Final Report

Flood Data Analysis
Lincoln County, New Mexico

FEMA-1783-DR-NM

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CBC	Concrete Box Culvert
cfs	Cubic Feet per Second
CMP	Corrugated Metal Pipe
DEM	Digital Elevation Model
DFIRM	Digital Flood Insurance Rate Map
DTM	Digital Terrain Model
ERM	Elevation Reference Mark
FEMA	Federal Emergency Management Agency
FIPS	Federal Information Processing Standards
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
GIS	Geographic Information Systems
G&S	FEMA's *Guidelines and Specifications for Flood Hazard Mapping Partners*
HARN	High-Accuracy Reference Network
HEC-HMS	Hydrologic Engineering Center Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Center River Analysis System
HMTAP	Hazard Mitigation Technical Assistance Program
IDIQ	Indefinite Delivery Indefinite Quantity
ITR	Independent Technical Review
LDS	Limited Detail Study
MAPVI	Mapping Alliance Partnership VI
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NGVD29	National Geodetic Vertical Datum of 1929
NRCS	Natural Resources Conservation Service
SCS	Soil Conservation Service
SIR	Scientific Investigations Report
TIN	Triangulated Irregular Network
TOC	Task Order Coordinator
TOM	Task Order Monitor
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WISE	Watershed Information System

SECTION ONE INTRODUCTION

Heavy rainfall from Hurricane Dolly produced between 6 and 9 inches of rain in the City of Ruidoso Downs, Village of Ruidoso, and the metropolitan area of unincorporated Lincoln County in July 2008. This rainfall caused extensive flash flooding of natural rivers, tributaries, manmade drainage systems, culverts, bridges, buried water/sewer lines, homes, and other utilities. On August 14, 2008, President Bush declared a Major Disaster for the State of New Mexico as a result of the effects of Hurricane Dolly from July 26-27, 2008.

The purpose of this task order is to determine accurate flood extents and elevations for the Rio Ruidoso, Cedar Creek, Brady Canyon, Carrizo Creek, Rio Bonito, and Salado Creek to provide the affected communities and residents with more accurate flood elevation data for mitigation, planning, and recovery. The data can be used to analyze the extent of the flood inundation and to assess mitigation options for long-term recovery. The flooding sources of concern for this study are shown in Table 1-1 below. The study areas and associated drainage basins are shown on Figure 1-1, Lincoln County Study Area. The funding for this study was provided by the Federal Emergency Management Agency (FEMA) under the Hazard Mitigation Technical Assistance Program (HMTAP) Contract Number HSFEHQ-06-D-0162, Task Order HSFEHQ-09-J-0005.

Table 1-1: Study Streams

Community Name	Flooding Sources	Upstream Limit	Downstream Limit	Length of Study Stream (Miles)	Study Type
City of Ruidoso Downs	Rio Ruidoso	West edge of Ruidoso Downs boundary	East edge of Ruidoso Downs boundary	3.0	Detailed with Floodway
Village of Ruidoso	Cedar Creek	2.4 miles upstream from confluence with Rio Ruidoso at west edge of Village of Ruidoso boundary	Confluence with the Rio Ruidoso	2.4	Detailed with Floodway
Village of Ruidoso	Brady Canyon	1.1 miles upstream from confluence with Rio Ruidoso	Confluence with the Rio Ruidoso	1.1	Detailed with Floodway
Village of Ruidoso	Carrizo Creek	2.2 miles upstream from confluence with Rio Ruidoso	Confluence with the Rio Ruidoso	2.2	Detailed with Floodway
Village of Ruidoso	Rio Ruidoso	6.5 miles upstream from east edge of Village of Ruidoso boundary	East edge of Village of Ruidoso boundary	6.5	Detailed with Floodway
Lincoln County	Rio Bonito	Bonito Lake	Intersection of Rio Bonito with Highway 37/48	4.7	Limited Detail

Community Name	Flooding Sources	Upstream Limit	Downstream Limit	Length of Study Stream (Miles)	Study Type
Lincoln County	Cedar Creek	2.0 miles upstream from Village of Ruidoso boundary	West edge of Village of Ruidoso boundary	2.0	Limited Detail
Lincoln County	Rio Ruidoso	East Edge of Ruidoso Downs boundary	Confluence with the Rio Hondo	22.8	Limited Detail
Lincoln County	Salado Creek	0.9 mile upstream from confluence with Oso Creek	Confluence with Oso Creek	1.3	Limited Detail

Collecting and assessing flood data and preparing flood recovery maps are activities outside of FEMA's regular flood hazard mapping operations. However, these activities must take place in the immediate aftermath of a disaster. When a flood occurs, valuable data become available that enable FEMA and its contractors to reassess the estimates of flood risk. Also, rebuilding efforts begin within a short period after a disaster, and timely, updated flood risk data are necessary to ensure that the rebuilding will protect properties from future flooding disasters. The new data need to be evaluated and, if necessary, incorporated into new engineering analyses. Appropriate hazard identification tools (such as flood recovery maps) must be produced quickly. In some cases, there may not be any existing detailed flood mapping at all, and flood recovery maps may be the only detailed guidance to assist the State and community in planning and managing rebuilding efforts. The results of this study are flood recovery maps showing the extent of the flood hazards, and flood profiles with elevation data. Study information for each task is included in Appendices A-F. The flood recovery maps and flood profiles are included in Appendix F. The flood recovery map panel layout is shown on Figure 1-2, Panel Layout.

Figure 1-1
Lincoln County Study Area

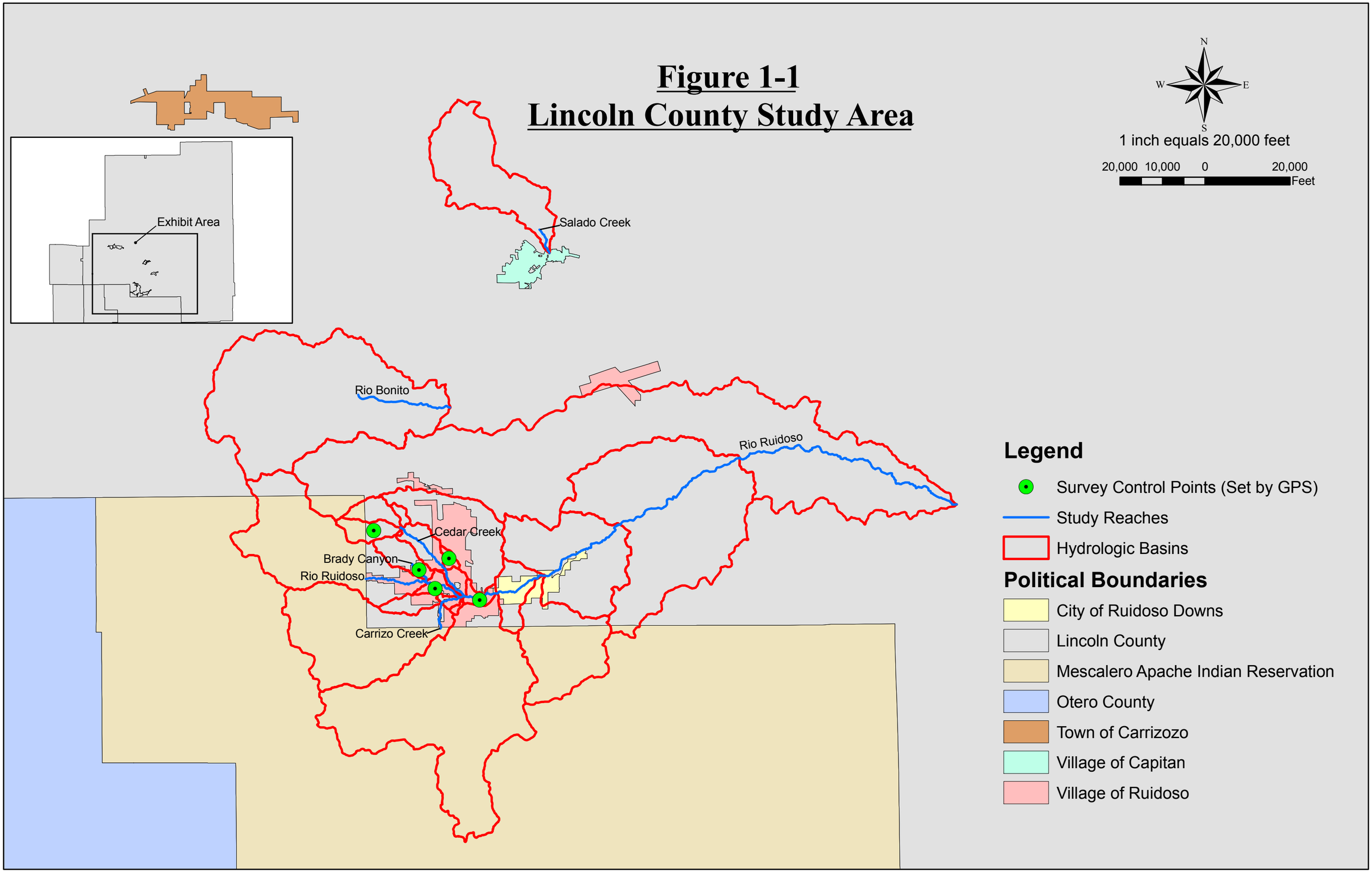
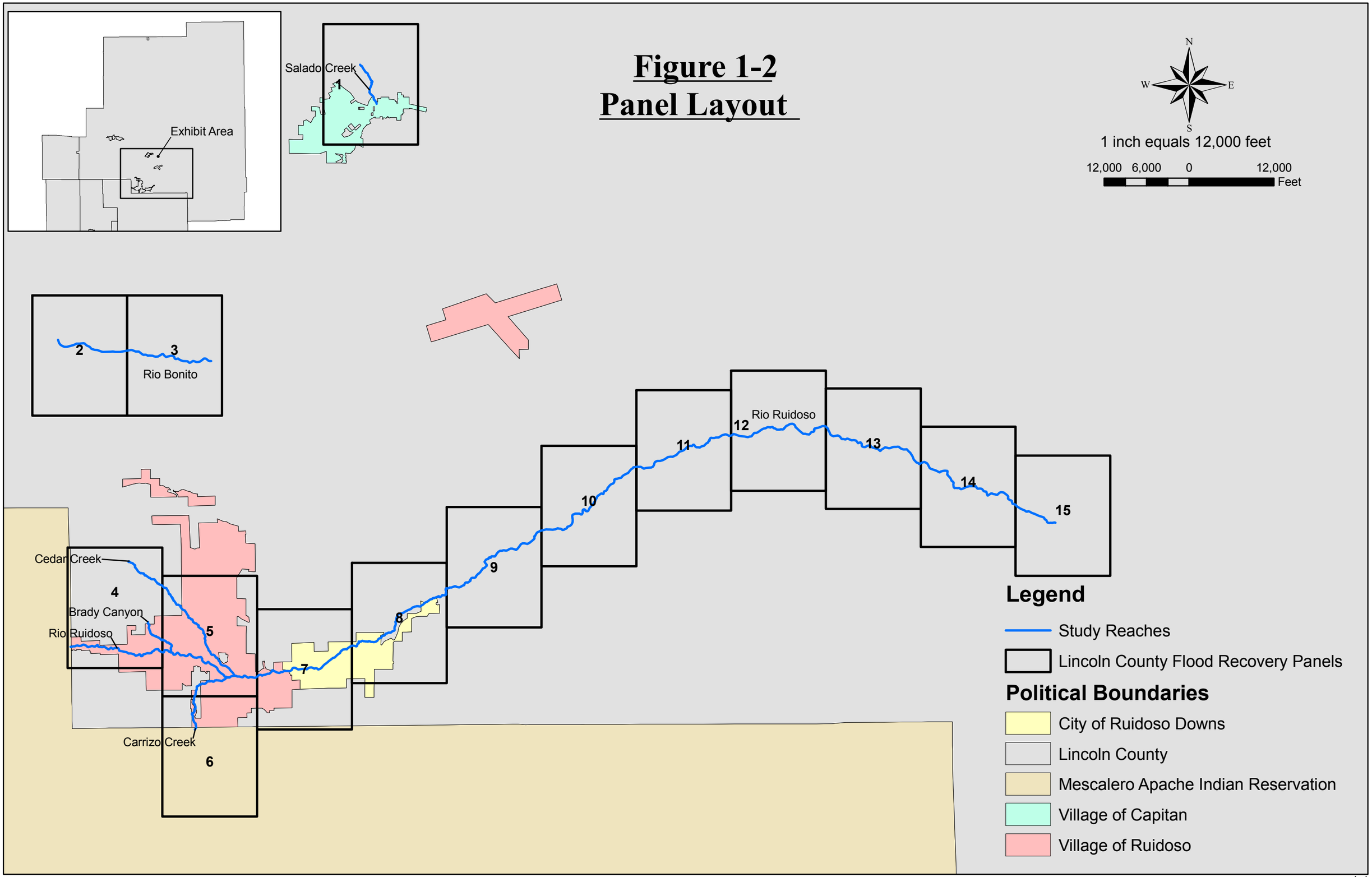


Figure 1-2
Panel Layout



1.1 STANDARDS AND DELIVERABLES

All tasks were performed in accordance with the standards specified in FEMA's *Guidelines and Specifications for Flood Hazard Mapping Partners* (G&S).

URS makes the following products available to FEMA:

- Digital copies of all hydrologic and hydraulic modeling (input and output) files for the 1-percent-annual-chance storm event.
- Digital and hardcopy versions of the Summary of Discharge Table presenting discharge data for the flooding sources for which hydrologic analysis were performed.
- Digital profiles of the applicable water surface elevations representing the existing conditions.
- Digital and hardcopy flood data analysis (work maps) at a scale of 1 inch = 500 feet on base maps readily available, showing the recommended flood recovery boundaries and flood elevations.
- Other materials, as specified in the national standards, including all notes, work maps, assumptions, and modeling performed by URS, with appropriate certifications.

1.2 QUALITY ASSURANCE AND CONTROL

All tasks were performed in accordance with the URS quality procedures. A detailed explanation of these procedures is listed in Appendix A.

SECTION TWO DATA COLLECTION

As part of the data collection efforts, URS obtained copies of the effective Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs) for all communities affected by the flooding, including Lincoln County. With the coordination of the FEMA Project Monitor, URS obtained the terrain data used in the countywide map updates study. This terrain data is discussed in further detail in Section Four and Appendix B. URS coordinated with the Office of the State Engineer, Bureau of Indian Affairs, and the State of New Mexico Floodplain Administrator to obtain information about water supply and detention structures in the study area. URS also obtained photographs of damage caused by the July 26-27, 2008, flooding from the State of New Mexico Department of Homeland Security and Emergency Management. Those photographs can be found in Appendix G.

URS obtained all base map data from the Map Modernization Indefinite Delivery Indefinite Quantity (IDIQ) Study Contractor, Mapping Alliance Partnership VI (MAPVI). MAPVI is currently preparing the Digital Flood Insurance Rate Map (DFIRM) and FIS updates for Lincoln County, NM. As part of this effort, MAPVI obtained base map data necessary to complete the DFIRMs for the entire county. This data was submitted to FEMA in November of 2008, and is considered up-to-date for mapping purposes.

SECTION THREE FIELD SURVEY AND RECONNAISSANCE

The field survey included obtaining cross-sections, the physical dimensions of hydraulic structures, and establishing elevation reference marks (ERMs). Field survey data was gathered for Detailed and Limited Detail studies. Field reconnaissance for this study included documenting vegetative cover along the overbanks and channel of the study streams to allow assessment of Manning's roughness coefficient values (n-values) that were used in developing the hydraulic analyses. Field reconnaissance notes with photos and Manning's n calculations are included in Appendix C.

3.1 CROSS-SECTION SURVEYS

Cross-sections were surveyed for Detailed and Limited Detail study areas. For each study reach, the cross-section locations were nominally placed at structures and at approximately 3,000-foot spacing between structures. These cross-sections were plotted on plan view sheets and provided to the surveyors. The cross-section survey followed the plan view as close as reasonably possible.

- Cross-sections were oriented perpendicular to the stream centerline and perpendicular to the direction of flow in the overbanks.
- All survey cross-sections were oriented from left to right when looking downstream.
- Cross-sections were numbered consecutively beginning at the downstream end of the survey reach, and correspond to the numbering on the provided plan view sheets.

Points were surveyed approximately every 50 feet along the ground (i.e., elevations and stations) and additional points were surveyed to represent significant breaks in ground slope, top of banks, toe of slopes, and bottom centerline of the channel. Cross-sections were extended right and left for approximately 200 feet from the edge of the channel bank. The list of surveyed cross-sections is provided in Table 3-1.

Table 3-1: List of Surveyed Cross-Sections for the Study Reaches

Cross-Section Name	Location	Station (Distance in feet)
Carrizo Creek		
CaC_XS1	Approximately 550 feet Upstream of CaC_UR6	12,187*
Cedar Creek		
CeC_XS1	Approximately 75 feet Upstream of confluence with Rio Ruidoso	97**
CeC_XS2	Approximately 2,650 feet Upstream of CeC_Alto	2,774**
CeC_XS3	Approximately 50 feet Upstream of East end of Half Circle Drive	6,920**
CeC_XS4	Approximately 500 feet Upstream of Musketball Drive	11,085**

Cross-Section Name	Location	Station (Distance in feet)
Rio Bonito		
RB_XS1	Approximately 150 feet Upstream of RB_CR48	437***
RB_XS2	Approximately 150 feet Downstream of RB_UR3	4,138***
RB_XS3	South of Intersection of County Road 37 and Bonito Lake Road	7,739***
RB_XS4	Approximately 2,000 feet Upstream of RB_UR5	11,457***
RB_XS5	Approximately 1,600 feet Downstream of RB_UR6	15,024***
RB_XS6	Approximately 275 feet Downstream of RB_UR10	18,748***
RB_XS7	Approximately 900 feet Downstream of RB_UR14	21,780***
RB_XS8	Approximately 200 feet Downstream of Rio Bonito Dam	24,905***
Rio Ruidoso		
RR_XS1	At confluence with Rio Bonito	16****
RR_XS2	Approximately 600 feet Downstream of RR_CR17	3,652****
RR_XS3	Approximately 4,800 feet Downstream of RR_UR2	7,035****
RR_XS4	Approximately 750 feet Upstream of RR_UR2	12,605****
RR_XS5	Approximately 400 feet Upstream of RR_UR3 (Tara Trail)	16,043****
RR_XS6	Approximately 1,900 feet Downstream of RR_UR4 (La Mancha)	22,031****
RR_XS7	Approximately 1,000 feet Upstream of RR_UR4 (La Mancha)	24,916****
RR_XS8	Approximately 150 feet Downstream of East end of El Valle Loop	29,689****
RR_XS9	Approximately 2,700 feet Upstream of East end of El Valle Loop	32,638****
RR_XS10	Approximately 3,200 feet Upstream of RR_XS9	35,813****
RR_XS11	Approximately 2,900 feet Downstream of West end of El Valle Loop	38,786****
RR_XS12	Approximately 50 feet Upstream of West end of El Valle Loop	41,718****
RR_XS13	Approximately 2,500 feet Downstream of RR_UR5 (McDaniel)	44,949****
RR_XS14	Approximately 1,000 feet Upstream of RR_UR5	48,398****
RR_XS15	Approximately 1,100 feet Upstream of RR_UR7 (Mardi Gras)	51,924****
RR_XS16	Approximately 1,600 feet Upstream of RR_UR9 (Rivers Edge)	55,146****
RR_XS17	Approximately 2,900 feet Upstream of RR_XS16	58,025****
RR_XS18	Approximately 3,400 feet Upstream of RR_XS17	61,428****
RR_XS19	Approximately 1,500 feet Downstream of RR_FS443 (Coe Canyon)	64,664****
RR_XS20	Approximately 150 feet Downstream of RR_UR11	67,945****
RR_XS21	Approximately 400 feet Upstream of RR_CRE003 (Tully)	71,492****
RR_XS22	Approximately 250 feet Downstream of RR_UR13	74,864****
RR_XS23	Approximately 2,600 feet Downstream of RR_UR15	77,972****
RR_XS24	Approximately 900 feet Upstream of RR_UR15	81,449****
RR_XS25	Approximately 1,600 feet Downstream of RR_UR16	84,429****
RR_XS26	Approximately 25 feet Upstream of RR_UR17 (Driveway off of	87,859****

Cross-Section Name	Location	Station (Distance in feet)
	Buckhorn Loop)	
RR_XS27	Approximately 300 feet Downstream of RR_UR19A	91,247****
RR_XS28	Approximately 75 feet Downstream of RR_UR19A	91,454****
RR_XS29	Approximately 50 feet Upstream of RR_UR22	94,965****
RR_XS30	Approximately 1,700 feet Upstream of RR_UR25	98,322****
RR_XS31	Approximately 1,400 feet Downstream of RR_UR27	101,082****
RR_XS32	Approximately 550 feet Upstream of RR_UR28	104,050****
RR_XS33	Approximately 1,700 feet Downstream of RR_US70	107,069****
RR_XS34	Approximately 1,600 feet Upstream of RR_US70	110,346****
RR_XS35	Approximately 3,500 feet Upstream of RR_XS34	113,860****
RR_XS36	Approximately 200 feet Downstream of RR_UR33	117,013****
RR_XS37	Approximately 3,000 feet Downstream of Parker Road	121,074****
RR_XS38	Approximately 2,800 feet Downstream of RR_JW (Joe Welch Drive)	127,032****
RR_XS40	Approximately 1,700 feet Upstream of RR_REESE	144,589****
RR_XS41	Approximately 1,400 feet Upstream of RR_MALONE (Malone Road)	175,886****
Salado Creek		
SC_XS1	Downstream of SC_Salado	31*****
SC_XS2	Approximately 1,700 feet Upstream of Canyon Road	3,131*****
SC_XS3	Upstream of SC_ La Cumbre	6,616*****

* Stream Distance in Feet Above Confluence with Rio Ruidoso
** Stream Distance in Feet Above Confluence with Rio Ruidoso
*** Stream Distance in Feet Above 297 Feet Downstream of County Road 48
**** Stream Distance in Feet Above Confluence with Rio Hondo
***** Stream Distance in Feet Above Confluence with Oso Creek

3.2 CULVERT SURVEYS

For Limited Detail Studies, culvert measurements include the following:

- Height, width, length, number, and type of culverts.
- Relative elevations of the culvert invert, the roadway, and the right and left channel banks.
- Top and bottom widths of the channel.

For culverts within Detailed Study areas, the required field survey information includes the following:

- Locate or establish an ERM.
- Sketch of the plan view and upstream face of the structure.

- Upstream and downstream culvert invert elevations.
- Longitudinal length of culvert.
- Diameter or rise and span of culverts.
- Top of road cross-section with survey points every 50 feet along the roadway and extend the cross-section right and left for 200 feet from the edge of the structure.
- Channel cross-section directly upstream of the structure with survey points every 50 feet along the ground and additional survey points to represent significant breaks in ground slope, top of banks, toe of slopes, and bottom centerline of the channel. Cross-section extended right and left for approximately 200 feet from the edge of the channel bank.
- Top of rail survey points.
- All other survey points required by Watershed Information System (WISE).

3.3 BRIDGE SURVEYS

For Limited Detail Studies, bridge measurements include the following:

- Height, length, and deck thickness of the bridge.
- At the bridge, the width at the top of the channel and the toe of the slope.
- Number of piers and the diameter of each pier.
- Relative elevations of the channel invert, the roadway, and the right and left channel banks.
- Channel top and bottom widths at a representative location outside any transition due to the bridge.

For bridges within Detailed Study areas, the required field survey information includes the following:

- Locate or establish an ERM.
- Sketch of the plan view and upstream face of the structure.
- Location of each pier.
- Upstream invert elevations for each bridge segment between piers.
- Downstream invert elevation.
- Low chord, top of bridge, and top of rail elevations.
- Longitudinal length of bridge.
- Top of road cross-section with survey points every 50 feet along the roadway and additional points at the edge of the structure. Cross-section extended right and left for approximately 200 feet from the edge of the structure.
- Channel cross-section directly upstream of the structure with survey points every 50 feet along the ground and additional survey points to represent significant breaks in ground slope,

top of banks, toe of slopes, and bottom centerline of the channel. Cross-section extended right and left for approximately 200 feet from the edge of the channel bank.

All other survey points required by WISE.

Table 3-2 lists the structures surveyed by the Limited Detail method.

Table 3-2: List of Limited Detail Structures

Structure Name	Location	Type	Station (Distance in feet)
Cedar Creek			
CEC_A	Driveway North of Musketball Drive	1-2-foot and 2-3-foot Round CMP	10,790*
CEC_B	In Cedar Creek Downstream of CEC_A	2.5-foot Round CMP	10,639*
CEC_CROSS	Driveway North of Cross Drive	3-foot x 5-foot Elliptical CMP	7,671*
CEC_DW106	106 Cedar Creek Dr.	5-foot Round CMP	6,574*
CEC_DW112	112 Cedar Creek Drive	4-foot Round CMP	7,339*
CEC_DW206	206 Cedar Creek Drive	3-foot Round CMP	8,568*
CEC_DW210	210 Cedar Creek Drive, Driveway with Gate	3-foot Round CMP 2-1.5-foot x 1.15-foot CBC	8,874*
CEC_HC1	Half Circle Drive	5-foot Round CMP	6,867*
CEC_HC1A	50 feet East of CEC_HC1	5-foot Round CMP	6,817*
CEC_HC1A Bridge	Upstream of HC2	Bridge	8,368*
CEC_HC2	Half Circle Drive	2-foot Round CMP	8,267*
CEC_K	Downstream of CEC_DW106	Bridge	6,210*
CEC_MB	Musketball Drive	4.15-foot x 4.83-foot Elliptical CMP	10,520*
CEC_RETREAT	300 Cedar Creek Drive	4-foot Round CMP	9,621*
CEC_UR1	Forest Road	3.25-foot x 6.40 Elliptical CMP	3,701*
CEC_UR2	Forest Road	2-6-foot Round CMP	4,850*
CEC_UR3	Forest Road	2-6-foot Round CMP	5,620*
CEC_UR4	Unnamed Road 4	2-3-foot Round CMP	9,118*
CEC_UR5	Road to Dickinson Ranch	3-foot Round CMP	9,398*
Rio Bonito			
RB_CR48	County Road 48	Bridge	297**
RB_PED	Bridge is Upstream of County Road 48	Bridge	618**
RB_UR10	Unnamed Road 10 (Bonito Stables)	Bridge	19,020**
RB_UR10A	Unnamed Road 10A (Bonito Stables)	Bridge	19,173**
RB_UR11	Unnamed Road 11	Bridge	19,598**

Structure Name	Location	Type	Station (Distance in feet)
RB_UR13	Unnamed Road 13	4-foot Round CMP	20,310**
RB_UR14	Unnamed Road 14	4-3-foot Round CMP	22,629**
RB_UR2	Unnamed Road 2	Bridge	1,426**
RB_UR3	Unnamed Road 3	3-10-foot x 8-foot Box CBC	4,311**
RB_UR3A	Unnamed Road 3	Bridge	5,181**
RB_UR4	Unnamed Road 4	Bridge	7,420**
RB_UR5	Unnamed Road 5	Bridge	9,379**
RB_UR6	Unnamed Road 6	Bridge	16,699**
RB_UR7	Unnamed Road 7 (Bonito Lou's Café)	2-10-foot x 8-foot Box CBC	16,893**
RB_UR8	Unnamed Road 8 (Bonito Falls Café)	Bridge	17,789**
RB_UR8A	Unnamed Road 8A (Bonito Falls Café)	Bridge	17,674**
RB_UR9	Unnamed Road 9	Bridge	18,284**
Rio Ruidoso			
RR_CR17	County Road 17 (El Ojito)	Bridge	4,267***
RR_CRE002	County Road E002	5-foot x 3.5-foot Elliptical CMP	105,523***
RR_CRE003	County Road E003 (Tully)	Bridge	71,113***
RR_CRE005	County Road E005 (Perry Spring)	Bridge	68,538***
RR_CRE008	County Road E008 (El Valle Loop)	Bridge	41,672***
RR_CRE008A	County Road E008 (El Valle Loop)	Bridge	29,876***
RR_FS443	Coe Canyon	Bridge	66,187***
RR_UR11	Off of Frontage Road near FS 443	Bridge	68,078***
RR_UR13	Unnamed Road 13 West of CRE003	Bridge	75,105***
RR_UR15	Off of Frontage Road West of FS 120	Bridge	80,556***
RR_UR16	Off of Frontage Road West of FS 120	Bridge	86,035***
RR_UR16A	Pedestrian Bridge on Private Property	Bridge	85,694***
RR_UR17	Driveway off of Buckhorn Loop	Bridge	87,841***
RR_UR19	San Ysidro	Bridge	93,179***
RR_UR19A	Pedestrian Bridge on Private Property	Bridge	91,541***
RR_UR2	Unnamed Road 2	Bridge	11,874***
RR_UR21	Driveway West of San Ysidro	Bridge	94,316***
RR_UR22	Driveway West of RR_UR21	Bridge	94,932***
RR_UR25	East end of Trailer Park East of FS 120B	Bridge	96,593***
RR_UR27	Unnamed Road 27 East of Cemetery	Bridge	102,471***

Structure Name	Location	Type	Station (Distance in feet)
RR_UR28	Unnamed Road 28 West of Cemetery	Bridge	103,530***
RR_UR3	Tara Trail	Bridge	15,633***
RR_UR33	Unnamed Road 33 North of Canyon Road	Bridge	117,239***
RR_UR4	La Mancha	Bridge	23,913***
RR_UR5	McDaniel	Bridge	47,412***
RR_UR7	Mardi Gras	Bridge	50,872***
RR_UR9	Rivers Edge	Bridge	53,585***
RR_US70	US 70 Highway	Bridge	108,759***
Salado Creek			
SC_LA CUMBRE	Salado Road	8-foot Round CMP	6,546****
SC_SALADO	Salado Road	2-2-foot Round CMP	475****
SC_UR1	Salado Road	2-6-foot Round CMP	1,398****

* Stream Distance in Feet Above Confluence with Rio Ruidoso
** Stream Distance in Feet Above 297 Feet Downstream of County Road 48
*** Stream Distance in Feet Above Confluence with Rio Hondo
**** Stream Distance in Feet Above Confluence with Oso Creek

Table 3-3 provides a list of structures surveyed by the Detailed method.

Table 3-3: List of Detailed Structures

Structure Name	Location	Type	Station (Distance in feet)
Brady Canyon			
BC_ALONZO3	Alonzo Way	4-foot Round CMP	869*
BC_ALTO	Mechem Drive	2-5-foot Round CMP Inlet 1-3.7-foot x 4.1-foot Concrete Block Outlet	437*
BC_ASH	Ash Drive	3-foot Round CMP	5,316*
BC_BC1	Brady Canyon Road	3-foot Round CMP	2,735*
BC_BC2	Brady Canyon Road	3-foot Round CMP	2,942*
BC_BC3	Umbrella Drive	3-foot Round CMP	6,216*
BC_OAK	South Oak Drive	3-foot Round CMP	4,363*
BC_PORR	Porr Drive	4-foot Round CMP	1,450*
BC_UR10	Driveway off Brady Canyon Road	2-foot Round CMP	2,335*
BC_UR4	Road Southwest off of Oak Drive	3-foot Round CMP	4,452*
BC_UR6	Driveway off Ponderosa Drive	2-foot Round CMP	3,636*

Structure Name	Location	Type	Station (Distance in feet)
BC_UR7	Driveway off Ponderosa Drive	2-foot Round CMP Inlet Bolted 1.5-foot Round Pipe Outlet	3,222*
BC_UR8	Driveway off Ponderosa Drive	2-1.5-foot Round CMP	3,129*
BC_UR9	Driveway off Ponderosa Drive	1.8-foot Round Metal Drum	3,099*
BC_VALONIA	Valonia Lane	2-3-foot Round CMP	3,834*
Carrizo Creek			
CAC_CC	Carrizo Canyon Road	8-foot Round CMP	8,419**
CAC_GK1	Go-Kart Track Near Sudderth Drive	Bridge	653**
CAC_GK3	Go-Kart Track Near Sudderth Drive	Bridge	891**
CAC_GK4	Go-Kart Track Near Sudderth Drive	Bridge	1,134**
CAC_MASSINGILL	Massingill Lane	2-3-foot Round CMP	5,682**
CAC_MC	Next to Rainbow Lake in RV Park	Bridge	8,957**
CAC_MC2	Bridge located within RV Park	Bridge	9,241**
CAC_SUDDERTH	Sudderth Drive	2-10-foot x 14-foot CBC	296**
CAC_TOMAHAWK1	Tomahawk Trail	3-3-foot Round CMP	2,733**
CAC_TOMAHAWK2	Tomahawk Trail	7.5-foot Round CMP	4,152**
CAC_UR1	Hickory Road	2-5-foot Round CMP	1,680**
CAC_UR2	Mort 818	6-foot Round CMP and 3-foot Round CMP	9,744**
CAC_UR2A	Gravel Road	2-5-foot Round CMP	9,889**
CAC_UR3	Canyon Creek Lodge	8-foot Round CMP	10,531**
CAC_UR4	Pedestrian Bridge	Bridge	11,013**
CAC_UR5	Driveway Downstream of CAC_UR6	5-foot Round CMP	11,096**
CAC_UR6	Mescalero Inn	Bridge	11,329**
Cedar Creek			
CEC_ALTO	Mechem Drive	2-9-foot x 8-foot CBC	13,318***
CEC_CM	Cree Meadows Drive	4-foot Round CMP 2.5-foot Round CMP	11,843***
CEC_HART	Hart Avenue	10-foot x 5-foot CBC	3,329***
CEC_HULL	Hull Road	3-foot Round CMP	8,186***
CEC_PC3	Paradise Canyon Drive	3-foot Round CMP	7,448***
CEC_PED_BR2	300 feet Upstream of PED_BR1 (Golf Course)	1-foot Round Pipe	12,413***

Structure Name	Location	Type	Station (Distance in feet)
CEC_PED_BR1	250 feet Upstream of CEC_CM (Golf Course)	1-foot Round Pipe	12,115***
CEC_STARLITE	Starlite Road	3-foot Round CMP	7,728***
CEC_UR3	Unnamed Road 3	3-foot Round CMP	457***
CEC_UR4	Unnamed Road 4	7-foot Round Steel Pipe	5,294***
Rio Ruidoso			
RR_ALTO	Mechem Drive	3-10-foot x 10-foot CBC	159,933****
RR_CC2	Country Club Drive	18-foot x 9-foot Elliptical CMP	154,686****
RR_CLOSE	Close Road	3-10-foot x 8-foot CBC	140,509****
RR_COYOTE	Coyote Lane	Bridge	164,728****
RR_DRIVEA	Driveway off of Robins Road	Bridge	150,817****
RR_EAGLE	Eagle Drive	3-10-foot x 8-foot CBC	155,890****
RR_FB	Freidan Bloom Drive	Bridge	139,494****
RR_GC	Gavilan Canyon Road	3-8-foot x 3-foot CBC	142,518****
RR_JW	Joe Welch Drive	Bridge	129,850****
RR_LOOP1	North Loop Road	Bridge	169,983****
RR_MAIN1	Main Road	Bridge	163,137****
RR_MAIN2	Main Road	Bridge	166,667****
RR_MALONE	Malone Road	Bridge	174,484****
RR_MARTIN	Martin Road	Bridge	174,176****
RR_MCDANIEL	McDaniel Drive	2-4-foot Round CMP and 1-1.5-foot Round CMP	172,802****
RR_NGC	North Grindstone Canyon Road	Bridge	157,474****
RR_PARKER1	Parker Road	Bridge	123,937****
RR_PARKER2	Parker Road	Bridge	123,932****
RR_PC	Paradise Canyon Drive	Bridge	147,057****
RR_PEDA	Pedestrian Bridge off of Robins Road	Bridge	150,706****
RR_PEDB	Pedestrian Bridge off of Robins Road	Bridge	149,823****
RR_REESE	Reese Drive	Bridge	143,305****
RR_SH_PED	Approximately 200 feet downstream of Sleepy Hollow Road	Bridge	160,444****
RR_UR35	Upstream of RR_UR36 in Horse Barn area	Bridge	131,164****
RR_UR36	East side of Horse Track	21-foot x 31-foot Elliptical CMP	132,261****

Structure Name	Location	Type	Station (Distance in feet)
RR_UR38	West side of Horse Track	10-foot x 4-foot Elliptical CMP and 8-foot x 4-foot Elliptical CMP	134,129****
RR_UR39	Entrance to Ruidoso Downs Track	18-foot x 8-foot Elliptical CMP	134,855****
RR_UR41	Dirt Road and Construction Site North of Wal-Mart Entrance	Bridge	136,227****
RR_UR46	Park entrance off of Sudderth Drive	Bridge	149,098****
RR_UR47	Driveway off of Robins Road	Bridge	151,328****
RR_WILLOW	Willow Road Intersection with River Trail	Bridge	151,970****

* Stream Distance in Feet Above Confluence with Rio Ruidoso
** Stream Distance in Feet Above Confluence with Rio Ruidoso
*** Stream Distance in Feet Above Confluence with Rio Ruidoso
**** Stream Distance in Feet Above Confluence with Rio Hondo

3.4 DROP STRUCTURE SURVEYS

The survey consists of the following:

- Photograph drop structure.
- Indicate drop distance through Upstream or Downstream Invert shot for Detailed Studies.
- Indicate drop distance by taking elevation reading or direct measurement for Limited Detail Studies.

Table 3-4 provides a list of drop structures.

Table 3-4: List of Drop Structures

Structure Name	Location	Drop Distance (feet)
Carrizo Creek		
CAC_UR1 (HICKORY)	Upstream of CAC_UR1	0.5
CAC_UR3	Upstream end of CAC_UR3	0.5
Cedar Creek		
CEC_MB	Downstream end of CEC_MB	2.5
CEC_PED_BR1	Downstream end of CEC_PED_BR1	4.0
CEC_PED_BR2	Downstream end of CEC_PED_BR2	7.0
CEC_UR4	Downstream end of CEC_UR4	1.0

Rio Ruidoso		
RR_DROP 1	Downstream of RR_MALONE	3.0
RR_CR17 EL OJITO	Upstream of RR_CR17	2.0
RR_CR17 EL OJITO	Upstream of RR_CR17	3.0
RR_GC	Downstream of RR_GC	4.0
RR_PARKER	Downstream of RR_PARKER	2.5
RR_UR29	Trailer Park Downstream of RR_US70	1.5
RR_UR19	Downstream of RR_UR19	1.0

3.5 DAM SURVEYS

Dam and weir surveys were not performed, as there are no dams or weirs present along the study reaches. Information regarding dam outlets at the upper reaches of streams where they existed was collected and utilized in the analysis where necessary.

3.6 ELEVATION REFERENCE MARKS

These ERMs include existing elevation references if they exist. An ERM was located or established for each structure surveyed.

Acceptable ERMs can consist of any solid object set in a stable structure or ground. As a general rule, ERM density should be approximately one every mile of stream length or four per square mile of floodplain, as appropriate. Surveys should not be taken for the sole purpose of establishing ERMs. The ERMs set during the course of the field survey are listed in Table 3-5.

Table 3-5: List of Elevation Reference Marks for Detailed Surveys

Structure Name	Structure Location	ERM Location	Elevation (feet NAVD88)
Brady Canyon			
BC_ALTO	Mechem Drive	25 feet Northeast of edge of structure.	6,761.94
BC_ALONZO3	Alonzo Way	Upstream edge of structure on top of wall.	6,773.17
BC_ASH	Ash Drive	Control Point set in road.	6,912.26
BC_BC1	Brady Canyon Road	9 feet Northwest of upstream edge of structure set in asphalt.	6,837.43
BC_BC2	Brady Canyon Road	17 feet Southeast of upstream edge of structure set in asphalt.	6,843.38
BC_BC3	Umbrella Drive	2 feet North of South edge of upstream guardrail.	6,938.14
BC_OAK	South Oak Drive	10 feet East of structure.	6,883.97
BC_PORR	Porr Drive	10 feet North of upstream edge of structure at edge of	6,793.38

Structure Name	Structure Location	ERM Location	Elevation (feet NAVD88)
		road.	
BC_UR10	Brady Canyon Road	12 feet North of upstream edge of structure.	6,825.46
BC_UR4	Road Southwest off of Oak Drive	North edge of upstream corner of structure.	6,883.36
BC_UR6	Ponderosa Drive and Driveway	North end of upstream edge of structure.	6,860.01
BC_UR7	Ponderosa Drive	Control Point set in road near structure.	6,852.41
BC_UR8	Ponderosa Drive and Driveway	25 feet East of upstream end of structure in driveway.	6,848.71
BC_UR9	Ponderosa Drive	Due to close proximity of structures, ERM for BC_UR8 was also used for BC_UR9.	6,848.71
BC_VALONIA	Valonia Lane	4 feet East of North structure.	6,865.80
Carrizo Creek			
CAC_CC	Carrizo Canyon Road	West edge of road by North side of guardrail.	6,700.89
CAC_GK1	Go-Kart Track Near Sudderth Drive	8 feet Northwest of downstream end of North edge of guardrail.	6,564.09
CAC_GK3	Go-Kart Track Near Sudderth Drive	Due to close proximity of structures, ERM for CAC_GK4 was also used for CAC_GK3.	6,574.66
CAC_GK4	Go-Kart Track Near Sudderth Drive	16 feet South of upstream end of North edge of guardrail.	6,574.66
CAC_MASSINGILL	Massingill Lane	West edge of upstream channel bank.	6,647.56
CAC_MC	Next to Rainbow Lake in RV Park	15 feet Northwest of corner of bridge. Set in sidewalk.	6,703.92
CAC_MC2	Bridge located within RV Park	Northwest corner of bridge deck.	6,705.47
CAC_SUDDERTH	Sudderth Drive	15 feet East of east edge of upstream guardrail.	6,561.61
CAC_TOMAHAWK1	Tomahawk Trail	Edge of pavement at Northeast end of structure.	6,597.85
CAC_TOMAHAWK2	Tomahawk Trail	Edge of road by Northwest end of guardrail.	6,628.36
CAC_UR1	Hickory Road	Edge of pavement at	6,582.29

Structure Name	Structure Location	ERM Location	Elevation (feet NAVD88)
		Northeast edge of road.	
CAC_UR2	Mort 818	15 feet Northwest of channel centerline.	6,718.34
CAC_UR2A	Gravel Road	10 feet East of channel centerline at edge of road.	6,720.62
CAC_UR3	Canyon Creek Lodge	20 feet South-West of channel centerline in asphalt.	6,739.36
CAC_UR4	Pedestrian Bridge	10 feet West of channel centerline in grass.	6,738.32
CAC_UR5	Driveway Downstream of CAC_UR6	25 feet West of channel centerline in ground.	6,744.26
CAC_UR6	Mescalero Inn	30 feet West of channel centerline on top of railroad ties.	6,747.80
Cedar Creek			
CEC_ALTO	Mechem Drive	30 feet North of upstream edge of structure.	6,847.01
CEC_CM	Cree Meadows Drive	13 feet East of upstream edge of structure.	6,803.54
CEC_HART	Hart Avenue	12 feet West of East edge of upstream guardrail.	6,611.35
CEC_HULL	Hull Road	17 feet North of upstream edge of structure.	6,716.69
CEC_PC3	Paradise Canyon Drive	23 feet South of upstream edge of structure. Set in road.	6,700.90
CEC_PED_BR1	250 feet Upstream of CEC_CM (Golf Course)	20 feet Northeast of upstream edge of structure. Set in sidewalk.	6,807.57
CEC_PED_BR2	300 feet Upstream of PED_BR1 (Golf Course)	25 feet Northeast of upstream edge of structure. Set in sidewalk.	6,818.96
CEC_STARLITE	Starlite Road	Control point set inroad.	6,728.28
CEC_UR3	Unnamed Road 3	19 feet East of upstream edge of structure.	6,543.43
CEC_UR4	Unnamed Road 4	40 feet Northeast of upstream edge of structure.	6,656.62
Rio Ruidoso			
RR_ALTO	Mechem Drive	14 feet South of upstream end of North edge of guardrail. Set in asphalt.	6,762.49
RR_CC2	Country Club Drive	17 feet South of upstream end of North edge of	6,652.57

Structure Name	Structure Location	ERM Location	Elevation (feet NAVD88)
		guardrail. Set in asphalt.	
RR_CLOSE	Close Road	North edge of downstream side of bridge.	6,447.36
RR_COYOTE	Coyote Lane	East edge of guardrail on upstream side.	6,861.10
RR_DRIVEA	Driveway off of Robins Road	Northeast corner of upstream side of bridge. Set on railroad tie.	6,580.03
RR_EAGLE	Eagle Drive	52 feet North of upstream end of North edge of guardrail.	6,673.32
RR_FB	Freidan Bloom Drive	South edge of downstream side of bridge.	6,433.01
RR_GC	Gavilan Canyon Road	Northwest corner of upstream side of bridge	6,467.96
RR_JW	Joe Welch Drive	South-East corner of downstream side of bridge. Set in asphalt.	6,334.32
RR_LOOP1	North Loop Road	Asphalt on upstream side North of bridge.	6,995.17
RR_MAIN1	Main Road	Northwest corner of upstream side of bridge.	6,821.38
RR_MAIN2	Main Road	North edge of road on upstream side. 15 feet from bridge. Control Point.	6,909.00
RR_MALONE	Malone Road	North edge of upstream side of bridge deck.	7,126.55
RR_MARTIN	Martin Road	North corner of upstream side of wooden bridge deck.	7,117.51
RR_MCDANIEL	McDaniel Drive	North edge of upstream guardrail.	7,072.15
RR_NGC	North Grindstone Canyon Road	4 feet South of upstream end of North edge of guardrail. Set in asphalt.	6,699.98
RR_PARKER1	Parker Road	Due to close proximity, ERM for RR_PARKER2 was also used for RR_PARKER1.	6,270.21
RR_PARKER2	Parker Road	North edge of upstream side of concrete bridge deck. Control Point.	6,270.21
RR_PC	Paradise Canyon Drive	Northwest corner of	6,523.10

Structure Name	Structure Location	ERM Location	Elevation (feet NAVD88)
		upstream side of bridge. Set in asphalt.	
RR_PEDA	Pedestrian Bridge off of Robins Road	Northeast corner of upstream side of bridge. Set on bridge deck.	6,576.15
RR_PEDB	Pedestrian Bridge off of Robins Road	Northeast corner of upstream side of bridge. Set on bridge deck.	6,561.83
RR_REESE	Reese Drive	Northwest corner of upstream side of bridge. Set in asphalt.	6,479.15
RR_SH_PED	Approximately 200 feet downstream of Sleepy Hollow Road	North end of upstream edge of bridge.	6,761.24
RR_UR35	Upstream of RR_UR36 in Horse Barn area	Northwest corner of upstream side of bridge. Set in wooden bridge deck.	6,342.32
RR_UR36	East side of Horse Track	24 feet Northwest edge of structure. Set on top of 2-foot CMP.	6,348.97
RR_UR38	West side of Horse Track	Northwest edge of upstream side of structure. Set on top of guardrail post.	6,366.85
RR_UR39	Entrance to Ruidoso Downs Track	North edge of upstream side of structure.	6,383.95
RR_UR41	Dirt Road and Construction Site North of Wal-Mart Entrance	Elevation is of control point used. Bridge is under construction. No ERM could be set on structure.	6,399.88
RR_UR46	Park entrance off of Sudderth Drive	North edge of upstream side of bridge. Set on guardrail post.	6,549.97
RR_UR47	Driveway off of Robins Road	East end of upstream side of bridge. Set on wing wall.	6,592.71
RR_WILLOW	Willow Road Intersection with River Trail	Northwest corner of upstream side of bridge.	6,596.14

SECTION FOUR TOPOGRAPHIC DATA DEVELOPMENT

4.1 ACQUISITION

The topographic data for this analysis consisted of two different datasets. Thomas R. Mann & Associates, using orthophotogrammetric methods, compiled and provided 5-foot contours that covered the Village of Ruidoso and the City of Ruidoso Downs. This data was considered the best available in the area by the communities. For regions outside of the contour dataset coverage area, the best topographic data available were 10-meter Digital Elevation Models (DEMs) obtained from the U.S. Geological Survey (USGS) National Map Seamless Server. All data was processed together to make one seamless terrain model.

4.2 PROCESSING

To provide complete coverage of the study reaches area, the 10-meter DEMs were pre-processed to be compatible with WISE Terrain Analyst software from Watershed Concepts, and then input into the terrain model for processing of the county areas. A total of four 10-meter DEMs were obtained from the USGS National Map Seamless Web site to provide adequate coverage of the study streams and all contributing drainage areas.

In their native download format, the DEMs were referenced to a Geographic North American Datum of 1983 (NAD83) horizontal datum and a North American Vertical Datum of 1988 (NAVD88) vertical datum with vertical units expressed in meters. In order to generate Triangulated Irregular Networks (TINs) in WISE Terrain Analyst, the DEMs vertical units were converted from meters to feet, and the DEMs were projected to NAD83 New Mexico State Plane Central Federal Information Processing Standards (FIPS) 3002 projection. In order to be imported into WISE Terrain Analyst, the DEMs were finally exported to ASCII text file format.

In the regions for which there was contour coverage, the contours were considered the best available data. Some additional processing was required in order to use the contours provided by Thomas Mann. Contours were provided in a ground coordinate system (NAD83 New Mexico Central High Accuracy Reference Network (HARN), and needed to be converted to a grid coordinate system (NAD83 New Mexico Central Feet). This was accomplished by applying a “ground to grid” conversion factor of 0.999596756. The vertical datum of the data was also provided in National Geodetic Vertical Datum of 1929 (NGVD29), and needed to be converted to the NAVD88. This could not be accomplished by computing a general conversion factor that covered the area of the contours, as it would not meet FEMA standards. Therefore, each contour vertex was converted separately, and then input into the terrain model. After these conversions were performed, all data was consistent with the terrain model.

In areas in which DEM and contour data were both available, the contours were prioritized higher for TIN creation in the WISE Terrain Analyst. The TINs provided complete coverage of areas that included the study streams. The WISE Digital Terrain Model (DTM) was exported and is included in this submittal.

Digital terrain information can be found in Appendix B of this document.

4.3 DATA EVALUATION

Because the USGS DEMs were provided from a Federal agency, URS did not perform a detailed evaluation of the data accuracy. It was not necessary to produce a hydro-correct DEM for this study because the hydrology was completed without the use of TINs or DEMs.

SECTION FIVE HYDROLOGIC ANALYSES

The original scope of this project specified the use of a FEMA-approved rainfall runoff model such as the Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) to estimate peak flow discharges. A HEC-HMS rainfall runoff model based on the Soil Conservation Service (SCS) method was developed to estimate the 10- to 1-percent-annual-chance discharges within the watershed. The model assumed a Natural Resource Conservation Service (NRCS) Type II-65 rainfall distribution for the design storms, a typical rainfall distribution for the area. Meanwhile, URS also performed a Log Pearson Type III analysis of recorded annual peak flows at two available USGS gaging stations (#08387000 and #08388000) along the Rio Ruidoso to compare with the results from the HEC-HMS models. These two gauges both have relatively long terms of record of 54 and 40 years, respectively, which would imply a high degree of confidence in the statistical analysis results. The gages are also located in the study area and in the Southeast Mountain Flood Region for the regional regression equations, which is the same region as the study streams. A comparison between the results of the two analyses indicated that the rainfall runoff model was significantly over-predicting flows.

A reasonable effort was made at calibrating the HEC-HMS model to the Log Pearson analysis Type-III analysis, including adjusting the initial abstraction, using an area reduction factor, and considering the water supply reservoir in the study area. Unfortunately, the HEC-HMS model was still significantly over-predicting flows in the area as compared to the gauge analysis, hence another methodology was sought.

In addition to the Log Pearson Type III analysis, URS also used the regression equations outlined in the USGS Scientific Investigations Report (SIR) 2008-5119, *Analysis of the Magnitude and Frequency of Peak Discharge and Maximum Observed Peak Discharge in New Mexico and Surrounding Areas* (2008) to estimate peak flow discharges. Flows estimated based on the recently released, USGS SIR 2008-5119 regression equations were very similar in comparison to the Log Pearson Type III analysis, and were also much closer to the values published in the effective FIS. This comparison indicated that the new regression equations were reporting correctly, because both analyses were based off of actual stream flow data and were similar in comparison. It was also considered more reasonable to use the regression equations because they are based off of actual flow data, and not a hypothetical storm.

As indicated in Table 5-1, based on the Log Pearson Type III analysis for the Hondo Gage record, the 1-percent-annual-chance discharge was estimated to be 22,210 cubic feet per second (cfs) compared with the 21,319 cfs estimated based on the USGS SIR 2008-5119 regression equation. The discharge estimated based on the USGS SIR 2008-5119 regression equation is also reasonable when compared to the discharge shown in the effective FIS.

Table 5-1: Flow Calculation Methodology Comparison for Rio Ruidoso

USGS Gage	Stream Name	Basin Area (Cumulative square miles)	HEC-HMS Q_{100} (cfs)	Log - Pearson Type III (cfs)	Ruidoso Effective FIS (cfs)	2008 Regression Calc Q_{100} (cfs)
Hollywood Gage #08387000	Rio Ruidoso	60.5	19,019	2,225	2,782	3,591
Hondo Gage #08388000	Rio Ruidoso	289.8	41,990	22,210	N/A	21,319

5.1 MODELING METHODOLOGY

The USGS SIR 2008-5119 lists separate regional regression equations for each of the nine hydrologic regions of New Mexico and the surrounding areas; standard errors of prediction for the 1-percent-annual-chance discharge range from 38 to 93 percent. The watersheds for Brady Canyon, Carrizo Creek, Cedar Creek, Rio Bonito, and Rio Ruidoso occupy the Southeast Mountain Flood Region 3. Salado Creek is located in the Southeast Plains Flood Region 4. However, due to suspected inconsistencies with Southeast Plains Flood Region 4 equations, the Southeast Mountain Flood Region 3 equation was used for Salado Creek as well. URS contacted USGS regarding the issues with the Southeast Plains equations, but USGS did not provide assistance in time to resolve the issue before the hydrology task was completed. URS determined that the differences between the discharge rates calculated using the two equations would most likely be minimal, and that using the Southeast Mountain Flood Region 3 equations for Salado Creek was an acceptable solution. The regression equation used in the peak flow estimation for the study area is summarized below:

$$Q_{100} = 1.856 \times 10^{6} (A)^{0.808} (E/1{,}000)^{-4.57}$$

Where,

A = Drainage area, in square miles

E = Average basin elevation, in feet

The original HEC-HMS analysis is also provided in the digital data of Appendix D for comparison purposes.

5.2 DRAINAGE BASIN AREA DELINEATION

The watersheds were delineated by visual inspection of available contour data using engineering judgment, orthophotogrammetric data, and field investigation. Figure D-1 in Appendix D shows the locations of each study stream and the delineated basin areas.

5.3 PARAMETERS

5.3.1 Watershed Parameters

Table 5-1 lists the parameters used for the regression analysis.

Table 5-2: Hydrology Parameters

Watershed	Basin ID	Cumulative Basin Area (square miles)	Basin Elevation (feet)
Brady Canyon	BASIN6	2.5	7,301
Carrizo Creek	BASIN9	22.5	7,747
Carrizo Creek	BASIN22	24.6	7,693
Cedar Creek	BASIN19	8.3	7,497
Cedar Creek LDS	BASIN23	2.1	7,991
Cedar Creek LDS	BASIN14	4.1	7,950
Cedar Creek LDS	BASIN24	6.9	7,623
Cedar Creek Tributary	BASIN13	0.5	6,891
Cherokee Bill Canyon	BASIN4	47.3	7,664
Grindstone Canyon	BASIN21	1.7	7,709
Musketball Canyon	BASIN5	0.4	7,553
North Fork	BASIN15	2.0	7,923
Rio Bonito	BASIN0	45.8	8,396
Rio Ruidoso	BASIN7	23.1	8,954
Rio Ruidoso	BASIN8	26.7	8,707
Rio Ruidoso	BASIN10	51.6	8,217
Rio Ruidoso	BASIN2	60.5	8,104
Rio Ruidoso	BASIN18	72.9	7,949
Rio Ruidoso	BASIN17	124.0	7,804
Rio Ruidoso	BASIN12	156.6	7,657
Rio Ruidoso	BASIN16	199.0	7,441
Rio Ruidoso	BASIN20	289.8	7,241
Salado Creek	BASIN3	16.1	7,068
Turkey Spring Canyon Creek	BASIN11	14.1	7,513
Unnamed Tributary 1	BASIN1	12.0	7,209

5.4 DISCHARGES

Table 5-3 presents the summary of the discharges computed from the hydrologic analyses.

Table 5-3: Summary of Discharges

Watershed	Basin ID	10-Percent-Annual-Chance Peak Discharge (cfs)*	2-Percent-Annual-Chance Peak Discharge (cfs)*	1-Percent-Annual-Chance Peak Discharge (cfs)*	0.2-Percent-Annual-Chance Peak Discharge (cfs)*
Brady Canyon	BASIN6	204	365	444	661
Carrizo Creek	BASIN9	736	1,531	1,985	3,404
Carrizo Creek	BASIN22	807	1,694	2,204	3,806
Cedar Creek	BASIN19	421	820	1,033	1,662
Cedar Creek LDS	BASIN23	123	210	252	366
Cedar Creek LDS	BASIN14	201	363	444	676
Cedar Creek LDS	BASIN24	345	658	823	1,306
Cedar Creek Tributary	BASIN13	83	133	155	208
Cherokee Bill Canyon	BASIN4	1,293	2,862	3,803	6,870
Grindstone Canyon	BASIN21	123	209	250	359
Mustketball Canyon	BASIN5	51	79	91	119
North Fork	BASIN15	122	207	248	359
Rio Bonito	BASIN0	870	1,854	2,439	4,341
Rio Ruidoso	BASIN7	415	818	1,046	1,761
Rio Ruidoso	BASIN8	515	1,039	1,339	2,285
Rio Ruidoso	BASIN10	1,033	2,240	2,965	5,334
Rio Ruidoso	BASIN2	1,221	2,697	3,591	6,545
Rio Ruidoso	BASIN18	1,506	3,399	4,562	8,443
Rio Ruidoso	BASIN17	2,354	5,576	7,628	14,674
Rio Ruidoso	BASIN12	2,993	7,274	10,045	19,685
Rio Ruidoso	BASIN16	3,978	9,957	13,895	27,790
Rio Ruidoso	BASIN20	5,780	15,053	21,319	43,906
Salado Creek	BASIN3	848	1,778	2,302	3,907
Turkey Spring Canyon Creek	BASIN11	601	1,219	1,561	2,604
Unnamed Tributary 1	BASIN1	639	1,301	1,664	2,763

SECTION SIX HYDRAULIC ANALYSES

The U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center – River Analysis System (HEC-RAS), Version 4.0, was used to perform the hydraulic analyses (USACE 2005). WISE was used as a pre-processor for inputs to the hydraulic models and as a post-processor for delineation of the resulting floodplains. The study was conducted in accordance with the requirements of Appendix C of FEMA's G&S (FEMA 2003).

6.1 MODELING METHODOLOGY

The scope of work for Rio Bonito and Salado Creek, and portions of Cedar Creek and the Rio Ruidoso specified the use of the Limited Detail study methodology. The remainder of the streams were studied using detailed methodology. A floodway analysis was also conducted on the detailed portions of Brady Canyon, Carrizo Creek, Cedar Creek and the Rio Ruidoso. The discharges presented in Table 5-3 were used for the hydraulic analyses.

6.2 CROSS-SECTION DEVELOPMENT

The WISE software was used to place cross-sections at 500-foot intervals. Additional cross-sections were placed along the reach in areas where the channel slope or geometry abruptly changed. WISE also automatically named and numbered the cross-sections sequentially from downstream to upstream. The cross-sections placed by WISE were then checked for reasonableness during a quality control phase of the hydraulic modeling. They were adjusted to extend across the entire anticipated floodplain width and were placed perpendicularly to the anticipated direction of flow in both the main channel and the overbank areas. The cross-sections were also realigned manually to avoid swales, to tie them into the high points, and to make sure the cross-sections were not intersecting with each other.

Besides the natural cross-sections drawn automatically by WISE, the additional five cross-sections required for the subsequent HEC-RAS hydraulic model were manually added at structures such as bridges and culverts. These five cross-sections include a downstream cross-section where flow is fully expanded, a cross-section at the downstream face of the structure, a cross-section representing the top of the structure, a cross-section at the upstream face of the structure, and an upstream cross-section prior to flow contraction.

The channel portion was surveyed at cross-sections identified in Section 3 of this report and this data was blended with the digital overbank topographic data in WISE at these cross-sections. For non-surveyed natural cross-sections, the channel geometry was copied from the nearest surveyed cross-section if applicable, and the overbank geometry was derived from the topographic data in WISE.

6.3 FLOODWAY ANALYSIS

Floodway analyses were conducted on Brady Canyon, Carrizo Creek, the detailed portion of Cedar Creek and the detailed portion of the Rio Ruidoso. Encroachments were calculated with a goal of a 1-foot water surface elevation rise, and a 1:1 width change. Given the steep nature each channel, this goal was not always reached. Many locations along the stream had no encroachments and no rise because the flow was near critical, or critical. Any encroachments in

these areas would result in negative changes in water surface elevations indicating higher velocities. These high velocities would cause excess degradation of channels and their banks.

Floodway data tables are provided in Appendix E.

6.4 MANNING'S ROUGHNESS COEFFICIENT CALCULATIONS

Qualified field personnel were dispatched to inspect each study stream in order to make determinations regarding the Manning's n-values and other hydraulic characteristics. Photographs were also taken to document the floodplain condition at the time of field reconnaissance (see digital data). The Manning's n-values were determined taking into consideration several factors, such as channel bed materials (type and density), height of existing vegetation, and existing structures in the overbanks. Determinations were also made by inspecting the stream and the surrounding floodplain, and comparing it to characteristics listed in the *HEC-RAS User's Manual*, Table 3-1, Manning's n-values (USACE 2005; see Appendix C, Field Survey and Reconnaissance). These determinations were listed on Field Reconnaissance Data Sheets. The Manning's n-values used in the hydraulics models were based on the Field Reconnaissance Data Sheets and examination of aerial imagery, and engineering judgment was exercised to develop the values for the model. Channel banks were placed to reflect the roughness coefficient changes along each cross-section in the hydraulic model.

Table 6-1 provides the Manning's n-values that were used in the HEC-RAS model for each study reach.

Table 6-1: Manning's n-Values

Flooding Sources	Left Overbank N-Value	Main Channel N-Value	Right Overbank N-Value
Brady Canyon	0.08–0.2	0.035–0.05	0.08–0.2
Carrizo Creek	0.1–0.13	0.026–0.055	0.02–0.14
Cedar Creek	0.04–0.12	0.035–0.07	0.04–0.12
Rio Bonito Creek	0.08–0.12	0.05	0.07–0.12
Rio Ruidoso	0.1–0.2	0.035–0.05	0.1–0.2
Salado Creek	0.06–0.07	0.045–0.05	0.06–0.07

During the June 18, 2009 Community Review Meeting, the Village of Ruidoso indicated that many of the streams in the Village of Ruidoso were full of debris from the flooding that occurred in July 2008. It was noted during this meeting that obstructed structure and channel situations are not modeled during hydraulic modeling. The analyses performed assumed unobstructed structure and channel conditions.

6.5 MODELING CONSIDERATIONS AND OTHER MODEL PARAMETERS

Typical expansion and contraction coefficients of 0.1 and 0.3, respectively, were used for all channel cross-sections to account for losses due to the changing width of the study stream. Expansion and contraction loss coefficients were also applied to all crossing structures within the HEC-RAS model to account for the additional energy losses. For normal culverts and bridges,

the expansion and contraction coefficients were set to 0.3 and 0.5, respectively. For locations where larger losses were expected, such as at a very small culvert, the expansion and contraction coefficients were set to 0.6 and 0.8, respectively. Ineffective flow areas were also used to describe portions of a cross-section where water is not active (i.e., at the abutments of a structure).

Due to minor bends in each stream, some survey data did not always line up with structures in the floodplain. Engineering judgment was used to more accurately refine data from the model.

Based on aerial imagery, there appears to be a dam on Rio Bonito, just upstream of structure RB_UR9 (Unnamed Road 9). No structure was surveyed at this location, but an approximate structure (DAM1) was added in the hydraulic model using the topographic information and aerial imagery.

On the Cedar Creek Limited Detail study reach, two culverts were added at Stations 12658 and 12852 based on field reconnaissance. The structures were not surveyed, but the dimensions were estimated based on photographs, topographic data, and similar structures surveyed.

All models were run at subcritical depth as per the G&S (FEMA 2003). For Brady Canyon, Cedar Creek, Salado Creek, Rio Bonito, and the Rio Ruidoso Limited Detail study, per C.3.4.3 of G&S Appendix C, normal depth was used as the starting downstream boundary condition for these streams. The Rio Ruidoso Detailed study ties into the Rio Ruidoso Limited Detail model and the Cedar Creek Limited Detail study ties into the Cedar Creek Detailed study. Therefore, a known water surface elevation was used as the starting downstream boundary condition for those models. Models and other hydraulic calculations were provided in Appendix E of this report.

SECTION SEVEN RESULTS

7.1 EXCEPTIONS

Basins, streamlines, cross-sections, hydrology and hydraulic calculations, and data used to generate TINs were provided as they were utilized as part of this analysis. These files were left in the format required by WISE and do not meet G&S. WISE is FEMA-approved software. Only data utilized was provided as part of this submittal.

7.2 FLOODPLAIN MAPPING

The 1-percent-annual-chance flood boundaries were exported from HEC-RAS to Geographic Information Systems (GIS) format and mapped. The shapefiles were then refined using visual inspection of orthophotographs and available contour data in areas between modeled cross-sections. The resulting floodplain shapefiles are in agreement with the modeling results for all study reaches.

Work maps at a 1:6000 scale (1 inch = 500 feet) were included with this submittal. The maps can be found in Appendix F of this report. Issues encountered while performing floodplain mapping are discussed below.

In many locations, survey data showed channels deeper than what was depicted by USGS data. Therefore, some floodplains needed to be mapped based on width instead of elevation. USGS topographic data was utilized for the terrain model in areas outside of the Village of Ruidoso and City of Ruidoso Downs. Surveys were also performed at a much higher accuracy than what was available from USGS. Therefore, survey data, supplemented by topographic data, was used to model and map floodplains. In many locations, hydraulic analyses indicated that floodplains were contained in channels. Cases were encountered where the TIN developed using USGS data did not reflect the modeling results or the surveyed cross-sections. For these cases, the top widths of the modeling results were used to map the floodplains.

On Rio Ruidoso, topography showed the Rio Ruidoso crossing Highway 70 near Station 94,000. Based on Field Reconnaissance and orthophotography, the Rio Ruidoso did not cross Highway 70 at this location. The floodplain was adjusted based on the top widths obtained from the HEC-RAS analysis.

The results of this study were tied into the studies from each available Effective FIS upstream and downstream of the study reach limits, where applicable. The Cedar Creek Limited Detail study tied into the North Fork and South Fork Cedar Creek effective studies at the upstream end. The downstream water surface elevations of those effective models are similar to the upstream water surface elevation of the Cedar Creek Limited Detail study. No other new studies tied into effective Zone AE studies.

7.3 FLOOD PROFILES

Water surface elevation data can be obtained from the flood profiles provided in Appendix F. Modeled cross-sections, excluding top-of-road cross-sections, were “lettered” and are included on the flood recovery maps and flood profiles as a reference for communities to locate areas

along the study streams. Lettered cross-sections are shown on the profiles along with road crossing information for reference purposes only. These cross-sections are not the standard lettered cross-sections such as those found in an Effective FIS, which typically indicate that a detailed study has been performed.

SECTION EIGHT REFERENCES

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Appendix A

Quality Assurance Procedures

To ensure quality of documents prepared for FEMA under the HMTAP contract, URS has implemented procedures so that all phases of this study were verified for correctness, completeness, and technical accuracy by a senior professional independent from the originator of the document to be checked, but part of the project team as assigned by the Task Order Monitor (TOM).

The FEMA HMTAP Quality Assurance Process consists of the detailed check, the Independent Technical Review (ITR), and the technical edit. Each phase of this process is discussed in greater detail below.

Detailed Check

When calculations have been completed, the Task Order Coordinator (TOC) assigns a competent, qualified person from the project team to check them. Calculations are normally checked immediately after completion to limit the possibility of perpetuating errors in subsequent calculations, drawings, or specifications but, in every event, before final project documents are released to the client.

For this study, all hydrologic and hydraulic model calculations were checked in detail during this phase of quality assurance.

ITR

The ITR includes a critical evaluation of the basis and validity of significant conclusions, opinions, assumptions, evaluations, recommendations, designs, and other items required as an end result of the project services. It emphasizes establishing the validity of the technical approach and other procedures used to form an opinion of the suitability of the end result. The review does not include a complete detail check of calculations or a detail check of plans, but does include verification that the required detail plan and calculation checking has been performed prior to the review.

At the completion of this study, the hydrologic and hydraulic analyses, the resulting flood recovery maps and flood profiles, and the final report were reviewed as part of this phase of quality assurance.

Technical Edit

Once the ITR has been completed, the deliverable is submitted to a Document Control Supervisor for formatting and technical editing. The editor ensures coherence of parts, subordination, proper referencing, and completeness of the document. The Document Control Supervisor will also ensure that the formatting and word usage adheres to the FEMA-specific style guide.

As this is the final stage of the quality assurance process prior to submittal, all documentation for earlier phases of quality assurance is provided to the Document Control Supervisor and the HMTAP Quality Assurance Officer to verify that all quality assurance procedures have been met. Once the technical edit has been completed, the final document is reviewed by the HMTAP Quality Assurance Officer, the URS-Program Manager, or the URS-Assistant Program Manager prior to submittal to FEMA.

Appendix B
Topographic Data

See Digital Data for Topographic Data

Appendix B - Topographic Data

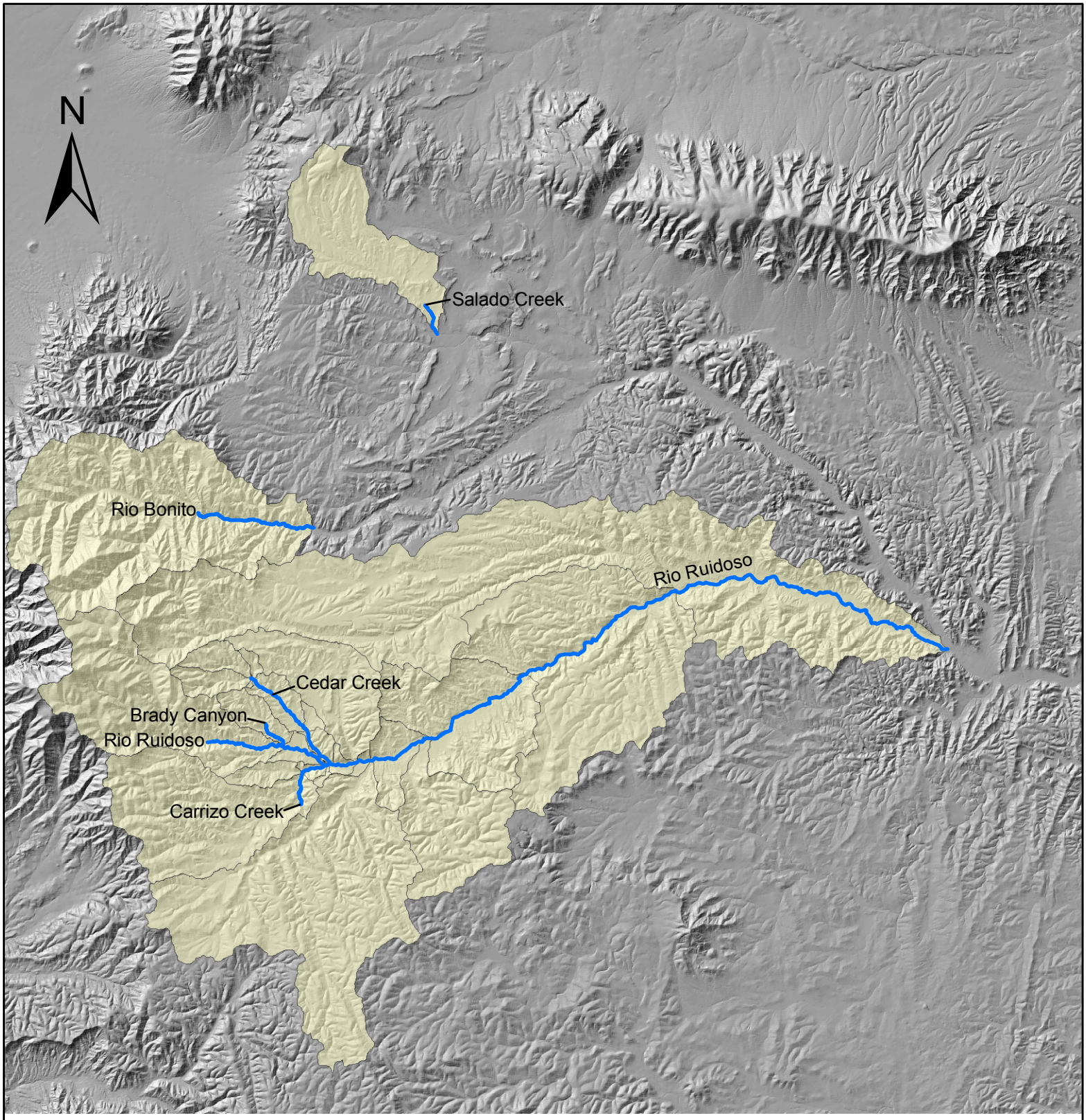
Appendix C

Field Survey and Reconnaissance

See Digital Data for Field Survey and Reconnaissance

Appendix C - Field Survey

Appendix D
Hydrology



Lincoln County Study Area

1 inch equals 25,000 feet

25,000 12,500 0 25,000 Feet

Legend

Study Reaches

Hydrologic Basins

See Digital Data for Hydrology

Appendix D - Hydrology

Appendix E

Hydraulics

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD)	WITHOUT FLOODWAY (NAVD)	WITH FLOODWAY (NAVD)	INCREASE
Brady Canyon								
A	573	38	275	1.6	6,761.7	6,761.7	6,762.5	0.8
B	824	20	50	8.9	6,767.3	6,767.3	6,767.3	0.0
C	901	52	201	2.2	6,772.5	6,772.5	6,773.5	1.0
D	1,062	24	54	8.2	6,775.2	6,775.2	6,775.2	0.0
E	1,415	9	38	11.6	6,790.0	6,790.0	6,790.2	0.2
F	1,492	31	195	2.3	6,795.3	6,795.3	6,795.5	0.2
G	1,617	16	50	8.8	6,795.1	6,795.1	6,795.1	0.0
H	2,036	34	61	7.3	6,810.1	6,810.1	6,810.1	0.0
I	2,311	22	52	8.5	6,821.6	6,821.6	6,821.7	0.1
J	2,367	35	254	1.8	6,827.5	6,827.5	6,827.9	0.4
K	2,424	30	160	2.8	6,827.5	6,827.5	6,827.9	0.4
L	2,676	10	39	11.3	6,832.0	6,832.0	6,832.2	0.2
M	2,775	29	127	3.5	6,839.3	6,839.3	6,840.1	0.8
N	2,904	20	58	7.6	6,843.9	6,843.9	6,844.1	0.2
O	2,988	24	93	4.8	6,845.4	6,845.4	6,846.2	0.8
P	3,079	41	145	3.1	6,846.1	6,846.1	6,847.1	1.0
Q	3,105	40	224	2.0	6,848.8	6,848.8	6,849.4	0.6
R	3,112	24	106	4.2	6,848.8	6,848.8	6,849.3	0.5
S	3,149	29	139	3.2	6,849.7	6,849.7	6,850.7	1.0
T	3,160	41	259	1.7	6,849.9	6,849.9	6,850.9	1.0
U	3,278	30	162	2.7	6,851.2	6,851.2	6,852.1	0.9
V	3,353	27	92	4.8	6,851.2	6,851.2	6,852.1	0.9
W	3,605	18	49	9.0	6,859.9	6,859.9	6,859.9	0.0
X	3,678	27	126	3.5	6,862.2	6,862.2	6,863.2	1.0

[1] Feet above confluence with Rio Ruidoso

TABLE 16

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, NM

AND INCORPORATED AREAS

FLOODWAY DATA

BRADY CANYON

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD)	WITHOUT FLOODWAY (NAVD)	WITH FLOODWAY (NAVD)	INCREASE
Brady Canyon (Continued)								
Y	3,729	21	58	7.7	6,862.7	6,862.7	6,862.9	0.2
Z	3,786	38	72	6.2	6,865.9	6,865.9	6,865.9	0.0
AA	3,862	54	158	2.8	6,866.8	6,866.8	6,867.7	0.9
AB	3,959	9	38	11.5	6,870.1	6,870.1	6,870.1	0.0
AC	4,327	20	53	8.4	6,878.8	6,878.8	6,878.9	0.1
AD	4,393	26	124	3.6	6,885.8	6,885.8	6,886.8	1.0
AE	4,427	19	94	4.8	6,885.8	6,885.8	6,886.8	1.0
AF	4,468	26	118	3.8	6,886.3	6,886.3	6,887.1	0.8
AG	4,838	24	53	8.4	6,896.3	6,896.3	6,896.3	0.0
AH	5,222	60	77	5.8	6,907.1	6,907.1	6,907.1	0.0
AI	5,394	46	141	3.2	6,914.2	6,914.2	6,914.9	0.7
AJ	5,508	68	75	5.9	6,917.3	6,917.3	6,917.4	0.1
AK	6,177	45	80	5.6	6,935.2	6,935.2	6,935.2	0.0
AL	6,259	26	140	3.2	6,939.3	6,939.3	6,940.3	1.0
AM	6,456	18	51	8.6	6,948.5	6,948.5	6,949.4	0.9

[1] Feet above confluence with Rio Ruidoso

TABLE 16

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, NM

AND INCORPORATED AREAS

FLOODWAY DATA

BRADY CANYON

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE
Carrizo Creek								
A	465	75	266	8.3	6,561.2	6,561.2	6,561.3	0.1
B	563	109	406	5.4	6,564.7	6,564.7	6,565.0	0.3
C	714	173	678	3.3	6,566.1	6,566.1	6,566.1	0.0
D	782	260	813	2.7	6,570.3	6,570.3	6,570.4	0.1
E	862	298	923	2.4	6,571.4	6,571.4	6,571.4	0.0
F	953	331	1,800	1.2	6,574.7	6,574.7	6,575.0	0.3
G	1,077	344	664	3.3	6,574.7	6,574.7	6,575.0	0.3
H	1,166	317	1,194	1.9	6,576.5	6,576.5	6,577.5	1.0
I	1,289	113	564	3.9	6,576.7	6,576.7	6,577.6	0.9
J	1,551	43	229	9.6	6,580.6	6,580.6	6,580.7	0.1
K	1,648	30	212	10.4	6,581.5	6,581.5	6,582.2	0.7
L	1,712	75	406	5.4	6,584.7	6,584.7	6,585.7	1.0
M	1,788	64	289	7.6	6,585.5	6,585.5	6,585.7	0.2
N	1,961	86	352	6.3	6,587.7	6,587.7	6,587.7	0.0
O	2,150	44	186	11.8	6,589.6	6,589.6	6,589.7	0.1
P	2,276	69	296	7.5	6,596.1	6,596.1	6,596.3	0.2
Q	2,426	64	453	4.9	6,598.5	6,598.5	6,598.9	0.4
R	2,668	46	306	7.2	6,598.8	6,598.8	6,599.8	1.0
S	2,765	67	529	4.2	6,602.5	6,602.5	6,603.3	0.8
T	3,019	63	268	8.2	6,607.1	6,607.1	6,607.2	0.1
U	3,352	72	441	5.0	6,612.7	6,612.7	6,613.0	0.3
V	3,684	47	275	8.0	6,615.1	6,615.1	6,615.8	0.7
W	3,993	26	200	11.0	6,618.4	6,618.4	6,618.5	0.1
X	4,113	66	332	6.7	6,620.3	6,620.3	6,621.2	0.9

[1] Feet above confluence with Rio Ruidoso

TABLE 16

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, NM

AND INCORPORATED AREAS

FLOODWAY DATA

CARRIZO CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE
Carrizo Creek (Continued)								
Y	4,180	66	686	3.2	6,631.2	6,631.2	6,632.1	0.9
Z	4,245	33	413	5.3	6,631.3	6,631.3	6,632.1	0.8
AA	4,735	37	198	11.1	6,634.4	6,634.4	6,634.6	0.2
AB	5,262	35	320	6.2	6,639.8	6,639.8	6,640.8	1.0
AC	5,648	78	281	7.1	6,646.6	6,646.6	6,646.7	0.1
AD	5,708	78	436	4.6	6,650.3	6,650.3	6,651.1	0.8
AE	6,163	51	241	8.2	6,655.6	6,655.6	6,655.9	0.3
AF	6,667	28	218	9.1	6,662.2	6,662.2	6,662.9	0.7
AG	7,183	51	201	9.9	6,670.4	6,670.4	6,670.4	0.0
AH	7,665	29	173	11.5	6,681.1	6,681.1	6,681.4	0.3
AI	8,134	59	385	5.2	6,687.9	6,687.9	6,688.9	1.0
AJ	8,360	73	238	8.3	6,697.0	6,697.0	6,697.2	0.2
AK	8,455	133	529	3.8	6,702.4	6,702.4	6,702.4	0.0
AL	8,648	35	237	8.4	6,703.2	6,703.2	6,703.3	0.1
AM	8,897	49	225	8.8	6,705.9	6,705.9	6,706.3	0.4
AN	8,981	49	386	5.2	6,709.3	6,709.3	6,709.4	0.1
AO	9,213	57	251	7.9	6,709.8	6,709.8	6,710.7	0.9
AP	9,266	57	314	6.3	6,711.3	6,711.3	6,711.6	0.3
AQ	9,423	21	175	11.4	6,712.1	6,712.1	6,712.9	0.8
AR	9,621	36	246	8.1	6,716.4	6,716.4	6,717.2	0.8
AS	9,699	72	300	6.6	6,717.5	6,717.5	6,717.9	0.4
AT	9,765	72	401	5.0	6,719.6	6,719.6	6,720.4	0.8
AU	9,839	65	233	8.5	6,720.9	6,720.9	6,720.9	0.0

[1] Feet above confluence with Rio Ruidoso

TABLE 16

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, NM

AND INCORPORATED AREAS

FLOODWAY DATA

CARRIZO CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE
Carrizo Creek (Continued)								
AV	9,915	60	283	7.0	6,723.0	6,723.0	6,723.9	0.9
AW	10,035	44	184	10.8	6,725.2	6,725.2	6,725.2	0.0
AX	10,337	36	181	11.0	6,732.5	6,732.5	6,732.5	0.0
AY	10,488	118	744	2.7	6,736.5	6,736.5	6,736.5	0.0
AZ	10,575	127	617	3.2	6,740.4	6,740.4	6,741.3	0.9
BA	10,685	143	606	3.3	6,741.0	6,741.0	6,741.7	0.7
BB	10,858	49	260	7.6	6,741.5	6,741.5	6,741.7	0.2
BC	10,967	80	330	6.0	6,743.6	6,743.6	6,744.2	0.6
BD	11,040	100	691	2.9	6,746.8	6,746.8	6,747.6	0.8
BE	11,058	111	686	2.9	6,746.8	6,746.8	6,747.6	0.8
BF	11,130	86	465	4.3	6,746.6	6,746.6	6,747.4	0.8
BG	11,257	112	358	5.6	6,748.5	6,748.5	6,748.5	0.0
BH	11,400	104	558	3.6	6,751.0	6,751.0	6,751.8	0.8
BI	11,466	52	320	6.2	6,751.3	6,751.3	6,751.8	0.5
BJ	11,636	101	260	7.6	6,755.1	6,755.1	6,755.1	0.0
BK	11,762	116	470	4.2	6,756.8	6,756.8	6,756.8	0.0
BL	12,187	118	738	2.7	6,758.6	6,758.6	6,758.6	0.0

[1] Feet above confluence with Rio Ruidoso

TABLE 16

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, NM

AND INCORPORATED AREAS

FLOODWAY DATA

CARRIZO CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD)	WITHOUT FLOODWAY (NAVD)	WITH FLOODWAY (NAVD)	INCREASE
Cedar Creek								
A	400	18	84	12.3	6,542.1	6,542.1	6,542.2	0.1
B	501	42	254	4.1	6,546.9	6,546.9	6,547.8	0.9
C	664	19	94	11.0	6,550.6	6,550.6	6,551.6	1.0
D	1,289	30	164	6.3	6,559.3	6,559.3	6,560.2	0.9
E	1,996	34	106	9.7	6,577.3	6,577.3	6,577.3	0.0
F	2,592	24	121	8.5	6,592.2	6,592.2	6,593.2	1.0
G	3,270	22	114	9.0	6,607.1	6,607.1	6,607.5	0.4
H	3,398	52	376	2.7	6,611.9	6,611.9	6,612.9	1.0
I	3,692	22	105	9.8	6,614.7	6,614.7	6,615.6	0.9
J	4,302	12	79	13.0	6,633.3	6,633.3	6,633.6	0.3
K	4,838	21	135	7.6	6,643.7	6,643.7	6,644.1	0.4
L	5,257	20	108	9.6	6,649.2	6,649.2	6,649.7	0.5
M	5,331	27	251	4.1	6,656.8	6,656.8	6,657.7	0.9
N	5,452	38	212	4.9	6,656.9	6,656.9	6,657.9	1.0
O	6,053	60	126	8.2	6,669.7	6,669.7	6,669.7	0.0
P	6,851	45	127	8.1	6,694.4	6,694.4	6,694.4	0.0
Q	7,386	21	120	8.6	6,701.8	6,701.8	6,702.3	0.5
R	7,520	49	292	3.5	6,705.7	6,705.7	6,706.4	0.7
S	7,615	30	91	11.4	6,706.1	6,706.1	6,706.6	0.5
T	7,821	84	664	1.6	6,722.9	6,722.9	6,723.8	0.9
U	7,937	92	1,323	0.8	6,723.0	6,723.0	6,723.9	0.9
V	8,102	182	1,677	0.6	6,723.0	6,723.0	6,723.9	0.9
W	8,376	162	1,281	0.8	6,723.0	6,723.0	6,723.9	0.9
X	8,717	42	128	8.1	6,725.9	6,725.9	6,726.2	0.3

[1] Feet above confluence with Rio Ruidoso

TABLE 16

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, NM

AND INCORPORATED AREAS

FLOODWAY DATA

CEDAR CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD)	WITHOUT FLOODWAY (NAVD)	WITH FLOODWAY (NAVD)	INCREASE
Cedar Creek (Continued)								
Y	9,313	35	90	9.2	6,738.1	6,738.1	6,738.1	0.0
Z	9,975	38	107	7.7	6,750.6	6,750.6	6,750.7	0.1
AA	10,387	23	79	10.5	6,761.1	6,761.1	6,761.1	0.0
AB	11,005	38	93	8.8	6,780.0	6,780.0	6,780.0	0.0
AC	11,433	27	83	10.0	6,790.8	6,790.8	6,790.8	0.0
AD	11,794	26	82	10.1	6,799.5	6,799.5	6,799.6	0.1
AE	11,904	48	413	2.0	6,805.9	6,805.9	6,806.9	1.0
AF	12,096	60	108	7.6	6,809.0	6,809.0	6,809.0	0.0
AG	12,176	50	151	5.4	6,809.9	6,809.9	6,810.3	0.4
AH	12,399	71	115	7.1	6,819.4	6,819.4	6,819.5	0.1
AI	12,450	51	223	3.7	6,821.3	6,821.3	6,822.0	0.7
AJ	12,544	70	165	5.0	6,821.5	6,821.5	6,822.2	0.7
AK	12,702	72	334	2.5	6,828.6	6,828.6	6,829.6	1.0
AL	12,760	86	350	2.4	6,828.6	6,828.6	6,829.6	1.0
AM	12,935	63	275	3.0	6,834.6	6,834.6	6,834.9	0.3
AN	13,176	50	119	6.9	6,836.3	6,836.3	6,836.4	0.1
AO	13,392	39	213	3.9	6,844.1	6,844.1	6,844.1	0.0
AP	13,623	41	96	8.6	6,847.6	6,847.6	6,847.6	0.0

[1] Feet above confluence with Rio Ruidoso

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE
Rio Ruidoso								
JZ	123,429	76	932	10.8	6,274.8	6,274.8	6,275.4	0.6
KA	123,907	178	2,416	4.4	6,278.8	6,278.8	6,278.9	0.1
KB	123,964	215	2,822	4.0	6,278.9	6,278.9	6,279.5	0.6
KC	124,217	84	1,176	8.5	6,279.0	6,279.0	6,279.9	0.9
KD	124,752	65	1,029	9.8	6,280.7	6,280.7	6,281.4	0.7
KE	125,236	84	1,028	9.8	6,282.3	6,282.3	6,283.2	0.9
KF	125,758	343	1,203	8.4	6,309.6	6,309.6	6,309.6	0.0
KG	126,295	56	468	16.3	6,316.4	6,316.4	6,316.5	0.1
KH	127,032	164	2,108	3.6	6,322.6	6,322.6	6,323.1	0.5
KI	127,432	204	1,654	4.6	6,322.7	6,322.7	6,323.6	0.9
KJ	127,932	110	821	9.3	6,323.9	6,323.9	6,324.9	1.0
KK	128,432	124	1,260	6.1	6,327.8	6,327.8	6,328.7	0.9
KL	128,932	120	1,214	6.3	6,329.2	6,329.2	6,330.1	0.9
KM	129,556	150	1,107	6.9	6,331.5	6,331.5	6,332.3	0.8
KN	129,798	380	1,475	6.4	6,334.6	6,334.6	6,334.6	0.0
KO	129,878	185	1,504	5.1	6,335.9	6,335.9	6,336.9	1.0
KP	129,951	185	1,236	6.2	6,336.0	6,336.0	6,337.0	1.0
KQ	130,702	159	721	10.6	6,340.9	6,340.9	6,340.9	0.0
KR	131,152	325	1,432	5.3	6,347.4	6,347.4	6,347.4	0.0
KS	131,172	140	1,188	6.4	6,347.7	6,347.7	6,348.7	1.0
KT	131,311	121	827	9.2	6,348.4	6,348.4	6,349.3	0.9
KU	131,596	150	1,016	7.5	6,351.3	6,351.3	6,352.1	0.8
KV	132,129	261	1,911	7.7	6,355.7	6,355.7	6,356.3	0.6
KW	132,372	454	3,930	1.9	6,362.3	6,362.3	6,363.3	1.0

[1] Feet above confluence with Rio Hondo

TABLE 16

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, NM

AND INCORPORATED AREAS

FLOODWAY DATA

RIO RUIDOSO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE
Rio Ruidoso (Continued)								
KX	132,576	302	2,158	3.5	6,362.3	6,362.3	6,363.3	1.0
KY	132,946	154	747	10.2	6,362.8	6,362.8	6,363.3	0.5
KZ	133,446	58	499	15.3	6,365.5	6,365.5	6,365.8	0.3
LA	133,807	263	1,230	6.2	6,369.8	6,369.8	6,369.8	0.0
LB	134,040	200	1,681	5.7	6,370.0	6,370.0	6,370.4	0.4
LC	134,231	290	2,672	3.8	6,371.9	6,371.9	6,372.8	0.9
LD	134,328	149	970	7.9	6,371.8	6,371.8	6,372.8	1.0
LE	134,575	89	723	10.6	6,372.6	6,372.6	6,373.3	0.7
LF	134,730	88	754	13.2	6,373.5	6,373.5	6,374.1	0.6
LG	134,937	197	3,285	3.6	6,389.9	6,389.9	6,390.4	0.5
LH	135,138	124	1,808	4.2	6,390.0	6,390.0	6,390.6	0.6
LI	135,446	67	717	10.6	6,389.6	6,389.6	6,390.6	1.0
LJ	135,734	145	1,135	6.7	6,392.4	6,392.4	6,392.6	0.2
LK	136,193	71	794	9.6	6,394.3	6,394.3	6,394.8	0.5
LL	136,266	71	999	7.6	6,397.2	6,397.2	6,398.2	1.0
LM	136,356	87	833	9.2	6,397.4	6,397.4	6,398.4	1.0
LN	136,946	133	673	11.3	6,403.0	6,403.0	6,403.2	0.2
LO	137,422	122	806	9.5	6,409.8	6,409.8	6,409.9	0.1
LP	138,046	149	893	8.5	6,415.1	6,415.1	6,415.5	0.4
LQ	138,543	247	954	8.0	6,424.0	6,424.0	6,424.7	0.7
LR	138,946	169	928	8.2	6,430.0	6,430.0	6,430.3	0.3
LS	139,455	368	864	8.8	6,435.0	6,435.0	6,435.0	0.0
LT	139,524	484	1,474	5.2	6,436.6	6,436.6	6,436.6	0.0

[1] Feet above confluence with Rio Hondo

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE
Rio Ruidoso (Continued)								
LU	139,711	206	518	8.8	6,437.6	6,437.6	6,437.6	0.0
LV	140,110	63	456	10.0	6,441.3	6,441.3	6,441.3	0.0
LW	140,474	244	331	13.8	6,445.5	6,445.5	6,445.5	0.0
LX	140,529	180	911	5.0	6,448.1	6,448.1	6,448.7	0.6
LY	140,946	216	820	5.6	6,450.6	6,450.6	6,451.3	0.7
LZ	141,446	167	723	6.3	6,456.3	6,456.3	6,457.3	1.0
MA	142,023	78	483	9.5	6,464.2	6,464.2	6,464.5	0.3
MB	142,489	78	745	8.6	6,468.0	6,468.0	6,469.0	1.0
MC	142,553	146	1,109	4.4	6,472.8	6,472.8	6,473.7	0.9
MD	142,946	111	531	8.6	6,474.6	6,474.6	6,475.1	0.5
ME	143,001	85	399	9.0	6,475.3	6,475.3	6,475.6	0.3
MF	143,282	207	522	6.9	6,479.0	6,479.0	6,479.0	0.0
MG	143,328	321	1,126	3.2	6,481.2	6,481.2	6,481.2	0.0
MH	143,549	211	825	4.4	6,482.0	6,482.0	6,482.0	0.0
MI	144,053	181	730	4.9	6,485.3	6,485.3	6,485.4	0.1
MJ	144,301	288	521	6.9	6,488.1	6,488.1	6,488.1	0.0
MK	144,589	264	873	4.1	6,492.3	6,492.3	6,492.3	0.0
ML	145,000	122	493	7.3	6,495.7	6,495.7	6,495.8	0.1
MM	145,493	65	329	10.9	6,502.5	6,502.5	6,502.6	0.1
MN	145,946	76	422	8.5	6,508.3	6,508.3	6,509.2	0.9
MO	146,446	100	471	7.6	6,513.9	6,513.9	6,514.1	0.2
MP	147,001	422	504	12.5	6,521.2	6,521.2	6,521.2	0.0
MQ	147,112	252	1,328	2.7	6,524.1	6,524.1	6,525.1	1.0

[1] Feet above confluence with Rio Hondo

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE
Rio Ruidoso (Continued)								
MR	147,339	102	343	10.5	6,525.6	6,525.6	6,525.9	0.3
MS	147,946	74	454	7.9	6,533.7	6,533.7	6,534.4	0.7
MT	148,427	247	532	5.6	6,542.1	6,542.1	6,542.2	0.1
MU	149,066	102	345	9.3	6,549.8	6,549.8	6,549.9	0.1
MV	149,129	250	1,002	3.0	6,552.8	6,552.8	6,552.8	0.0
MW	149,281	76	341	8.7	6,552.9	6,552.9	6,552.9	0.0
MX	149,629	58	214	6.3	6,557.3	6,557.3	6,557.3	0.0
MY	149,816	51	139	9.6	6,559.5	6,559.5	6,559.5	0.0
MZ	149,833	59	215	6.2	6,560.7	6,560.7	6,560.7	0.0
NA	150,050	31	121	11.1	6,566.3	6,566.3	6,566.4	0.1
NB	150,406	82	290	4.6	6,570.7	6,570.7	6,571.7	1.0
NC	150,698	96	106	12.7	6,574.9	6,574.9	6,574.9	0.0
ND	150,712	38	198	6.8	6,577.2	6,577.2	6,577.7	0.5
NE	150,801	24	121	11.0	6,578.0	6,578.0	6,578.3	0.3
NF	150,835	81	305	4.4	6,579.3	6,579.3	6,579.9	0.6
NG	150,944	61	270	5.0	6,579.7	6,579.7	6,580.5	0.8
NH	151,103	42	133	10.1	6,581.4	6,581.4	6,581.4	0.0
NI	151,314	42	168	8.0	6,585.7	6,585.7	6,585.7	0.0
NJ	151,359	44	198	6.8	6,586.7	6,586.7	6,586.7	0.0
NK	151,462	52	218	6.1	6,587.5	6,587.5	6,587.5	0.0
NL	151,614	97	221	6.1	6,590.9	6,590.9	6,591.0	0.1
NM	151,951	38	157	8.5	6,596.3	6,596.3	6,596.4	0.1
NN	151,981	105	380	3.5	6,597.7	6,597.7	6,597.8	0.1

[1] Feet above confluence with Rio Hondo

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE
Rio Ruidoso (Continued)								
NO	152,147	99	179	7.5	6,598.5	6,598.5	6,598.6	0.1
NP	152,456	57	159	8.4	6,605.2	6,605.2	6,605.3	0.1
NQ	152,844	62	185	7.2	6,612.1	6,612.1	6,612.4	0.3
NR	153,538	49	141	9.5	6,626.7	6,626.7	6,626.7	0.0
NS	153,784	62	172	7.8	6,632.4	6,632.4	6,632.6	0.2
NT	153,911	61	148	9.0	6,635.7	6,635.7	6,635.7	0.0
NU	154,479	51	177	7.6	6,646.8	6,646.8	6,646.8	0.0
NV	154,655	51	220	7.3	6,648.5	6,648.5	6,648.5	0.0
NW	154,723	65	549	2.4	6,653.1	6,653.1	6,654.0	0.9
NX	154,855	59	328	4.1	6,653.1	6,653.1	6,654.0	0.9
NY	155,770	44	135	9.9	6,666.6	6,666.6	6,666.6	0.0
NZ	155,859	50	212	6.6	6,668.8	6,668.8	6,668.8	0.0
OA	155,905	56	296	4.5	6,671.4	6,671.4	6,671.4	0.0
OB	156,085	95	195	6.9	6,674.9	6,674.9	6,675.9	1.0
OC	156,498	76	206	6.5	6,684.7	6,684.7	6,685.3	0.6
OD	157,010	66	166	8.1	6,693.8	6,693.8	6,694.7	0.9
OE	157,456	116	269	5.0	6,700.0	6,700.0	6,700.3	0.3
OF	157,493	61	272	4.9	6,700.7	6,700.7	6,701.2	0.5
OG	157,623	36	140	9.6	6,701.6	6,701.6	6,702.0	0.4
OH	157,885	25	116	11.5	6,707.4	6,707.4	6,707.6	0.2
OI	158,201	31	135	9.9	6,714.9	6,714.9	6,715.7	0.8
OJ	158,553	61	155	8.6	6,726.0	6,726.0	6,726.0	0.0
OK	159,191	94	204	6.6	6,739.7	6,739.7	6,739.8	0.1

[1] Feet above confluence with Rio Hondo

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE
Rio Ruidoso (Continued)								
OL	159,297	29	103	10.2	6,741.3	6,741.3	6,741.4	0.1
OM	159,446	31	101	10.3	6,745.7	6,745.7	6,745.9	0.2
ON	159,847	50	275	3.8	6,749.3	6,749.3	6,749.7	0.4
OO	159,976	49	220	4.8	6,754.0	6,754.0	6,754.0	0.0
OP	160,169	87	144	7.3	6,757.1	6,757.1	6,757.1	0.0
OQ	160,420	34	114	9.2	6,762.6	6,762.6	6,763.0	0.4
OR	160,455	44	200	5.2	6,763.8	6,763.8	6,764.4	0.6
OS	160,592	26	96	10.9	6,766.7	6,766.7	6,766.7	0.0
OT	160,753	58	179	5.9	6,770.2	6,770.2	6,770.8	0.6
OU	161,331	46	116	9.0	6,781.1	6,781.1	6,781.1	0.0
OV	161,820	26	109	9.6	6,792.1	6,792.1	6,792.4	0.3
OW	162,085	74	135	7.8	6,800.4	6,800.4	6,800.4	0.0
OX	162,300	74	174	6.0	6,805.0	6,805.0	6,805.0	0.0
OY	162,783	20	99	10.6	6,812.5	6,812.5	6,813.2	0.7
OZ	163,110	84	163	6.4	6,818.2	6,818.2	6,818.7	0.5
PA	163,163	113	414	2.5	6,823.4	6,823.4	6,823.4	0.0
PB	163,291	48	118	8.9	6,825.4	6,825.4	6,825.5	0.1
PC	163,941	26	116	9.1	6,838.5	6,838.5	6,838.8	0.3
PD	164,328	48	124	8.4	6,846.4	6,846.4	6,846.4	0.0
PE	164,708	28	104	10.1	6,855.0	6,855.0	6,855.1	0.1
PF	164,754	194	147	7.1	6,857.3	6,857.3	6,857.3	0.0
PG	164,953	43	115	9.1	6,866.0	6,866.0	6,866.0	0.0
PH	165,374	110	159	6.6	6,878.8	6,878.8	6,878.8	0.0

[1] Feet above confluence with Rio Hondo

TABLE 16

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, NM

AND INCORPORATED AREAS

FLOODWAY DATA

RIO RUIDOSO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE
Rio Ruidoso (Continued)								
PI	166,031	68	160	6.5	6,892.5	6,892.5	6,892.5	0.0
PJ	166,644	171	99	10.6	6,907.0	6,907.0	6,907.0	0.0
PK	166,712	65	457	2.3	6,911.9	6,911.9	6,912.9	1.0
PL	166,957	60	125	8.4	6,916.0	6,916.0	6,916.0	0.0
PM	167,508	46	131	8.0	6,928.1	6,928.1	6,928.1	0.0
PN	168,007	88	145	7.2	6,944.8	6,944.8	6,944.9	0.1
PO	168,670	62	149	7.0	6,959.4	6,959.4	6,959.5	0.1
PP	169,167	91	147	7.1	6,973.4	6,973.4	6,973.4	0.0
PQ	169,548	90	150	7.0	6,984.4	6,984.4	6,984.5	0.1
PR	169,936	132	173	6.1	6,991.8	6,991.8	6,991.8	0.0
PS	170,015	183	682	1.5	6,997.0	6,997.0	6,997.0	0.0
PT	170,186	93	147	7.1	6,999.6	6,999.6	6,999.6	0.0
PU	170,740	48	128	8.2	7,013.2	7,013.2	7,013.2	0.0
PV	171,190	38	114	9.2	7,023.0	7,023.0	7,023.0	0.0
PW	171,545	43	112	9.3	7,033.6	7,033.6	7,033.6	0.0
PX	172,057	66	131	8.0	7,050.2	7,050.2	7,050.2	0.0
PY	172,514	72	150	7.0	7,065.2	7,065.2	7,065.3	0.1
PZ	172,775	34	119	8.8	7,070.6	7,070.6	7,070.7	0.1
QA	172,826	70	363	2.9	7,074.4	7,074.4	7,074.5	0.1
QB	172,975	44	115	9.1	7,076.7	7,076.7	7,076.7	0.0
QC	173,539	60	128	8.2	7,095.4	7,095.4	7,095.4	0.0
QD	173,875	48	118	8.9	7,106.6	7,106.6	7,106.6	0.0
QE	174,148	155	127	8.2	7,112.6	7,112.6	7,112.6	0.0

[1] Feet above confluence with Rio Hondo

TABLE 16

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, NM

AND INCORPORATED AREAS

FLOODWAY DATA

RIO RUIDOSO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE
Rio Ruidoso (Continued)								
QF	174,205	150	389	3.9	7,116.3	7,116.3	7,116.3	0.0
QG	174,438	54	140	10.0	7,120.8	7,120.8	7,120.8	0.0
QH	174,548	66	379	2.8	7,128.1	7,128.1	7,128.4	0.3
QI	174,726	241	246	4.3	7,133.7	7,133.7	7,133.7	0.0
QJ	174,901	142	185	5.7	7,139.2	7,139.2	7,139.2	0.0
QK	175,150	118	193	5.4	7,144.5	7,144.5	7,144.6	0.1
QL	175,393	59	127	8.3	7,152.6	7,152.6	7,152.6	0.0
QM	175,886	41	132	7.9	7,173.1	7,173.1	7,173.5	0.4
QN	175,929	23	119	8.8	7,173.8	7,173.8	7,174.7	0.9
QO	175,971	62	284	3.7	7,175.3	7,175.3	7,176.0	0.7

[1] Feet above confluence with Rio Hondo

TABLE 16

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, NM

AND INCORPORATED AREAS

FLOODWAY DATA

RIO RUIDOSO

See Digital Data for Hydraulics

Appendix E - Hydraulics

Appendix F

Flood Recovery Maps and Profiles

See Digital Data for Flood Recovery Maps and Profiles

Appendix F - Flood Recovery Maps and Profiles

Appendix G

Supplementary Data

See Digital Data for Supplementary Data

Appendix G - Supplementary Data