# Appendix 4

# Facies Distribution Maps

Geostock Sandia

## FACIES DISTRIBUTION AND WORKFLOW

Seventy-Three wells in the vicinity of the Project Blue injection site had sufficient log suites to build a Rock Type "facies" log (**see following Figure 1 and Table 1**). The methodology used for determining facies is described in Section 3.1 of the "*Area of Review and Corrective Action Plan"* technical report. The facies logs were then upscaled and propagated for each of the intervals within the confinement-injection system for the Project Blue CCS Site.

**Figures 2 thru 7** are histograms of the facies data in three states: 1) that of the raw well log data, 2) the range in the upscaled cells, and 3) the range in the model populated property. The Confining Zone (LSCB unit) histogram shows the facies distribution for the well log data is 73.7% shale and 26.3% sand. Over the Lower Hosston Injection Interval, the histogram shows that the facies distribution from the well log data is 72.4% sand and 27.6% shale. For the Cotton Valley Injection Interval, the well data is 32.9% sand and 67.1% shale. For the sub-divided intervals, Cotton Valley 3 interval is 64.1% sand and 35.9% shale; Cotton Valley 2 is 69.7% sand and 30.3% shale; and the Cotton Valley 1 is 79.2% sand and 22.5% shale. All the data for the Project Blue CCS confinement-injection site facies can be observed in **Tables 2 thru 7**.

It is worth noting that this is a simplified facies model and there may be more than two rock types in the injection intervals of the Project Blue CCS site. Rock type and facies are governed by multiple parameters from depositional environment (grain size, sorting, mineralogy) to diagenesis (depth, temperature, pressure). With further data acquisition the facies model maybe refined in the future to incorporate additional details.

Once the well logs had been upscaled, the porosity property was then distributed across the entire model extent. For all layers, facies were modeled using *Truncated Gaussian Simulation.* Due to the spatial distribution of available well data, the major and minor trends for the variogram analysis were set at 045 and 315 orientations respectively (**Figure 8).** The spatial distribution of the data when using a North-South (000) orientation for the variograms, less data is captured than when using the orientations used in the model; this is the primary driver for variogram changes. Additionally, as observed in the structure maps **(Appendix 2** of the technical report**)** the dip direction is Southwest at an approximate 045 orientation, which fits with the major and minor direction for the variograms. For populating the model with the facies logs, the specific variogram

settings can be found in **Figures 9 thru 14.** With additional data collected at the proposed injection site, the methodology behind property distribution will be re-evaluated. **Figures 15 and 16** display the 3D cube of facies distribution. Full size facies distribution maps can be found in **Figures 17 to 28**.

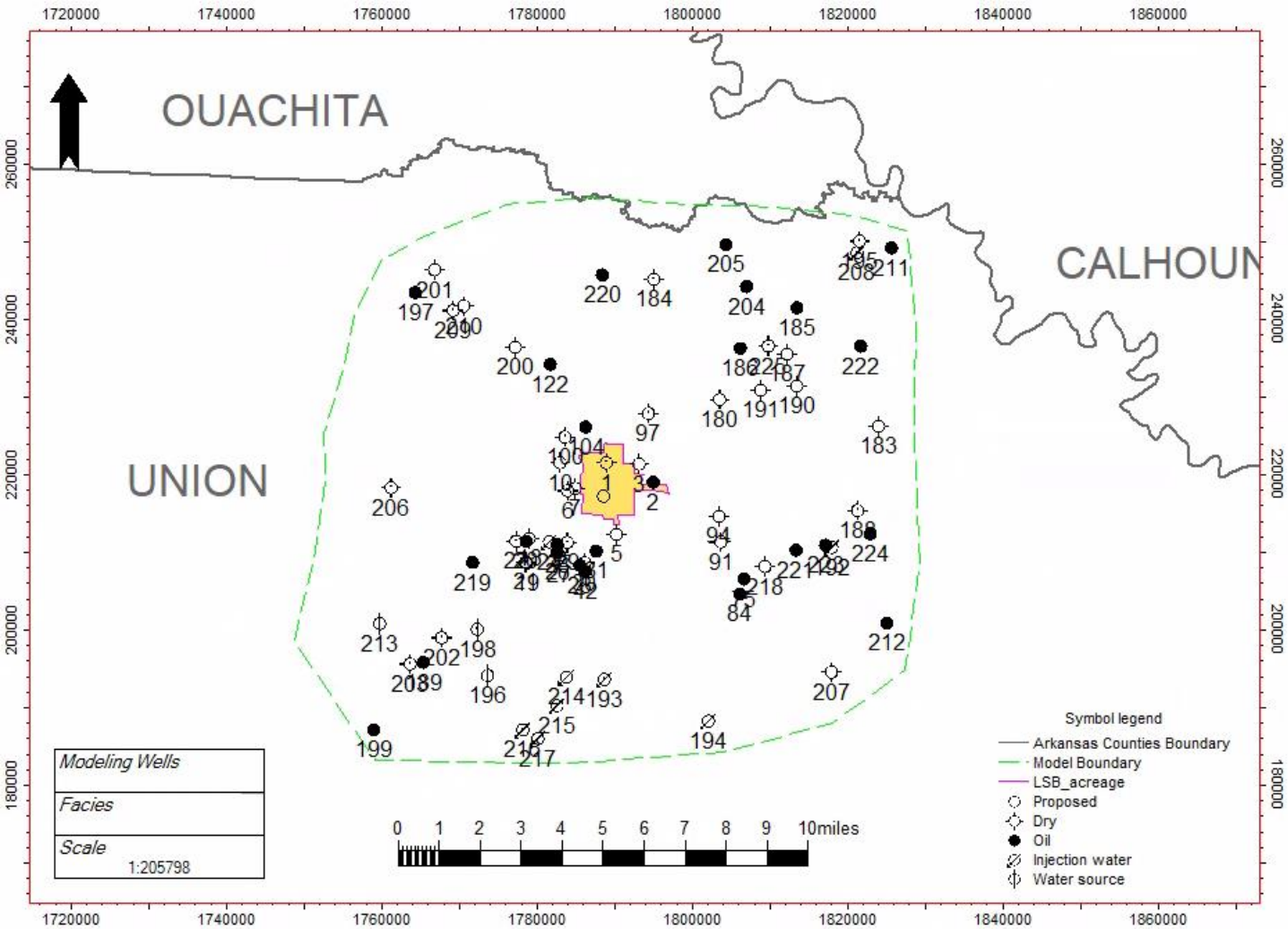


**Figure 1: Location of wells with Logs used for Rock Type (Facies Log).**

| Map Number | Name | UWI | Well symbol | Surface X | Surface Y | Latitude | Longitude | Well datum | Well datum value | Total Depth (feet- TVDSS) | Total Depth (feet-MD) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | EDC 1 | 03139129790000 | P&A | 1788937 | 221703 | 33.27398 | -92.6905 | KB EST | 217.00 | -6361 | 6564 |
| 2 | GOODWIN, WALTER 1 | 03139126790000 | P&A | 1794990 | 219205 | 33.26723 | -92.6707 | KB EST | 186.00 | -3377 | 3545 |
| 3 | SOUTHERN HOTEL 1 | 03139127460000 | P&A | 1793144 | 221549 | 33.27364 | -92.6768 | KB EST | 221.00 | -3362 | 3565 |
| 5 | FLOURNOY, SCOTT ET AL 1 | 03139020820000 | P&A | 1790204 | 212470 | 33.24863 | -92.6862 | KB EST | 175.38 | -4835.62 | 4993 |
| 6 | HANEY 1 | 03139022680000 | P&A | 1783949 | 218104 | 33.264 | -92.7068 | KB EST | 242.00 | -3276 | 3500 |
| 7 | HANEY 2 | 03139022690000 | P&A | 1784931 | 218422 | 33.26489 | -92.7036 | KB EST | 250.58 | -2772.42 | 3005 |
| 10 | PICKERING, JP 1 | 03139022160000 | P&A | 1782975 | 221732 | 33.27395 | -92.71 | KB EST | 217.00 | -3201 | 3400 |
| 18 | BRASHER 1 | 03139022740000 | P&A | 1779019 | 211947 | 33.24699 | -92.7227 | KB EST | 225.00 | -4418 | 4625 |
| 19 | BRASHIER 1 | 03139104060000 | P&A | 1778678 | 208809 | 33.23835 | -92.7238 | KB EST | 223.00 | -4782 | 4991 |
| 20 | BRASHER, F S 1 | 03139048220000 | P&A | 1778637 | 211575 | 33.24595 | -92.724 | KB EST | 234.31 | -6601.69 | 6818 |
| 21 | ANDRESS HEIRS 1 | 03139022750000 | P&A | 1778553 | 208900 | 33.2386 | -92.7242 | KB EST | 234.31 | -6521.69 | 6738 |
| 22 | MILNER HEIRS 1 | 03139022730000 | P&A | 1777315 | 211601 | 33.246 | -92.7283 | KB EST | 234.31 | -4828.69 | 5045 |
| 23 | PARNELL, JOHN ETAL 1 | 03139128020000 | P&A | 1782599 | 211190 | 33.24497 | -92.711 | KB | 248.00 | -6564 | 6800 |
| 24 | PARNELL, JOHN 1 | 03139128440000 | P&A | 1781621 | 211526 | 33.24588 | -92.7142 | KB EST | 267.00 | -5748 | 6001 |
| 26 | HANEY 1 | 03139022710000 | P&A | 1782591 | 210154 | 33.24213 | -92.711 | KB EST | 258.00 | -6523 | 6763 |
| 27 | HANEY, J A 1 | 03139022720000 | P&A | 1782918 | 209814 | 33.2412 | -92.7099 | KB EST | 252.00 | -3737 | 3971 |
| 28 | MCMAHAN 1 | 03139119110000 | P&A | 1785513 | 208483 | 33.23759 | -92.7014 | KB EST | 204.00 | -6545 | 6735 |
| 29 | PARNELL 1 | 03139022700000 | P&A | 1783912 | 211433 | 33.24567 | -92.7067 | KB EST | 254.82 | -6512.18 | 6749 |
| 30 | WHATLEY 1 | 03139103730000 | P&A | 1786153 | 208830 | 33.23855 | -92.6993 | KB EST | 234.00 | -6479 | 6699 |
| 31 | HAMMOND, IRIS G ET AL UNIT 1 | 03139114150000 | P&A | 1787644 | 210331 | 33.24271 | -92.6945 | KB EST | 193.88 | -6820.12 | 7000 |
| 42 | ANDERSON 1 | 03139126020000 | P&A | 1786205 | 207685 | 33.23541 | -92.6991 | KB EST | 222.00 | -6533 | 6740 |
| 75 | WILSON ESTATE 1 | 03139128150000 | P&A | 1806670 | 206737 | 33.23317 | -92.6322 | KB EST | 256.00 | -4617 | 4855 |
| 84 | MURPHY 1 | 03139124140000 | Active | 1806132 | 204812 | 33.22787 | -92.6339 | KB EST | 231.00 | -4540 | 4753 |
| 91 | SEAMSTER, B 1 | 03139124220000 | P&A | 1803670 | 211530 | 33.24629 | -92.6421 | KB EST | 181.72 | -6349.28 | 6517 |
| 94 | GULF 1 | 03139020260000 | P&A | 1803433 | 214791 | 33.25525 | -92.643 | KB EST | 202.00 | -3391 | 3575 |
| 97 | GOODWIN EST. "A" 1 | 03139055670000 | P&A | 1794339 | 228084 | 33.29162 | -92.673 | KB EST | 172.80 | -3647.2 | 3802 |
| 100 | BYRD 1 | 03139009180000 | P&A | 1783610 | 225054 | 33.28309 | -92.708 | KB EST | 215.00 | -3171 | 3368 |
| 104 | J.P. PICKERING 1 | 03139055550000 | P&A | 1786276 | 226313 | 33.2866 | -92.6993 | KB EST | 213.53 | -2804.47 | 3000 |
| 122 | COMBS 1 | 03139008320000 | P&A | 1781701 | 234395 | 33.30873 | -92.7145 | KB EST | 208.75 | -3309.25 | 3500 |
| 180 | FREELAND 1 | 03139055590000 | P&A | 1803525 | 229862 | 33.29667 | -92.643 | KB EST | 126.27 | -3396.73 | 3505 |
| 183 | H.C. ARMER 1 | 03139002520000 | P&A | 1824016 | 226422 | 33.28755 | -92.5758 | KB | 246.10 | -5642.9 | 5875 |
| 184 | JESSIE MURPHY #1 | 03139002780000 | P&A | 1795012 | 245338 | 33.33905 | -92.6711 | DF | 238.00 | -2306 | 2530 |
| 185 | ANTHONY 1 | 03139004240000 | P&A | 1813496 | 241682 | 33.32932 | -92.6106 | DF | 107.00 | -5334 | 5427 |
| 186 | LINGLEBACH "A" 9 | 03139005570000 | Active | 1806185 | 236454 | 33.31483 | -92.6344 | DF | 106.00 | -4816 | 4908 |
| 187 | EZZELL 1 | 03139005590000 | P&A | 1812187 | 235711 | 33.31289 | -92.6147 | DF | 127.80 | -3388.2 | 3502 |
| 188 | STEPHENS, E J 1 | 03139014980000 | P&A | 1821308 | 215587 | 33.25773 | -92.5845 | DF | 169.00 | -6043 | 6198 |
| 189 | RUSSELL, T F 1 | 03139023130000 | P&A | 1765351 | 196007 | 33.20291 | -92.767 | DF | 236.50 | -8152.5 | 8375 |
| 190 | GOODWIN 1 | 03139044930000 | P&A | 1813494 | 231606 | 33.30163 | -92.6104 | DF | 151.80 | -3014.2 | 3152 |
| 191 | GOODWIN 1 | 03139044940000 | P&A | 1808816 | 231081 | 33.30011 | -92.6257 | DF | 125.00 | -3140 | 3251 |
| 192 | LONG-ANTHONY A-3 | 03139104310000 | P&A | 1817960 | 210817 | 33.24457 | -92.5954 | DF | 176.00 | -6020 | 6182 |
| 193 | SWD 5 | 03139104520000 | Active | 1788686 | 193803 | 33.19731 | -92.6907 | DF | 262.50 | -7131.5 | 7380 |

| Map Number | Name | UWI | Well symbol | Surface X | Surface Y | Latitude | Longitude | Well datum | Well datum value | Total Depth (feet- TVDSS) | Total Depth (feet-MD) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 194 | SWD 8 | 03139105300000 | Active | 1802088 | 188411 | 33.18273 | -92.6468 | DF | 216.80 | -7237.2 | 7440 |
| 195 | ROSEN 1 | 03139106500000 | P&A | 1821552 | 250273 | 33.35306 | -92.5843 | DF | 82.00 | -5182 | 5250 |
| 196 | BRINE SUPPLY | 03139108200000 | P&A | 1773631 | 194322 | 33.19844 | -92.7399 | KB | 242.80 | -7274.2 | 7503 |
| 197 | DELTIC FARM & TIMBER 1 | 03139110100000 | P&A | 1764317 | 243642 | 33.33379 | -92.7716 | KB | 210.10 | -5927.9 | 6124 |
| 198 | BRINE SUPPLY WELL 11 | 03139110630000 | P&A | 1772316 | 200253 | 33.21472 | -92.7444 | KB | 238.30 | -7142.7 | 7367 |
| 199 | NATURAL RESOURCES 1 | 03139110720000 | Active | 1758991 | 187305 | 33.17886 | -92.7876 | KB | 180.50 | -7504.5 | 7671 |
| 200 | HICKS 1 | 03139111360000 | P&A | 1777214 | 236604 | 33.31471 | -92.7292 | KB | 144.00 | -5953 | 6083 |
| 201 | SAXON, C H TR 1 | 03139115030000 | P&A | 1766795 | 246562 | 33.34187 | -92.7636 | KB | 180.00 | -5918 | 6084 |
| 202 | WINGFIELD 1 | 03139115350000 | P&A | 1767699 | 199162 | 33.21162 | -92.7594 | KB | 262.00 | -6910 | 7158 |
| 203 | J & M POULTRY PACKING 1 | 03139115770000 | P&A | 1763650 | 195787 | 33.20227 | -92.7726 | KB | 228.00 | -7196 | 7410 |
| 204 | GILLER 5 | 03139115960000 | Active | 1806979 | 244425 | 33.33675 | -92.632 | KB | 110.00 | -5262 | 5358 |
| 205 | PATE "A" 25 | 03139117120000 | Active | 1804359 | 249827 | 33.35155 | -92.6406 | KB | 108.40 | -5194.6 | 5289 |
| 206 | HARRELL 1 | 03139117360000 | P&A | 1761229 | 218493 | 33.26462 | -92.7811 | KB | 267.00 | -6697 | 6950 |
| 207 | HARPER, W L 1 | 03139117460000 | P&A | 1817931 | 194731 | 33.20036 | -92.5951 | KB | 230.90 | -6593.1 | 6810 |
| 208 | LANGLEY 1 | 03139117550000 | Active | 1821238 | 248783 | 33.34896 | -92.5853 | KB | 89.00 | -2713 | 2788 |
| 209 | ARMSTRONG EST. 1 | 03139118800000 | P&A | 1769183 | 241345 | 33.32758 | -92.7556 | KB | 174.70 | -5939.3 | 6100 |
| 210 | JOHNSON 1 | 03139119620000 | P&A | 1770579 | 241908 | 33.32916 | -92.7511 | KB | 151.80 | -5906.2 | 6044 |
| 211 | IPRC 1 | 03139120730000 | P&A | 1825648 | 249402 | 33.35073 | -92.5709 | KB | 82.00 | -5202 | 5270 |
| 212 | SMITH ET AL 1 | 03139122150000 | P&A | 1825057 | 201043 | 33.21782 | -92.572 | KB | 243.00 | -6422 | 6651 |
| 213 | BSW 13 | 03139127790000 | Active | 1759737 | 200991 | 33.21649 | -92.7855 | KB | 236.00 | -7378 | 7600 |
| 214 | SWD 15 | 03139129120000 | Active | 1783788 | 194089 | 33.198 | -92.7067 | KB | 249.20 | -7077.8 | 7313 |
| 215 | SWD 16 | 03139129190000 | Active | 1782576 | 190402 | 33.18784 | -92.7106 | KB | 272.50 | -7227.5 | 7486 |
| 216 | WASTE DISPOSAL WELL 5 | 03139129370000 | Active | 1778181 | 187297 | 33.17923 | -92.7249 | KB | 227.90 | -5086.1 | 5300 |
| 217 | WASTE DISPOSAL WELL 6 | 03139129380000 | Active | 1780112 | 186150 | 33.17611 | -92.7186 | KB | 295.00 | -5019 | 5300 |
| 218 | MAHONEY CORPORATION 1 | 03139129590000 | P&A | 1809368 | 208343 | 33.23763 | -92.6234 | KB | 251.00 | -6363 | 6600 |
| 219 | DUMAS 1 | 03139131850000 | P&A | 1771702 | 208885 | 33.23843 | -92.7466 | KB | 203.40 | -6660.6 | 6850 |
| 220 | MURPHY 1 | 03139131930000 | P&A | 1788413 | 245934 | 33.34057 | -92.6928 | KB | 147.10 | -4512.9 | 4646 |
| 221 | FROST "C" | 03139133030000 | Active | 1813393 | 210444 | 33.24347 | -92.6103 | KB | 220.40 | -5796.6 | 6003 |
| 222 | BARKER 1 | 03139133780000 | Active | 1821716 | 236739 | 33.31587 | -92.5836 | KB | 156.70 | -5357.3 | 5500 |
| 223 | EZZELL 1 | 03139135060000 | Active | 1817172 | 211080 | 33.24528 | -92.5979 | KB | 210.40 | -6053.6 | 6250 |
| 224 | PAMCO-MOODY 1 | 03139135610000 | Active | 1822932 | 212554 | 33.24942 | -92.5791 | KB | 204.00 | -6024 | 6214 |
| 225 | MURPHY, W R 1 | 03139835660000 | P&A | 1809817 | 236759 | 33.31573 | -92.6225 | KB | 98.40 | -3294.6 | 3379 |

**Table 1: Detailed Information for wells identified in Figure 1.**

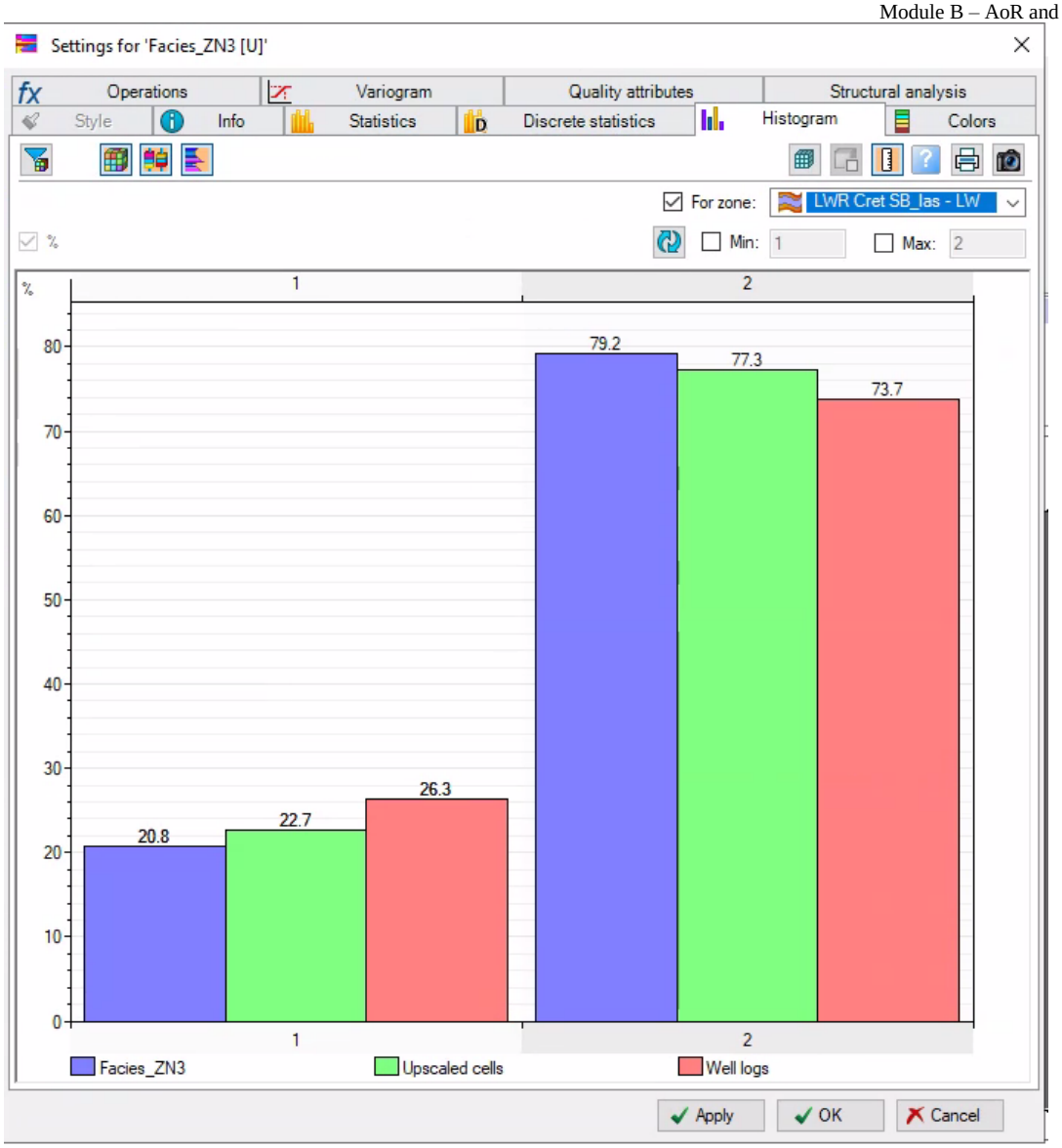


**Figure 2: Histogram of data for Well Logs, Upscaled Cells and Modeled Property over the LCSB interval.**

| TYPE | SAND | SHALE |
|---|---|---|
| Modeled Property | 20.8 | 79.2 |
| Upscaled Cells | 22.7 | 77.3 |
| Well Logs | 26.3 | 73.7 |

**Table 2: Table of data for Well Logs, Upscaled Cells and Modeled Property over the LCSB interval.**

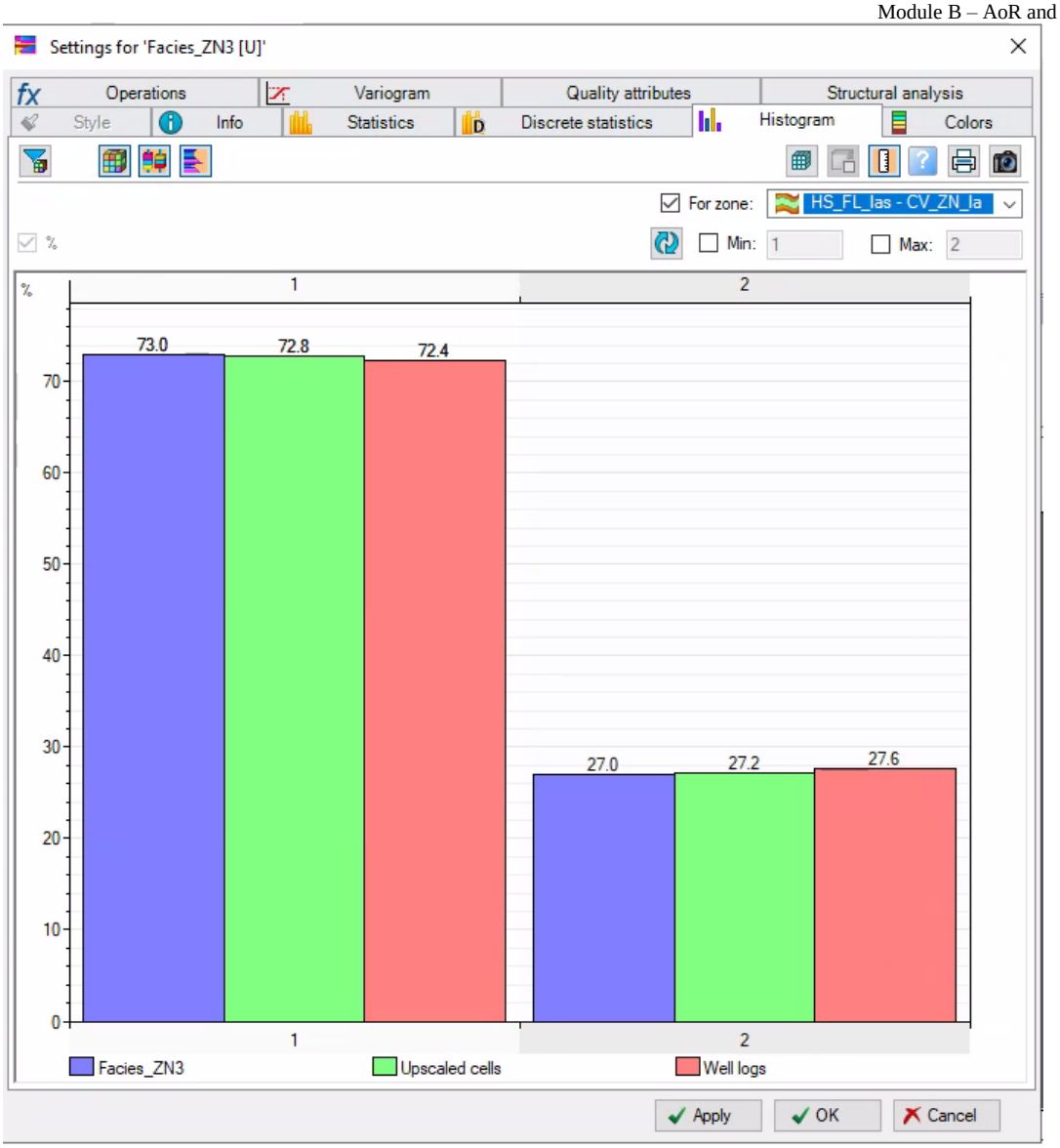


**Figure 3: Histogram of data for Well Logs, Upscaled Cells and Modeled Property over the Lower Hosston Injection Zone.**

| TYPE | SAND | SHALE |
|---|---|---|
| Modeled Property | 73.0 | 27.0 |
| Upscaled Cells | 72.8 | 27.2 |
| Well Logs | 72.4 | 27.6 |

**Table 3: Table of data for Well Logs, Upscaled Cells and Modeled Property over the Lower Hosston Injection Zone.**

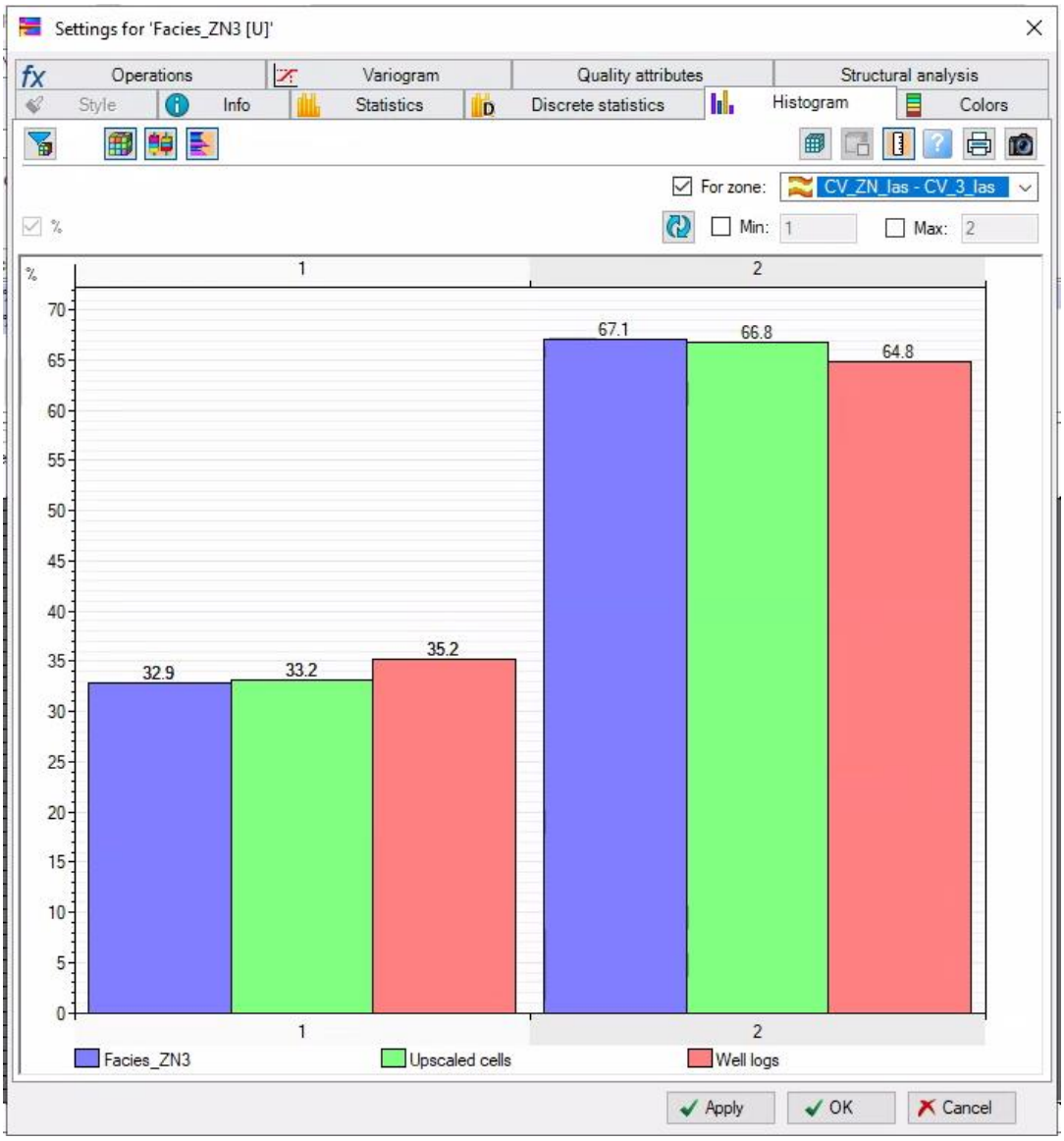


**Figure 4: Histogram of data for Well Logs, Upscaled Cells and Modeled Property over the Cotton Valley Injection Zone.**

| TYPE | SAND | SHALE |
|---|---|---|
| Modeled Property | 32.9 | 67.1 |
| Upscaled Cells | 33.2 | 66.8 |
| Well Logs | 35.2 | 64.8 |

**Table 4: Table of data for Well Logs, Upscaled Cells and Modeled Property over the Cotton Valley Injection Zone.**

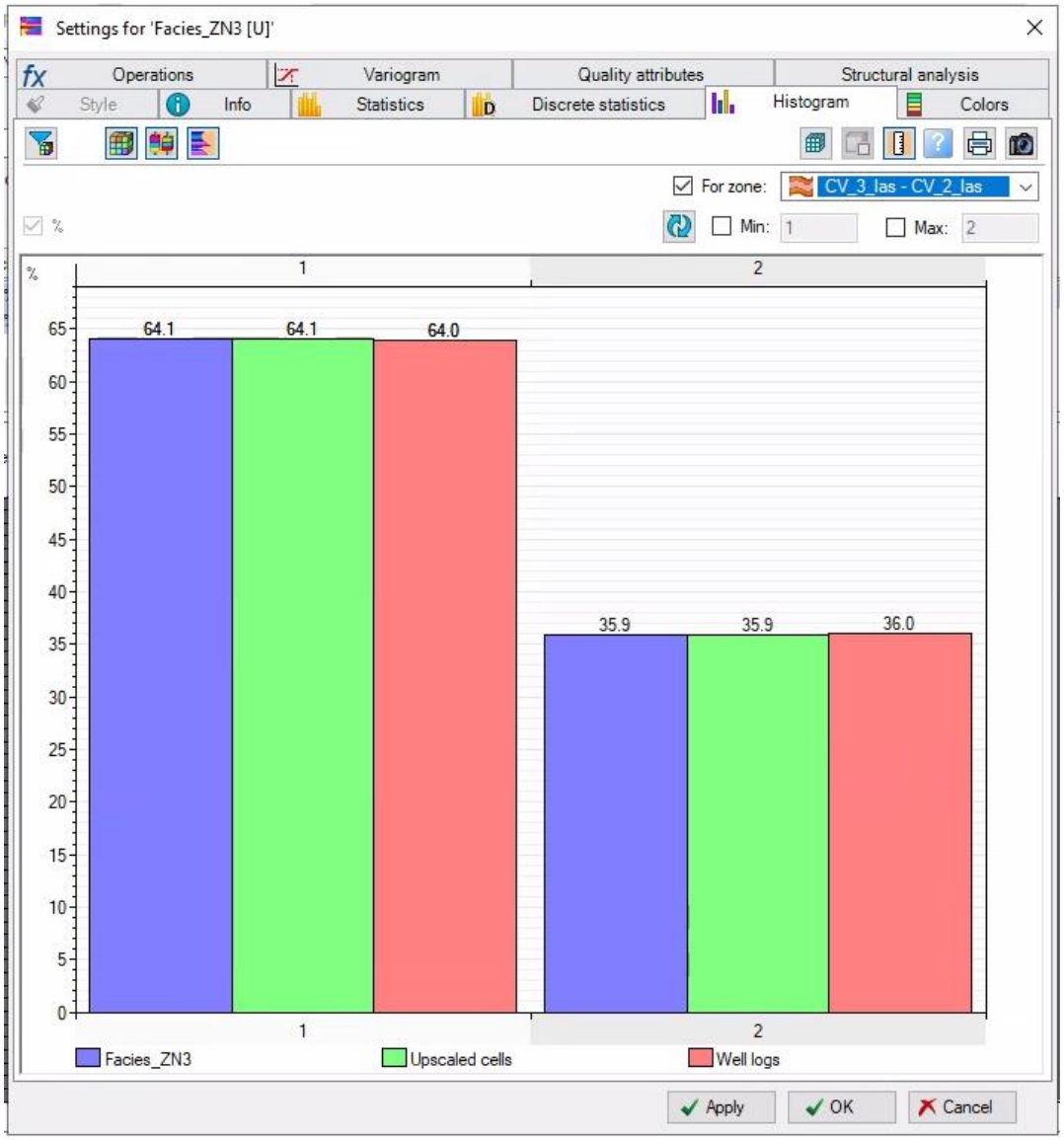


**Figure 5: Histogram of data for Well Logs, Upscaled Cells and Modeled Property over the CV3 interval.**

| TYPE | SAND | SHALE |
|---|---|---|
| Modeled Property | 64.1 | 35.9 |
| Upscaled Cells | 64.1 | 35.9 |
| Well Logs | 64.0 | 36.0 |

**Table 5: Table of data for Well Logs, Upscaled Cells and Modeled Property over the CV3 interval.**

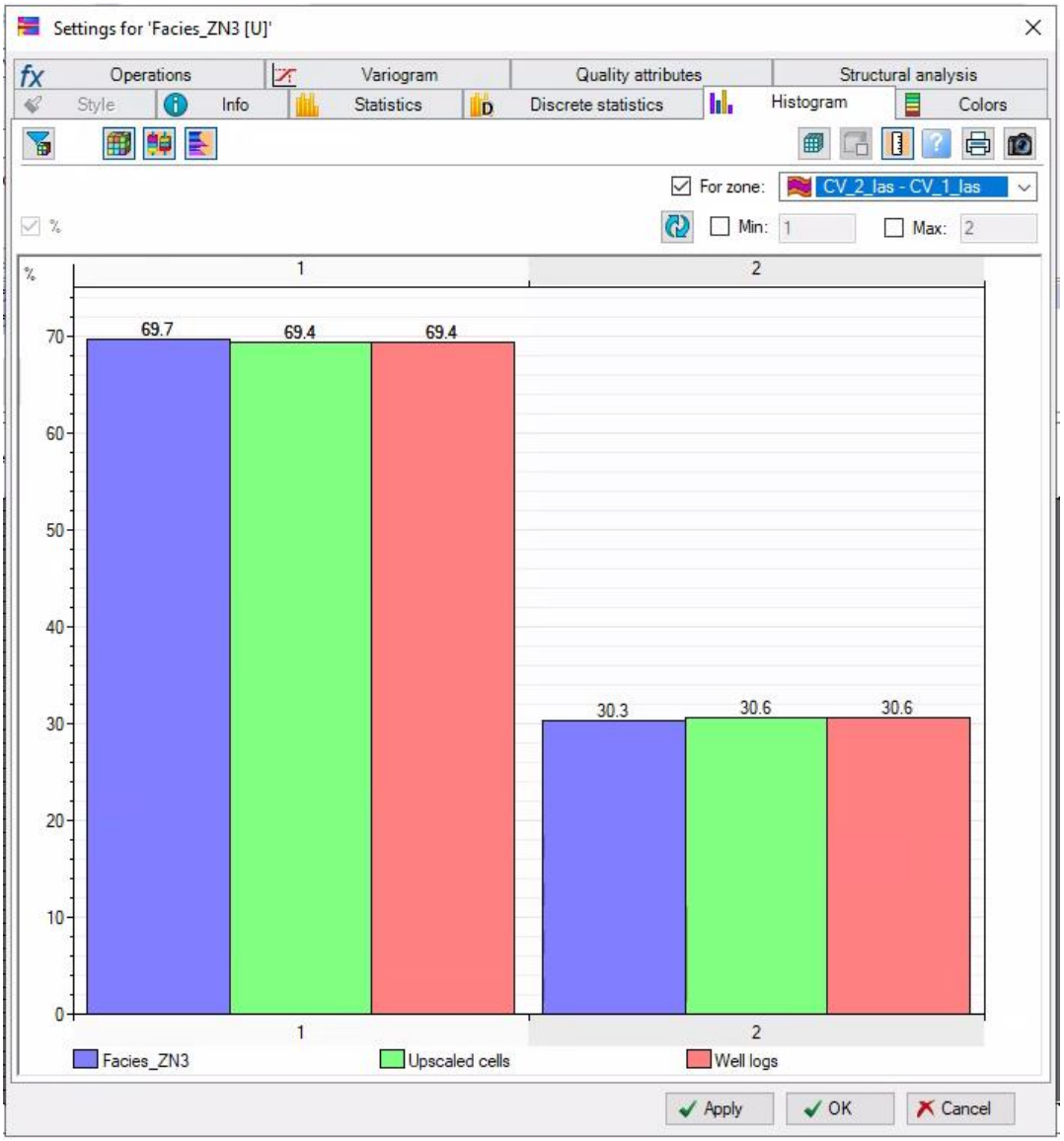


**Figure 6: Histogram of data for Well Logs, Upscaled Cells and Modeled Property over the CV2 interval.**

| TYPE | SAND | SHALE |
|---|---|---|
| Modeled Property | 69.7 | 30.3 |
| Upscaled Cells | 69.4 | 30.6 |
| Well Logs | 69.4 | 30.6 |

**Table 6: Table of data for Well Logs, Upscaled Cells and Modeled Property over the CV2 interval.**

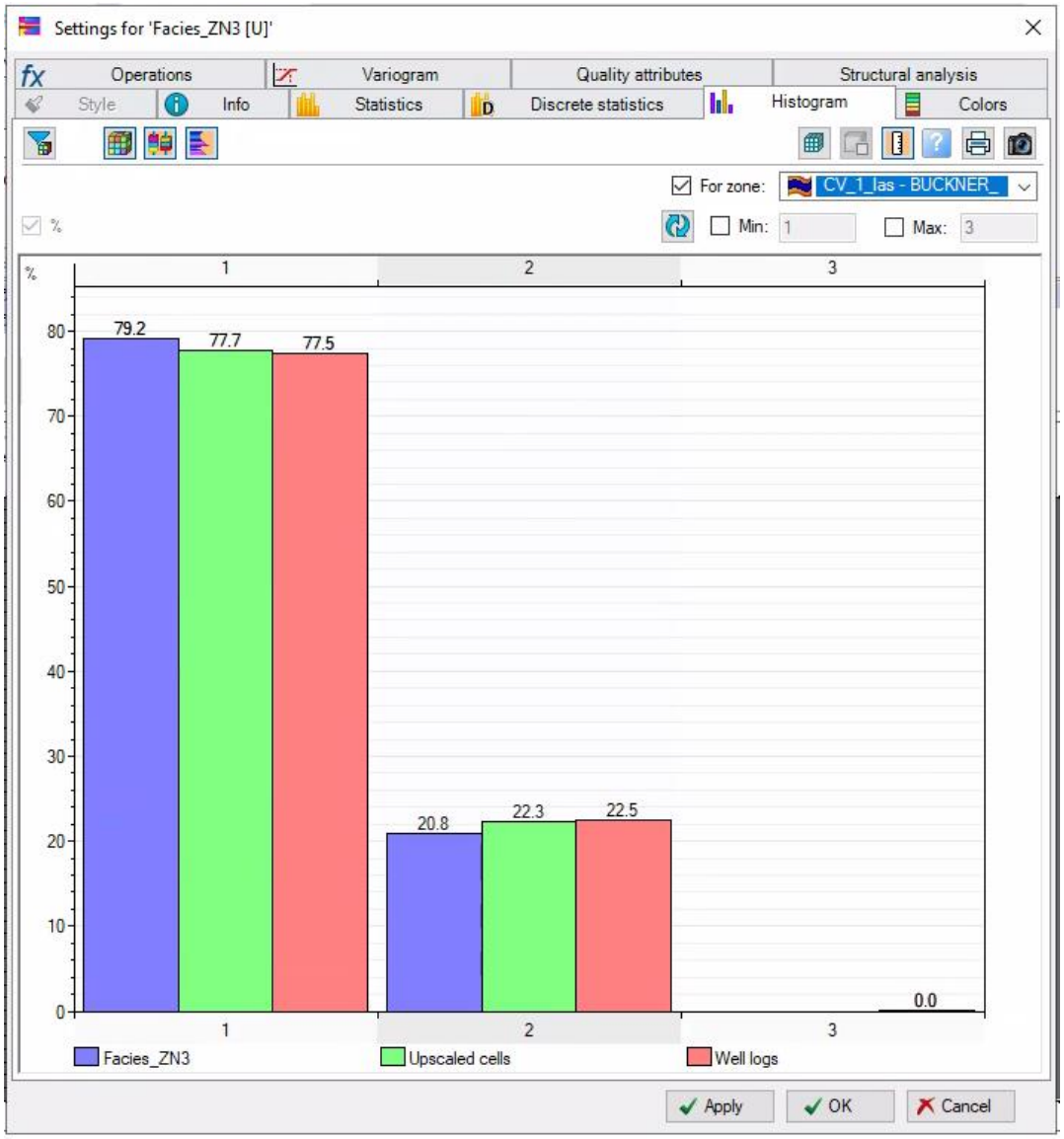


**Figure 7: Histogram of data for Well Logs, Upscaled Cells and Modeled Property over the CV1 interval.**

| TYPE | SAND | SHALE |
|---|---|---|
| Modeled Property | 79.2 | 20.8 |
| Upscaled Cells | 77.7 | 22.3 |
| Well Logs | 77.5 | 22.5 |

**Table 7: Table of data for Well Logs, Upscaled Cells and Modeled Property over the CV1 interval.**

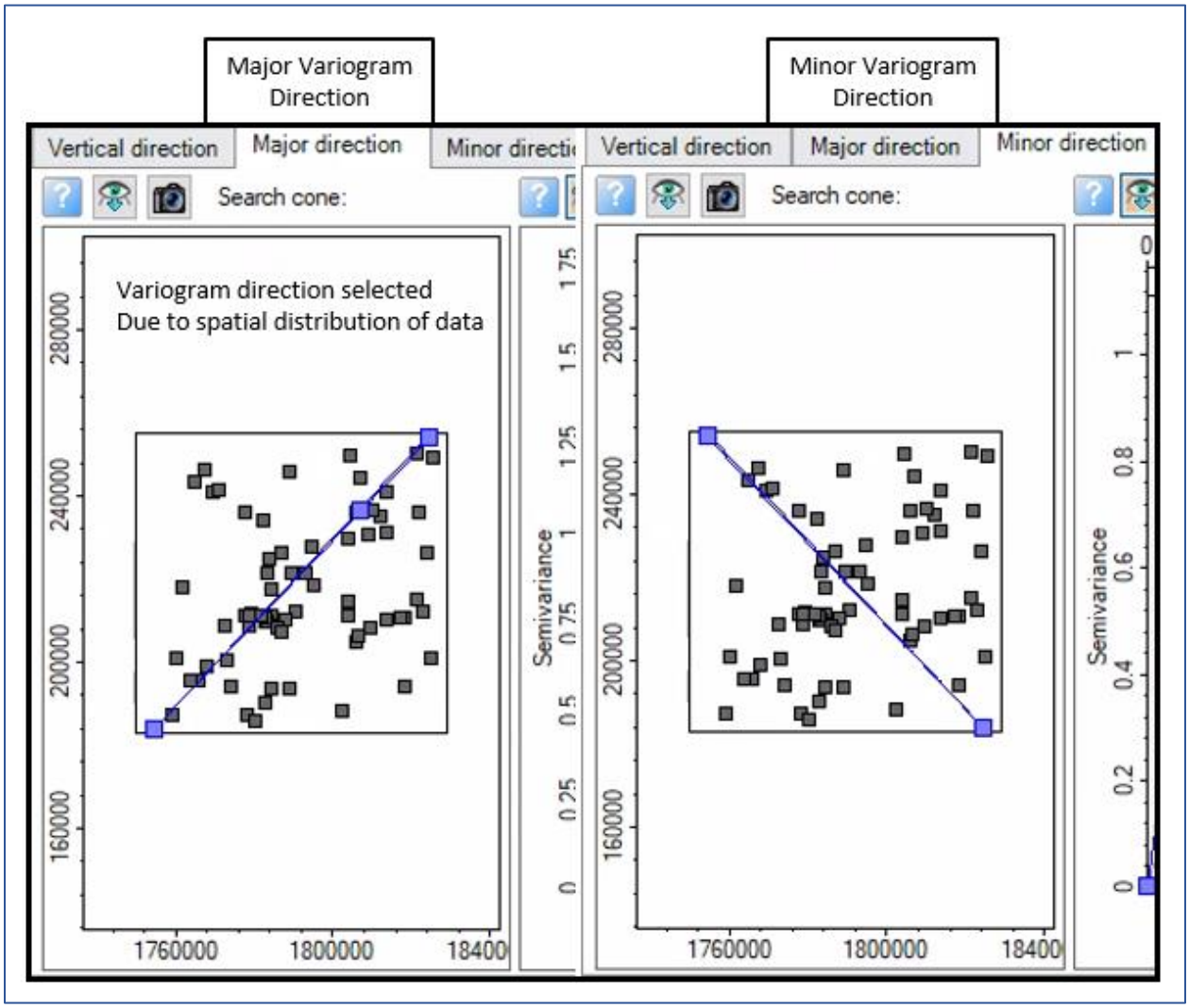


**Figure 8: Settings for major and minor direction for variogram analysis based upon spatial distribution of well data.**

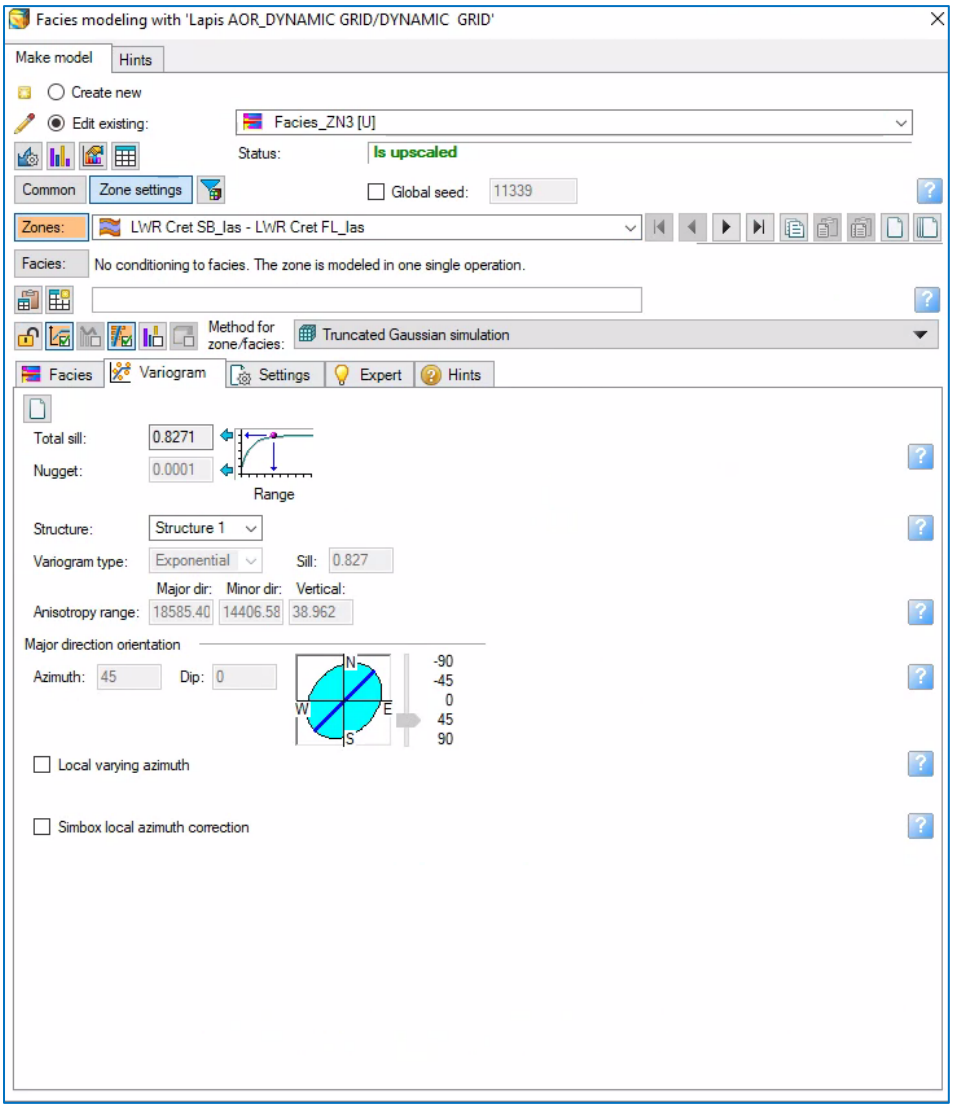


**Figure 9: Variogram settings for facies distribution for the LCSB Confining Zone**

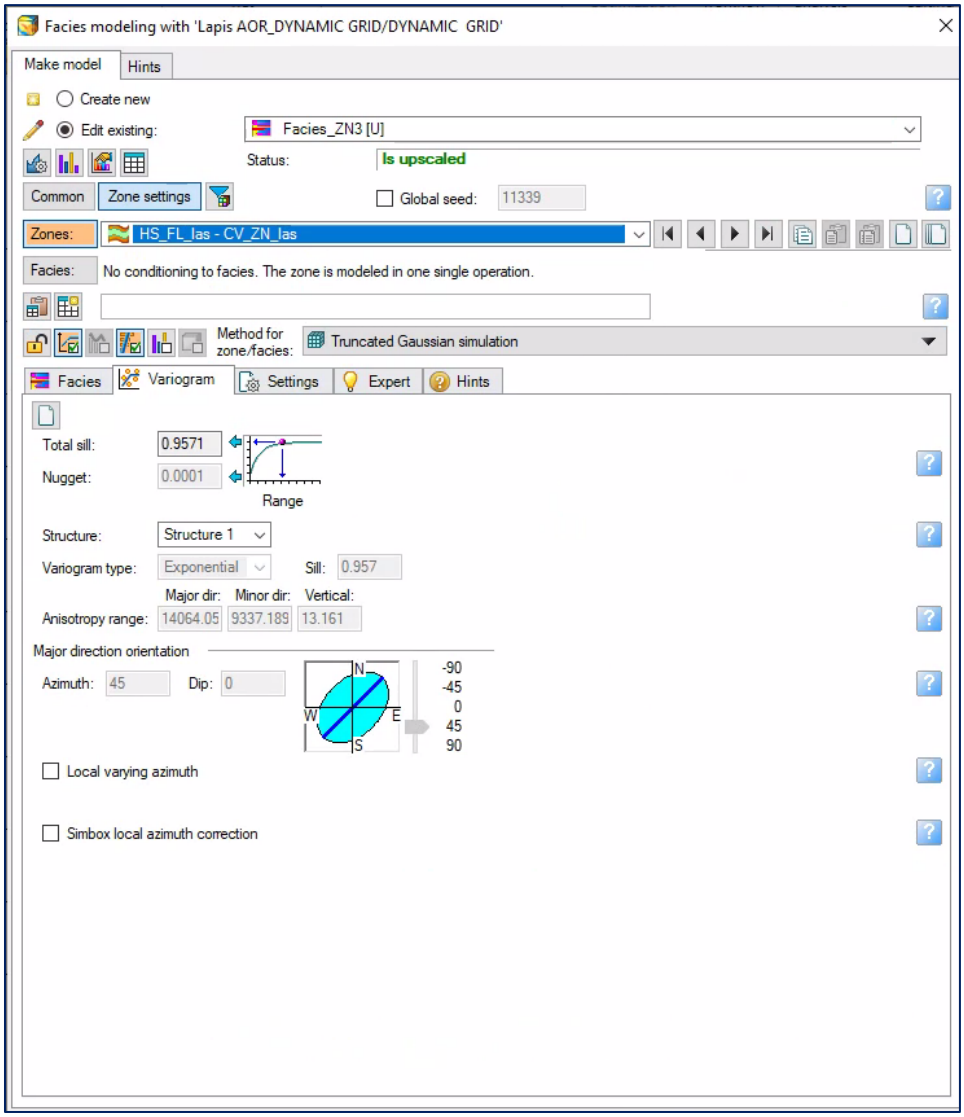


**Figure 10: Variogram settings for facies distribution for the Lower Hosston Injection Zone**

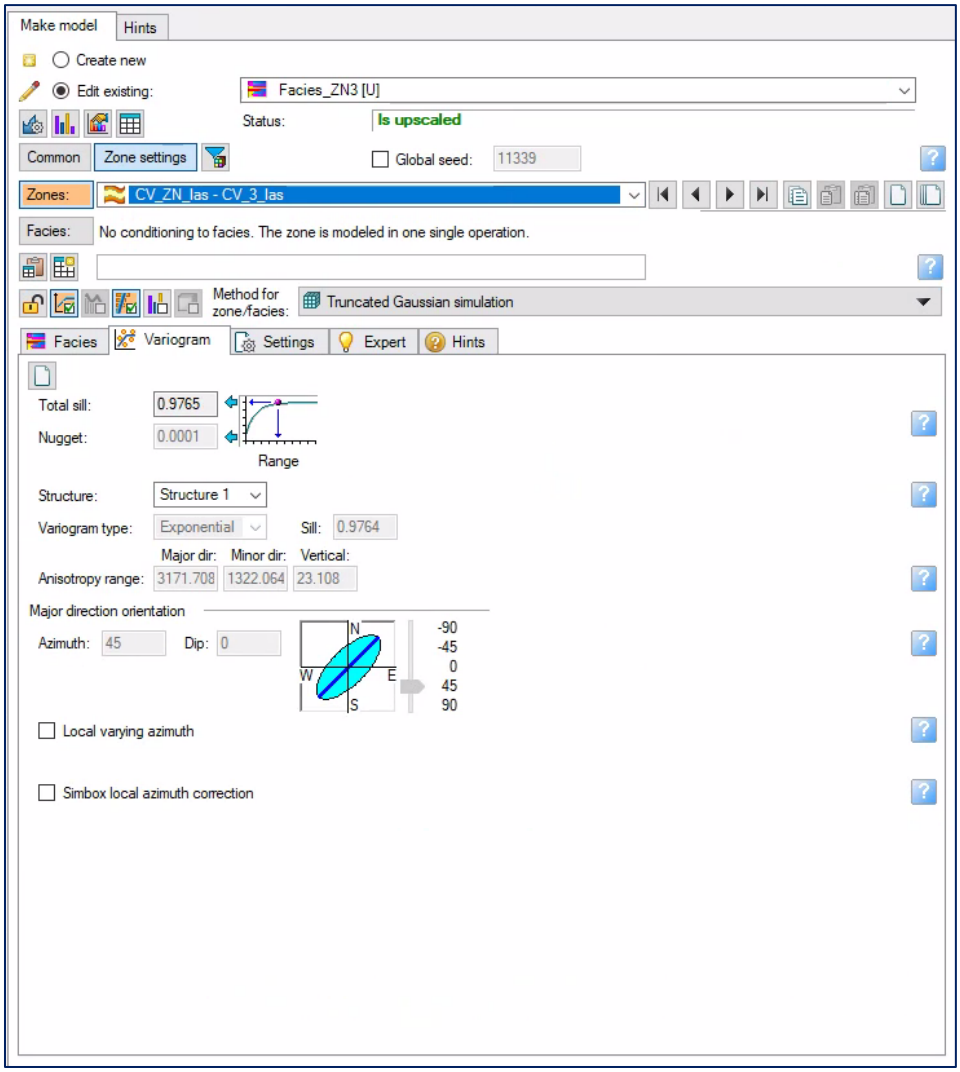


**Figure 11: Variogram settings for facies distribution for the Cotton Valley Injection Zone**

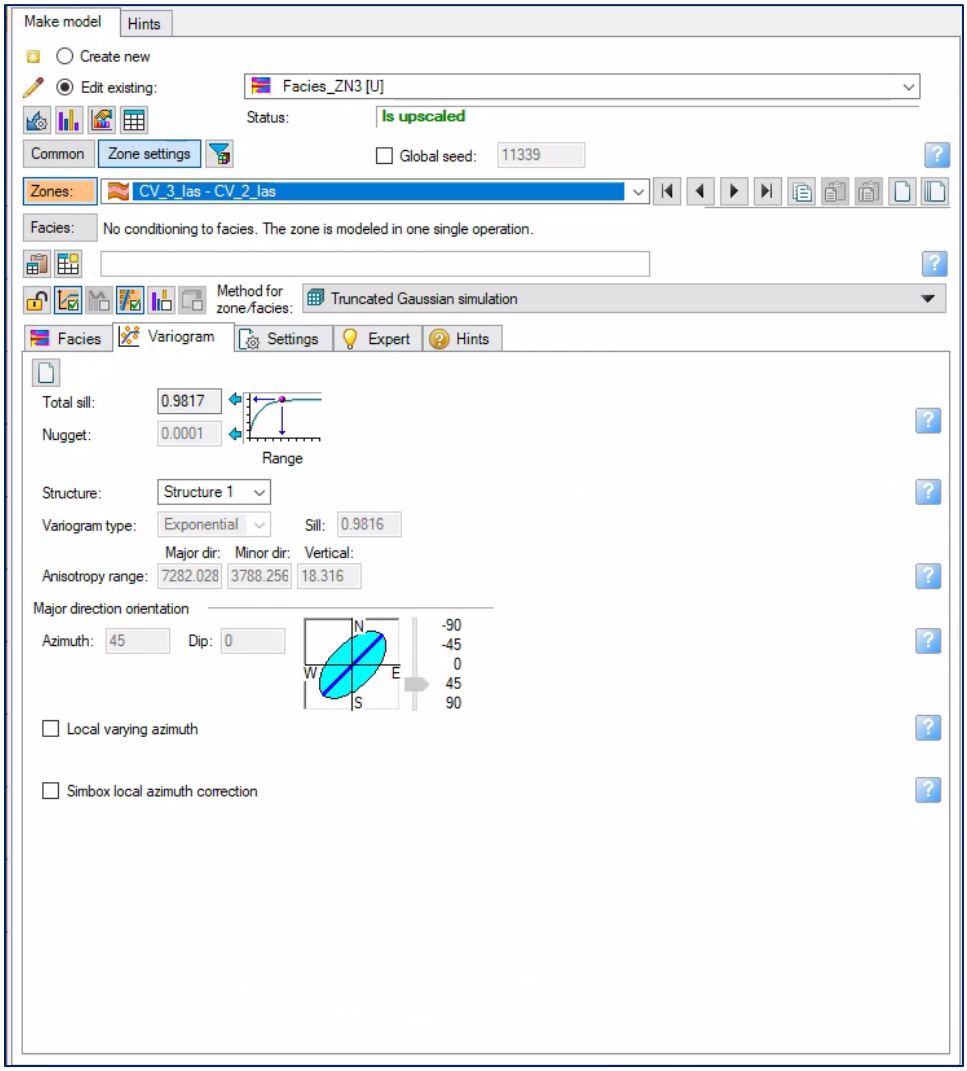


**Figure 12: Variogram settings for facies distribution for the CV3 interval**

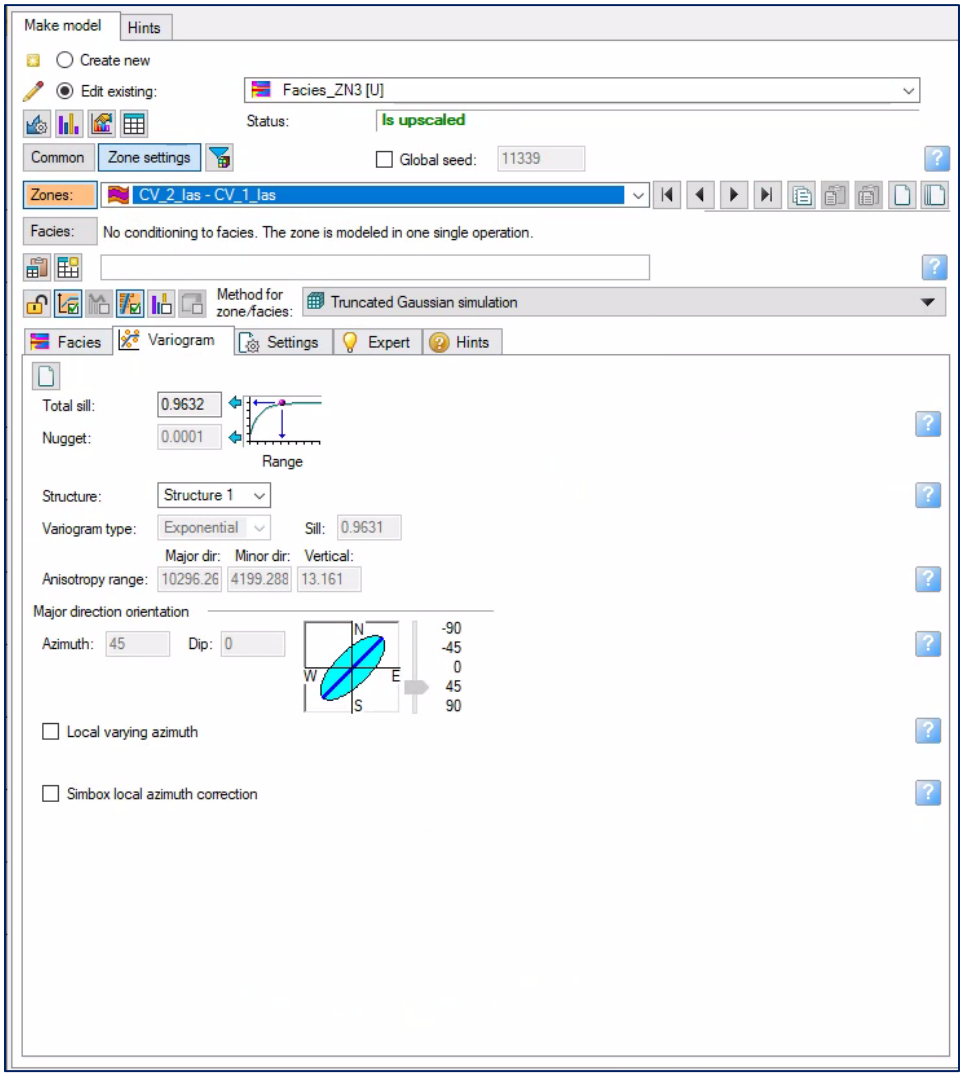


**Figure 13: Variogram settings for facies distribution for the CV2 interval**

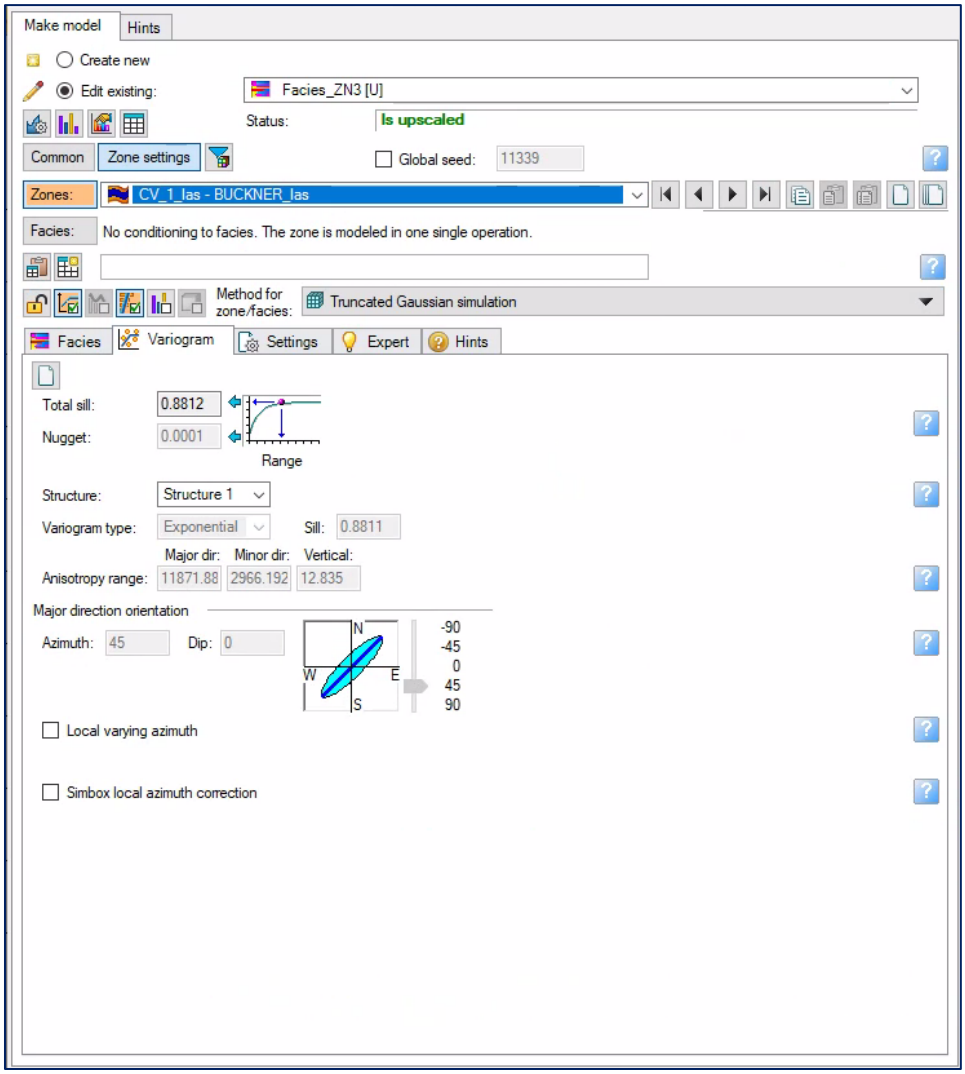


**Figure 14: Variogram settings for facies distribution for the CV1 interval**

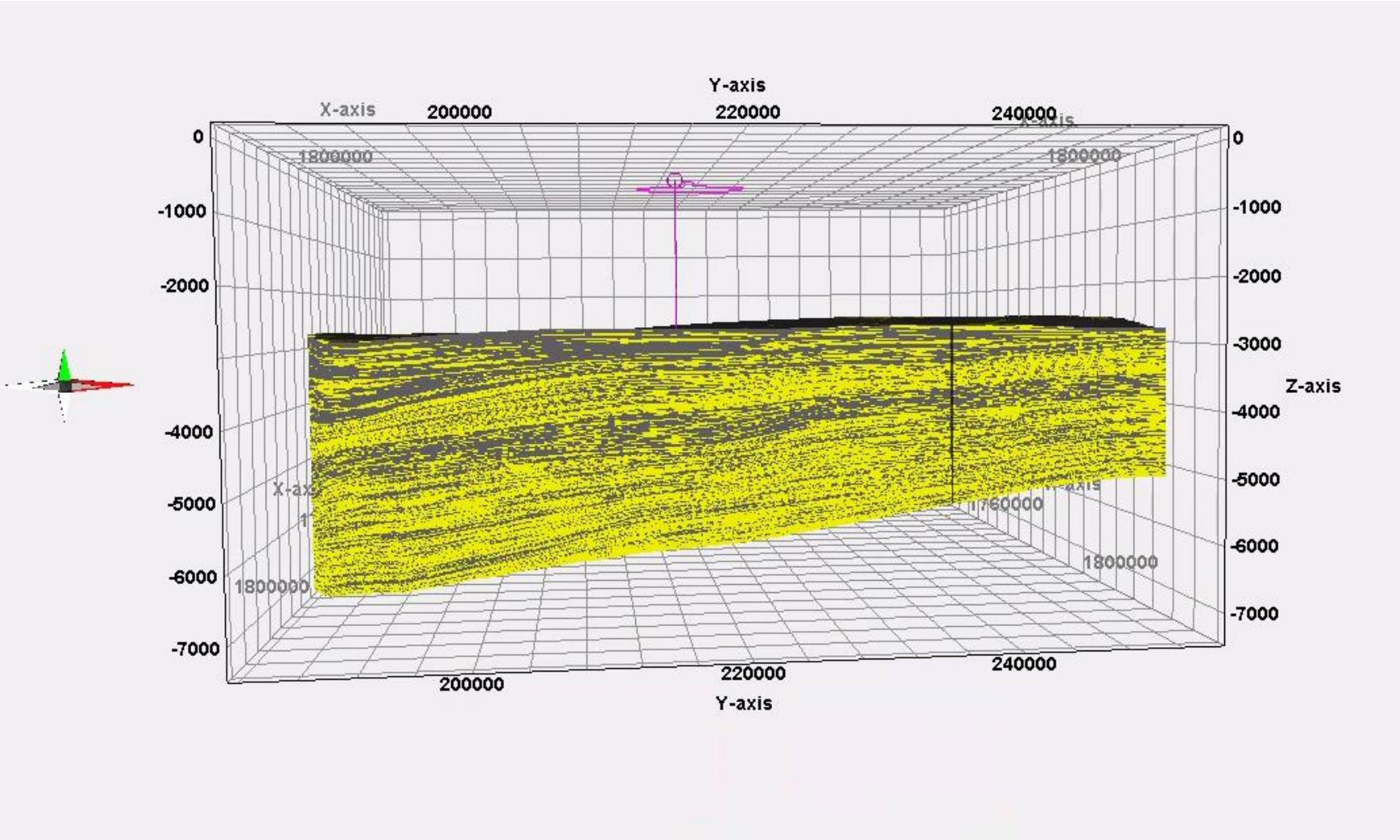


**Figure 15: 3D property cube of facies distribution at the Project Blue CCS Site looking West. Model is displayed with 5x vertical exaggeration. The facies are color coded as follows. Yellow is Sand; Gray is Shale.**

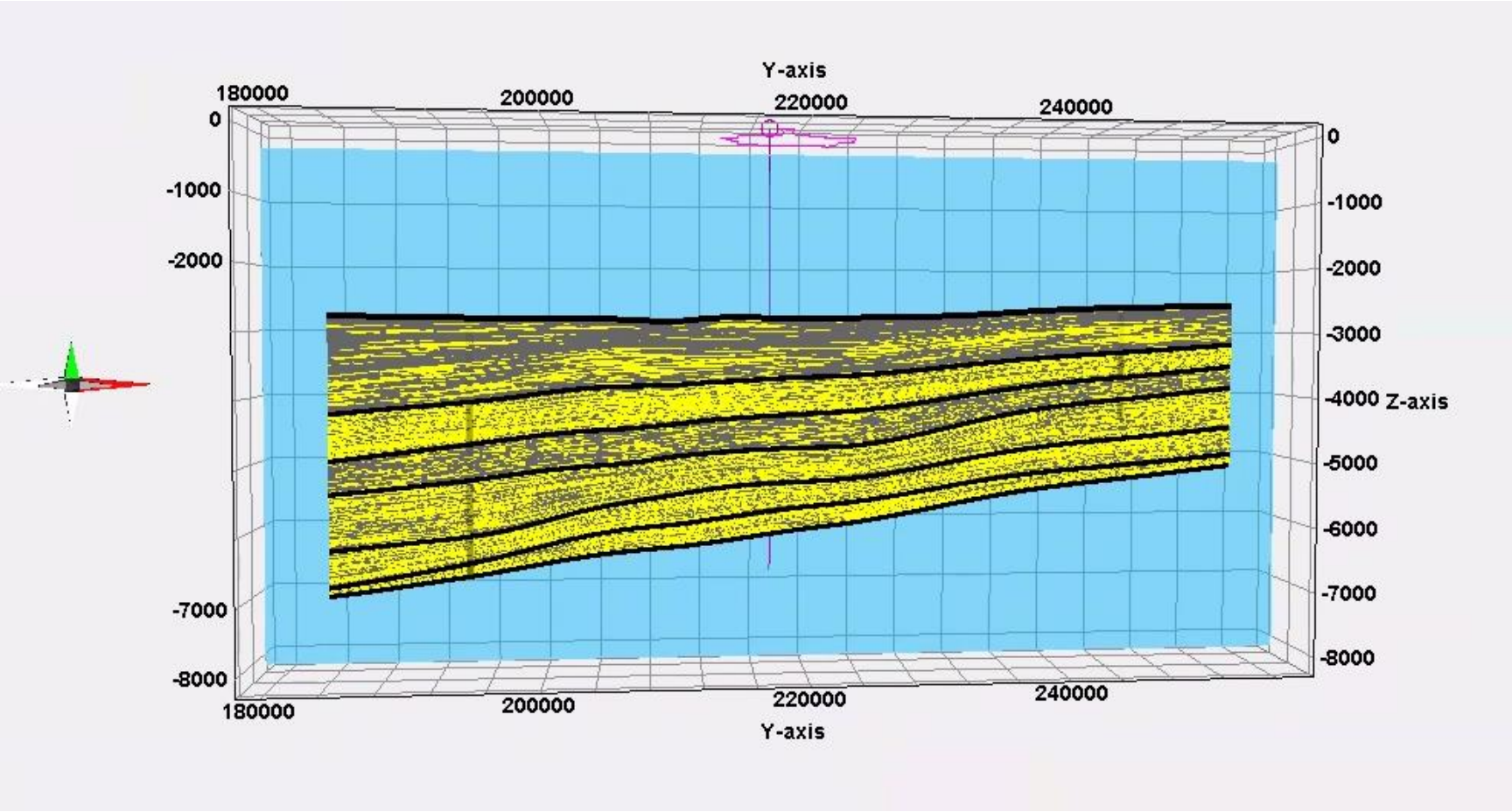


**Figure 16: N-S intersection plane view of facies cube at the Project Blue CCS Site looking West. Model is displayed with 5x vertical exaggeration. The facies are color coded as follows. Yellow is Sand; Gray is Shale.**

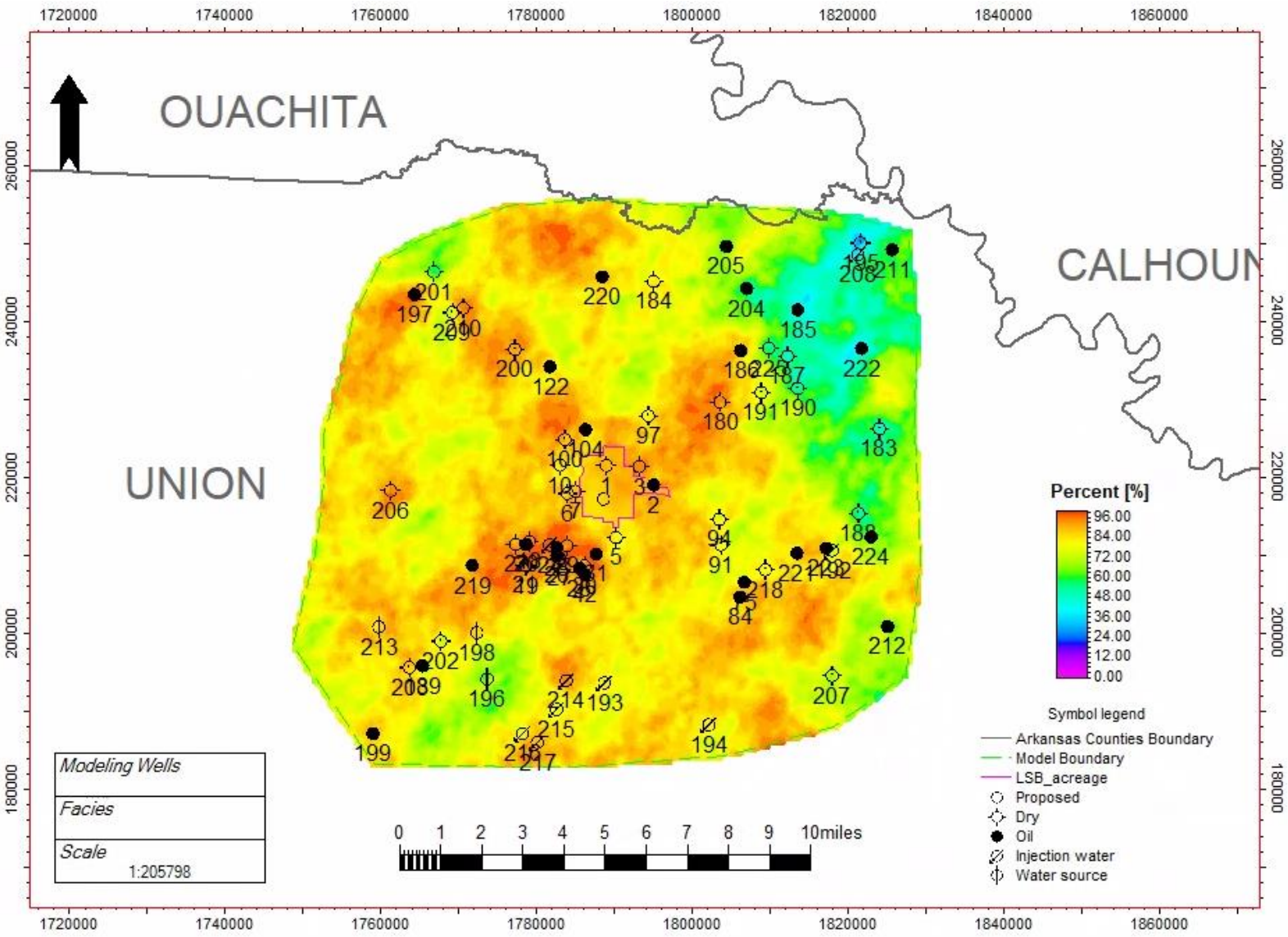


**Figure 17: Shale distribution map for the LCSB Confining Zone**

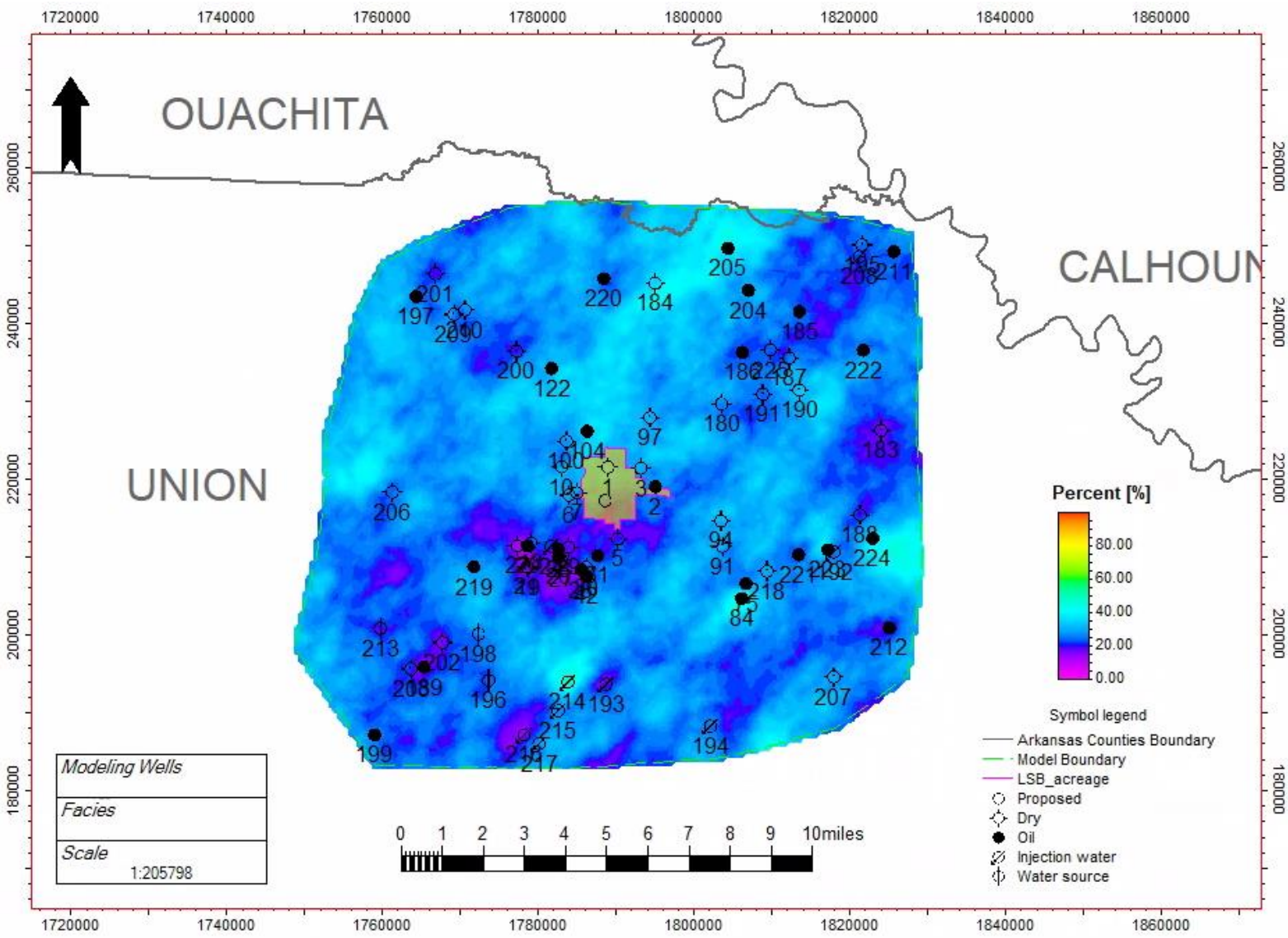


**Figure 18: Shale distribution map for the Lower Hosston Injection Zone**

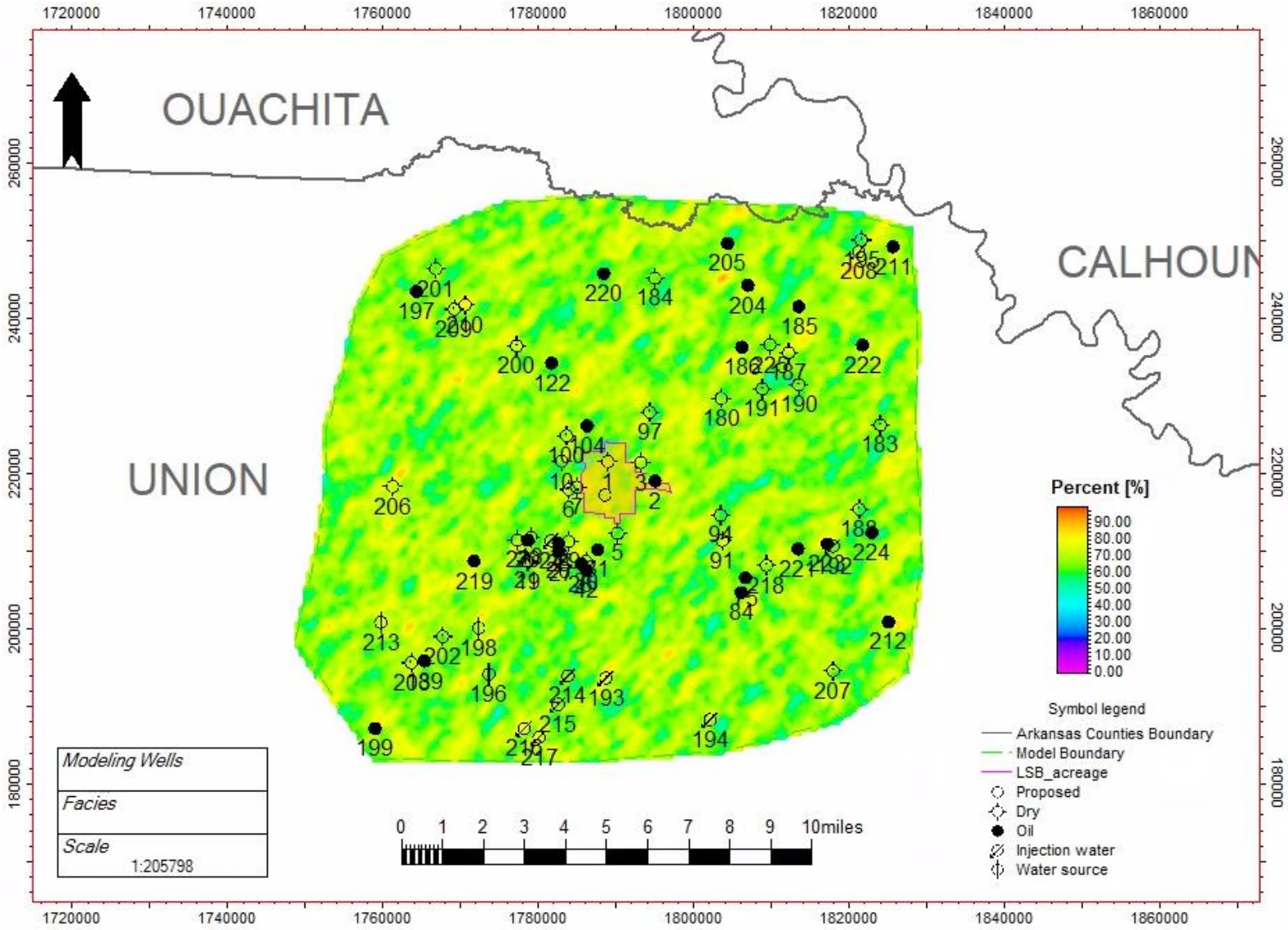


**Figure 19: Shale distribution map for the Cotton Valley Injection Zone**

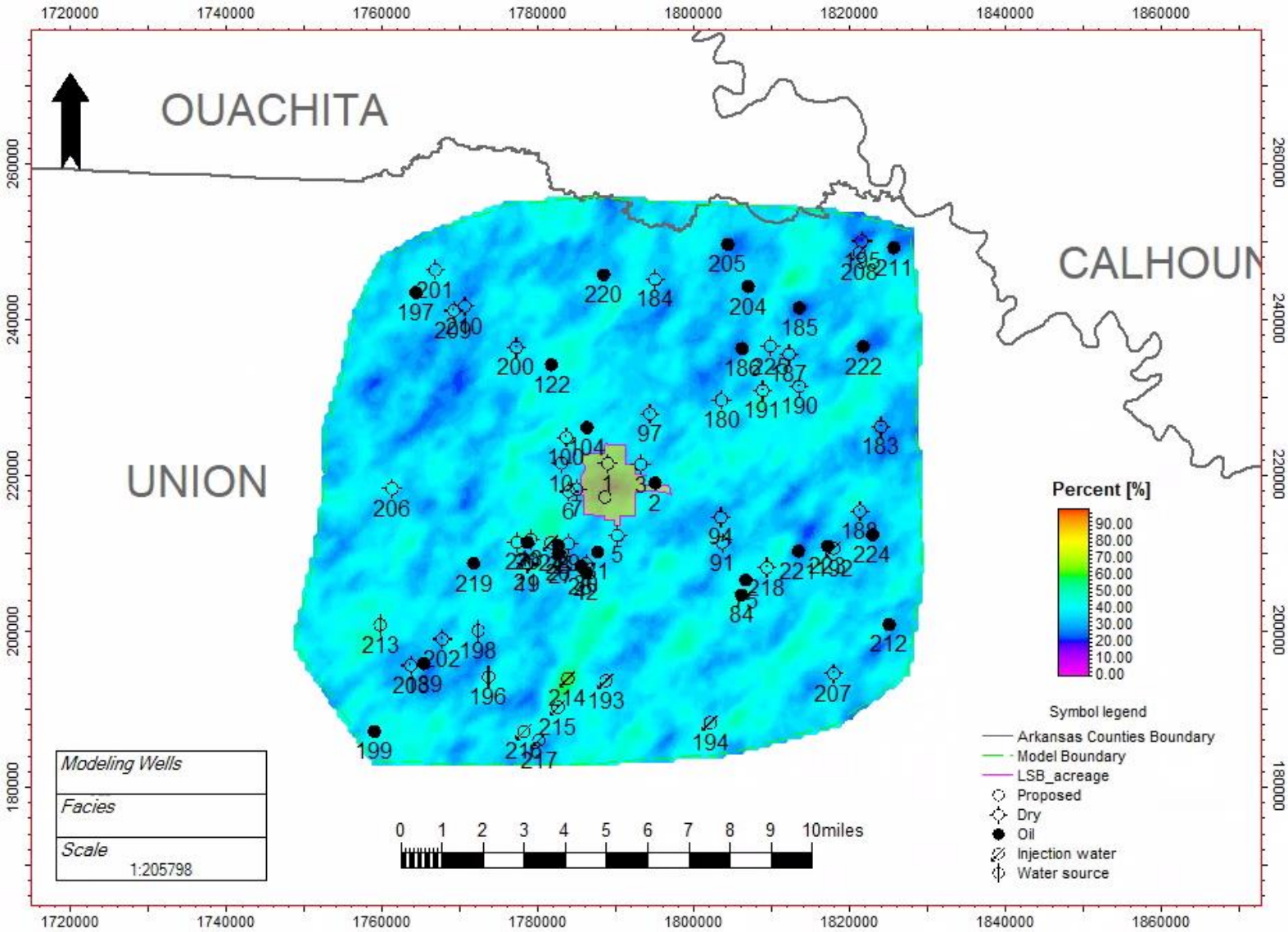


**Figure 20: Shale distribution map for the CV3 interval**

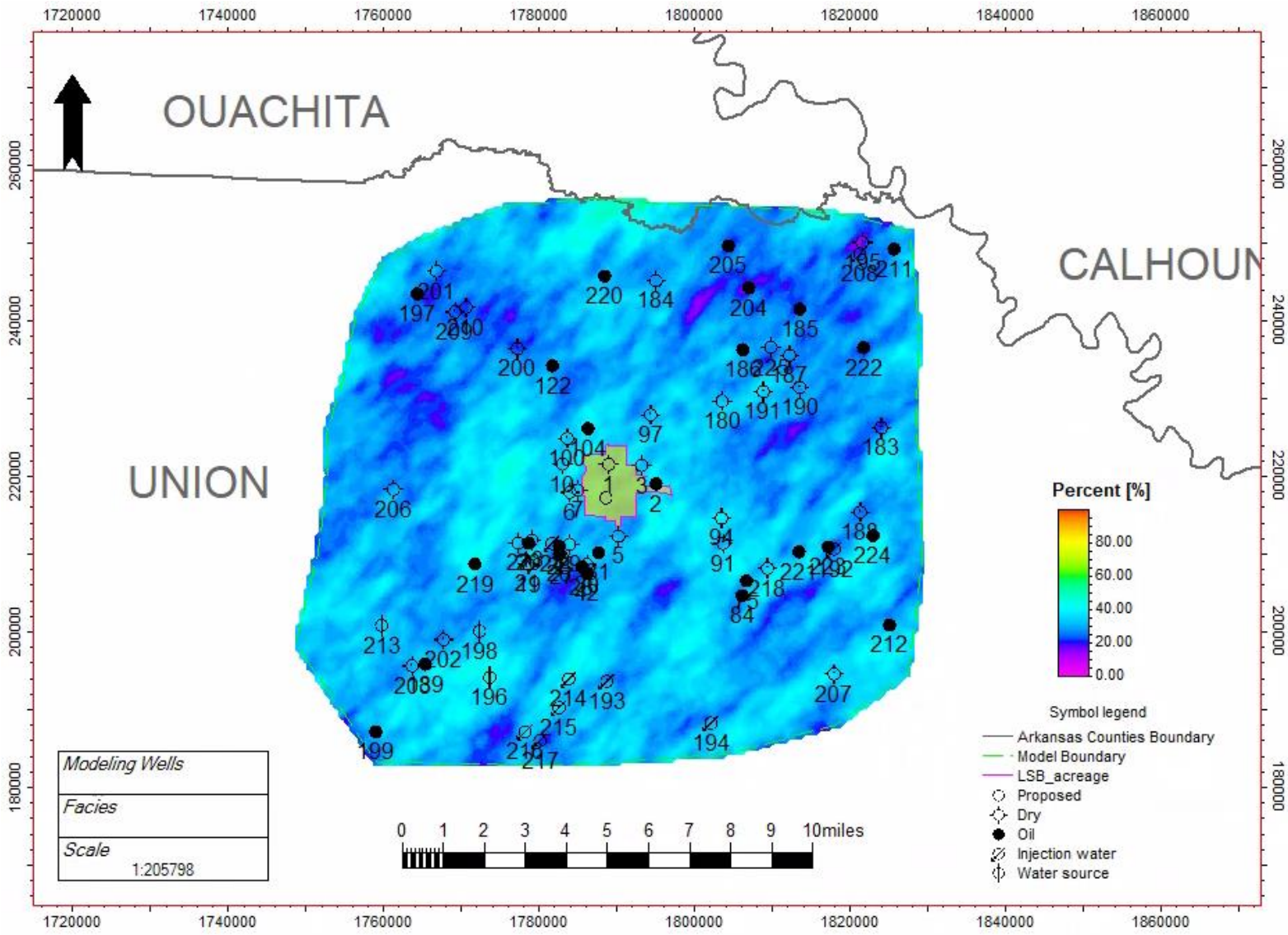


**Figure 21: Shale distribution map for the CV2 interval**

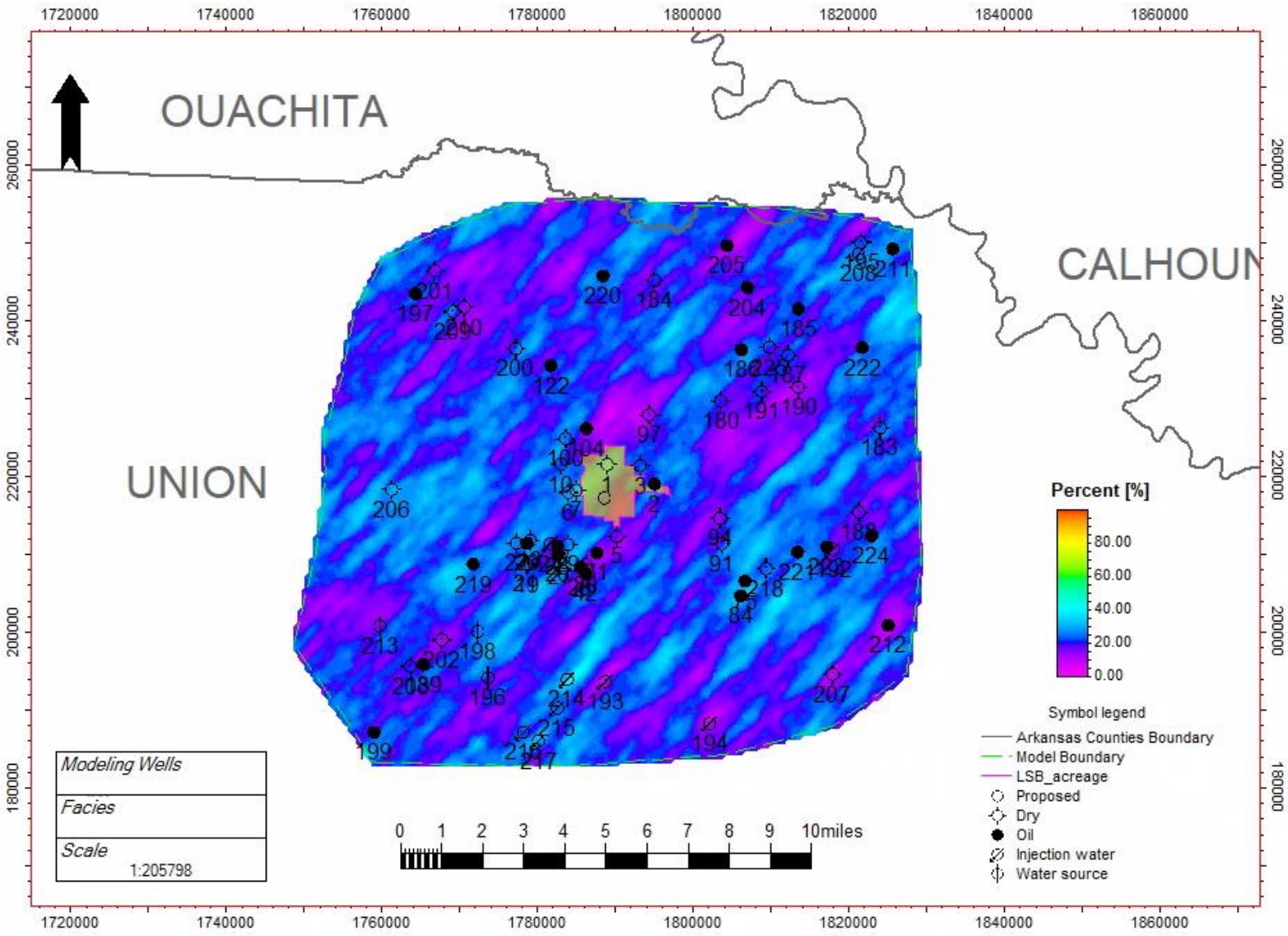


**Figure 22: Shale distribution map for the CV1 interval**

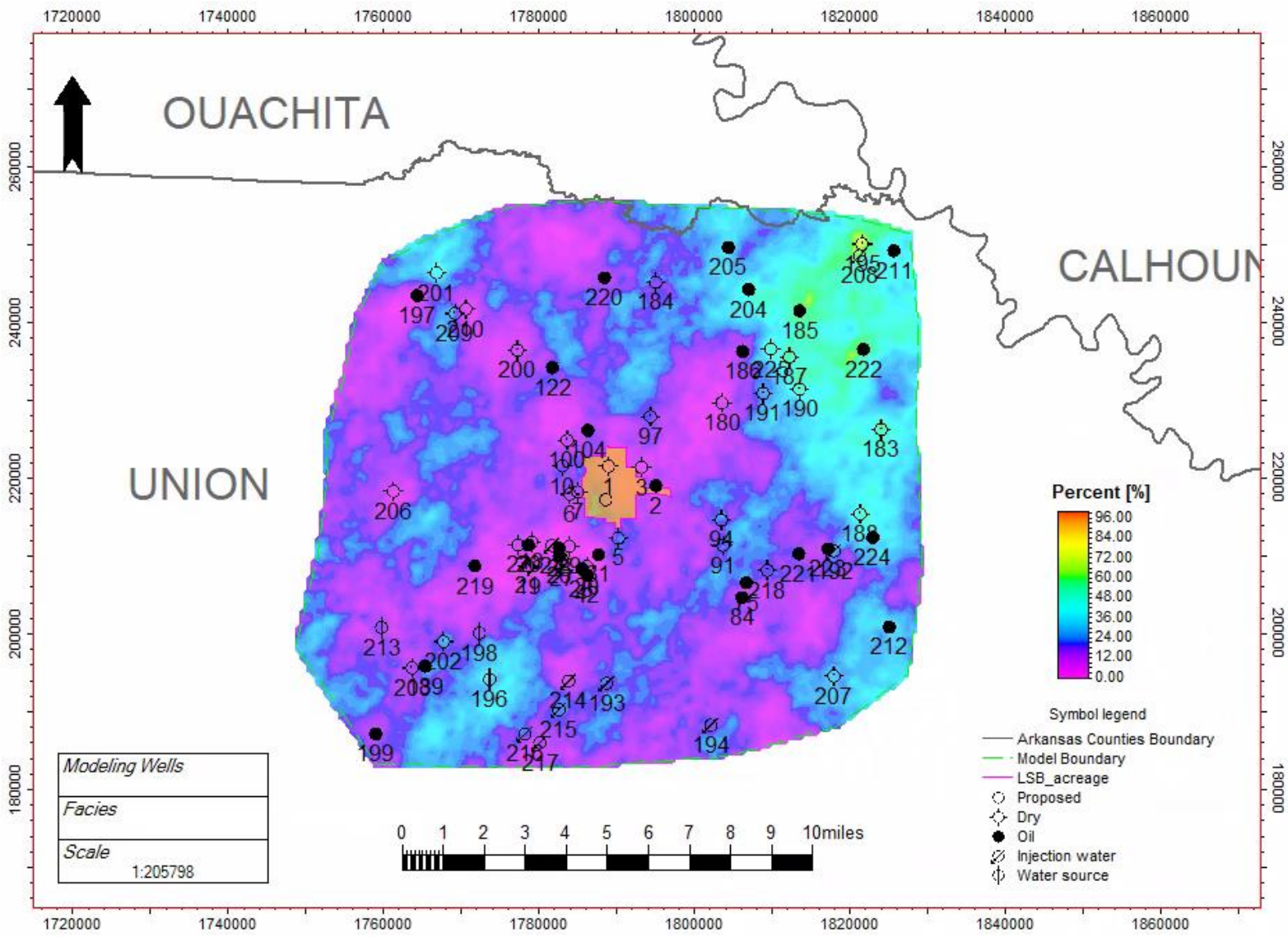


**Figure 23: Sand distribution map for the LCSB Confining Zone**

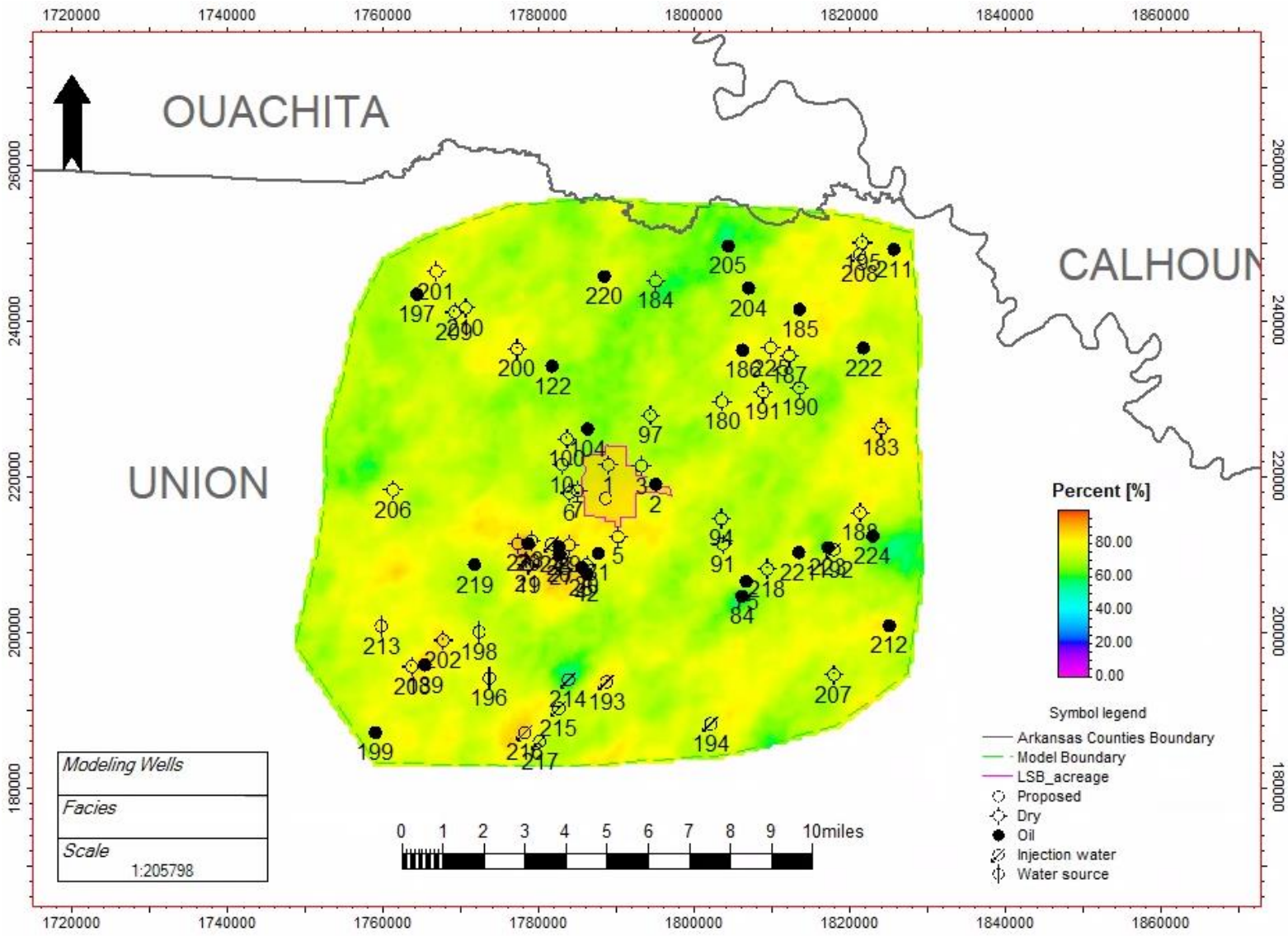


**Figure 24: Sand distribution map for the Lower Hosston Injection Zone**

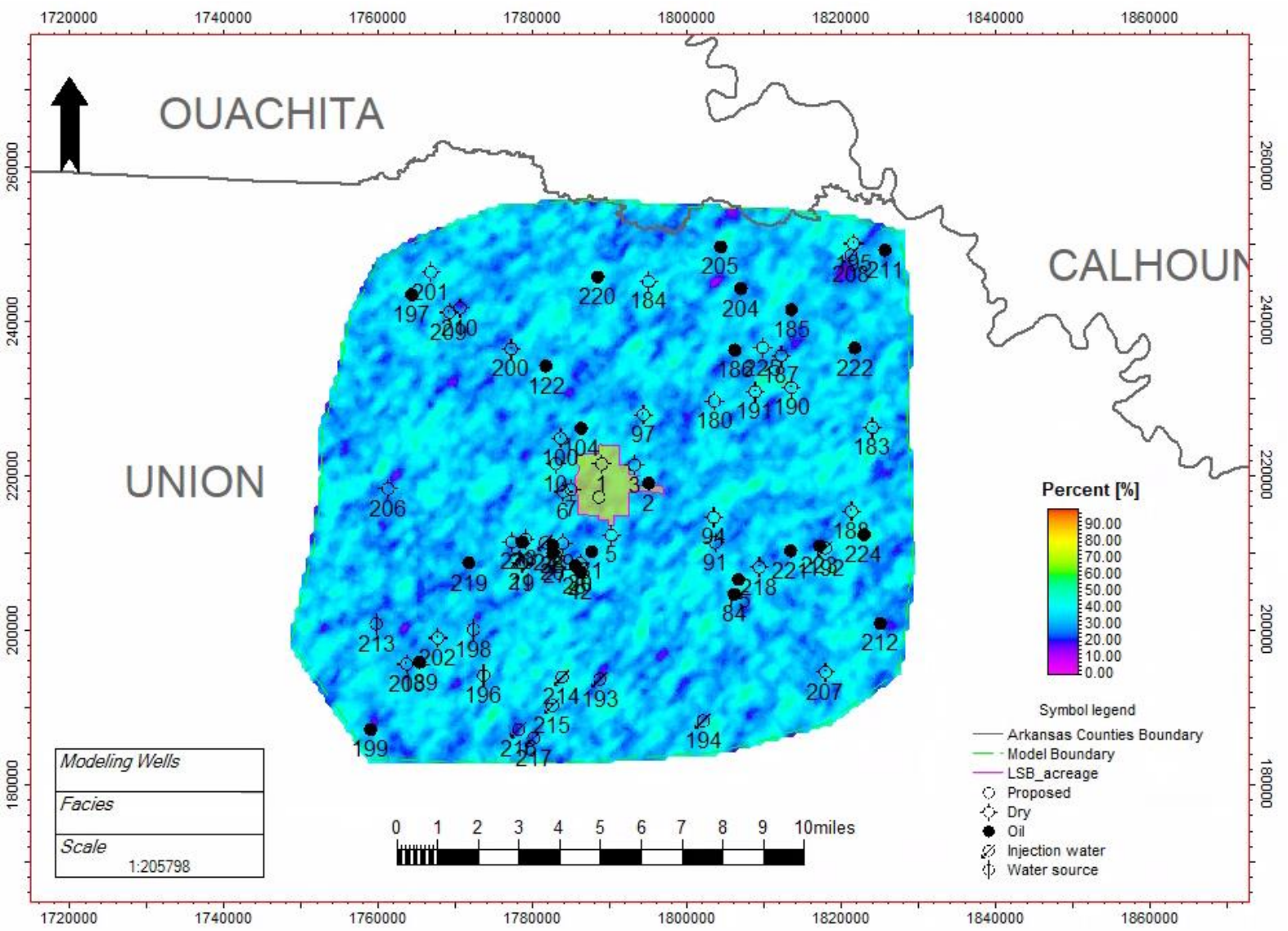


**Figure 25: Sand distribution map for the Cotton Valley Injection Zone**

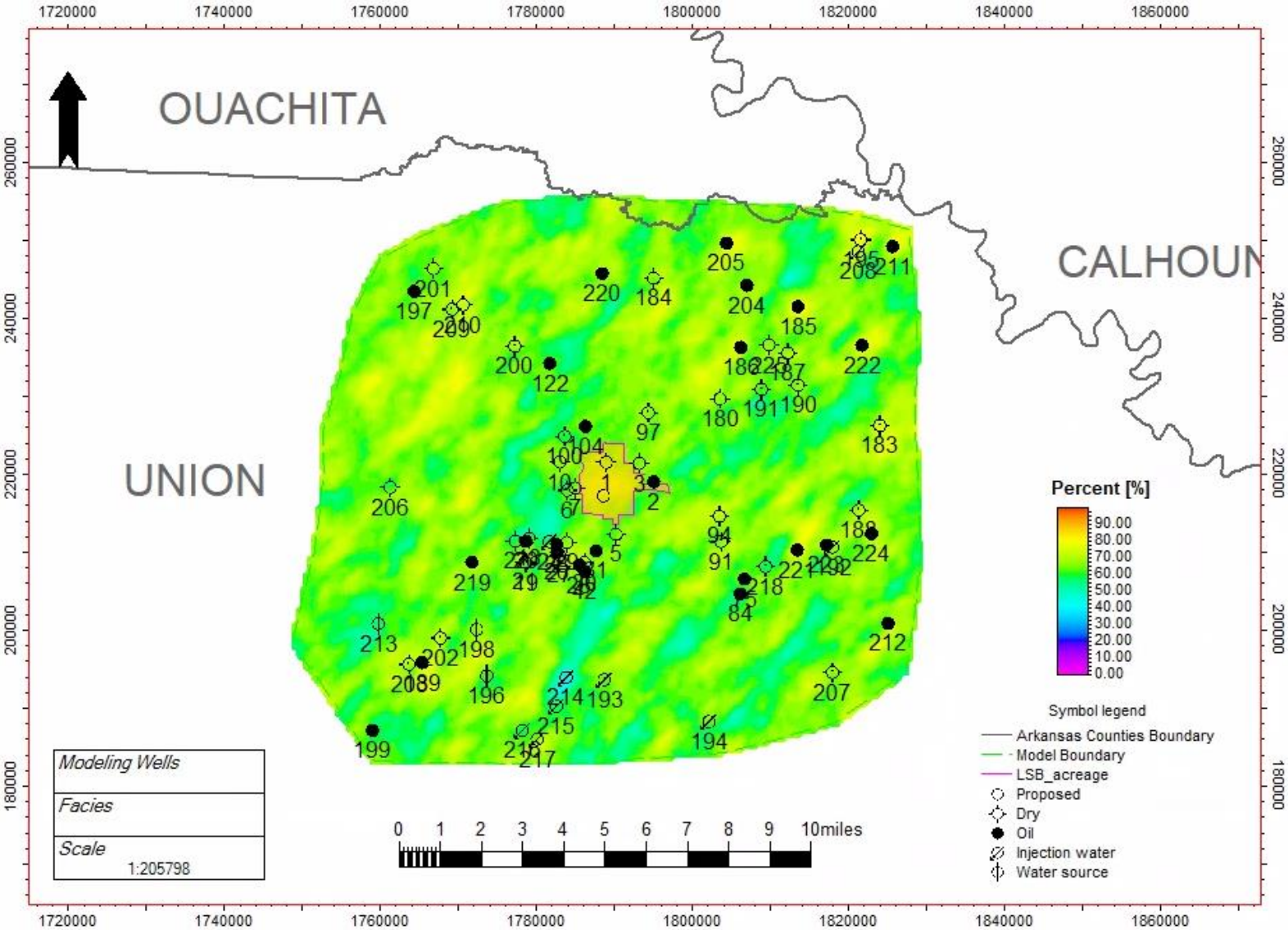


**Figure 26: Sand distribution map for the CV3 interval**

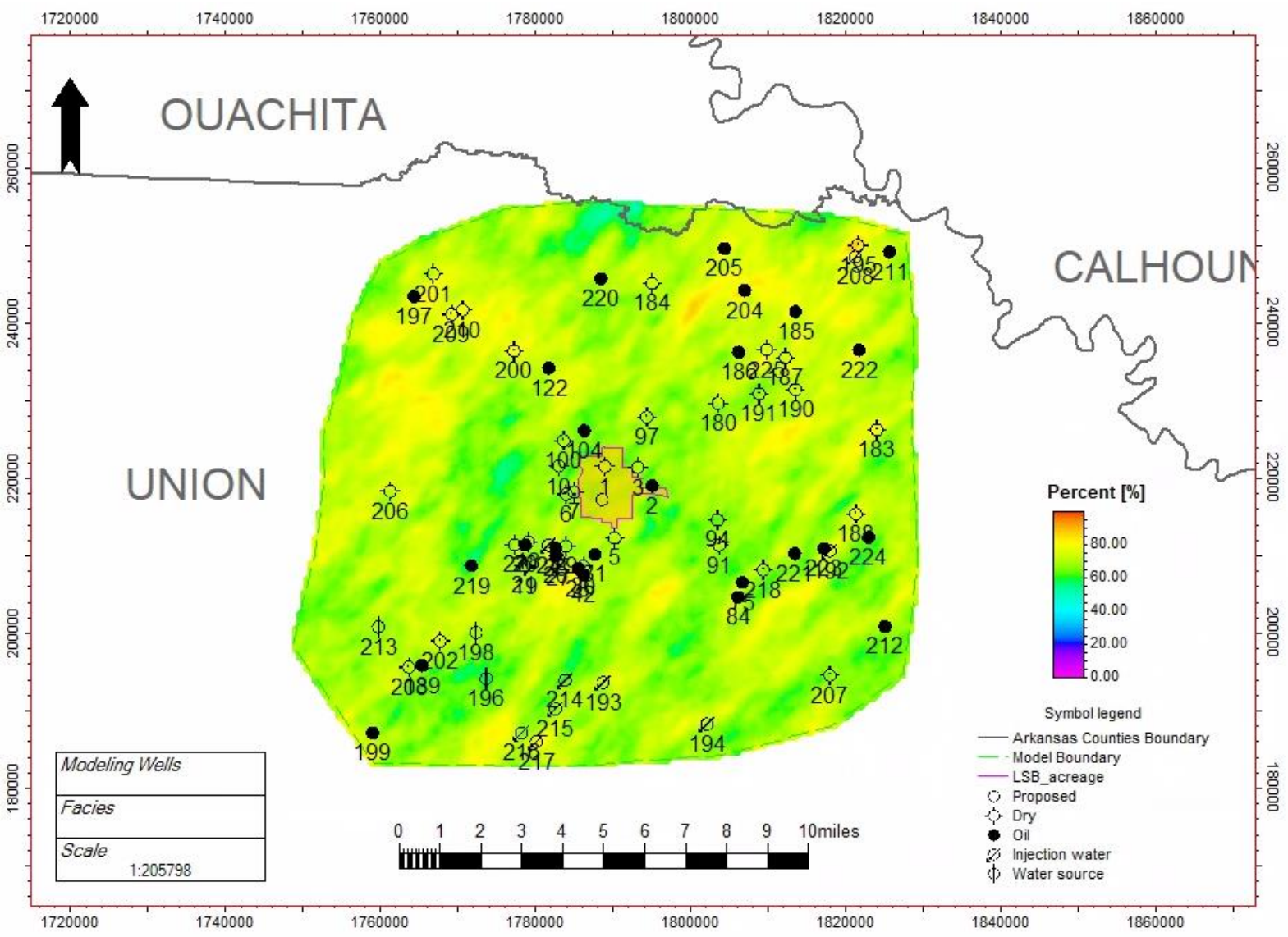


**Figure 27: Sand distribution map for the CV2 interval**

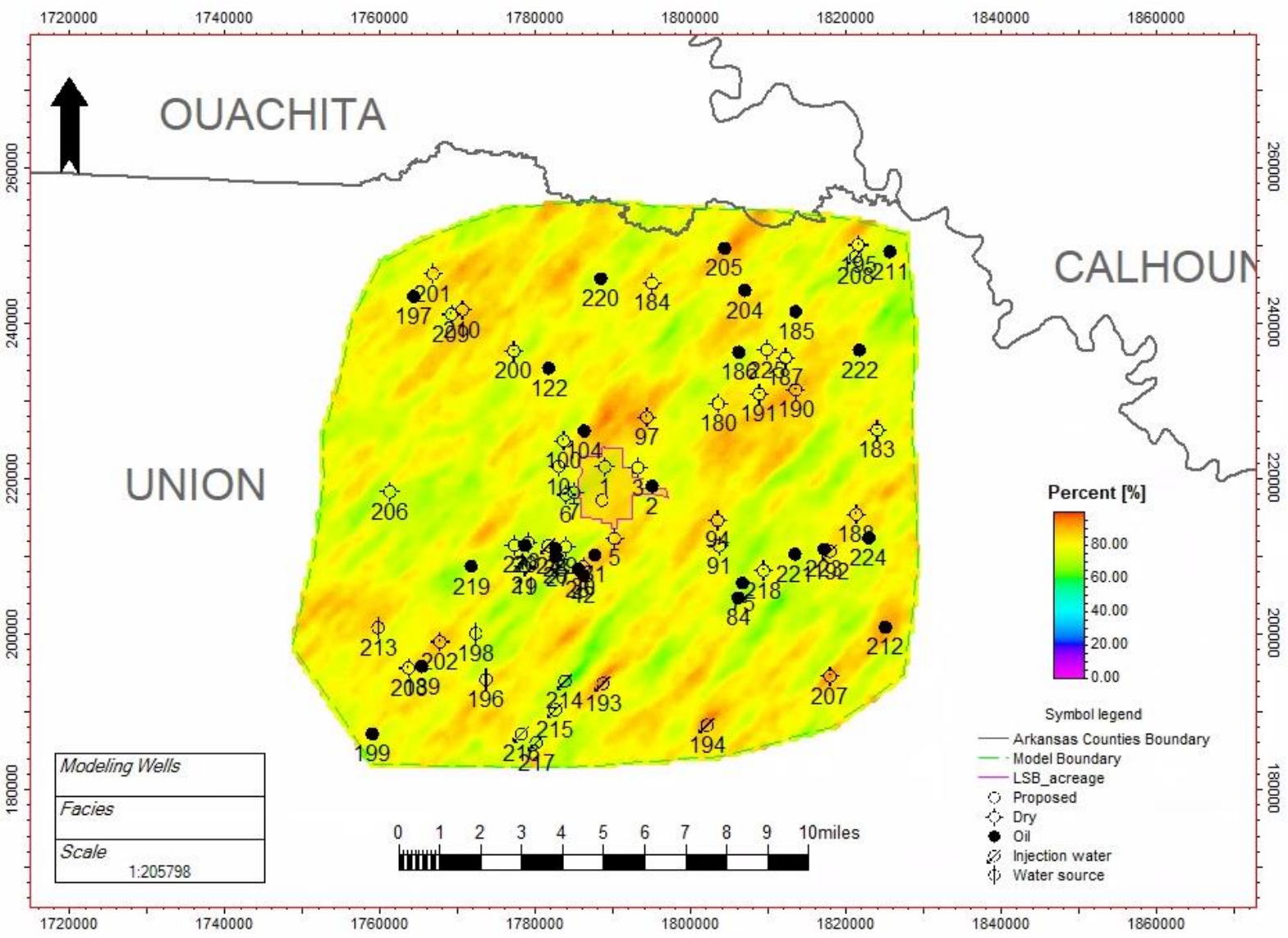


**Figure 28: Sand distribution map for the CV1 interval**