Los Alamos National Laboratory
Los Alamos,New Mexico 87545

memorandum

To: DISTRIBUTION

DATE: October6, 1993

FROM: Greg Cole

MAIL STOP/TELEPHONE: 7-1858/D462

SYMBOL: EES-1, Geology/Geochemistry

QUALITY REPORT - ER AERIAL SURVEY AND RESULTANT ORTHOPHOTO AND DIGITAL CONTOUR DATA

RELEVANT DOCUMENTS:

JUL-93, "Lab Wide Ground Survey - Phases I & 11, Los Alamos, New Mexico", REPORT prepared through Molzen-Corbin and Associates, Inc., for Greg Cole from GEONEX, Denver, Colorado.

30-SEP-93, "Quality Report - ER Aerial Survey and Resultant Orthophoto and Digital Contour Data", MEMO to ER Distribution from Greg Cole.

SUMMARY:

A study of the quality of available GIS (Geographic Information System) electronic data was performed concurrently with a study of the quality of orthophoto data from the ER aerial survey. The study was limited to the accuracy of structures (buildings, storage tanks, houses, etc.) relative to established benchmarks, and limited to 15 percent of the total data coverage. Error estimates are based on orthophoto data. Positional errors within the range of uncertainty of the orthophoto data (+/- 2 feet) are not considered significant.

The maximum average error of misfit identified at a Laboratory Tech Area occurs at TA-46, and is about 6 feet. The maximum error for any Laboratory structure in the data subset is about 27 feet; for a storage tank at TA-21. Most Tech Areas of the Laboratory, which were included in this study, have average structure location errors, which fall within the limits of the uncertainties of the control data. Structure locations in the townsite also exhibit average errors that fall within the uncertainties of the orthophoto control. Subsets of the Tech Area/townsite data, for example, townsite data near the Pueblo Complex, have effors, which may be of significance to local surveys.

BACKGROUND:

The project to perform the aerial survey was initiated in early 1991 by the FIMAD on behalf of the ER Program. A goal of this survey was to provide a baseline to assess the quality of existing digital GIS data. Complaints about the quality of existing GIS data had been received from several Operable Unit Project Leaders of the ER Program, and misgivings about the quality of some of the utilities data were expressed by ENG-2 personnel. The new, high-quality, orthophoto data would allow the quality of the existing digital data to be checked. Originally, ENG-2 intended to

whitewash all manhole covers to allow positions of utility data (electric, water, and sewer lines) to be identified on the orthophotos. Due to lack of resources, and a decision to use GPS (Global Positioning System) surveys to accurately locate the manholes, this painting was not accomplished and evaluation of the quality of the existing digital utilities data cannot be performed from analysis of the orthophoto data. The orthophoto data can be used to evaluate the quality of digital data such as structures and roads, providing that the intersection of the feature with the existing ground surface is visible.

DESCRIPTION OF DATA QUALITY ANALYSIS:

The data quality analysis of the existing digital GIS data was a two-step process. The first step of this process was to evaluate the quality of the newly-acquired, 1" = 100' scale, orthophoto data. A study describing the quality of these data was provided to the ER program (Memo of 30 Sep 93). These data meet National Map Accuracy Standards, in that 90% of the data have positional errors of less than 2 feet.

The second step of the quality appraisal involved overlaying the orthophotos with mylar plots of structure locations, and quantifying any misfits. The set of orthophoto sheets used in the first step was also used for the second step in order to utilize existing mylar overlays, and to allow the two tasks to be done concurrently. The electronic data plotted on the mylars is of similar vintage to the orthophoto data; representing the Laboratory and townsite as it appeared 2 years ago. Due to the coarseness of the registration marks on the orthophotos, and to irregular distortion of the photographic media (paper), co-registration of the two media (photo and mylar) is considered accurate to 0.5 feet at best. For this reason, offsets were estimated to the nearest 0.5 feet.

For each sheet, an attempt was made to identify a representative set of easily-identifiable comers of structures, which could be seen on both the orthophotos, and mylar overlays. Due to the camera angle, shadows, and other obscuring features, it was often impossible to co-locate a structure on the two different media. Also, some of the sheets used in the orthophoto quality evaluation, had few digitized structures. Therefore the quality analysis for many of the geographical areas is biased by both the selection process, and the limited number of samples available.

RESULTS OF DATA QUALITY ANALYSIS:

Most of the electronic coordinate data, which was checked during this study, is accurate to within the uncertainties of the orthophoto control data. The only Laboratory region identified as having consistent errors significantly larger than the uncertainties of the control data is Tech Area 46. Large errors in townsite data at Barranca Mesa were identified shortly after the first batch of orthophotos was received, and these errors in the electronic data were corrected prior to this study. There are still sizeable errors in some of the White Rock data, with a 50-60 foot, East-Northeast shift of some road locations on sheet 756651-1.

There are also localized errors. A 5-foot average error was identified for structures on Sheet 780618-1, which includes the neighborhood of the Pueblo Complex. A water tank near the gate of TA-21 is misplaced by about 28 feet. And the size and shape of many digitized structures show minor differences to the orthophoto data. For example, Structure 16-445 is approximately 30% too large. Table I provides a listing of the data locations used in this study and provides average errors by tech area.

CONCLUSIONS AND RECOMMENDATIONS:

Many of the minor differences noted between the digital and orthophoto data may have been collected since the time of the survey. Comparisons with the current edition of the ENG-2 database are warranted before any major effort is made to adjust locations of the electronic data. Tech Area 46 is the only region for which a "rubber-sheeting" update of the electronic data may be justified. The orthophoto image data is in the process of being scanned so that electronic evaluation of the vector data will soon be possible for the entire Laboratory and townsite, and corrections can be made on an "as needed" basis.

CREDITS:

Liz Zeiler created the mylar overlays used in this study.

DISTRIBUTION:

RPF, M707
Mike Ray, EM- 13. M707
Lars Soholt, EM- 13, M992
Paul Aamodt, EM-13, M992
Nancy Marusak, EES-5, F665
Tom Garrison, EES-5, D462
Merrick and Company, M992
ENG-DO, M719
Brian Comer, ENG-2, M701
Larry Jones, ENG-3, M984
EES-1, D462

Table 1. Summary of Structure Location Errors based on Differences between ENG-2/LA County and Merrick Orthophoto Data (ENG-2 - Merrick).

ORTHOPHOTO ID	STRUCTURE ID	Δ EAST	Δ NORTH	IXYI
TECH AREA: 0				
776615-1(57)				
	1080	+.3	-.1	+.3
	1111	+.0	-.2	+.2
AVERAGE ERROR (2 Samples)		+.2	-.2	+.3
TECH AREA: 3				
772615-1(55)				
	30	1	+.6	+.6
	31	1	+.2	+.2
	38	+.1	-.5	+.5
	40	+.0	+.0	+.0
	100	+.2	+. 1	+.2
	142	+.2	+.1	+.2
	215	+.0	+.0	+.0
	253	+1.0	+.0	+1.0
	374	+.5	+.5	+.7
	400	+.0	+.0	+.0
	494	+.0	+.0	+.0
	473	+.0	+.0	+.0
774618-1(74)	1911	+1.5	+.5	+1.6
	41	-3.0	-1.0	+3.2
	70	+.5	+2.0	+2.1
	207	+1.5	+3.0	+3.4
	271	+.5	+3.0	+3.0
	1837	+.0	+.0	+.0
	1966	+1.0	+3.0	+3.2
AVERAGE ERROR (19 Samples)		+.2	+.6	+1.0
TECH AREA: 8				
766609-1(20)				
	21	-.5	+2.0	+2.1
	23	-2.0	+3.0	+3.6
	86	+.0	+1.0	+1.0
770621-1(93)				
	171	+.2	+.0	+.2
	207	+.5	+.1	+.5
	1002	+.0	+.0	+.0
AVERAGE ERROR (6 Samples)		-.3	+1.0	+1.2

Table 1. (Continued)

ORTHOPHOTO ID	STRUCTURE ID	Δ EAST	ΔNORTH	IXYI	
TECH AREA: 9					
766609-1(20)					
	28	-1.0	+3.0	+3.2	
AVERAGE ERROR (1 Samples)		-1.0	+3.0	+3.2	
TECH AREA: 16					
762609-1(18)					
	10	+.0	+.3	+.3	
	13	+.0	+.3	+.3	
	16	+.4	+.7	+.8	
	27	+.0	+.2	+.2	
	54	+.0	+.3	+.3	
	89	+.0	+.0	+.0	
	92	+.l	+.l	+.I	
	164	-.1	+.3	+.3	
	180	+.5	+.3	+.6	
	200	+2.0	+1.9	+2.8	
	202	+.6	+1.0	+1.2	
	203	+.6	+.8	+1.0	
	206	+.8	+.8	+1.1	
	207	+.7	+.9	+1.1	
	332	+.7	+.8	+1.1	
	445	-1.4	+.0	+1.4	Note: 30% too large
	515	+.0	+.0	+.0	
	540	+.5	+.l	+.5	
AVERAGE ERROR (18 Samples)		+.3	+.5	+.7	
TECH AREA: 18					
762633-1(185)					
	23	-1.0	-.4	+1.1	
	168N	+.0	+.0	+.0	
AVERAGE ERROR (2 Samples)		-.5	-.2	+.6	

Table 1. (Continued)

ORTHOPHOTO ID	STRUCTURE ID	Δ EAST	Δ NORTH	IXYI
TECH AREA: 21				
774630-1(165)				
	1	+1.0	+2.0	+2.2
	14	+.0	+.0	+.0
	21	+.0	+2.0	+2.0
	46	-.5	+.5	+.7
	228	+.0	+3.0	+3.0
	258	-17.0	-22.0	+27.8
	286	-1.5	+2.0	+2.5
	357	-3.0	+1.5	+3.4
	365	+.0	+.1	+.1
AVERAGE ERROR (9 Samples)		-2.3	-1.2	+4.6
TECH AREA: 28				
758609-1(16)				
	1	+.6	+2.5	+2.6
	2	+.4	+.4	+.6
	3	+.4	+.3	+.5
	4	+.4	+.1	+.4
	5	+.2	+.4	+.4
AVERAGE ERROR (5 Samples)		+.4	+.7	+.9
TECH AREA: 33				
736639-1(232)				
	175	+.0	-.3	+.3
736645-1(289)				
	151	+.0	+.0	+.0
AVERAGE ERROR (2 Samples)		+.0	-.2	+.2
TECH AREA: 39				
742639-1(235				
	2	+.6	+.2	+.6
	69	+.3	-.4	+.5
	89	+.4	+.0	+.4
	98	+.8	+.2	+.B
	103	+.6	+.1	+.6
AVERAGE ERROR (5 Samples)		+.5	+.0	+.6

Table 1. (Continued)

ORTHOPHOTO ID	STRUCTURE ID	Δ EAST	Δ NORTH	IXYI
TECH AREA: 46				
764630-1(160)				
	24	+1.0	-8.0	+8.1
	41	+.0	-1.0	+1.0
	119	+.0	-6.0	+6.0
	121	+2.0	-2.0	+2.8
	158	+2.0	-2.0	+2.8
	217	-4.0	-5.0	+6.4
	326	+5.0	-9.0	+10.3
	333	-2.0	-9.0	+9.2
AVERAGE ERROR (8 Samples)		+.5	-5.3	+5.8
TECH AREA: 48				
766627-1(136)				
	342	+.0	+.0	+.0
770621-1(93)				
	1	+.1	+.1	+.1
	8	+.0	+.0	+.0
	29	+.1	+.2	+.2
AVERAGE ERROR (4 Samples)			+.1	+.1
TECH AREA: 52				
766627-1(136)				
	1	+.0	+.0	
	36	+1.0	+.0	+1.0
	44	+1.0	+.0	+1.0
	45	+1.0	+.0	+1.0
AVERAGE ERROR (4 Samples)		+.8	+.0	+.8

Table 1. (Continued)

ORTHOPHOTO ID	STRUCTURE ID	Δ EAST	Δ NORTH	IXYI
TECH AREA: 53				
770633-1(189				
	1	+.1	+.4	+.4
	2	+.1	+.2	+.2
	3 A,B,C	+.0	+.4	+.4
	38	+.0	+.0	+.0
	40	+.0	+.4	+.4
	44	+.1	+.1	+.1
	55	+.0	+.2	+.2
	60	+.0	+.2	+.2
	70	+.0	+.4	+.4
	733	+.0	+.3	+.3
AVERAGE ERROR (10 Samples)		+.0	+.3	+.3
TECH AREA: 54				
754648-1(326)				
	169	+.6	+.5	+.8
756651-1(352)				
	75	+.0	+.0	+.0
762633-1(185)				
	38	+1.5	+.0	+1.5
	34	+1.0	+.0	+1.0
	1004	-2.0	+.0	+2.0
	1006	-1.0	+.1	+1.0
	1008	-2.0	+.0	+2.0
AVERAGE ERROR (7 Samples)		-.3	+.1	+1.2
TECH AREA: 59				
770621-1(93)				
	96	+.5	-1.5	+1.6
	97	+.1	-.2	+.2
AVERAGE ERROR (2 Samples)		+.3	-.9	+.9

Table 1. (Continued)

ORTHOPHOTO ID	STRUCTURE ID	Δ EAST	Δ NORTH	IXYI
TECH AREA: 60				
770621-1(93)				
	17	+.0	+.2	+.2
	19	+.9	+.3	+.9
	29	+.5	+1.0	+1.1
	86	+.0	+.0	+.0
AVERAGE ERROR (4 Samples)		+.3	+.4	+.6
TECH AREA: 61				
774618-1(74)				
	16	-1.0	+2.0	+2.2
	23	-1.0	+4.0	+4.1
AVERAGE ERROR (2 Samples)		-1.0	+3.0	+3.2
TECH AREA: 66				
766627-1(136)				
	1	+1.0	-1.0	+1.4
AVERAGE ERROR (1 Samples)		+1.0	-1.0	+1.4
TECH AREA: 69				
770609-1(22)				
	3	+3.0	+1.0	+3.2
	4	+.0	+.7	+.7
AVERAGE ERROR (2 Samples)		+1.5	+.9	+2.0
TECH AREA: 72				
766645-1(304)				
	3	-4.0	-2.0	+4.5
768639-1(248)				
	8	-1.0	+.0	+1.0
	14	+.0	-1.0	+1.0
	41	+.0	+.0	+.0
768642-1(277)				
	7	-1.0	+.0	+1.0
AVERAGE ERROR (5 Samples)		-1.2	-.6	+1.5

Table 1. (Continued)

ORTHOPHOTO ID	STRUCTURE ID	Δ EAST	Δ NORTH	IXYI	
TECH AREA: 73					
774630-1(165)					
	4	-.5	+.5	+.7	
AVERAGE ERROR (1 Samples)		-.5	+.5	+.7	
TECH AREA: Townsite					
776615-1(57)					
	1277	-.3	+.3	+.4	
	1331	-.1			
	4797	-.1			
776624-1(118)					
	1340	-2.0	-3.0	+3.6	
	1341	+.0	+.0	+.0	Library
	1401	-.5	+.5	+.7	Pizza Hut
	1670	+.0	+1.0	+1.0	
	1725	-1.0	+1.0	+1.4	
	1967	-1.0	+.0	.+1.0	
	2002	-.5	+.0	+.5	
	2300	+.0	+1.5	+1.5	Community Bldg.
778621-1(97)	2400	+2.0	+1.0	+2.2	Church
	2805	-1.0	-1.0	+1.4	
	3007	+.0	+.0	+.0	
	3089	+.0	+.0	+.0	
	3405A	-1.0	-1.0	+1.4	
	B2738A	-1.0	-3.0	+3.2	
778633-1(193)					
	1050	+2.5	+2.5	+3.5	
	1075	+.5	+2.0	+2.1	
	1093	+.0	+2.0	+2.0	
	1103	+.0	+1.5	+1.5	
	1199	-1.0	+1.0	+1.4	
	1330	-1.5	+1.0	+1.8	
	1393	+3.0	-2.0	+3.6	
780618-1(77)					
	1951	+1.5	+4.0	+4.3	
	1952	-1.0	+7.0	+7.1	
	1962	-6.0	+4.0	+7.2	
	2100	-4.0	+2.5	+4.7	
	2141	+2.0	+4.0	+4.5	
	2184	-6.0	-1.0	+6.1	
	Pueblo Complex	-.5	+.5	+.7	

Table 1. (Continued)

ORTHOPHOTO ID	STRUCTURE ID	Δ EAST	Δ NORTH	|XY|
780624-1(120)				
	1992	+.4	-.3	+.5
	Middle School	-.5	-2.0	+2.1
782630-1(169)				
	55			
	Barranca School	-.1	+.2	+.2
784624-1(122)		+.1	-.4	+.4
	140	+.0	+.0	+.0
	246	-.5	+.2	+.5
774630-1(165)				
	986	+.0	+.0	+.0
AVERAGE ERROR (38 Samples)		-.5	+.6	+1.9