

A

A1. CBR test results

| Sample no | Bitumen content (%) | Moulding Density (kg/m ³) | Moulding Moisture content (%) | Swell (%) | CBR | | |
|-----------|---------------------|---------------------------------------|-------------------------------|-----------|---------|---------|---------|
| | | | | | 2.54 mm | 2.00 mm | 1.02 mm |
| 1009/01a | 0.6 | 1991 | 12.2 | 0.0 | 18.1 | 16.7 | 18.0 |
| 1009/01b | 0.6 | 1947 | 12.2 | 0.0 | 18.6 | 17.6 | 18.4 |
| 1009/01c | 0.6 | 1974 | 12.2 | 0.0 | 19.0 | 18.3 | 19.3 |
| 1009/01s | 1.0 | 1940 | 12.7 | 0.0 | 12.0 | 15.0 | 18.5 |
| 1009/01b | 1.8 | 1963 | 12.7 | 0.0 | 14.3 | 15.4 | 21.2 |
| 1009/01c | 1.8 | 1952 | 12.7 | 0.0 | 12.0 | 14.3 | 16.8 |
| 1109/01a | 3.0 | 1952 | 10.7 | 0.0 | 14.1 | 17.2 | 2.9 |
| 1109/01b | 3.0 | 1952 | 10.7 | 0.0 | 14.1 | 17.2 | 45.2 |
| 1109/01c | 3.0 | 1906 | 10.7 | 0.0 | 14.1 | 17.2 | 42.1 |

APPENDIX A. LABORATORY TEST RESULTS

A1. California Bearing Ratio (CBR)

A2 Unconfined compressive Strength (UCS)

A3. Indirect Tensile Strength (ITS)

A4. Flexural Beam Tests

A5 Static Triaxial Tests

A6 Dynamic Triaxial Tests

A1. CBR test results

| Sample no | Bitumen content (%) | Moulding Density (kg/m ³) | Moulding Moisture content (%) | Swell (%) | CBR | | |
|-----------|---------------------|---------------------------------------|-------------------------------|-----------|---------|---------|---------|
| | | | | | 2.54 mm | 2.05 mm | 7.62 mm |
| 10/09/01a | 0.6 | 1 991 | 12.2 | 0.0 | 12.1 | 16.7 | 19.0 |
| 10/09/01b | 0.6 | 1 947 | 12.2 | 0.0 | 16.6 | 17.6 | 18.4 |
| 10/09/01c | 0.6 | 1 974 | 12.2 | 0.0 | 13.0 | 16.3 | 19.3 |
| 4/09/01a | 1.8 | 1 940 | 12.7 | 0.0 | 12.9 | 15.6 | 18.9 |
| 4/09/01b | 1.8 | 1 968 | 12.7 | 0.0 | 14.4 | 18.4 | 21.7 |
| 4/09/01c | 1.8 | 1 952 | 12.7 | 0.0 | 10.9 | 14.9 | 16.9 |
| 11/09/01a | 3.0 | 1 982 | 10.7 | 0.0 | 14.2 | 17.2 | 2.3 |
| 11/09/01b | 3.0 | 1 979 | 10.7 | 0.2 | 30.7 | 43.2 | 45.2 |
| 11/09/01c | 3.0 | 1 996 | 10.7 | 0.0 | 30.4 | 38.2 | 42.1 |

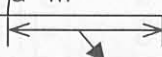
A2. UCS test results

| Sample no | Cement content (%) | Bitumen content (%) | Moulding Density (kg/m ³) | Moulding Moisture content (%) | UCS (kPa) |
|-----------|--------------------|---------------------|---------------------------------------|-------------------------------|-----------|
| 10/09/01a | 0 | 0.6 | 1 947 | 12.6 | 174 |
| 10/09/01b | 0 | 0.6 | 1 980 | 12.6 | 137 |
| 10/09/01c | 0 | 0.6 | 1 980 | 12.6 | 165 |
| 3/09/01g | 0 | 1.8 | 1 950 | 11.9 | 131.6 |
| 3/09/01h | 0 | 1.8 | 1 941 | 11.9 | 142.5 |
| 3/09/01i | 0 | 1.8 | 1 924 | 11.9 | 120.6 |
| 11/09/01a | 0 | 3.0 | 1 964 | 11.1 | 285 |
| 11/09/01b | 0 | 3.0 | 1 938 | 11.1 | 280 |
| 11/09/01c | 0 | 3.0 | 1 964 | 11.1 | 384 |
| 3/09/01a | 1 | 0.6 | 1 964 | 12.5 | 543 |
| 3/09/01b | 1 | 0.6 | 1 943 | 12.5 | 510 |
| 3/09/01c | 1 | 0.6 | 1 945 | 12.5 | 592 |
| 5/09/01d | 1 | 1.8 | 1 944 | 12.0 | 548 |
| 5/09/01e | 1 | 1.8 | 1 949 | 12.0 | 543 |
| 5/09/01f | 1 | 1.8 | 1 943 | 12.0 | 543 |
| 7/09/01a | 1 | 3.0 | 1 976 | 10.0 | 724 |
| 7/09/01b | 1 | 3.0 | 1 991 | 10.0 | 658 |
| 7/09/01c | 1 | 3.0 | 1 971 | 10.0 | 981 |

A3. ITS test results

| Sample no | Cement content (%) | Bitumen content (%) | Moulding Density (kg/m ³) | Moulding Moisture content (%) | ITS (kPa) |
|-----------|--------------------|---------------------|---------------------------------------|-------------------------------|-----------|
| 10/09/01d | 0 | 0.6 | 1 942 | 12.6 | 16.4 |
| 10/09/01e | 0 | 0.6 | 1 963 | 12.6 | 16.4 |
| 10/09/01f | 0 | 0.6 | 1 972 | 12.6 | 16.4 |
| 3/09/01a | 0 | 1.8 | 1 953 | 12.3 | 16.4 |
| 3/09/01b | 0 | 1.8 | 1 936 | 12.3 | 29.6 |
| 3/09/01c | 0 | 1.8 | 1 949 | 12.3 | 26.3 |
| 11/09/01d | 0 | 3.0 | 1 950 | 11.1 | 32.9 |
| 11/09/01e | 0 | 3.0 | 1 966 | 11.1 | 36.2 |
| 11/09/01f | 0 | 3.0 | 1 978 | 11.1 | 32.9 |
| 3/09/01d | 1 | 0.6 | 1 918 | 12.3 | 49.3 |
| 3/09/01e | 1 | 0.6 | 1 977 | 12.3 | 59.2 |
| 3/09/01f | 1 | 0.6 | 1 932 | 12.3 | 59.2 |
| 5/09/01g | 1 | 1.8 | 1 965 | 12.0 | 65.8 |
| 5/09/01h | 1 | 1.8 | 1 915 | 12.0 | 65.8 |
| 5/09/01i | 1 | 1.8 | 1 945 | 12.0 | 62.5 |
| 7/09/01d | 1 | 3.0 | 1 945 | 10.0 | 131.6 |
| 7/09/01e | 1 | 3.0 | 1 954 | 10.0 | 115.1 |
| 7/09/01f | 1 | 3.0 | 1 957 | 10.0 | 161.2 |

A4. Flexural beam test results

| | | | | | | | | | | | | | <div style="border: 1px solid black; padding: 2px; display: inline-block;"> B e a m <div style="text-align: center; margin-top: 5px;">  </div> </div> | |
|-----------|--------|--------|----------|--------|-------|--------|--|--------|--------|--------|-----------|----------|--|--|
| Sample no | Binder | Cement | Wet Mass | Height | width | length | LVDT#1 | LVDT#1 | LVDT#2 | LVDT#2 | Comments | Moisture | Failure | |
| | (%) | (%) | (g) | (mm) | (mm) | (mm) | Strain | Stress | Strain | Stress | | (%) | (mm) | |
| Betb1-1 | 0.0 | 1.0 | 5715 | 75 | 75 | 450 | 144 | 53 | 53 | 54 | | 10.4 | 260 | |
| Betb1-1x | 0.0 | 1.0 | 5715 | 76 | 75 | 450 | Data looks incorrect | | | | | 10.7 | 205 | |
| Betb1-3 | 0.0 | 1.0 | 5705 | 76 | 75 | 450 | 129 | 30 | 129 | 30 | | 10.3 | 265 | |
| Betb1-5 | 0.0 | 1.0 | 5685 | 76 | 75 | 450 | 72 | 29 | 46 | 33 | | 11.0 | 165 | |
| Betb2-6 | 1.8 | 0.0 | 5665 | 75 | 75 | 450 | Broke under 2kg load | | | | | 10.4 | 200 | |
| Betb2-4 | 1.8 | 0.0 | 5665 | 75 | 75 | 450 | Broke under own weight | | | | | 10.4 | 210 | |
| Betb2-3 | 1.8 | 0.0 | 5645 | 75 | 75 | 450 | Broke under 2kg load | | | | | 10.2 | 140 | |
| Betb2-2 | 1.8 | 0.0 | 5730 | 75 | 75 | 450 | Broke under 2kg load | | | | | 10.0 | 285 | |
| Betb3-1 | 1.8 | 1.0 | 5660 | 75 | 75 | 450 | 632 | 32 | 599 | 32 | | 10.2 | 250 | |
| Betb3-3 | 1.8 | 1.0 | 5720 | 75 | 75 | 450 | 200 | 18 | 231 | 18 | | 10.2 | 260 | |
| Betb3-9 | 1.8 | 1.0 | 5715 | 75 | 75 | 450 | 255 | 26 | 313 | 25 | | 10.0 | 230 | |
| Betb3-11 | 1.8 | 1.0 | 5690 | 75 | 75 | 450 | 229 | 26 | 229 | 25 | Stone (b) | 9.4 | 240 | |
| Betb4-6 | 0.6 | 0.0 | 5680 | 75 | 75 | 450 | Broke under 2kg load | | | | | 10.2 | 210 | |
| Betb4-16 | 0.6 | 0.0 | 5680 | 76 | 75 | 450 | Broke under 2kg load | | | | | 10.3 | 160 | |
| Betb4-18 | 0.6 | 0.0 | 5675 | 76 | 75 | 450 | Broke under 2kg load under both load platforms | | | | | 10.1 | 150 / 310 | |
| Betb4-26 | 0.6 | 0.0 | 5680 | 76 | 75 | 450 | Broke under 2kg load | | | | | 10.7 | 150 | |
| Betb5-1 | 3.0 | 1.0 | 5680 | 75 | 75 | 450 | Broke under 2kg load | | | | Stone (b) | 9.6 | 160 | |
| Betb5-10 | 3.0 | 1.0 | 5680 | 75 | 75 | 450 | 633 | 37 | 1189 | 37 | | 8.6 | 240 | |
| Betb5-13 | 3.0 | 1.0 | 5665 | 75 | 75 | 450 | 601 | 68 | 601 | 68 | | 8.4 | 280 | |
| Betb5-14 | 3.0 | 1.0 | 5670 | 75 | 75 | 450 | 462 | 64 | 549 | 64 | Stone (b) | 7.8 | 285 | |
| Betb6-5 | 3.0 | 0.0 | 5620 | 75 | 75 | 450 | Tested but no load change from loadcell | | | | | 8.2 | 310 | |
| Betb6-8 | 3.0 | 0.0 | 5615 | 75 | 75 | 450 | Broke under 2kg load after 20 -30 seconds | | | | | 8.6 | 210 | |
| Betb6-12 | 3.0 | 0.0 | 5615 | 75 | 75 | 450 | Broke under 2kg load after 20 -30 seconds | | | | | 8.5 | 215 | |
| Betb6-15 | 3.0 | 0.0 | 5610 | 75 | 75 | 450 | Broke under 2kg load after 20 -30 seconds | | | | Stone (b) | 9.3 | 195 | |

(b) = bottom

A5. Static triaxial test results

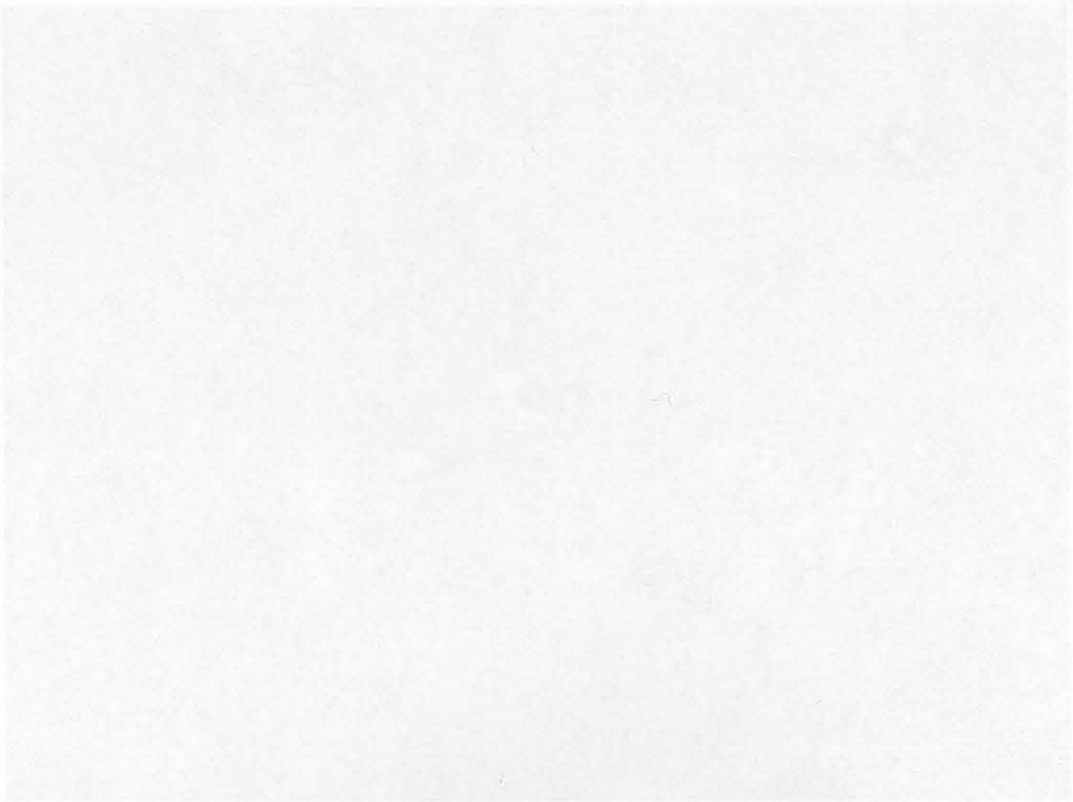
 MDD: 1971
 OMC: 12.5
 ARD: 2.7770

| Sample # | Dry density (kg/cub m) | Compaction (%) | Moisture Content (MC) (%) | Saturation (%) | Residual Binder Content (%) | Confining stress (kPa) | Static test results | | | | | | Cohesion and friction angle | Actual MC (%) | Actual Dry density (kg/cub m) | Compaction (%) | Compaction Average | Saturation (%) | Saturation Average |
|----------|---------------------------|-------------------|---------------------------------|-------------------|-----------------------------------|------------------------------|---------------------|-------------------------|--------------------|------------------|------------|------------|--------------------------------|---------------------|-------------------------------------|-------------------|-----------------------|-------------------|-----------------------|
| | | | | | | | Failure load kN | Failure stress (kPa) | Stiffness (MPa) | Sigma 1 (kPa) | p (kPa) | q (kPa) | | | | | | | |
| ETF01 | 1870 | 67.3% | 13 | 74.3% | 1.8% | 22 | 36.3 | 1998 | 474 | 2020 | 1021 | 999 | 543.0 32.5 | 10.48 | 1974 | 71.1% | 70.4% | 63.2% | 64.5% |
| ETF02 | 94.9 | | | | | 80 | 40.8 | 2246 | 398 | 2326 | 1203 | 1123 | | 11.19 | 1960 | 70.6% | | 67.1% | |
| ETF03 | | | | | | 140 | 41.1 | 2264 | 482 | 2404 | 1272 | 1132 | | 10.76 | 1936 | 69.7% | | 63.7% | |
| ETF04 | | | | | | 200 | 44.0 | 2427 | 285 | 2627 | 1413.5 | 1213.5 | | 10.77 | 1944 | 70.0% | | 64.0% | |
| ETF05 | 1870 | 67.3% | 8 | 45.7% | 1.8% | 20 | 30.8 | 1700 | 357 | 1720 | 870 | 850 | 328.6 46.5 | 10.56 | 1930 | 69.5% | 69.5% | 62.3% | 59.0% |
| ETF06 | 94.9 | | | | | 80 | 39.3 | 2167 | 442 | 2247 | 1163.5 | 1083.5 | | 9.99 | 1923 | 69.2% | | 58.7% | |
| ETF07 | | | | | | 140 | 43.1 | 2377 | 307 | 2517 | 1328.5 | 1188.5 | | 9.99 | 1943 | 70.0% | | 59.4% | |
| ETF08 | | | | | | 200 | 48.3 | 2664 | 438 | 2864 | 1532 | 1332 | | 9.45 | 1923 | 69.2% | | 55.6% | |
| ETF09 | 2030 | 73.1% | 10 | 75.5% | 1.8% | 20 | 45.8 | 2524 | 419 | 2544 | 1282 | 1262 | 458.0 48.3 | 10.50 | 2022 | 72.8% | 73.2% | 64.9% | 62.8% |
| ETF10 | 103.0 | | | | | 80 | 52.2 | 2878 | 514 | 2958 | 1519 | 1439 | | 8.66 | 2041 | 73.5% | | 54.1% | |
| ETF11 | | | | | | 140 | 50.8 | 2801 | 494 | 2941 | 1540.5 | 1400.5 | | 10.74 | 2011 | 72.4% | | 66.0% | |
| ETF12 | | | | | | 200 | 53.0 | 2922 | 904 | 3122 | 1661 | 1461 | | 10.57 | 2051 | 73.9% | | 66.3% | |
| ETF13 | 2030 | 73.1% | 6 | 45.3% | 1.8% | 20 | 45.6 | 2513 | 350 | 2533 | 1276.5 | 1256.5 | 370.0 54.8 | 9.77 | 2026 | 73.0% | 72.4% | 60.5% | 58.2% |
| ETF14 | 103.0 | | | | | 80 | 55.3 | 3050 | | 3130 | 1605 | 1525 | | 10.14 | 1985 | 71.5% | | 61.6% | |
| ETF15 | | | | | | 140 | 51.9 | 2858 | 707 | 2998 | 1569 | 1429 | | 8.87 | 2017 | 72.6% | | 54.7% | |
| ETF16 | | | | | | 200 | 63.5 | 3500 | | 3700 | 1950 | 1750 | | 9.09 | 2012 | 72.5% | | 55.9% | |

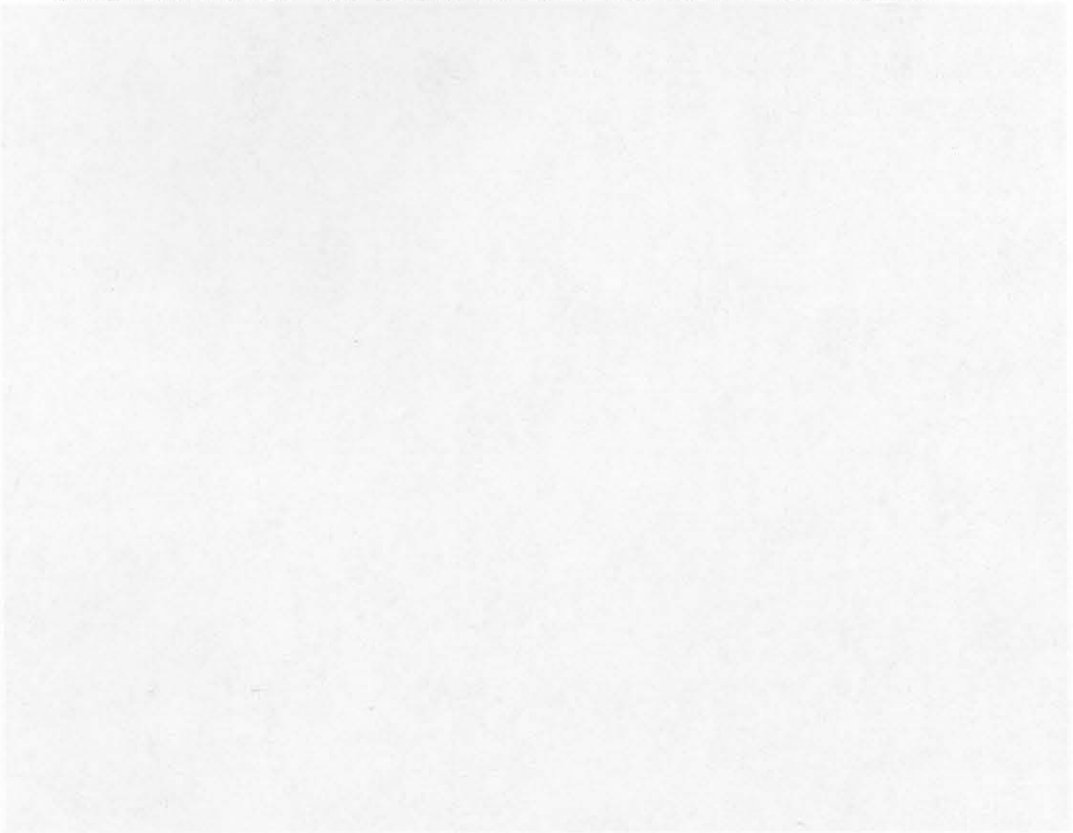
(This section contains a large, faint, and mostly illegible table, likely a duplicate or bleed-through from the reverse side of the page. The text is too light to transcribe accurately.)

A6. Dynamic triaxial tests

| Sample | Relative density (%) | Saturation (%) | Confining stress (kPa) | Dynamic test conditions | | | Actual MC (%) | Actual Dry density (kg/cub m) | Sample height (mm) | LVDT #1 | | | | LVDT #2 | | | |
|--------|----------------------|----------------|------------------------|-------------------------|--------------|--------------|---------------|-------------------------------|--------------------|---------|----------|------|------|---------|----------|------|------|
| | | | | Load kN | Stress (kPa) | Stress Ratio | | | | a | m | b | c | a | m | b | c |
| ETF18 | 74.00 | 82.20 | 80 | 21.6 | 1189.7 | 0.55 | 10.4 | 2055 | 303 | | | | | 0.44 | 1.84E-06 | 1.00 | 0.00 |
| ETF19 | 74.25 | 85.69 | 80 | 35.3 | 1946.8 | 0.90 | 10.7 | 2062 | 304 | 1.08 | 1.77E-06 | 0.62 | 0.00 | 1.16 | 2.45E-06 | 1.00 | 0.00 |
| ETF20 | 74.97 | 90.68 | 140 | 8.4 | 460.4 | 0.20 | 10.9 | 2082 | 301 | 0.28 | 4.27E-07 | 1.00 | 0.07 | 0.51 | 2.57E-06 | 0.93 | 0.02 |
| ETF21 | 74.47 | 89.91 | 140 | 23.0 | 1266.1 | 0.55 | 11.1 | 2068 | 303 | 0.28 | 1.80E-06 | 0.70 | 0.02 | 0.33 | 1.80E-06 | 0.53 | 0.01 |
| ETF22 | 72.85 | 80.47 | 140 | 37.6 | 2071.9 | 0.90 | 10.8 | 2023 | 304 | | | | | 1.18 | 3.50E-06 | 1.10 | 0.01 |
| ETF23 | 73.93 | 61.42 | 80 | 7.5 | 413.7 | 0.20 | 7.8 | 2053 | 302 | 0.41 | 2.86E-07 | 1.00 | 0.00 | 0.43 | 5.64E-07 | 0.85 | 0.01 |
| ETF24 | 73.82 | 67.34 | 80 | 20.6 | 1137.8 | 0.55 | 8.6 | 2050 | 300 | 0.90 | 9.93E-07 | 0.80 | 0.01 | 1.20 | 2.50E-06 | 0.95 | 0.01 |
| ETF25 | 74.32 | 64.31 | 80 | 33.8 | 1861.8 | 0.90 | 8 | 2064 | 300 | 2.45 | 6.47E-06 | 0.78 | 0.01 | 1.51 | 1.59E-07 | 1.00 | 0.05 |
| ETF27 | 74.54 | 67.48 | 140 | 23.8 | 1311.9 | 0.55 | 8.3 | 2070 | 300 | 1.10 | 2.69E-07 | 0.90 | 0.00 | 0.94 | 7.00E-07 | 0.72 | 0.00 |
| ETF28 | 75.19 | 61.43 | 140 | 39.0 | 2146.8 | 0.90 | 7.3 | 2088 | 300 | 2.00 | 4.54E-06 | 0.98 | 0.01 | | | | |
| ETF29 | 77.93 | 92.15 | 80 | 10.4 | 575.6 | 0.20 | 9.4 | 2164 | 305 | 0.37 | 6.55E-07 | 1.05 | 0.00 | 0.53 | 8.84E-07 | 0.85 | 0.01 |
| ETF30 | 78.54 | 82.31 | 80 | 28.7 | 1582.9 | 0.55 | 8.1 | 2181 | 304 | | | | | 1.15 | 8.69E-07 | 0.85 | 0.01 |
| ETF32 | 76.13 | 99.17 | 140 | 11.7 | 646.4 | 0.20 | 11.2 | 2114 | 307 | 0.79 | 1.44E-06 | 0.95 | 0.01 | 0.42 | 1.00E-06 | 1.01 | 0.01 |
| ETF33 | 75.77 | 98.10 | 140 | 32.3 | 1777.6 | 0.55 | 11.3 | 2104 | 305 | 2.12 | 1.22E-05 | 0.72 | 0.00 | 2.00 | 1.55E-05 | 0.71 | 0.02 |
| ETF35 | 77.42 | 78.08 | 80 | 11.1 | 610.0 | 0.20 | 8.2 | 2150 | 305 | | | | | 0.18 | 3.00E-06 | 0.60 | 0.00 |
| ETF36 | 77.49 | 86.06 | 80 | 30.4 | 1677.5 | 0.55 | 9 | 2152 | 303 | 1.06 | 1.55E-06 | 0.95 | 0.01 | | | | |
| ETF38 | 77.35 | 80.61 | 140 | 13.0 | 717.4 | 0.20 | 8.5 | 2148 | 305 | 0.35 | 2.00E-06 | 0.63 | 0.00 | | | | |
| ETF39 | 77.49 | 75.54 | 140 | 35.8 | 1972.9 | 0.55 | 7.9 | 2152 | 305 | | | | | 1.63 | 4.50E-06 | 1.30 | 0.03 |



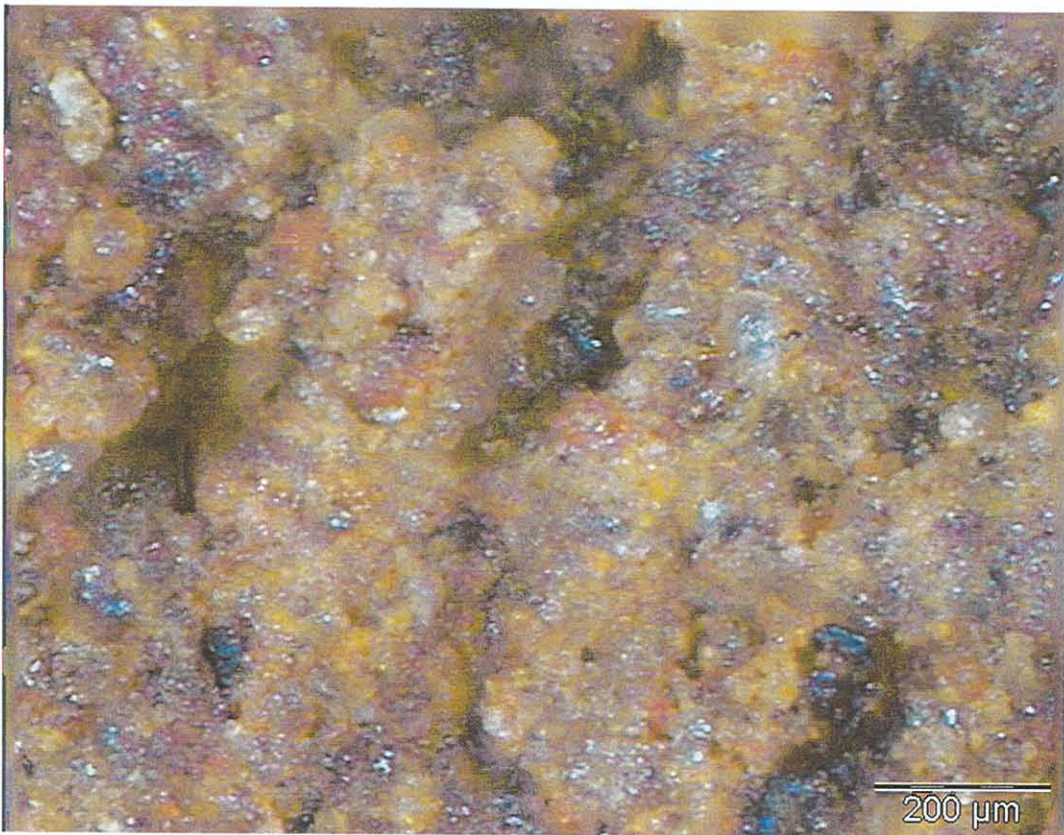
APPENDIX B. OPTICAL MICROSCOPE PICTURES



Photograph A2: 0.5% w/v solution, 0% carbon, 30x magnification



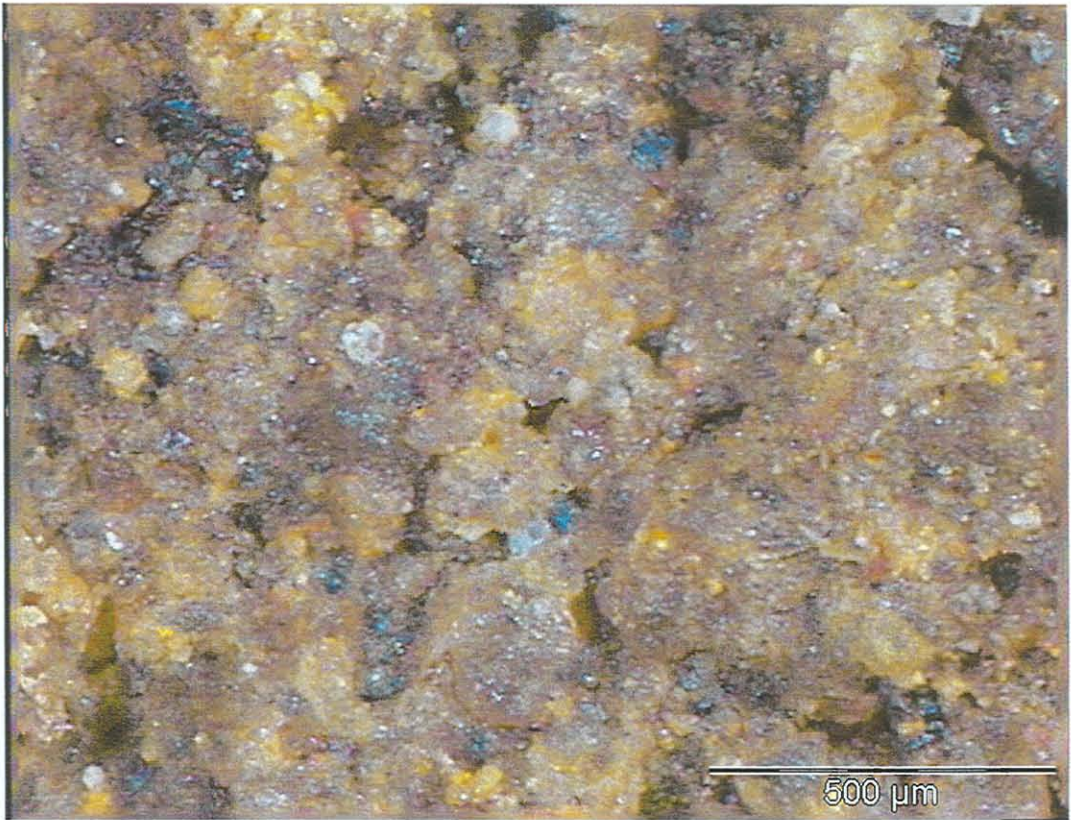
Photograph A1. 0.6 % net bitumen, 0% cement, 7x magnification



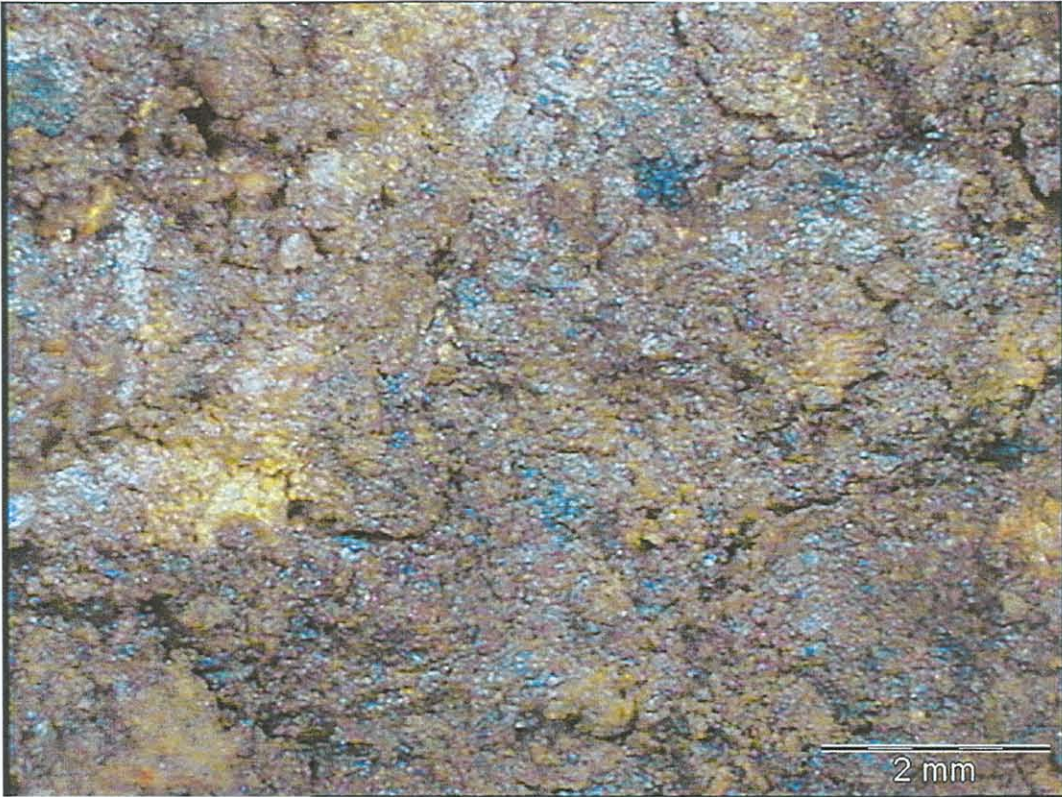
Photograph A2. 0.6 % net bitumen, 0% cement, 50x magnification



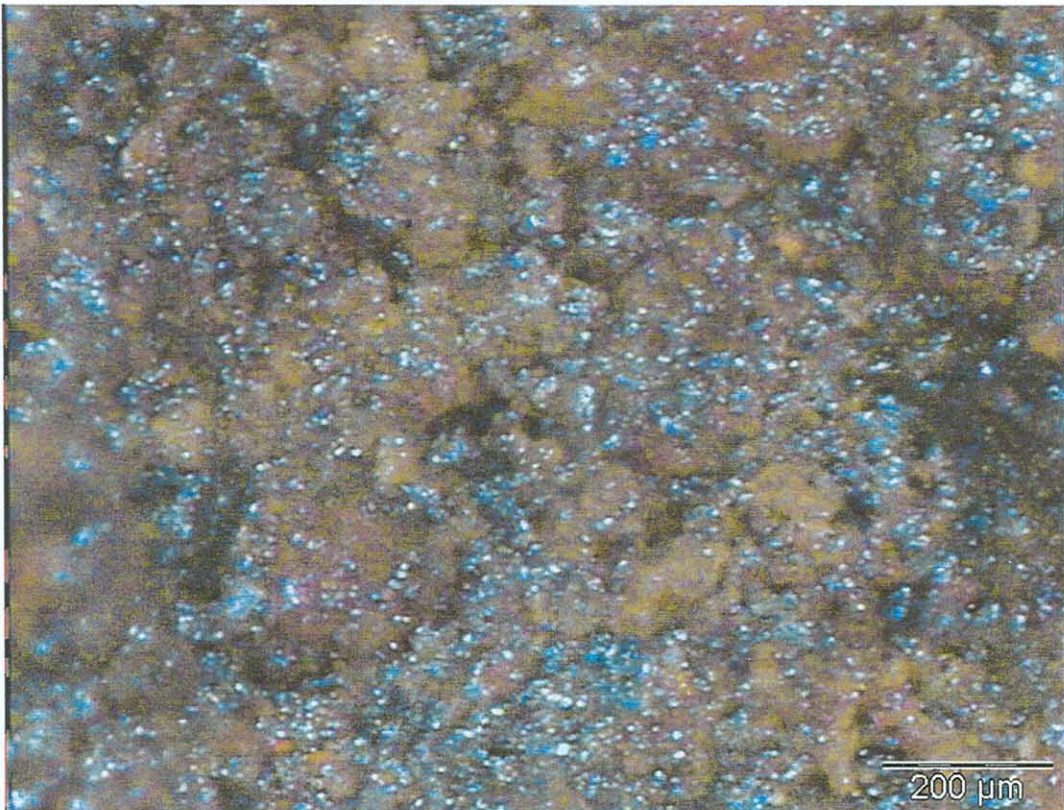
Photograph A3. 0.6 % emulsion, 1% cement, 7x magnification



Photograph A4. 0.6 % emulsion, 1% cement, 40x magnification



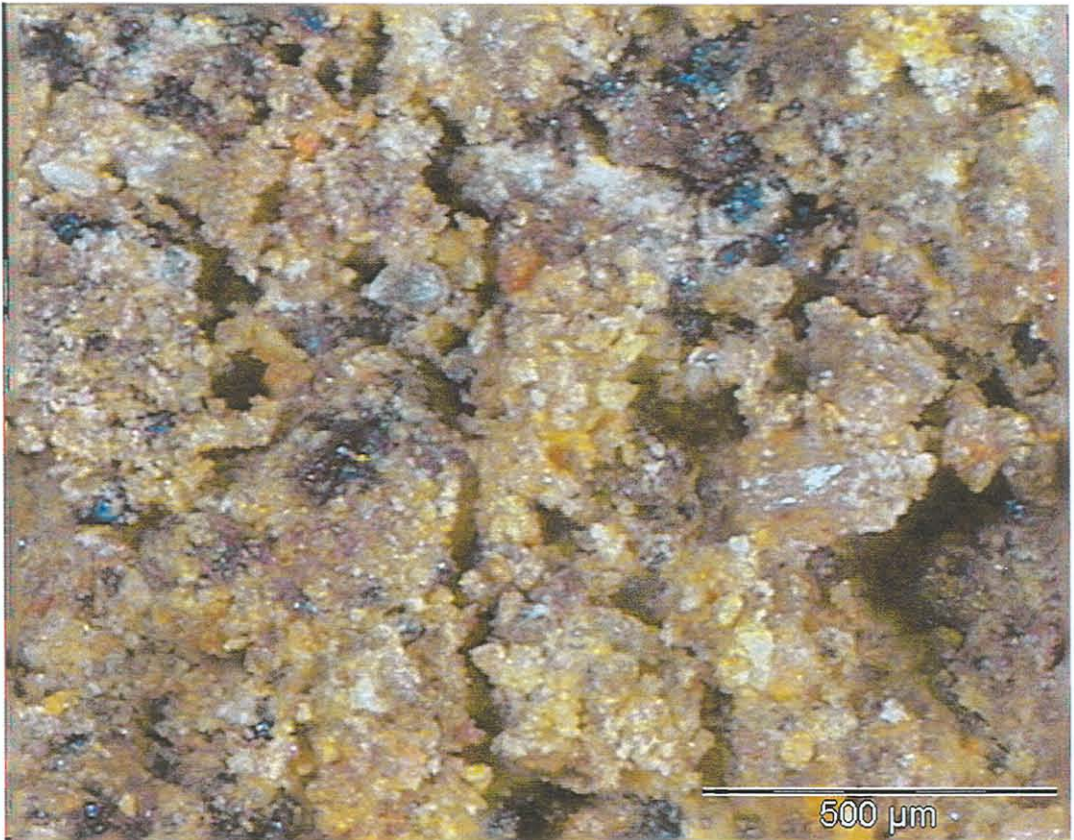
Photograph A5. 1.8% net bitumen, 0% cement, 7x magnification



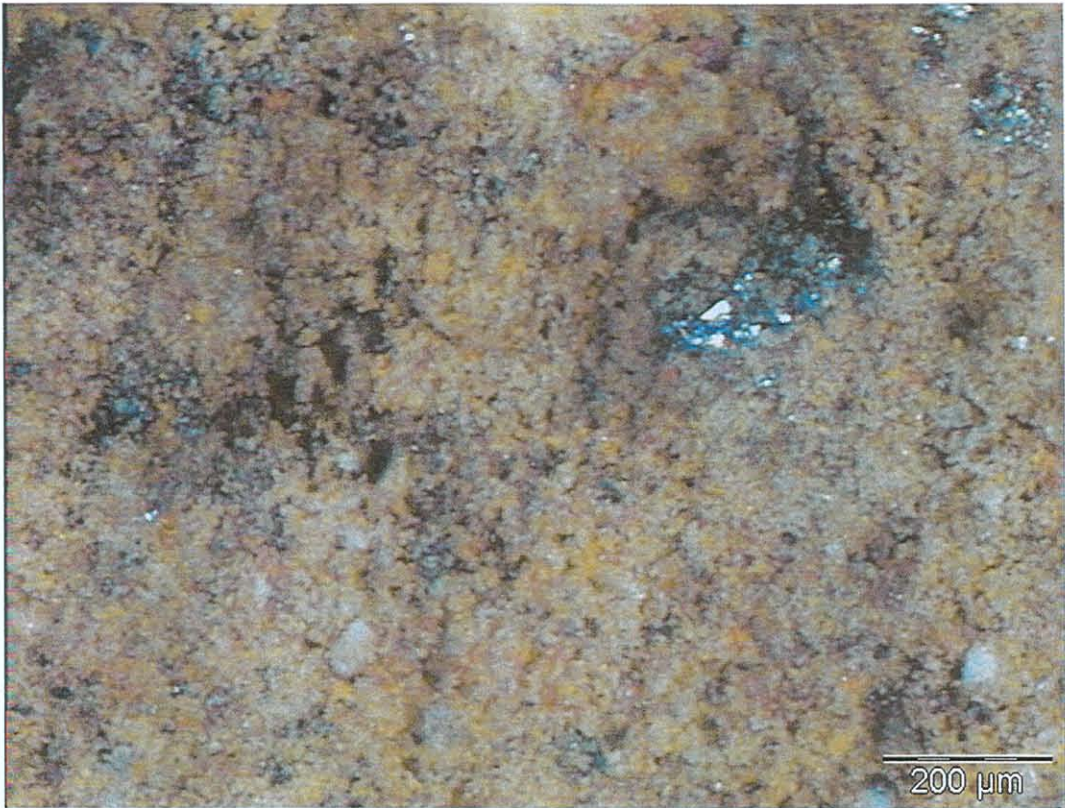
Photograph A6. 1.8% net bitumen, 0% cement, 50x magnification (sample very wet)



Photograph A7. 1.8% net bitumen, 1% cement, 7x magnification



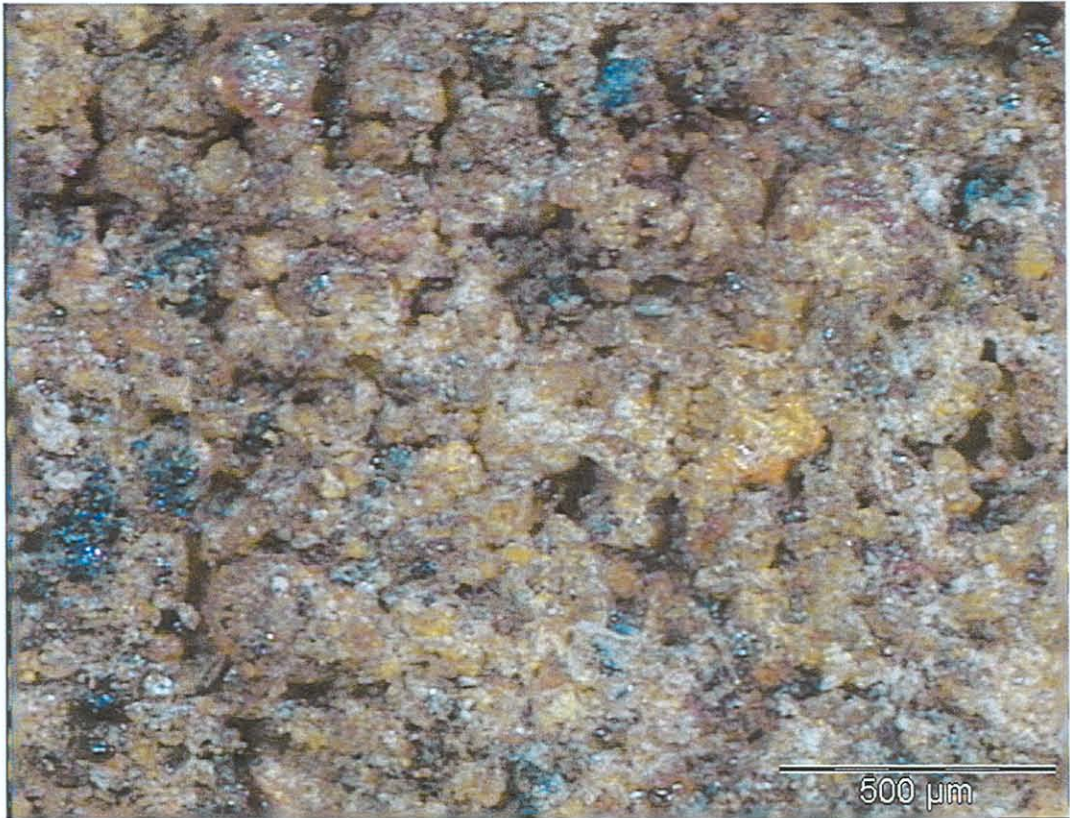
Photograph A8. 1.8% net bitumen, 1% cement, 40x magnification



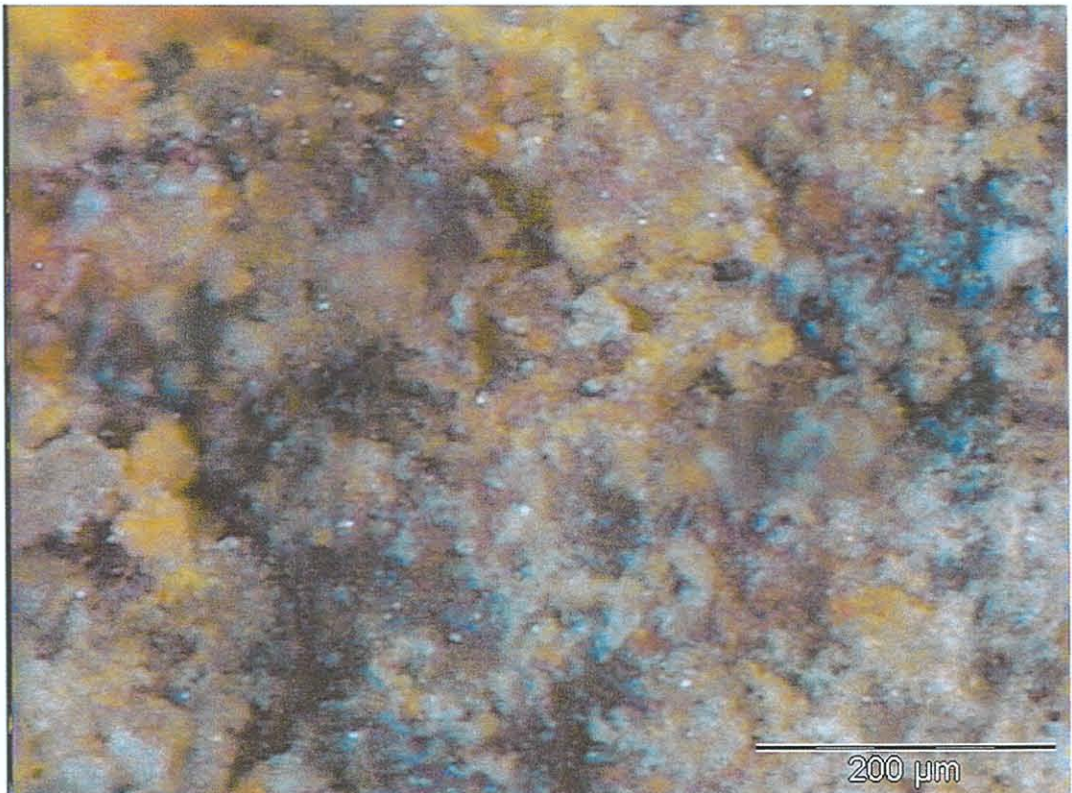
Photograph A9. 1.8% net bitumen, 1% cement, 50x magnification



Photograph A10. 1.8% net bitumen, 2% cement, 7x magnification



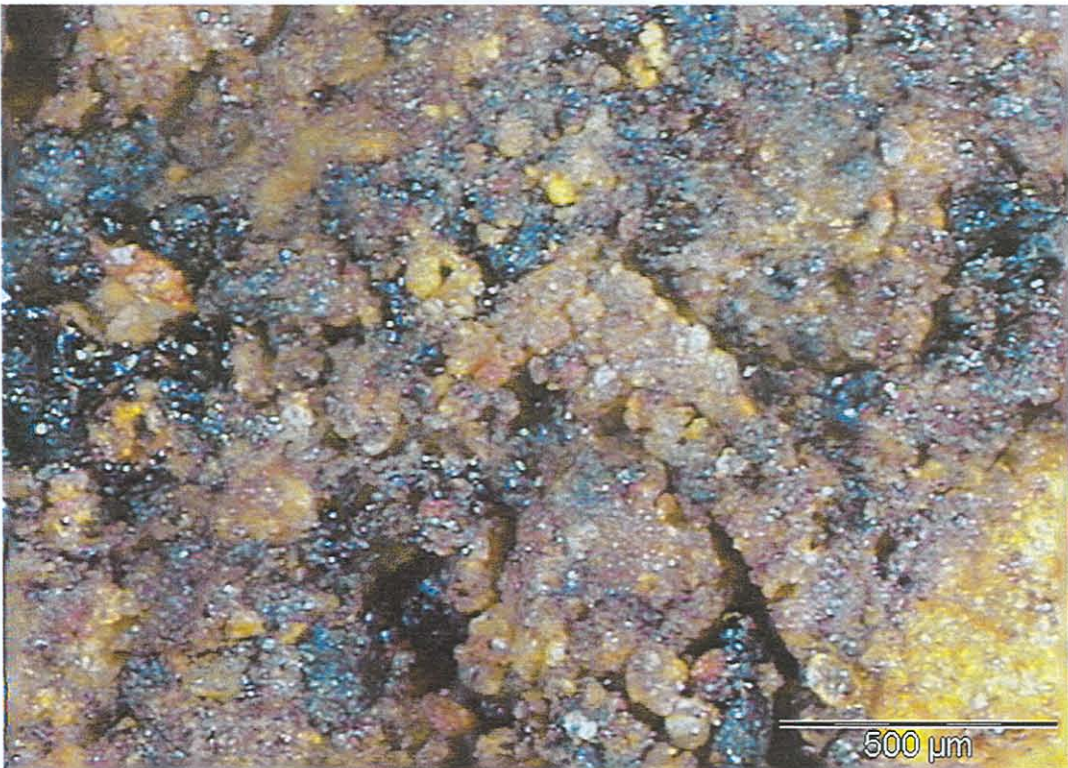
Photograph A11. 1.8% net bitumen, 2% cement, 32x magnification



Photograph A12. 1.8% net bitumen, 2% cement, 90x magnification



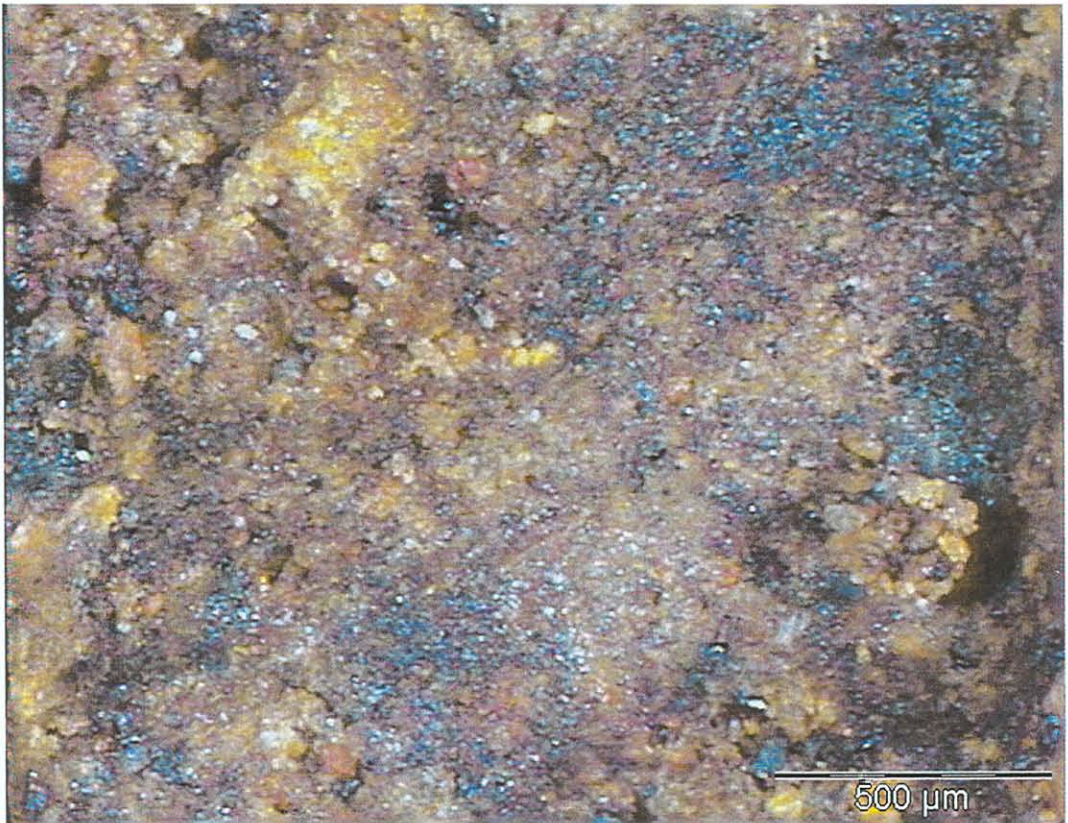
Photograph A13. 3.0% net bitumen, 0% cement, 7x magnification



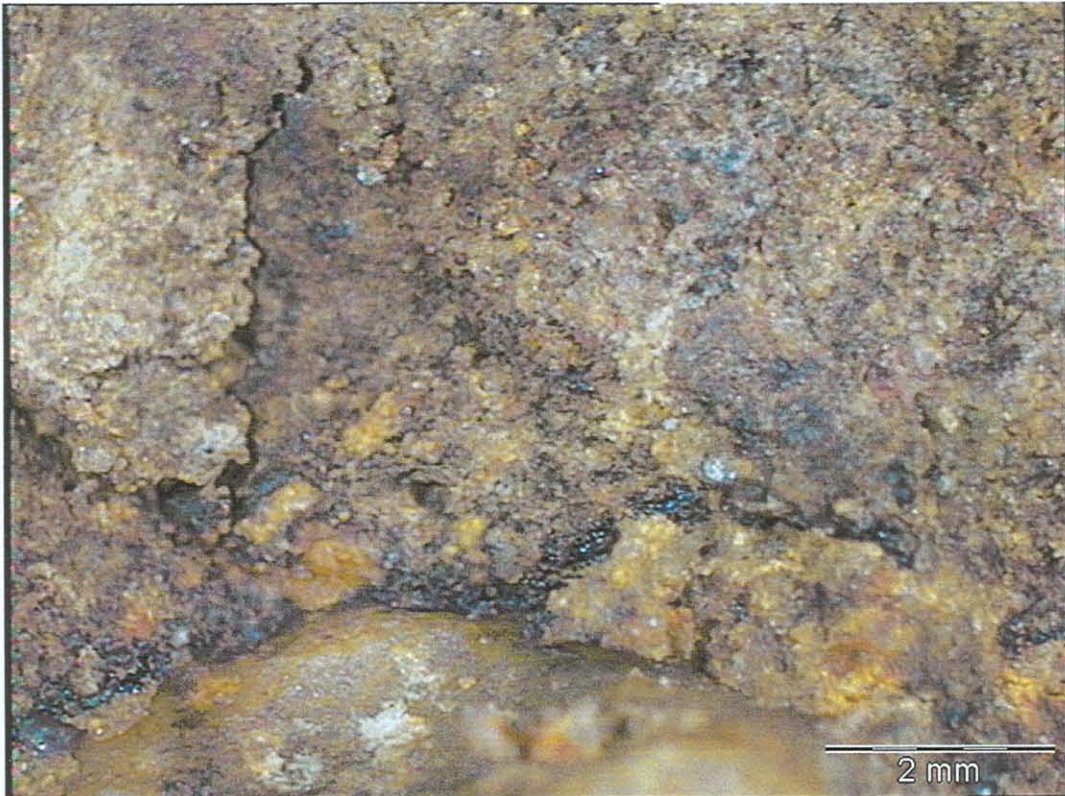
Photograph A14. 3.0% net bitumen, 0% cement, 32x magnification



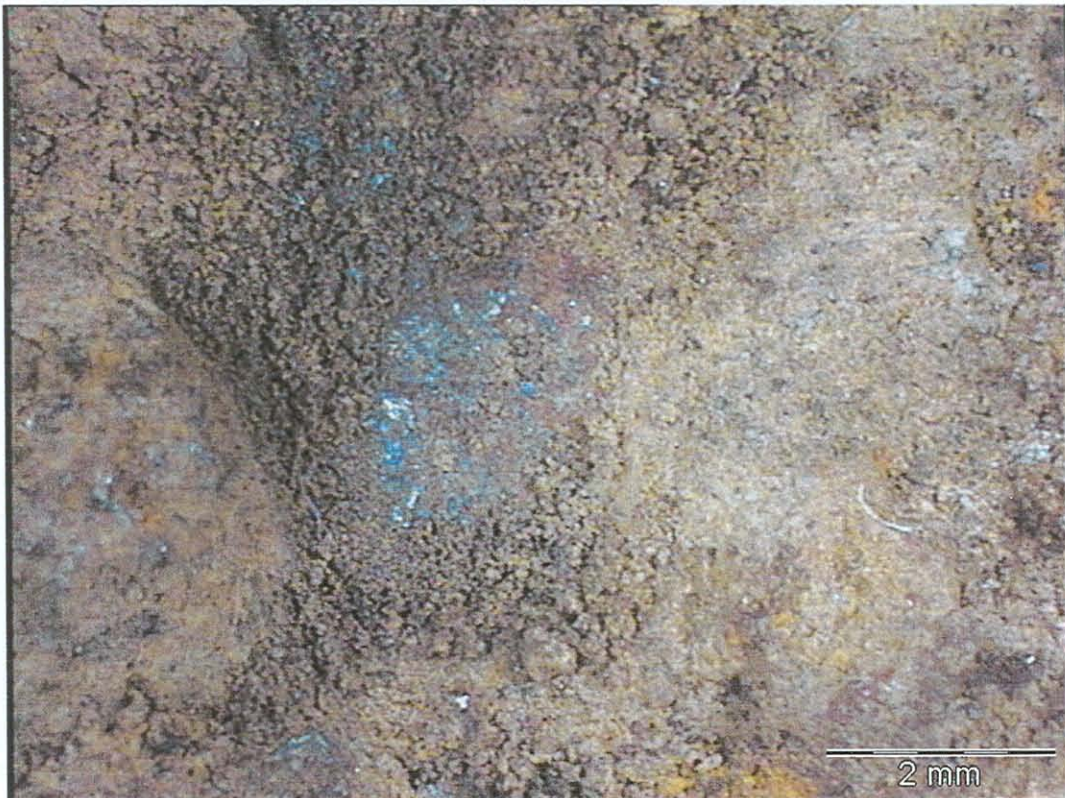
Photograph A15. 3.0% net bitumen, 1% cement, 7x magnification



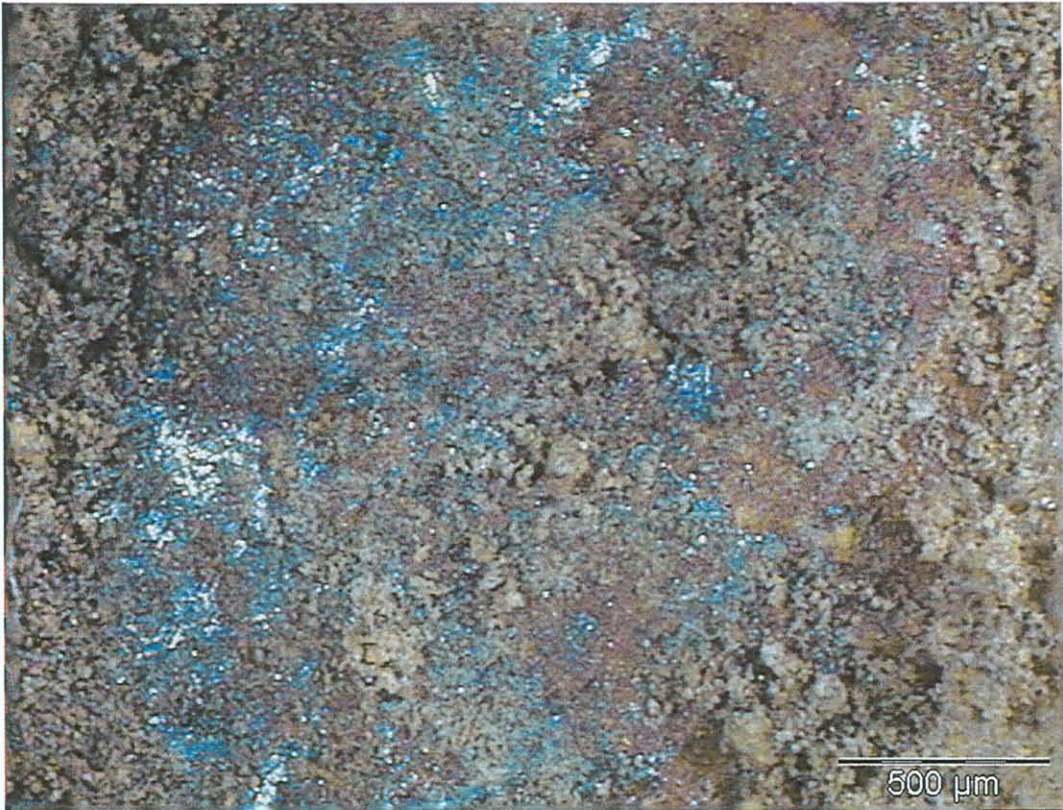
Photograph A16. 3.0% net bitumen, 1% cement, 32x magnification



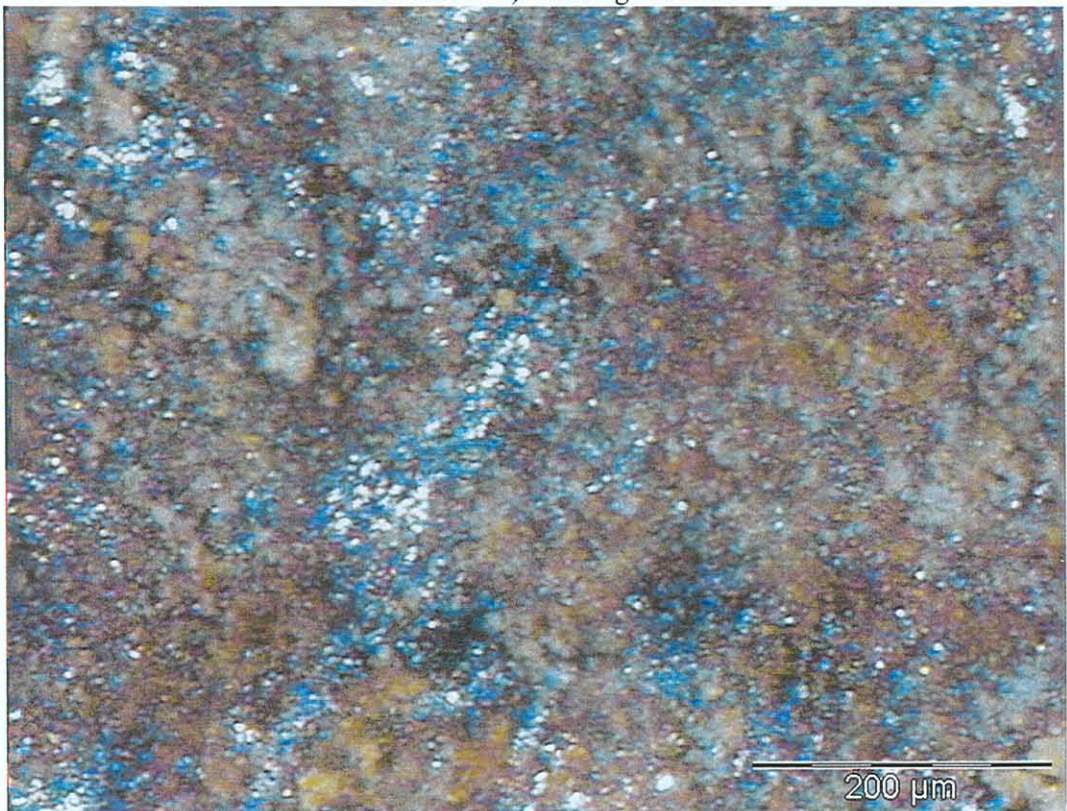
Photograph A17. 3.0% net bitumen, 1% cement, 7x magnification (note bitumen film around bigger aggregate)



Photograph 18. HVS site sample. Aggregate coated with bitumen, 7x magnification



Photograph 19. HVS site sample. Aggregate coated with bitumen. (Some of the binder has been rubbed off) 25x magnification



Photograph A20. HVS site sample. Aggregate coated with bitumen. (Some of the binder has been rubbed off) 90x magnification



Photograph A21. HVS site sample. Bitumen with cement, 50x magnification