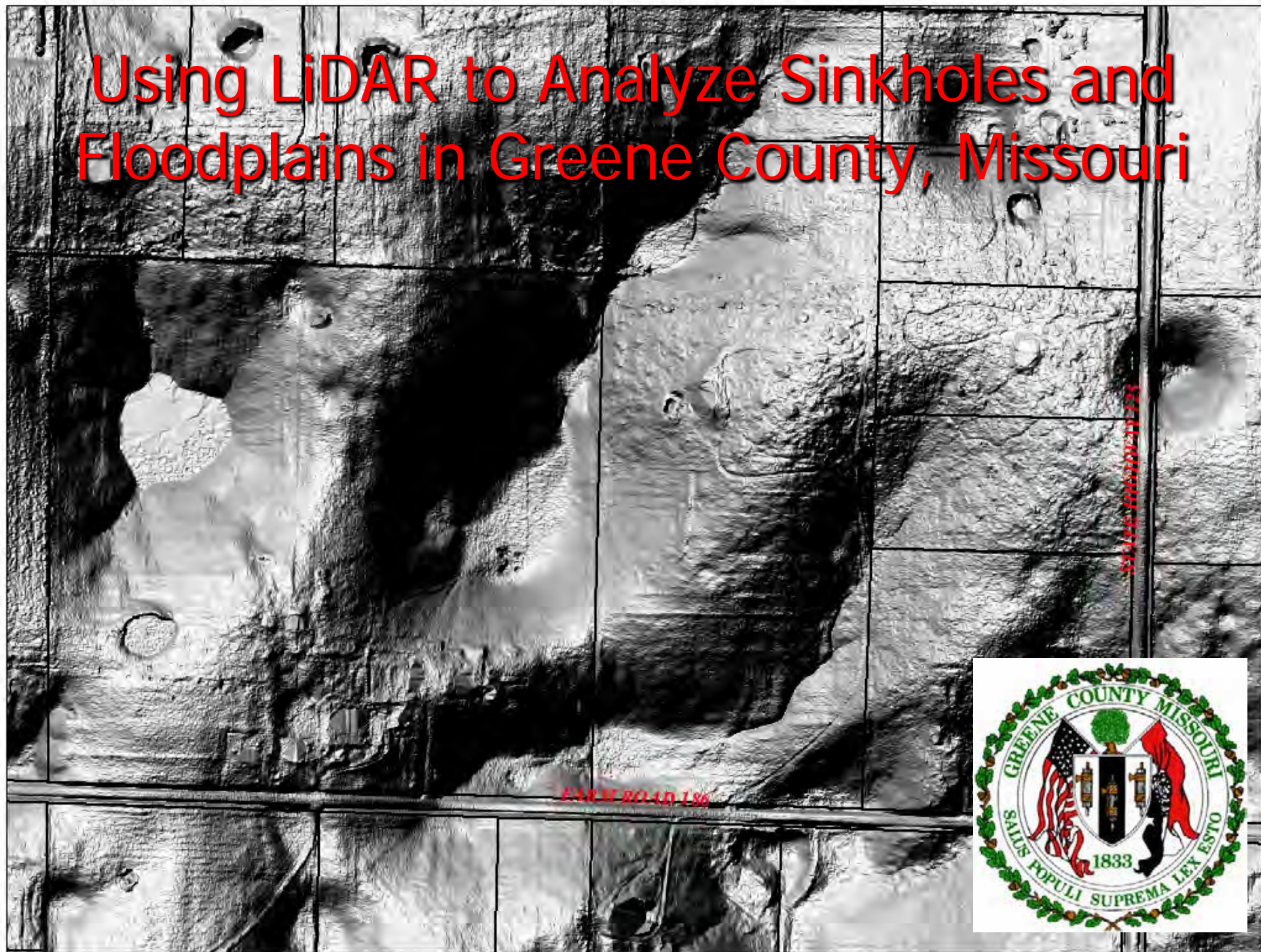
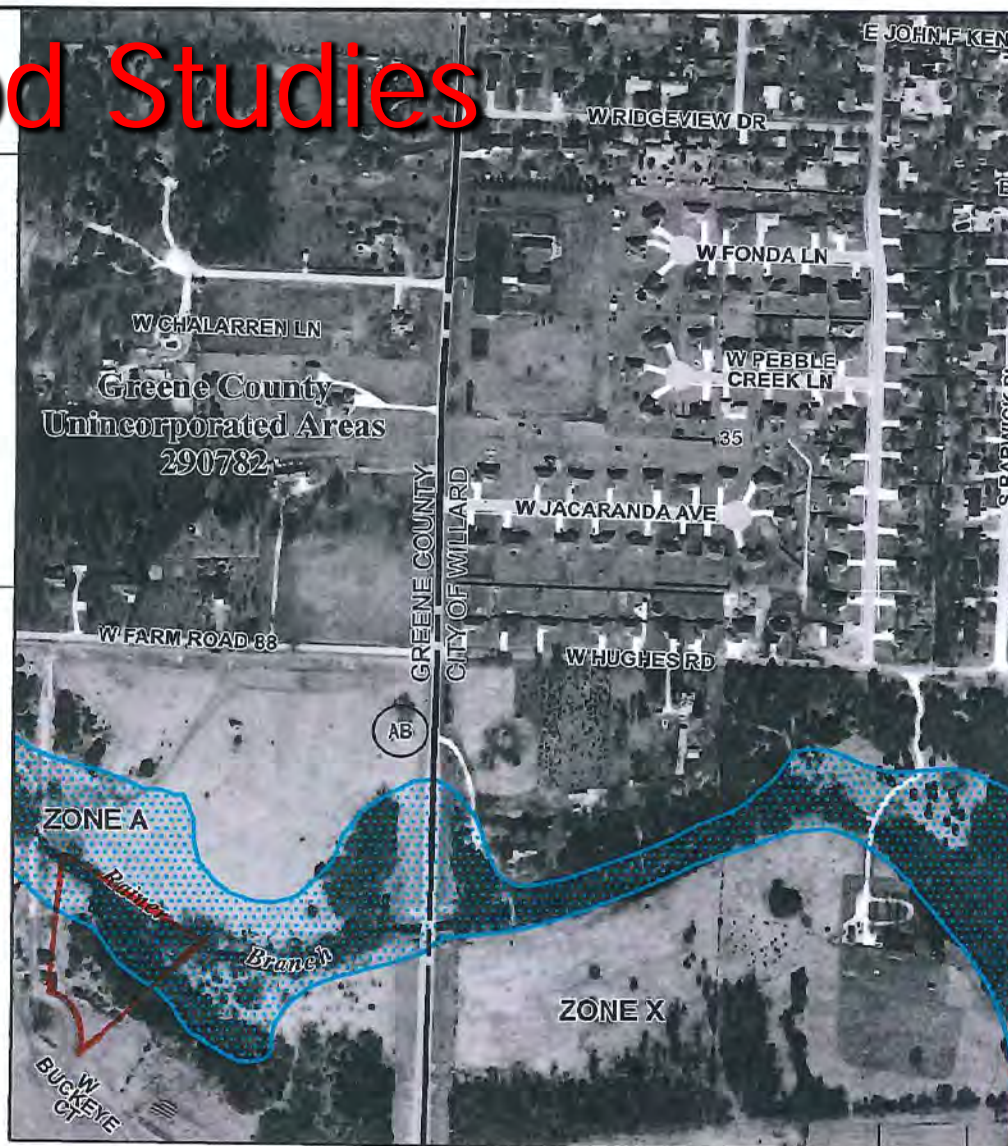


Using LiDAR to Analyze Sinkholes and Floodplains in Greene County, Missouri



Flood Studies

41°27'00"N



37°16'52.5"

93°26'15"

1370000 FT

ance Program at 1-800-638-6520.



MAP SCALE 1" = 500'

0 250 500 750 1,000 FEET

NIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0191E

FIRM

FLOOD INSURANCE RATE MAP
GREENE COUNTY,
MISSOURI
AND INCORPORATED AREAS

PANEL 191 OF 506

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
GREENE COUNTY	290782	0191	E
WILLARD, CITY OF	290553	0191	E

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.



MAP NUMBER
29077C0191E
EFFECTIVE DATE
DECEMBER 17, 2010

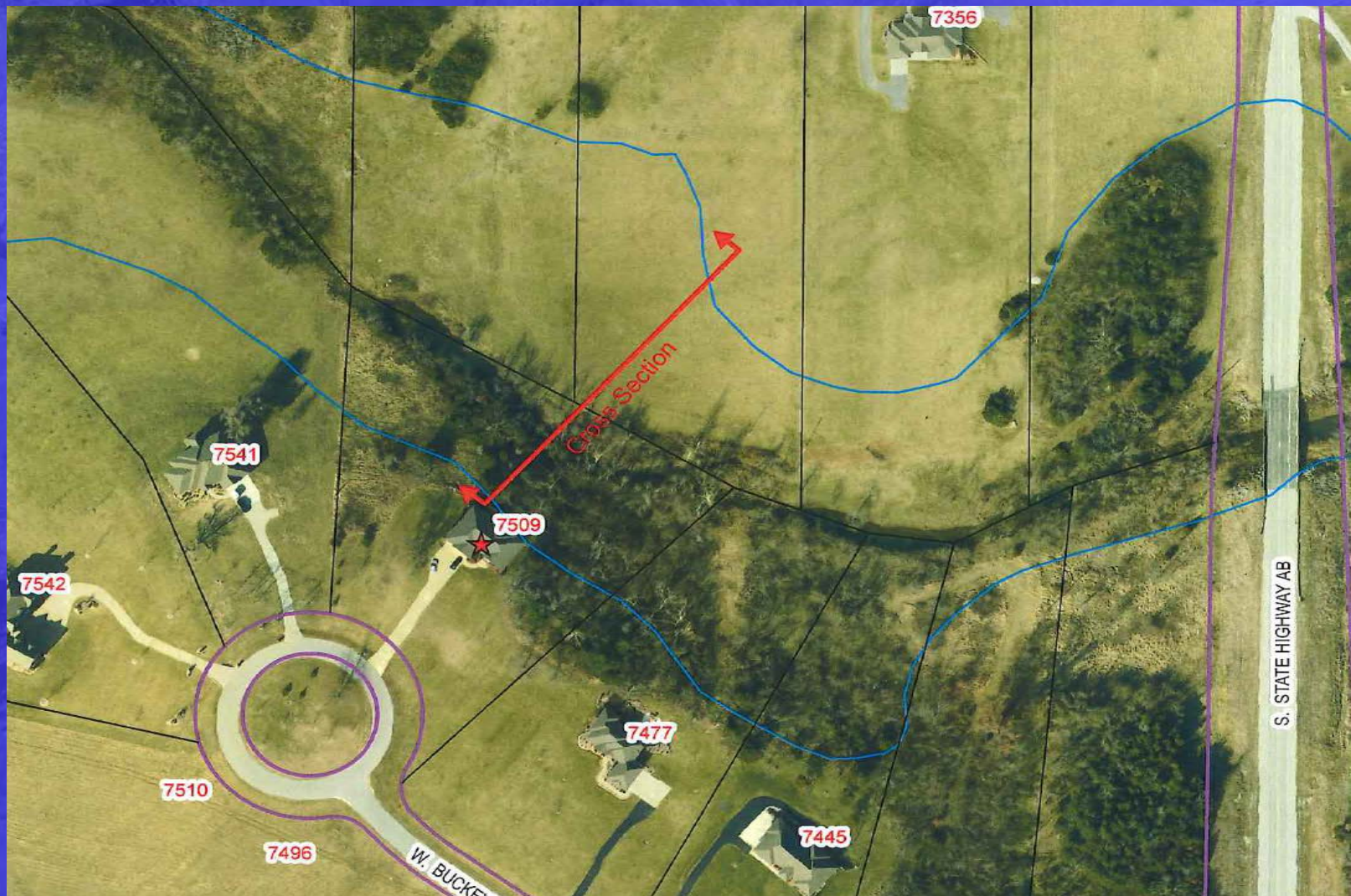
Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

This map shows the Lake Umbagog area in Maine. The lake is depicted in blue, with its irregular shoreline clearly marked. Surrounding the lake are various land parcels, many of which are labeled with lot numbers (e.g., 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 8

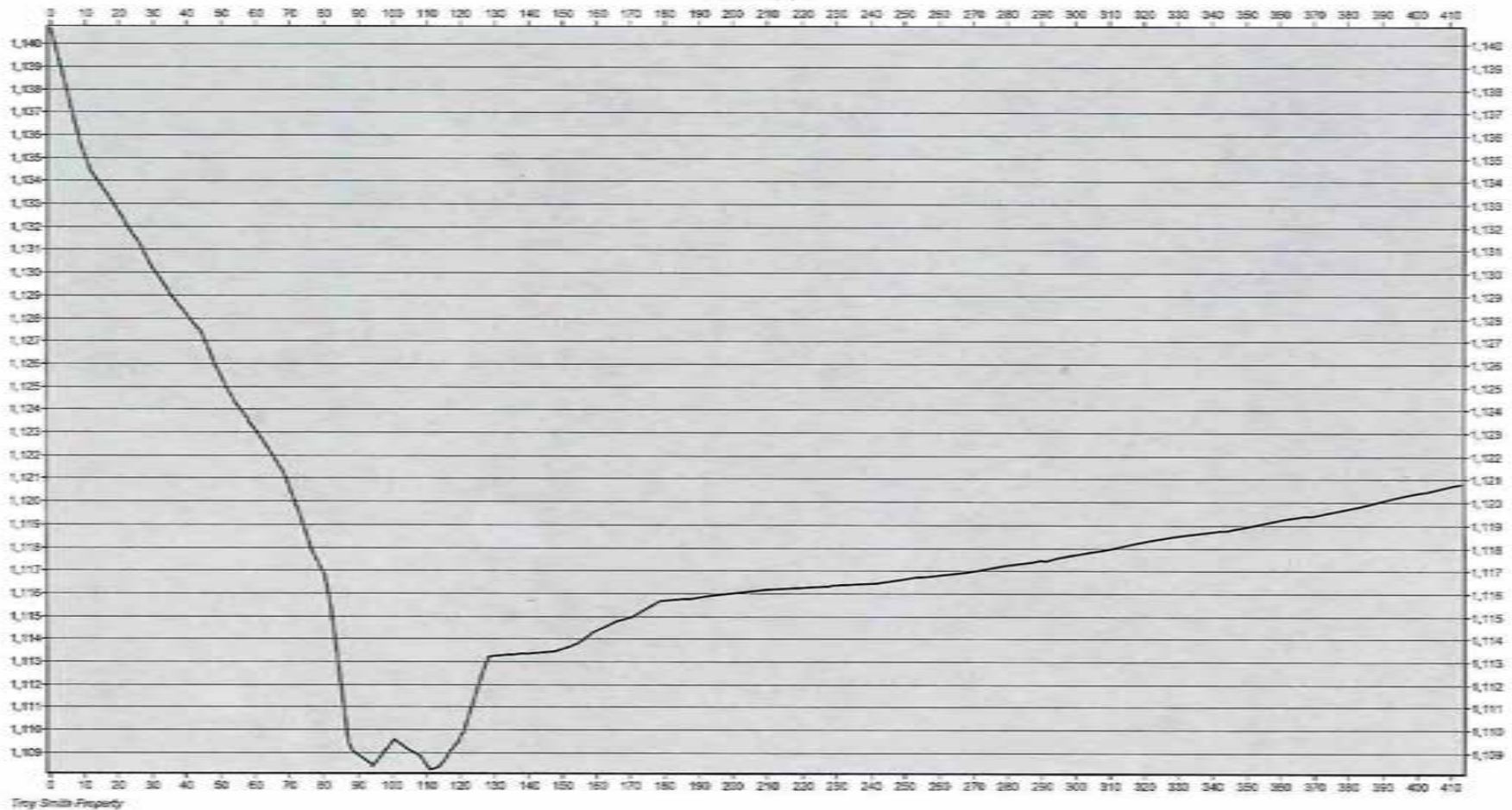
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Cut Cross-Section



Cross-Section from LP360

Profile Graph



Compute Normal Depth Water Surface Elevation

Input Data				
Channel Slope	0.005000 ft/ft			
Elevation range: 1,106.42 ft to 1,147.84 ft.				
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	1,142.37	0.00	115.50	0.100
5.00	1,141.97	115.50	148.80	0.050
15.30	1,140.51	148.80	982.00	0.070
19.50	1,136.33			
23.70	1,134.28			
53.30	1,127.41			
92.20	1,117.40			
115.50	1,110.67			
120.00	1,107.00			
133.80	1,106.42			
145.00	1,107.00			
148.80	1,111.54			
251.50	1,114.71			
351.10	1,116.26			
548.30	1,138.91			
982.00	1,147.84			
Discharge	6,480.00	cfs		

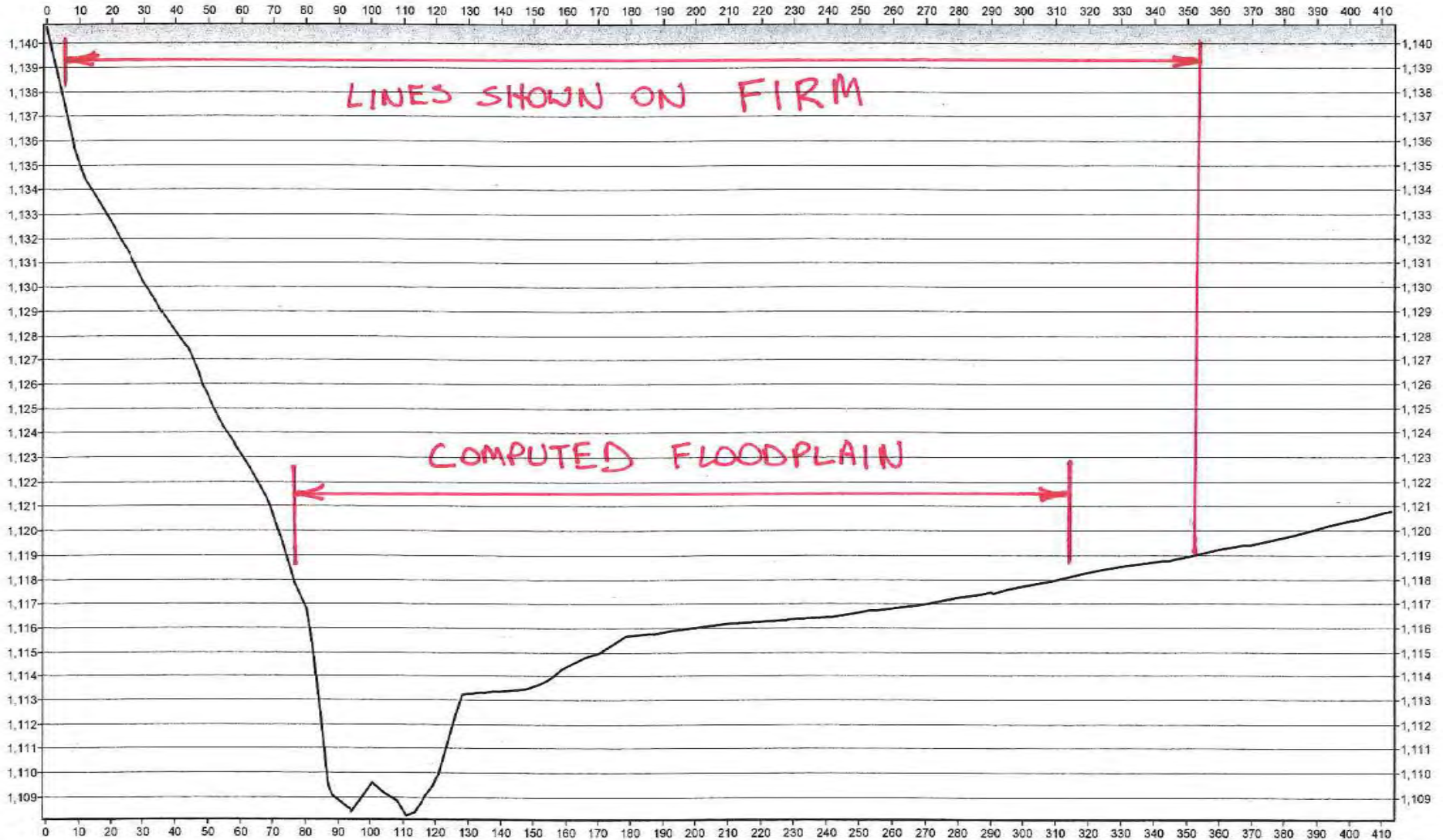
Results		
Wtd. Mannings Coefficient	0.054	
Water Surface Elevation	1,118.11	ft
Flow Area	1,243.76	ft ²
Wetted Perimeter	282.39	ft
Top Width	277.73	ft
Height	11.69	ft
Critical Depth	1,115.93	ft
Critical Slope	0.034831	ft/ft
Velocity	5.21	ft/s
Velocity Head	0.42	ft
Specific Energy	1,118.53	ft
Froude Number	0.43	
Flow is subcritical.		




W. BUCKEYE CT

S. STATE HIGHWAY AB

Profile Graph



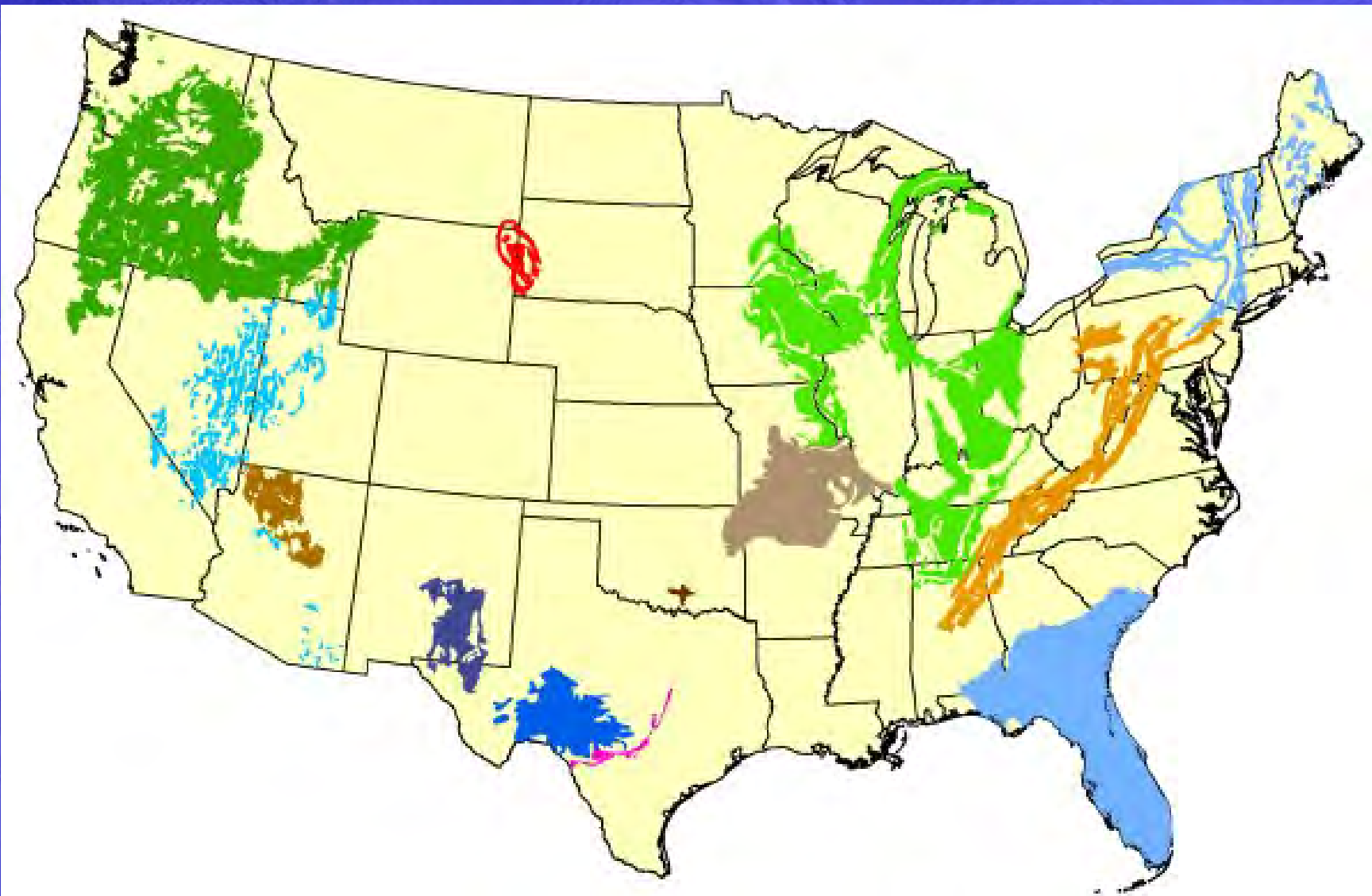
Submit for Letter of Map Amendment

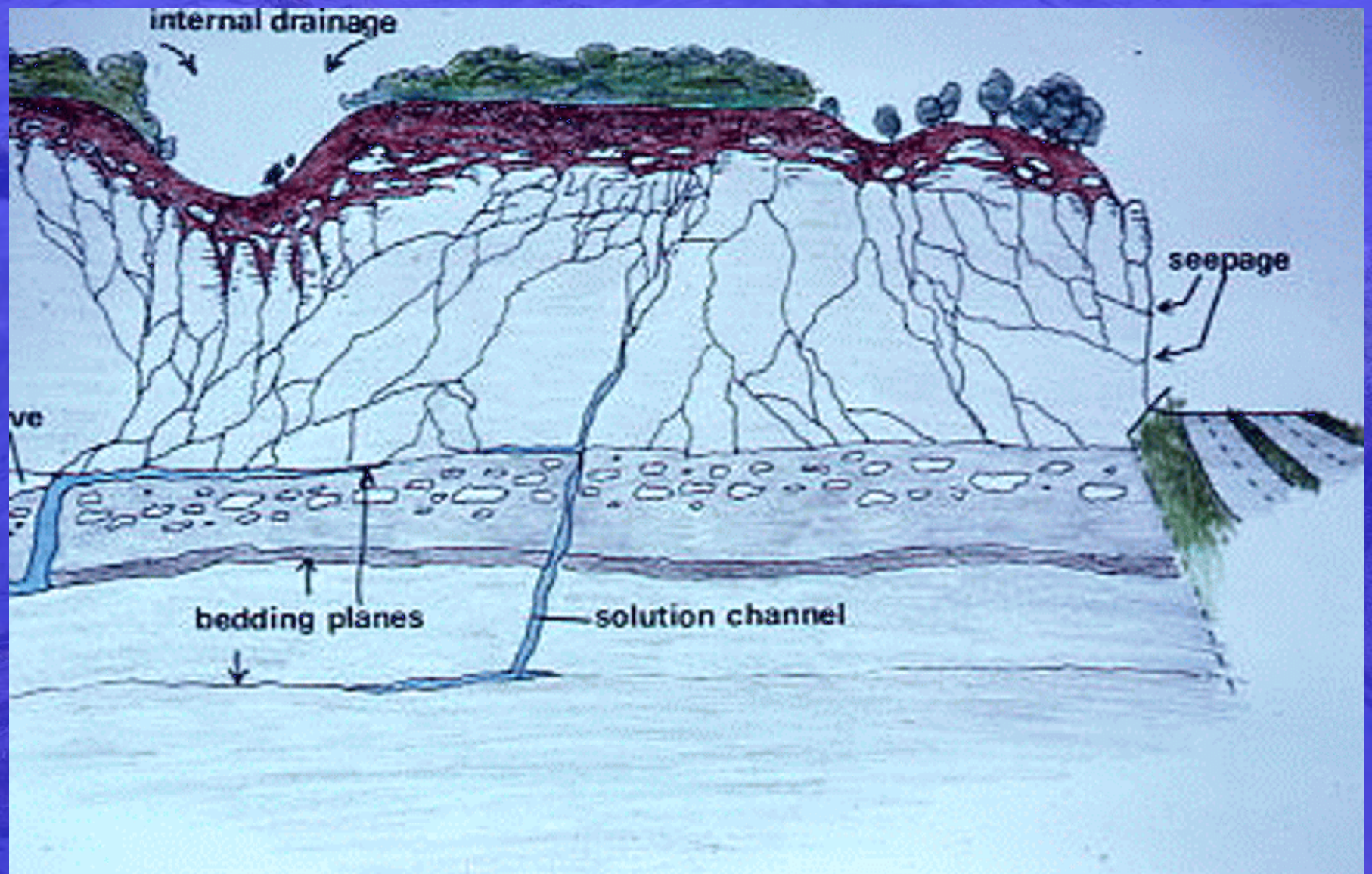
Page 1 of 2		Date: November 15, 2011		Case No.: 11-07-3406A		LOMA		
				Federal Emergency Management Agency Washington, D.C. 20472				
LETTER OF MAP AMENDMENT DETERMINATION DOCUMENT (REMOVAL)								
COMMUNITY AND MAP PANEL INFORMATION				LEGAL PROPERTY DESCRIPTION				
COMMUNITY	GREENE COUNTY, MISSOURI (Unincorporated Areas)			Lot 3, Clear Creek Estates 2nd Addition, as described in the Warranty Deed by Corporation, recorded in Book 2003, Page 059485-03, in the Office of the Recorder of Deeds, Greene County, Missouri				
	COMMUNITY NO.: 290782							
AFFECTED MAP PANEL	NUMBER: 29077C0191E							
	DATE: 12/17/2010							
FLOODING SOURCE: RAINER BRANCH				APPROXIMATE LATITUDE & LONGITUDE OF PROPERTY: 37.282, -93.437 SOURCE OF LAT & LONG: STREETS & TRIPS 2010 DATUM: WGS 84				
DETERMINATION								
LOT	BLOCK/ SECTION	SUBDIVISION	STREET	OUTCOME WHAT IS REMOVED FROM THE SFHA	FLOOD ZONE	1% ANNUAL CHANCE FLOOD ELEVATION (NAVD 88)	LOWEST ADJACENT GRADE ELEVATION (NAVD 88)	LOWEST LOT ELEVATION (NAVD 88)
3	--	Clear Creek Estates, 2nd Addition	7509 W. Buckeye Court	Structure	X (unshaded)	1118.1 feet	1142.4 feet	--
Special Flood Hazard Area (SFHA) - The SFHA is an area that would be inundated by the flood having a 1-percent chance of being equalled or exceeded in any given year (base flood).								
ADDITIONAL CONSIDERATIONS (Please refer to the appropriate section on Attachment 1 for the additional considerations listed below.)								
PORTIONS REMAIN IN THE SFHA: ZONE A STUDY UNDERWAY								
This document provides the Federal Emergency Management Agency's determination regarding a request for a Letter of Map Amendment for the property described above. Using the information submitted and the effective National Flood Insurance Program (NFIP) map, we have determined that the structure(s) on the property(ies) is/are not located in the SFHA, an area inundated by the flood having a 1-percent chance of being equalled or exceeded in any given year (base flood). This document amends the effective NFIP map to remove the subject property from the SFHA located on the effective NFIP map; therefore, the Federal mandatory flood insurance requirement does not apply. However, the landowner has the option to continue the flood insurance requirement to protect its financial risk on the loan. A Preferred Risk Policy (PRP) is available for buildings located outside the SFHA. Information about the PRP and how one can apply is enclosed.								
This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at (877) 336-2627 (877-FEMA MAP) or by letter addressed to the Federal Emergency Management Agency, LOMA Clearinghouse, 6730 Santa Barbara Court, Elkridge, MD 21075.								
Luis Rodriguez, P.E., Chief Engineering Management Branch Federal Insurance and Mitigation Administration								

Sinkhole Mapping



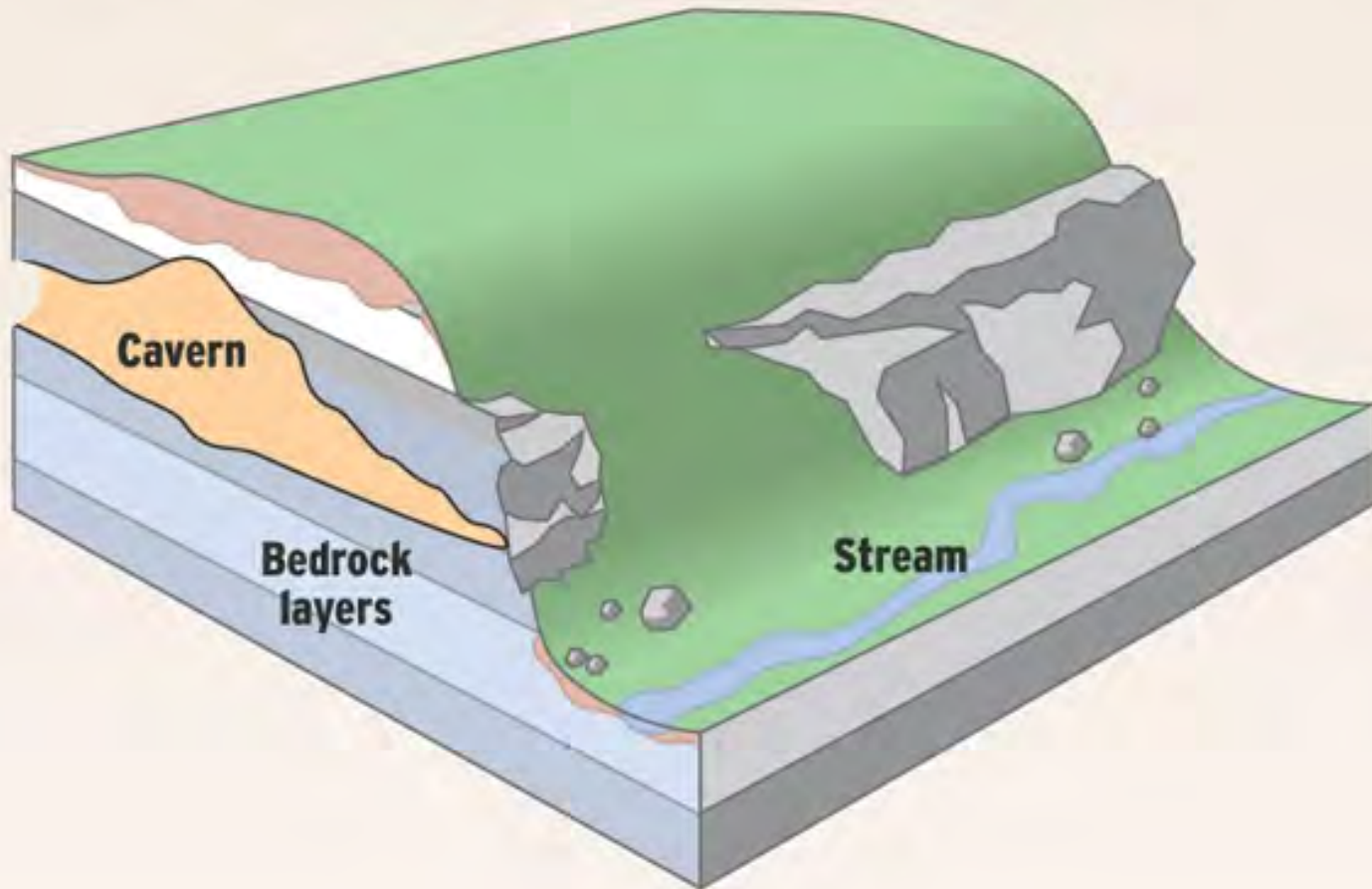
Karst Areas



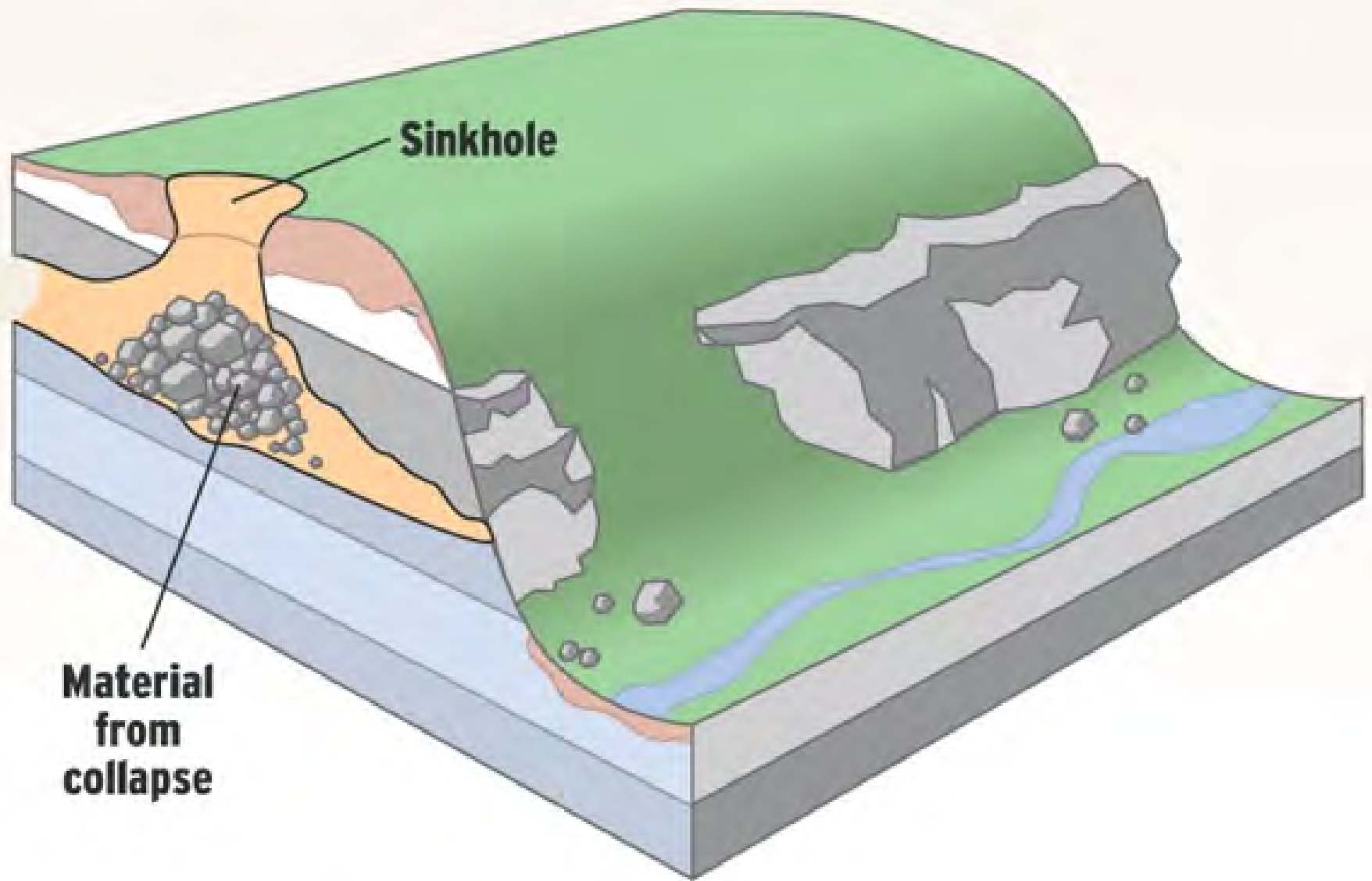


Sinkhole formation

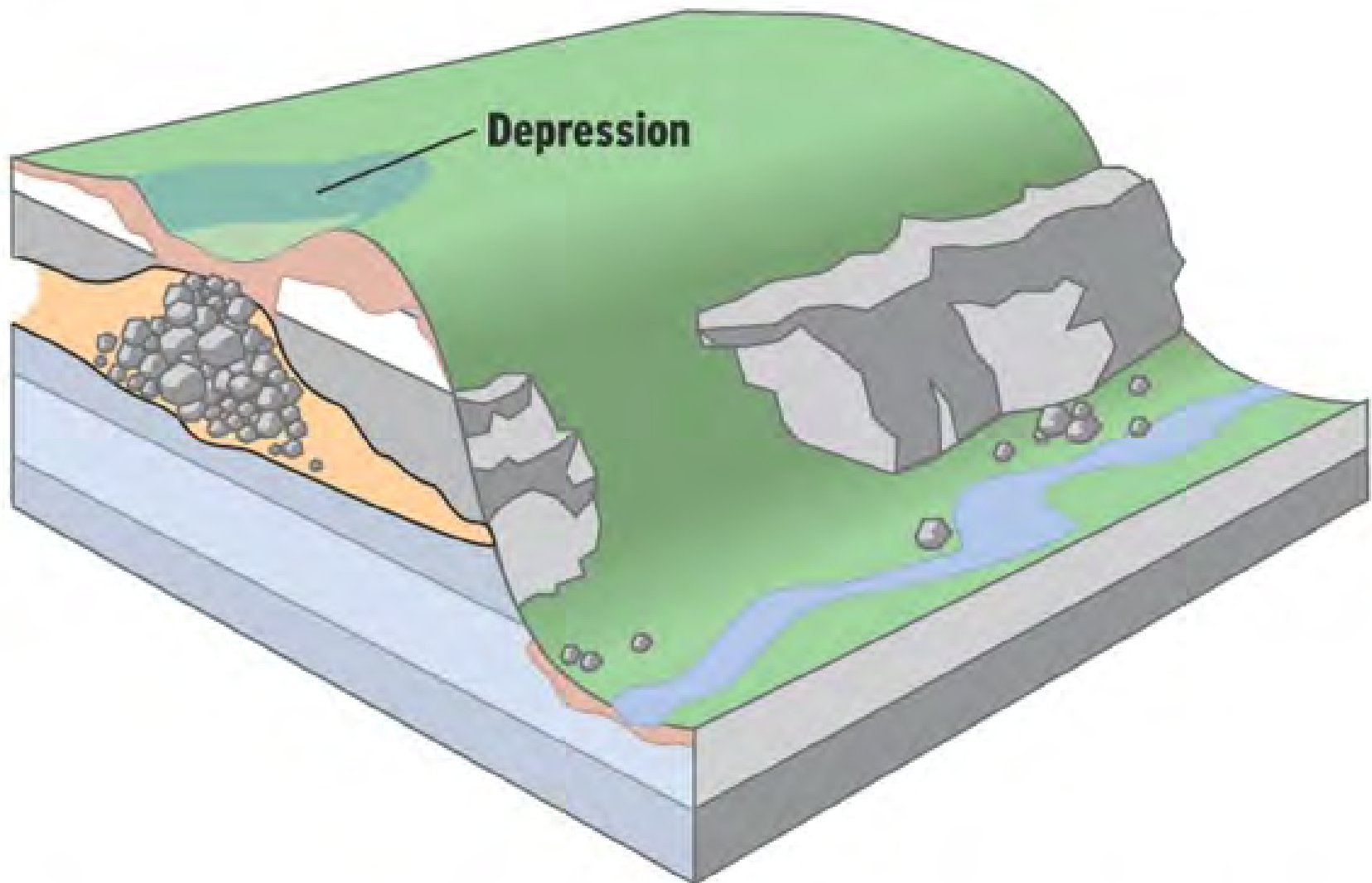
- A.** Rainwater absorbs a small amount of carbon dioxide while in the atmosphere, forming a mild carbonic acid solution. Some acids may also be added by decaying vegetation on the ground. Water flows through cracks and crevices and along planes between rock layers, slowly dissolving and eroding the rock to form voids or caverns.



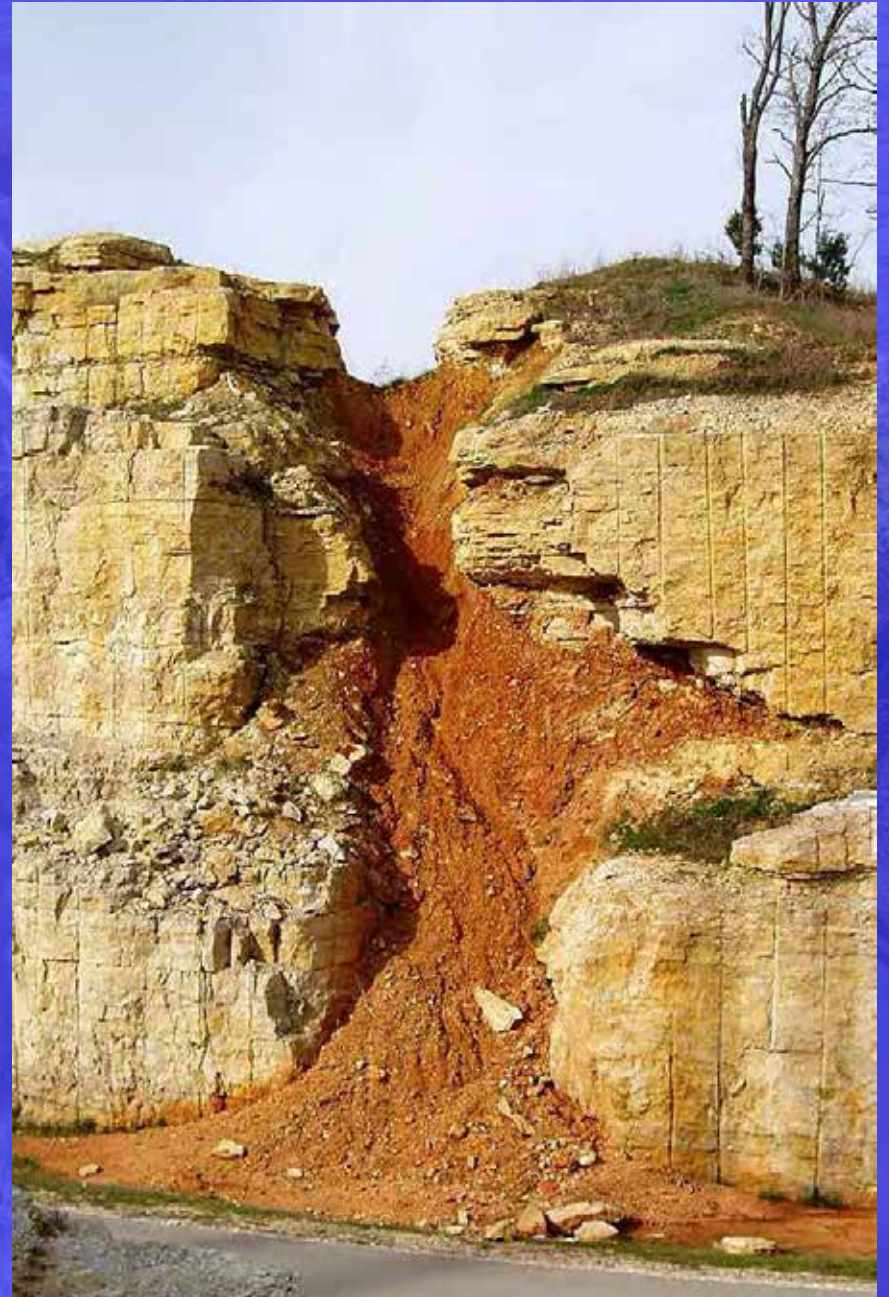
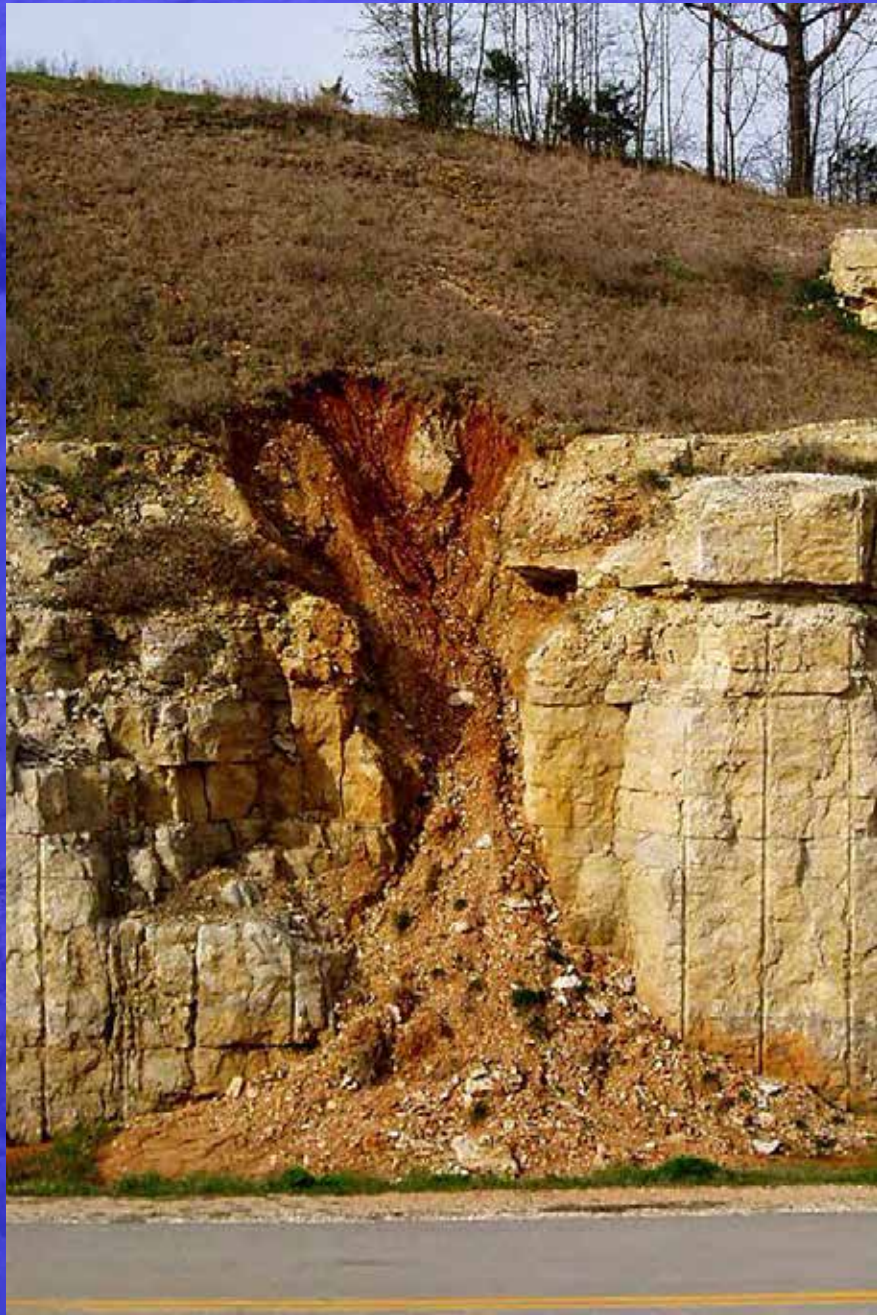
B. Sometimes the roof of a void or cavern can no longer support material above it and a collapse occurs, creating a sinkhole.

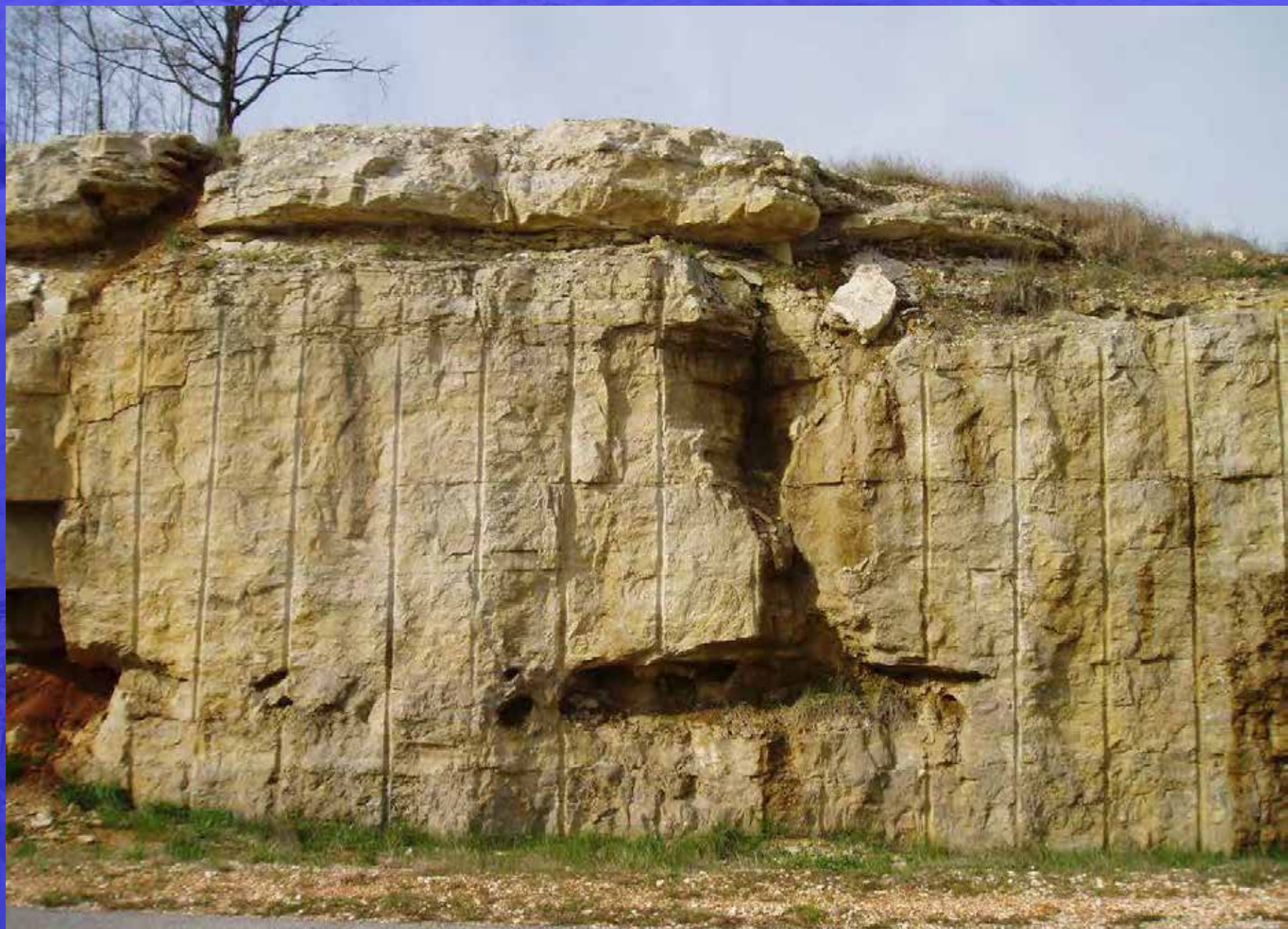


- C.** Over time, the sides of a sinkhole erode and may eventually fill in the sinkhole, leaving a depression.









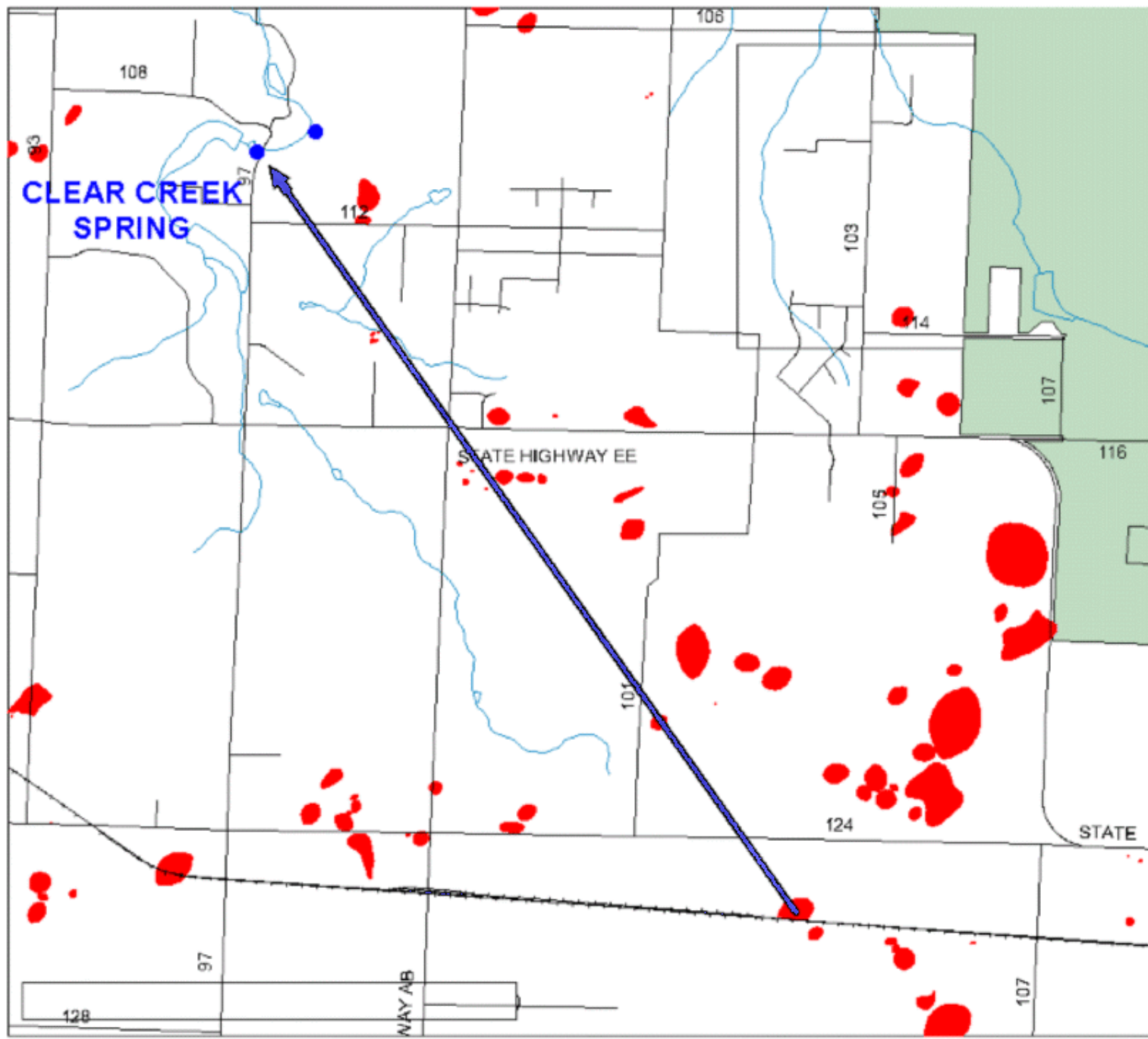
Water Quality

- No Dumping or Filling of Sinkholes













Flooding

- Analysis assumes 8 inches of rainfall over the watershed and no discharge from the sinkhole
- Residential structures must be elevated at least one foot above the rim elevation or 5 feet above the computed flooding elevation



FR 219 South of US 60



FR 219 South of US 60



FR 219 South of US 60



FR 219 South of US 60



US 60 Near FR 219



FR 186 Near MO 125



FR 186 Near MO 125



FR 186 Near MO 125



FR 193 Near FR 174 – March 19, 2008



FR 193 Near FR 174 – March 24, 2008



FR 193 Near FR 174 – March 24, 2008

Structural Stability

- Presently required to address only when building inside the rim

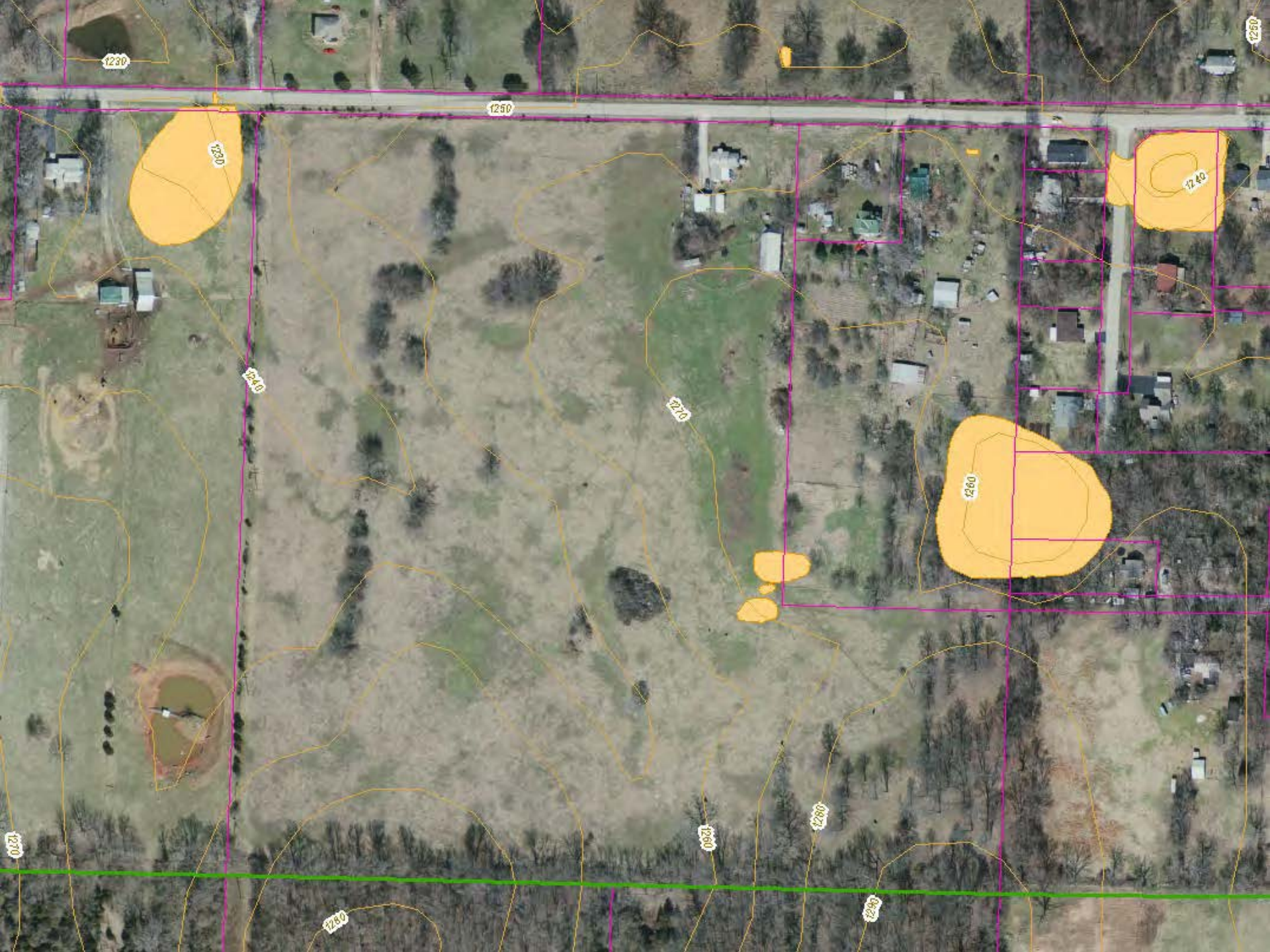


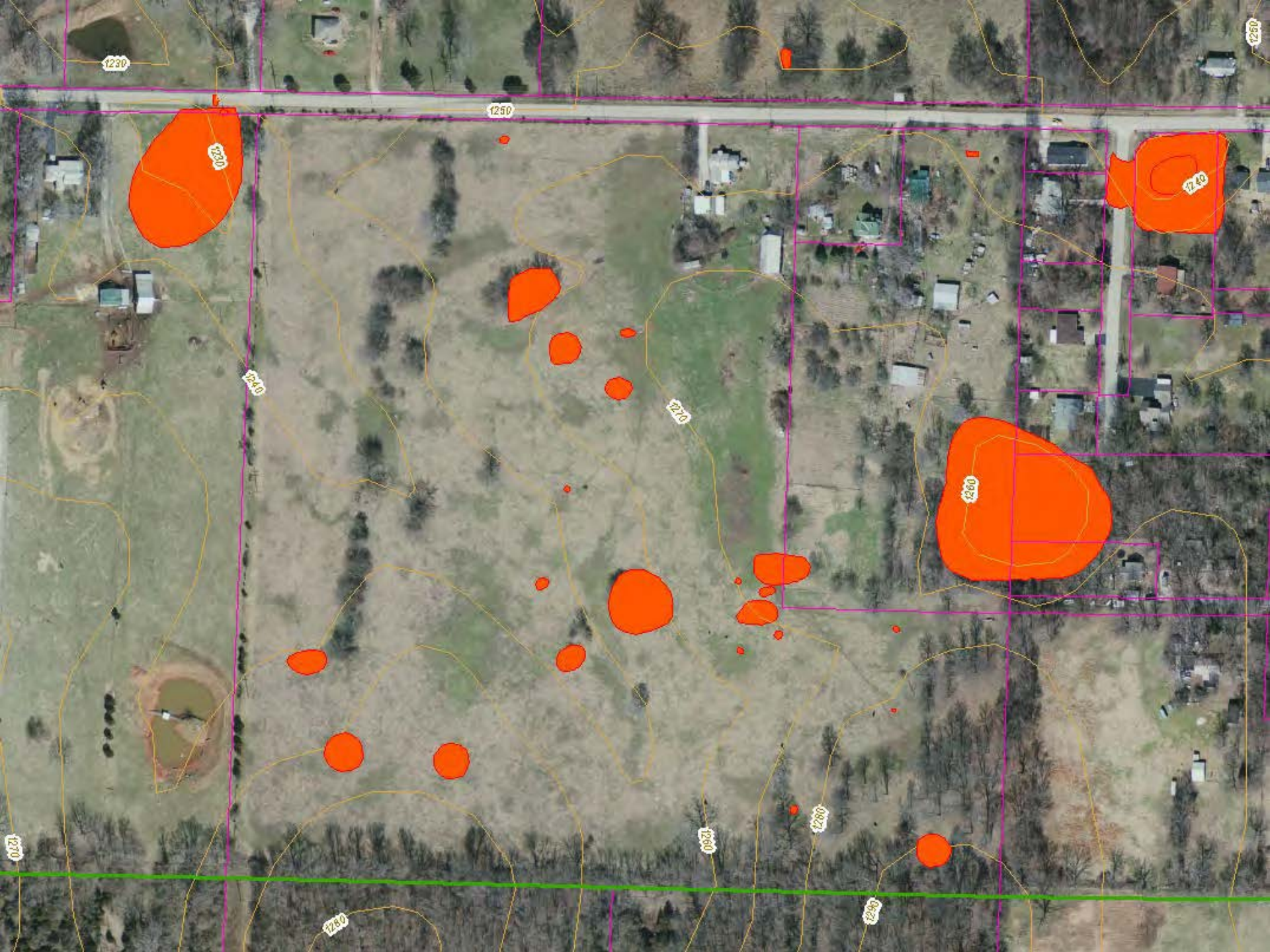


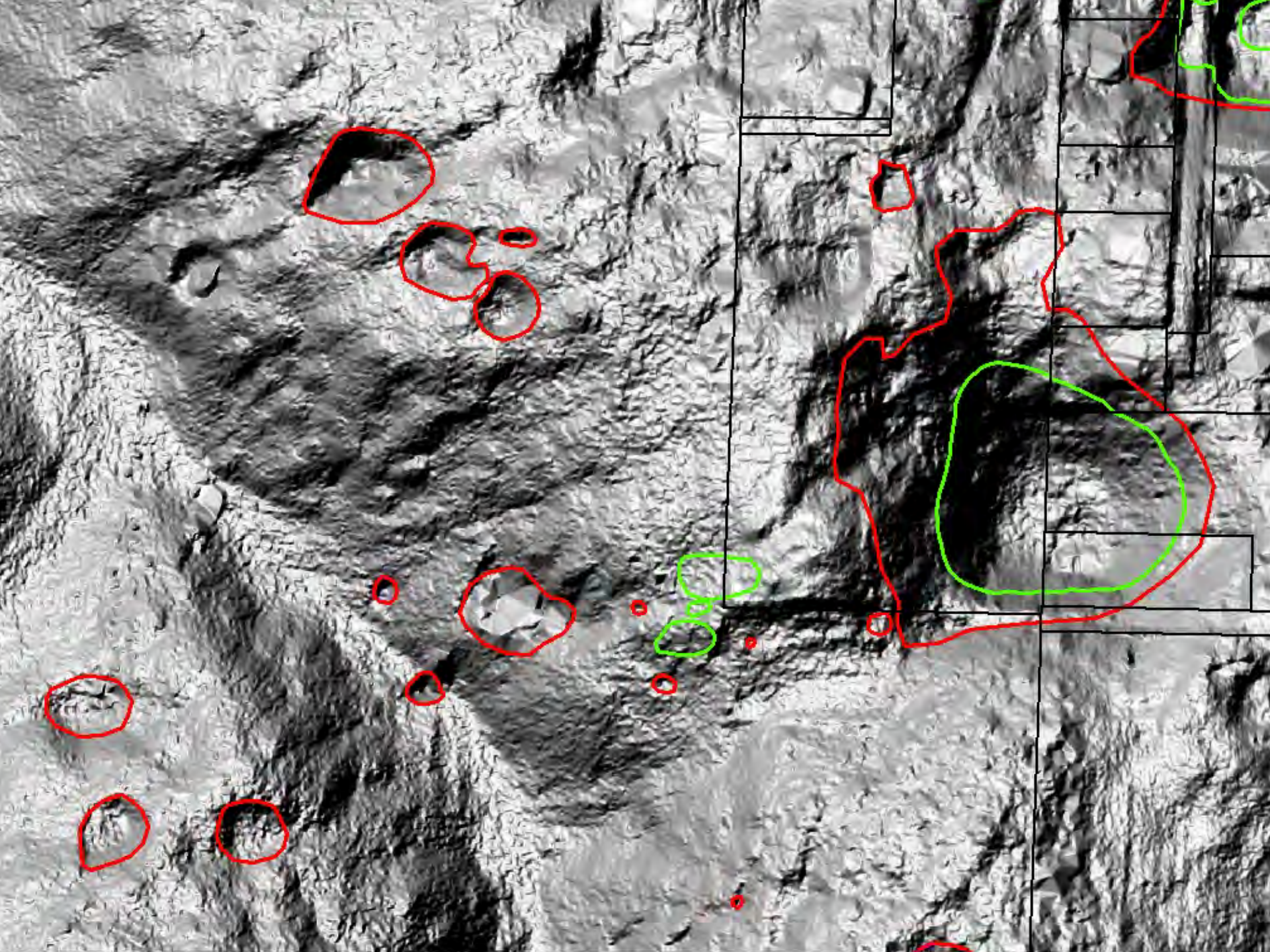




Bent Tree Detention Basin

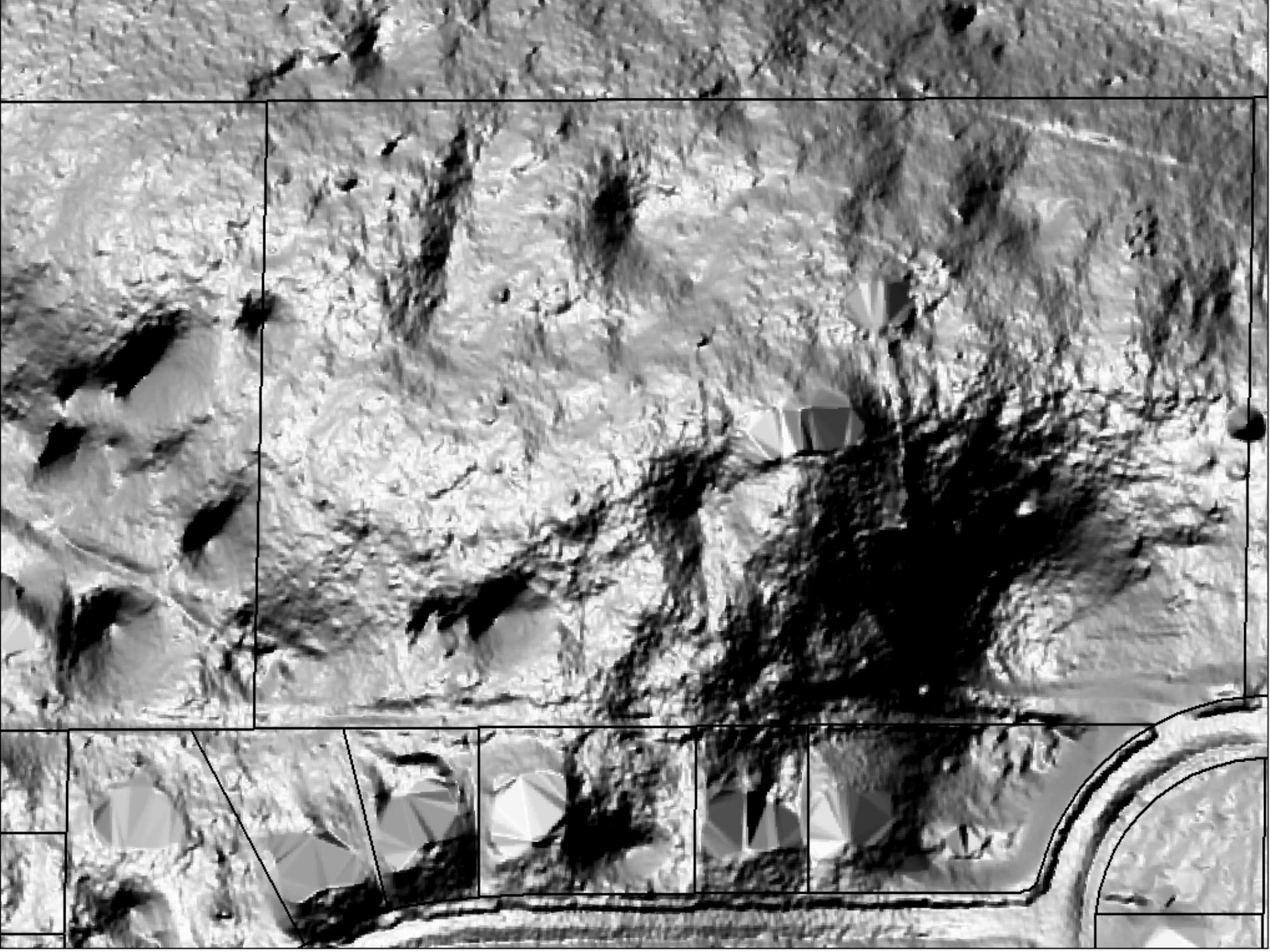


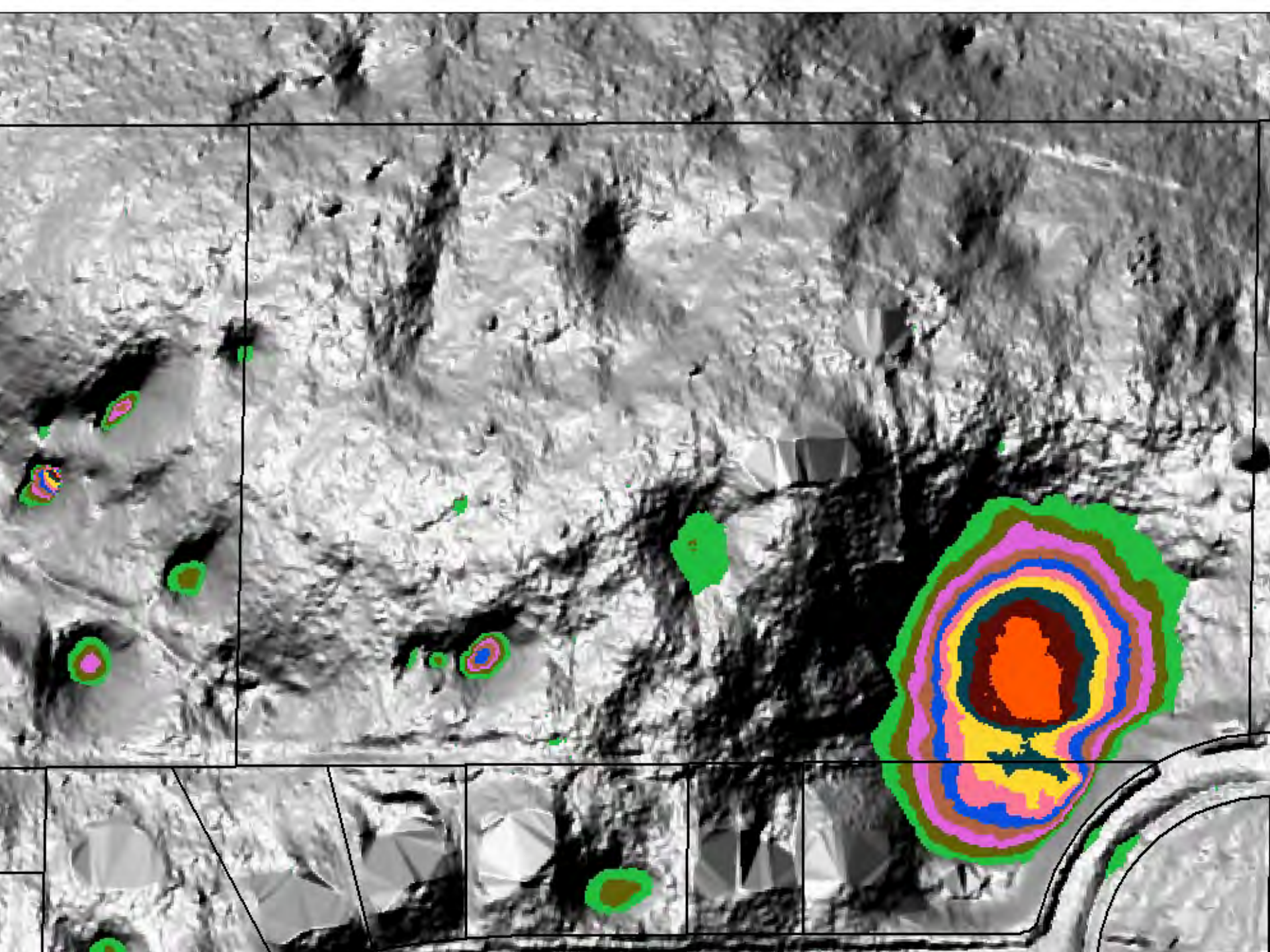


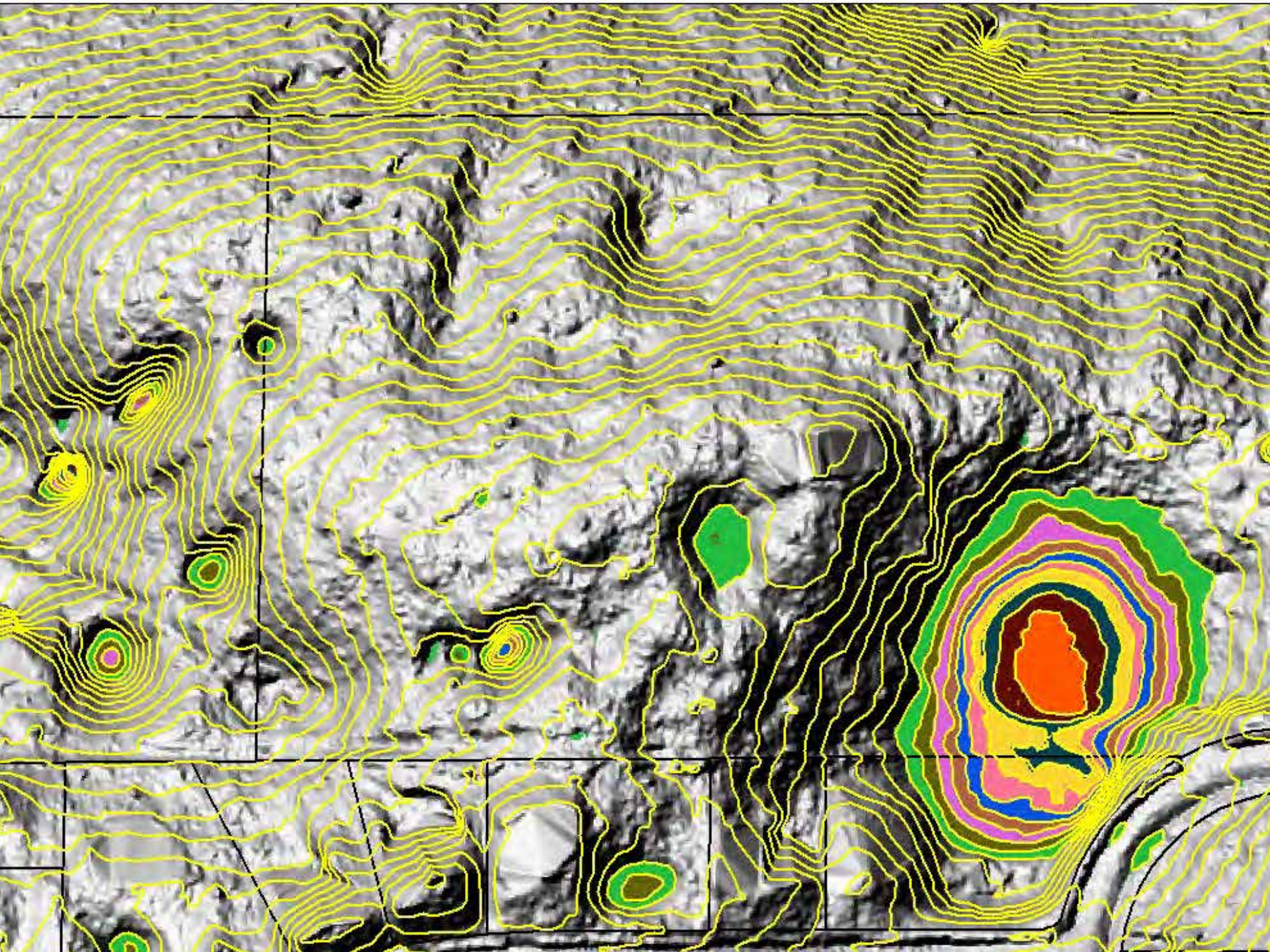


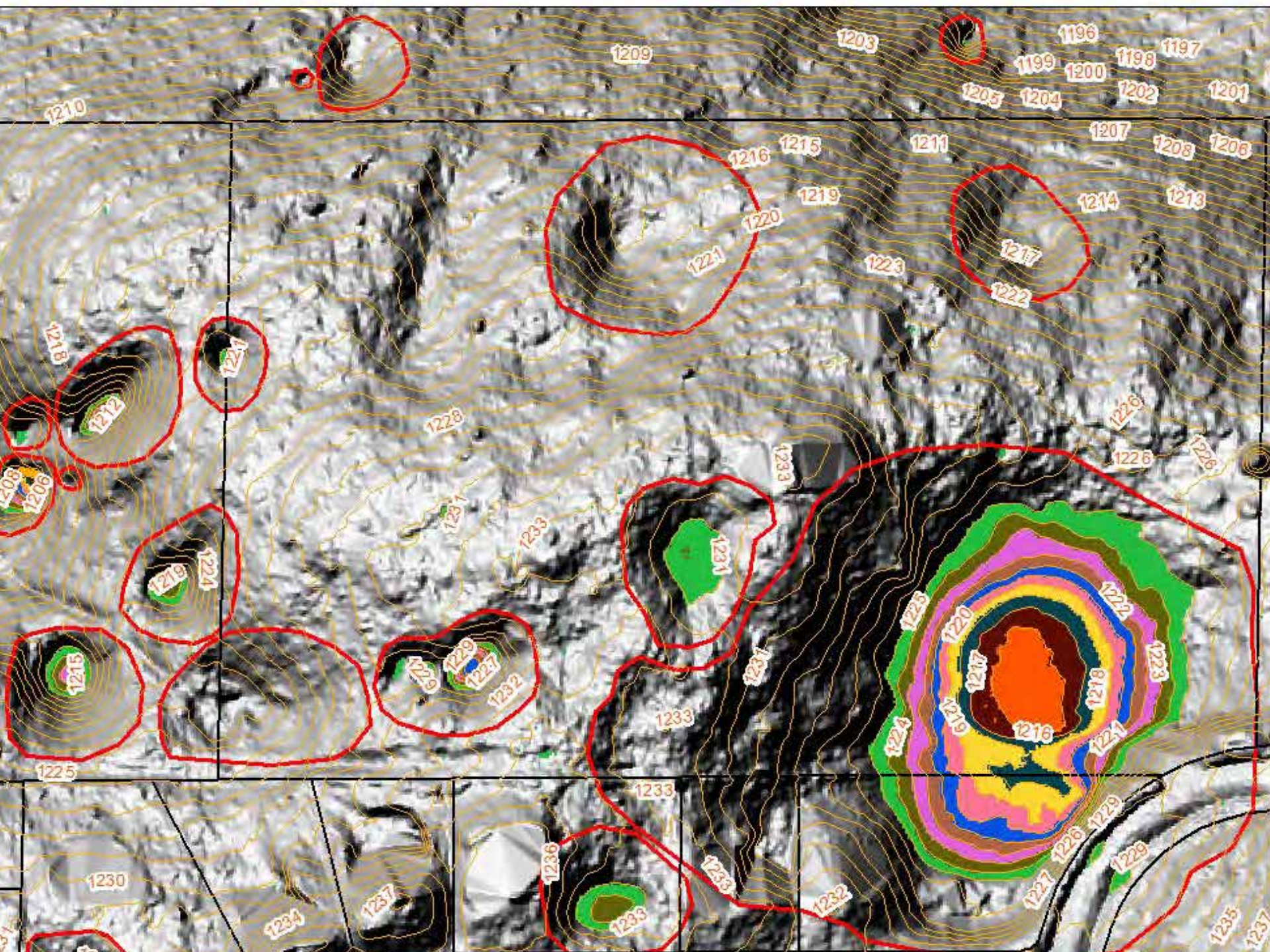


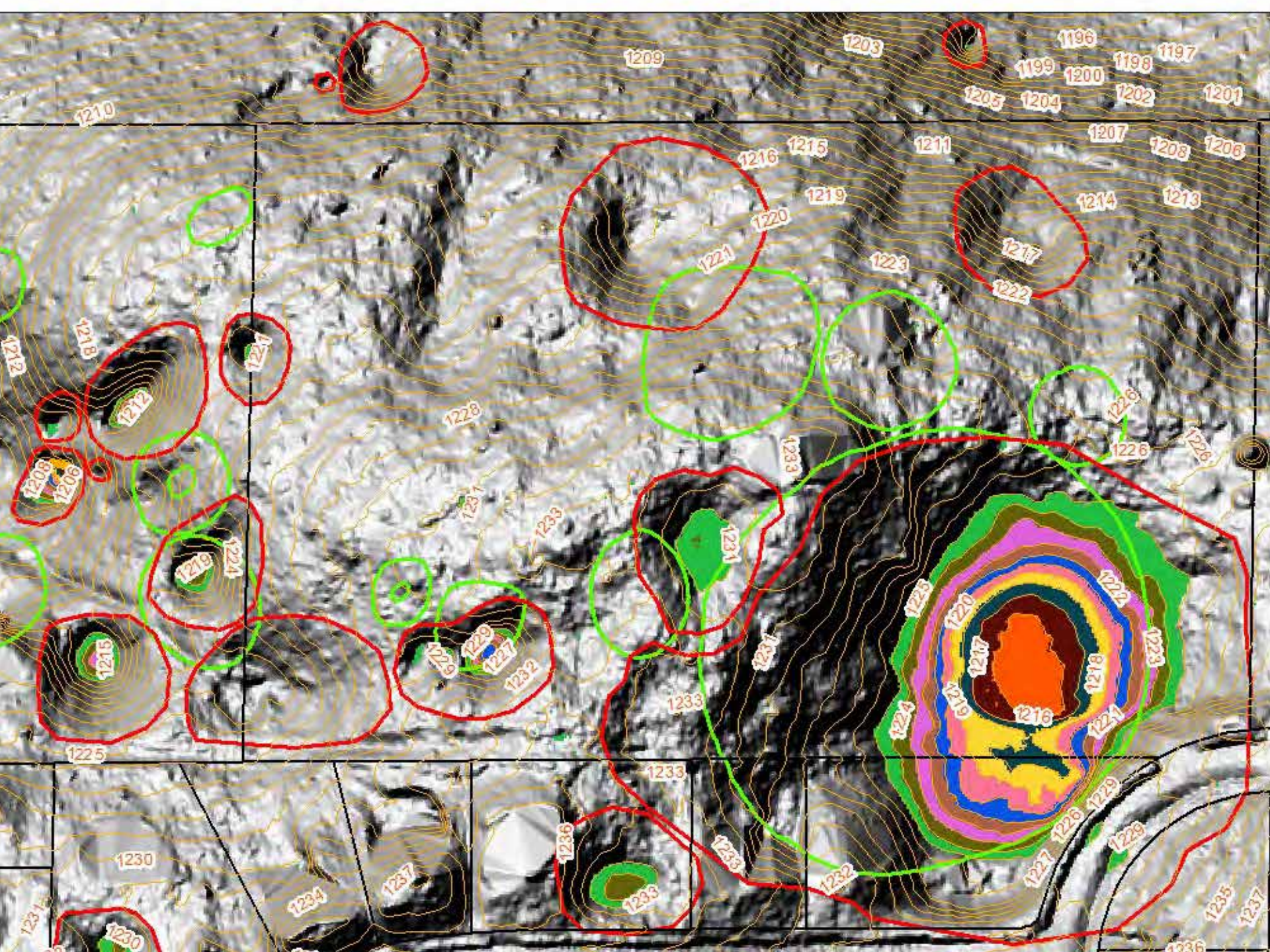


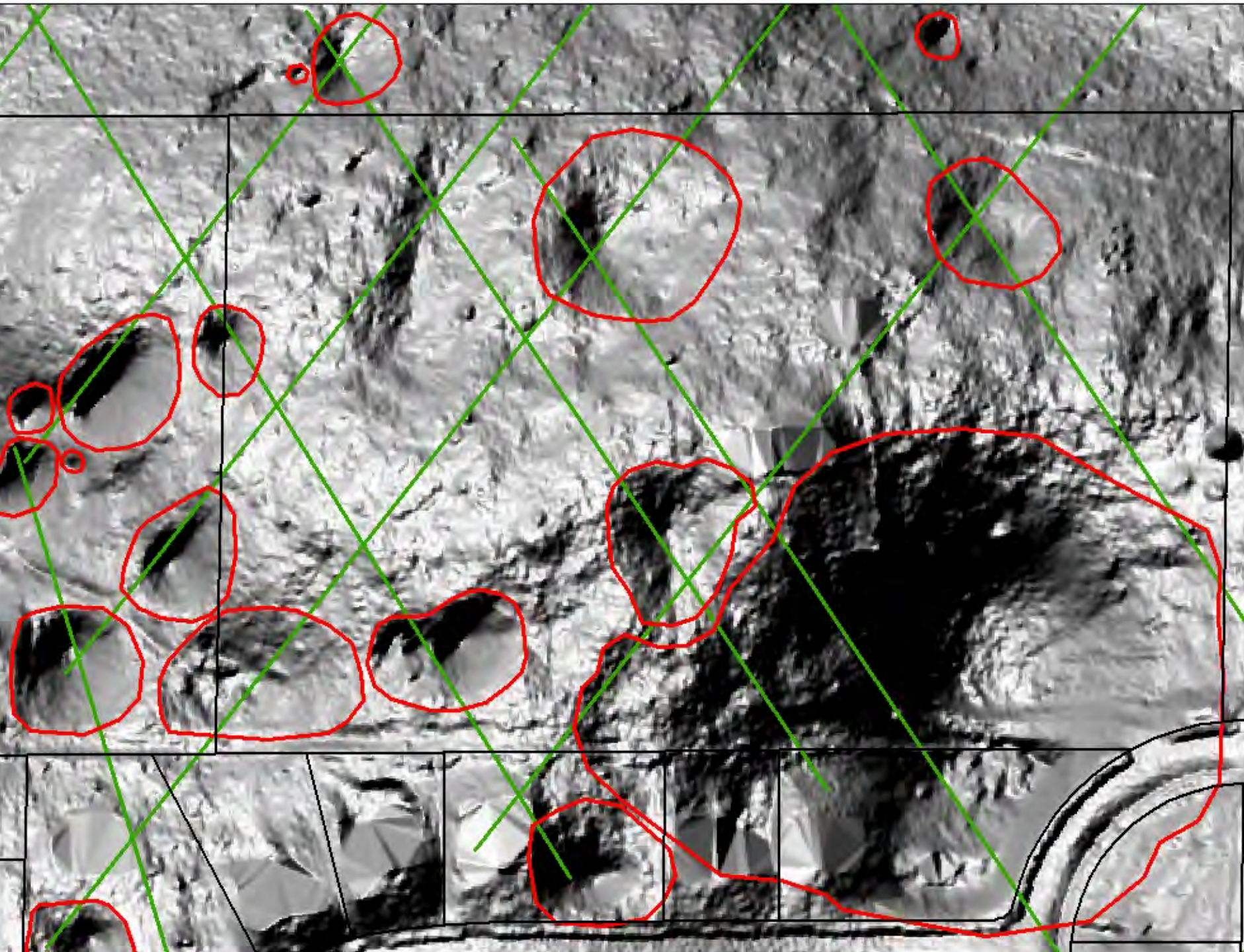






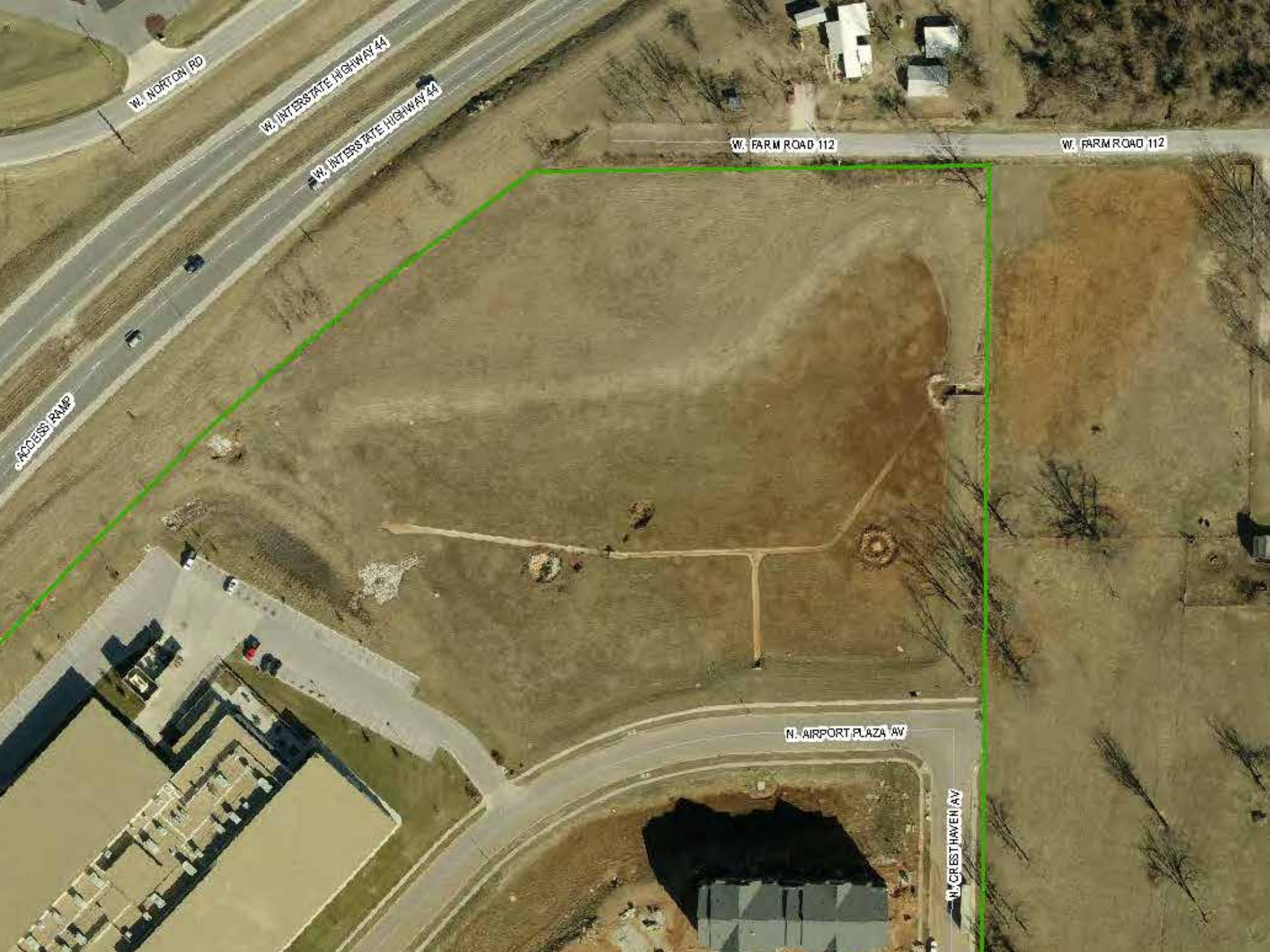












W. NORTON RD

W. INTERSTATE HIGHWAY 44

W. INTERSTATE HIGHWAY 44

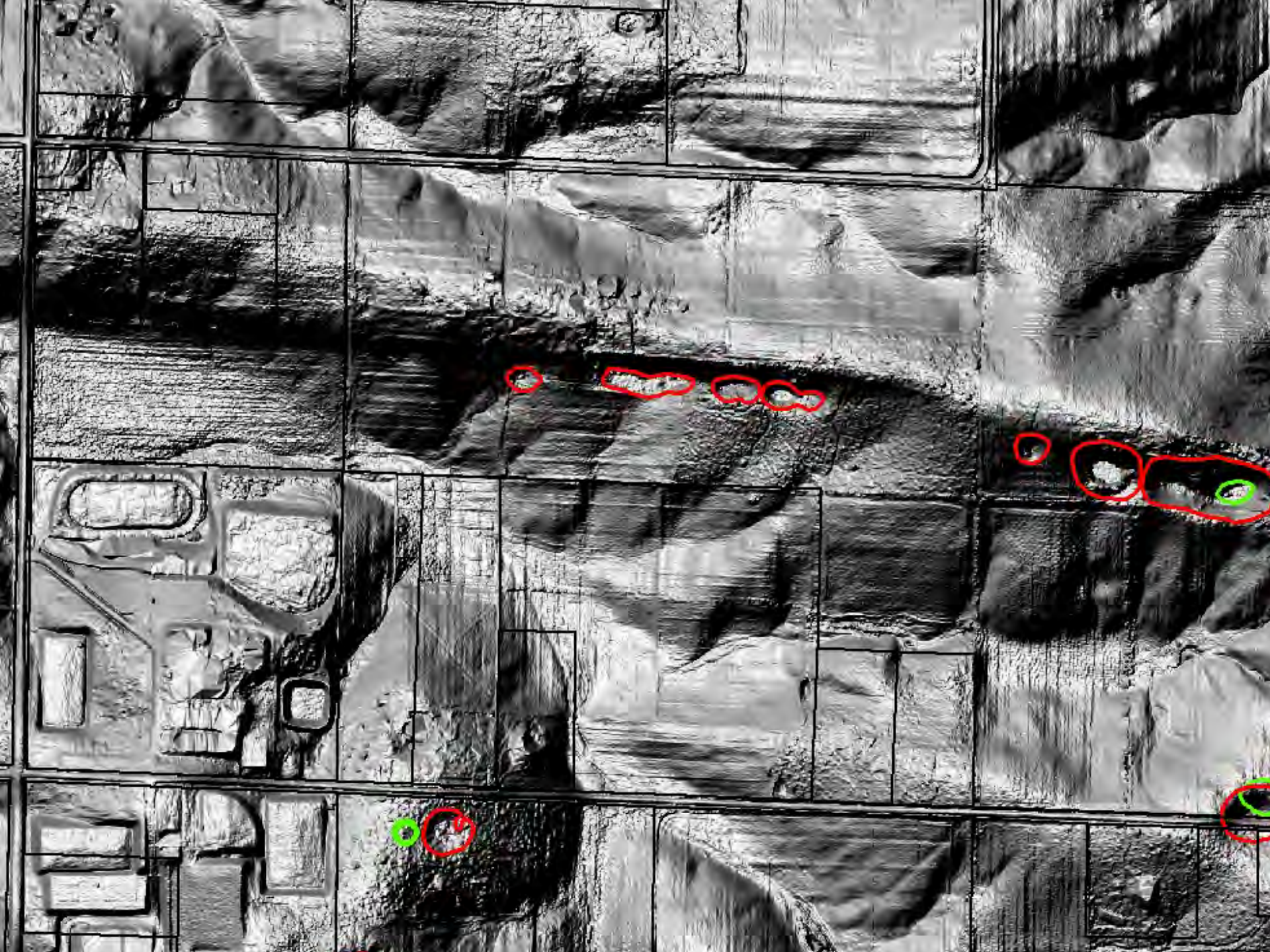
W. FARM ROAD 112

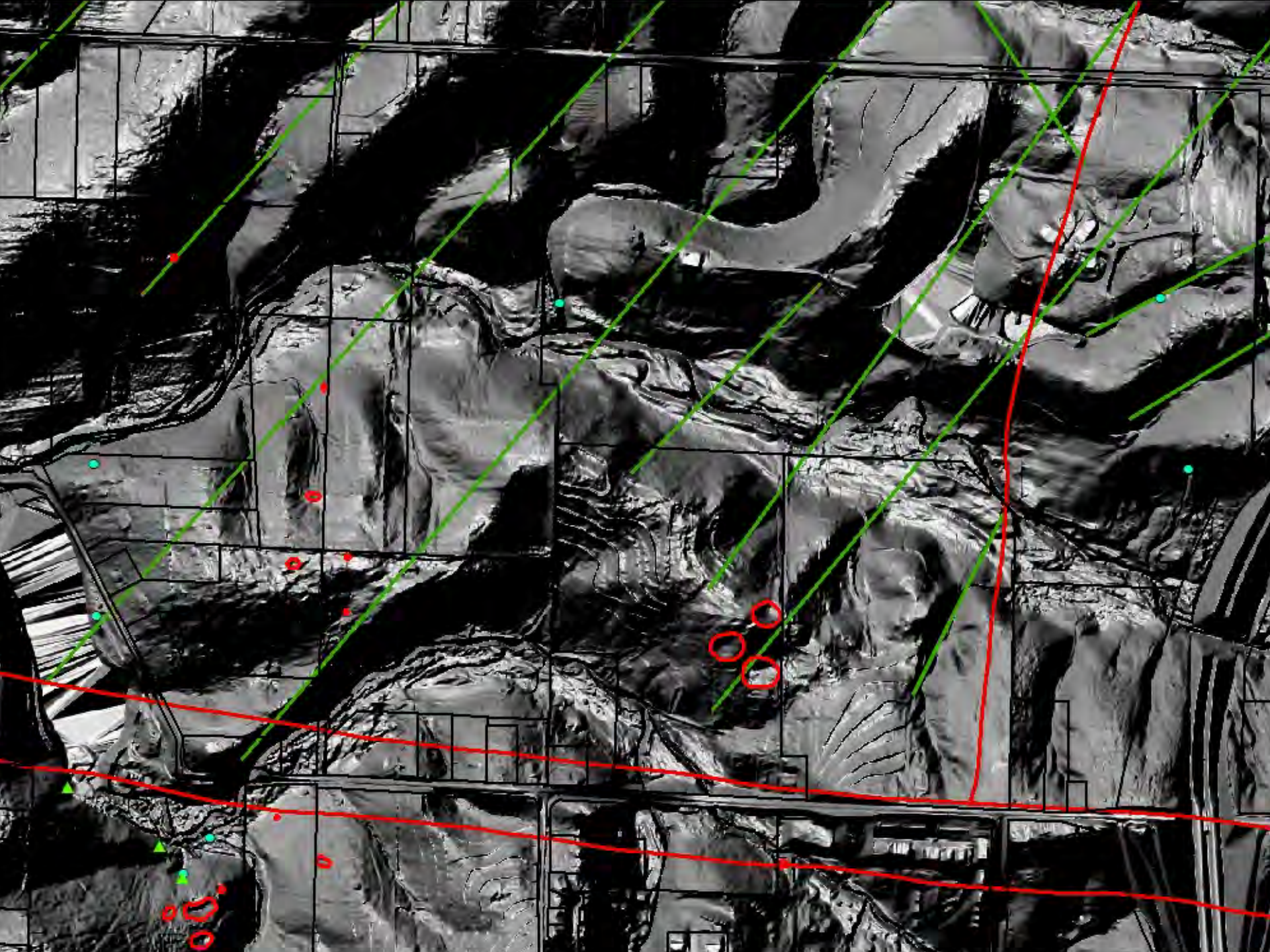
W. FARM ROAD 112

ACCESS RAMP

N. AIRPORT PLAZA AV

N. CRESTHAVEN AV





Using LiDAR to Analyze Sinkholes and Floodplains in Greene County, Missouri

