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| **Table 1.**  Mean blood serum levels for each herd | | | | | | | |
| Mineral | Normal Range1 | Herd | | | | SEM | P-value |
| 1 | 2 | 3 | 4 |
| Cobalt, ng/mL | > 0.1 | 0.19a | 0.21a | 0.79b | 0.47a | 0.06 | 0.04 |
| Copper, ug/mL | 0.6-0.8 | 0.61a | 0.51b | 0.67a | 0.57b | 0.04 | 0.03 |
| Iron, ug/dL | 110-180 | 124.50a | 148.88ab | 158.22ab | 162.10b | 13.22 | 0.05 |
| Manganese, ng/mL | 1.5-2.5 | 5.05 | 2.89 | 6.17 | 0.67 | 1.77 | 0.08 |
| Molybdenum, ng/mL | 4-100 | 23.32b | 31.59c | 6.52a | 12.44a | 2.13 | 0.05 |
| Selenium, ng/mL | 0.07-0.1 | 101.50a | 127.00b | 107.56a | 125.00b | 3.49 | < 0.01 |
| Zinc, ug/mL | 0.9-2.0 | 0.73a | 0.94b | 0.93b | 0.86b | 0.04 | 0.03 |
| 1Normal ranges are based on MSU-DCPA. Levels are determined to be adequate if within listed ranges.  2Mineral levels represented for each herd are averaged values for each herd.  a,b,cMeans differ within herd (*P* < 0.05). | | | | | | | |

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| **Table 2.** Mineral composition of feed samples1 | | | | | |
|  | Mineral Requirements2 | Rec. Maximum Levels3 | Herd | | |
| Mineral |  |  | 1 | 3 | 4 |
| Aluminum | - | - | 51.5 | 681.8 | 824.4 |
| Antimony | - | - | < 5.0 | < 5.0 | < 5.0 |
| Arsenic | - | - | < 2.5 | < 2.5 | < 2.5 |
| Barium | - | - | 32.4 | 35.2 | 42.2 |
| Boron | - | - | 5.7 | 14.5 | 9.5 |
| Cadmium | - | - | < 0.3 | < 0.3 | < 0.3 |
| Calcium | - | - | 3436 | 14.5 | 3794 |
| Chromium | - | 1,000.00 | < 1.0 | 4.9 | 1.4 |
| Cobalt | 0.15 | 25.00 | < 0.50 | 0.53 | < 0.50 |
| Copper | 10.00 | 40.00 | 4.2 | 20.5 | 6.1 |
| Iron | 50.00 | 500.00 | 225 | 965 | 917 |
| Lead | - | - | < 2.5 | < 2.5 | < 2.5 |
| Magnesium | 1,200-2,000 | 4,000 | 1583 | 3167 | 2276 |
| Manganese | 40.00 | 1,000.00 | 63.1 | 134.9 | 71.5 |
| Mercury | - | - | < 10.0 | < 10.0 | < 10.0 |
| Molybdenum | - | 5.0 | 3 | < 1.0 | 1 |
| Phosphorus | - | - | 1928 | 2747 | 1685 |
| Potassium | 600-700 | 20,000 | 22714 | 12684 | 16051 |
| Selenium4 | 0.10 | 5.00 | < 10.0 | < 10.0 | < 10.0 |
| Sodium | 600-1,000 | - | < 50 | 787 | 463 |
| Sulfur | 1,500 | 3,000-5,000 | 1095 | 2210 | 1568 |
| Thallium | - | - | < 12.5 | < 12.5 | < 12.5 |
| Zinc | 30.00 | 500.00 | 10.5 | 53.2 | 20.7 |
| 1Mineral results are reported as ppm  2, 3Adapted from National Research Council (NRC). Nutrient requirements of beef cattle. 8th (revised) edition. Washington, DC. National Academy Press. 2016. p. 110.  4Labrotory sensitivity not adequate to detect differences in feed samples | | | | | |

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| **Table 3.** Mineral composition of water samples1 | | | | | | |
|  |  | Herd | | | | |
| Mineral | Rec. Maximum Levels2 | 1a | 1b | 2a | 3 | 4 | |
| Aluminum | < 5.0 | < 0.05 | < 0.05 | 0.31 | 0.53 | < 0.25 | |
| Antimony | - | < 0.006 | < 0.006 | < 0.25 | < 0.25 | < 0.25 | |
| Arsenic | < 0.05-0.2 | < 0.10 | < 0.10 | < 0.25 | < 0.25 | < 0.25 | |
| Barium | < 1.0 | < 2.0 | < 2.0 | 0.053 | 0.356 | < 0.025 | |
| Boron | < 5.0-3.0 | . | . | 0.33 | 0.06 | 0.36 | |
| Cadmium | < 0.05 | < 0.005 | < 0.005 | < 0.025 | < 0.025 | < 0.025 | |
| Calcium | < 1,000 | . | . | 73.34 | 131.08 | 68.49 | |
| Chromium | < 0.1 | < 0.10 | < 0.10 | < 0.05 | < 0.05 | < 0.05 | |
| Cobalt | < 0.1 | . | . | < 0.025 | < 0.025 | < 0.025 | |
| Copper | < 0.5 | < 1.3 | < 1.3 | < 0.025 | 0.031 | < 0.025 | |
| Iron | < 0.4 | < 0.30 | < 0.30 | 0.4246 | 1.404 | 3.429 | |
| Lead | < 0.05-0.1 | < 0.015 | < 0.015 | < 0.10 | < 0.10 | < 0.10 | |
| Magnesium | < 90-250 | . | . | 49.072 | 36.457 | 30.109 | |
| Manganese | < 0.05 | < 0.05 | < 0.085 | 0.141 | 0.716 | 0.051 | |
| Mercury | < 0.003-0.01 | < 0.002 | < 0.002 | < 0.50 | < 0.50 | < 0.50 | |
| Molybdenum | < 0.06 | . | . | < 0.10 | < 0.10 | < 0.10 | |
| Phosphorus | < 0.7 | < 10.0 | < 10.0 | 0.64 | < 0.50 | < 0.50 | |
| Potassium | < 20 | . | . | 17.2 | 4.8 | 8.7 | |
| Selenium3 | < 0.01-0.05 | < 0.050 | < 0.050 | < 0.50 | < 0.50 | < 0.50 | |
| Sodium | < 150-800 | 69.41 | 47.23 | 470.1 | 16.00 | 628.8 | |
| Sulfur | < 500 | < 250.0 | < 250.0 | 253.0 | 78.4 | 271.2 | |
| Thallium | 0.002 | < 0.002 | < 0.002 | < 0.50 | < 0.50 | < 0.50 | |
| Zinc | < 5.0-25 | < 5.0 | < 5.0 | 0.086 | 0.29 | 0.091 | |
| 1Mineral results are reported as mg/kg.  2Recommended maximum levels based on water quality- MSU-DCPAH.  3Labrotory sensitivity not adequate to detect differences in water samples. | | | | | | |