78	34.9114688618498	-85.1219078791591	0.4
79	34.9114831709949	-85.1219067258905	0.4
80	34.9114981583000	-85.1219071132346	0.4
81	34.9115069864972	-85.1219056366449	0.4
82	34.9115176889656	-85.1219059729928	0.4
83	34.9115300986568	-85.1219066295946	0.4
84	34.9116043278711	-85.1218961095743	0.4
85	34.9115477261190	-85.1218853571856	0.6
86	34.9115326377692	-85.1218856294122	0.4
87	34.9115211320680	-85.1218861954620	0.5
88	34.9115076989223	-85.1218855362208	0.5
89	34.9114954717745	-85.1218859030395	0.6
90	34.9114785111398	-85.1218886043278	0.5
91	34.9114671192771	-85.1218895629119	0.4
92	34.9114389826119	-85.1218901992883	0.4
93	34.9114559254846	-85.1218901148227	0.5
94	34.9114447728162	-85.1218896463556	0.5
95	34.9114254420552	-85.1218916278620	0.5
96	34.9114150411490	-85.1218925907694	0.5
97	34.9113995176113	-85.1218913588805	0.4
98	34.9113948918244	-85.1218930695603	0.4
99	34.9113604132252	-85.1218954715977	0.5
100	34.9113049194857	-85.1218725024793	0.4
101	34.9113228537754	-85.1218701312136	0.4
102	34.9113581330430	-85.1218665375795	0.4
103	34.9113851666032	-85.1218643829190	0.4
104	34.9113980900942	-85.1218631715234	0.4
105	34.9114104048779	-85.1218633005767	0.4
106	34.9114209689522	-85.1218642794380	0.4
107	34.9114454997986	-85.1218544630392	0.4
108	34.9114517469601	-85.1218655463995	0.4
109	34.9114622869988	-85.1218626481159	0.4
110	34.9114960995949	-85.1218635690497	0.4
111	34.9115113889105	-85.1218609934966	0.4

112	34.9115171544430	-85.1218606818453	0.4
113	34.9115297237961	-85.1218618469842	0.4
114	34.9115444006457	-85.1218613867631	0.4
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116	34.9115653735411	-85.1218550250003	0.4
117	34.9116952860924	-85.1218729435931	0.4
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119	34.9115565181752	-85.1218307438620	0.5
120	34.9115447850122	-85.1218310038619	0.5
121	34.9115223300432	-85.1218340830738	0.5
122	34.9115132996130	-85.1218436258471	0.5
123	34.9115008926992	-85.1218372500205	0.5
124	34.9114874817775	-85.1218391307820	0.5
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126	34.9114617098099	-85.1218409893289	0.4
127	34.9114177617667	-85.1218444198194	0.4
128	34.9113954355934	-85.1218475066829	0.6
129	34.9113831456702	-85.1218460825384	0.5
130	34.9113602437037	-85.1218464605262	1.1
131	34.9113237943391	-85.1218509478715	0.4
132	34.9114381748671	-85.1218215448079	0.4
133	34.9114592833582	-85.1218192097587	0.4
134	34.9117718362774	-85.1218912439002	0.6
135	34.9117820397868	-85.1219968942602	0.4
136	34.9117888100676	-85.1219926860285	0.4
137	34.9118293482427	-85.1219658238962	0.4
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