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4  Exhibit 321.100a
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**Shrubs and Trees**

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NOTE: This table contains species lists for all plant communities that have been quantitatively sampled by Plateau or are reported from site specific Forest Service studies as being present in the plant communities found in the CPMC Permit Area.
### TABLE 321.100d
1981 Sample Adequacy Calculations

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<tr>
<th>Site</th>
<th>Parameter</th>
<th>Mean</th>
<th>SD</th>
<th># Samples Taken</th>
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<td>Nm 90/10</td>
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<td>Mountain Grassland Reference Area</td>
<td>% Cover</td>
<td>43.6</td>
<td>16</td>
<td>40</td>
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<tr>
<td>Sagebrush Community Predisturbance Area</td>
<td>% Cover</td>
<td>42.1</td>
<td>28.7</td>
<td>54</td>
<td>125.76</td>
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<tr>
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<td>% Canopy Cover</td>
<td>55</td>
<td>12</td>
<td>50</td>
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<td># Stems Per 10 ft²</td>
<td>4.5</td>
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<td>50</td>
<td>76.97</td>
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<td>% Cover</td>
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<td>30.5</td>
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<td>% Canopy Cover</td>
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<td># Stems Per 10 ft²</td>
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<td>2.2</td>
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### Table 321.100e
Total Plant Cover and Species Composition for the Mountain Grassland Reference Area

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<th>Species</th>
<th>Percent Cover</th>
<th>Composition</th>
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<td>Elymus salinus</td>
<td>25.3</td>
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<td><strong>SUBTOTAL</strong></td>
<td>26.9</td>
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<td><strong>Forbs</strong></td>
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<td>0.92</td>
</tr>
<tr>
<td>Rosa woodsii</td>
<td>0.4</td>
<td>0.92</td>
</tr>
<tr>
<td>Symphoricarpos oreophilus</td>
<td>0.2</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>SUBTOTAL</strong></td>
<td>4.5</td>
<td>10.32</td>
</tr>
<tr>
<td><strong>TOTAL PLANT COVER</strong></td>
<td>43.6</td>
<td>100.11</td>
</tr>
<tr>
<td><strong>TOTAL LITTER</strong></td>
<td>42.3</td>
<td>-</td>
</tr>
<tr>
<td><strong>TOTAL BARE GROUND</strong></td>
<td>14.1</td>
<td>-</td>
</tr>
</tbody>
</table>
### TABLE 321.100f
Statistical Comparison of Pre-Disturbance and Reference Areas Sampled in 1981

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Predisturbance Mean</th>
<th>Reference Mean</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sagebrush Community</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Cover</td>
<td>42.2</td>
<td>26.4</td>
<td>2.1073**</td>
</tr>
<tr>
<td>% Canopy Cover</td>
<td>55</td>
<td>36</td>
<td>4.4591***</td>
</tr>
<tr>
<td># Stems Per 10 ft²</td>
<td>4.2</td>
<td>4.6</td>
<td>0.7303*</td>
</tr>
</tbody>
</table>

* t-value indicates sample means are not significantly different at the 0.1 probability level.
** t-value indicates sample means are significantly different at the 0.5 probability level.
*** t-value indicates sample means are significantly different at all probability levels.
### TABLE 321.100g
Total Plant Cover and Species Composition Comparisons for the Predisturbance and Reference Sagebrush Areas

<table>
<thead>
<tr>
<th>Species</th>
<th>Pre-Disturbance</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cover</td>
<td>Comp.</td>
</tr>
<tr>
<td><strong>Grasses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elymus elymoides</td>
<td>4.9</td>
<td>11.57</td>
</tr>
<tr>
<td>Bromus tectorum</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Stipa comata</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Agropyron cristatum</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Elymus salinus</td>
<td>2</td>
<td>4.72</td>
</tr>
<tr>
<td>Poa secunda</td>
<td>1.4</td>
<td>3.31</td>
</tr>
<tr>
<td>Stipa hymenoides</td>
<td>1</td>
<td>2.36</td>
</tr>
<tr>
<td><strong>SUBTOTAL</strong></td>
<td>9.3</td>
<td>22.09</td>
</tr>
<tr>
<td><strong>Forbs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sphaeralcea coccinea</td>
<td>0.3</td>
<td>0.71</td>
</tr>
<tr>
<td>Machaeranthera canescens</td>
<td>0.1</td>
<td>0.23</td>
</tr>
<tr>
<td>Erigeron eatonii</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Arabis spp.</td>
<td>0.2</td>
<td>0.47</td>
</tr>
<tr>
<td>Calochortus nuttallii</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Eriogonum spp.</td>
<td>0.1</td>
<td>0.23</td>
</tr>
<tr>
<td>Penstemon carnosus</td>
<td>0.1</td>
<td>0.23</td>
</tr>
<tr>
<td><strong>SUBTOTAL</strong></td>
<td>0.8</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>Shrubs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artemisia tridentata</td>
<td>30.8</td>
<td>72.92</td>
</tr>
<tr>
<td>Chrysothamnus viscidiflorus</td>
<td>1.4</td>
<td>3.31</td>
</tr>
<tr>
<td><strong>SUBTOTAL</strong></td>
<td>32.2</td>
<td>76.48</td>
</tr>
<tr>
<td><strong>Total Plant Cover</strong></td>
<td>42.1</td>
<td>100.06</td>
</tr>
<tr>
<td><strong>Litter</strong></td>
<td>25.2</td>
<td></td>
</tr>
<tr>
<td><strong>Total Ground Cover</strong></td>
<td>67.3</td>
<td></td>
</tr>
<tr>
<td><strong>Bare Ground</strong></td>
<td>32.7</td>
<td></td>
</tr>
</tbody>
</table>

- N = 54, X = 42.1, SD = 28.7, Nm 90/10 = 125.76, Nm 80/10 = 76.38
<table>
<thead>
<tr>
<th>Species</th>
<th>Predisturbance Cover</th>
<th>Reference Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artemisia tridentata</td>
<td>55</td>
<td>35.6</td>
</tr>
<tr>
<td>N = 50</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>X = 55.0%</td>
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<td>35.8%</td>
</tr>
<tr>
<td>SD = 12</td>
<td></td>
<td>19</td>
</tr>
<tr>
<td>Nm 90/10 = 12.88</td>
<td></td>
<td>76.22</td>
</tr>
<tr>
<td>Nm 80/10 = 7.82</td>
<td></td>
<td>46.29</td>
</tr>
</tbody>
</table>
### TABLE 321.100i
Woody Plant Density Characteristics of the Sagebrush Plant Community

<table>
<thead>
<tr>
<th>Species</th>
<th>Stem Size Classes</th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>0-1&quot;</td>
<td>1-2&quot;</td>
<td>2&quot;+</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td><strong>PREDISTURBANCE AREA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transect Totals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artemisia tridentata</td>
<td>84</td>
<td>64</td>
<td>79</td>
<td>227</td>
<td></td>
</tr>
<tr>
<td>Average Height (dm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artemisia tridentata</td>
<td>5.5</td>
<td>7.4</td>
<td>8.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td># Stems Per Acre</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artemisia tridentata</td>
<td>7318</td>
<td>5576</td>
<td>6882</td>
<td>19,776*</td>
<td></td>
</tr>
</tbody>
</table>

*This value represents the total number of stems per acre, not the actual number of shrubs. Based upon the 153 individual plants encountered during the sampling the estimated shrub density is 13,329 shrubs per acre.

N = 50; Mean = 4.5 stems per 10 ft²; SD = 2.4; Nm 90/10 = 76.97; Nm 80/10 = 46.75

| **REFERENCE AREA**               |                   |     |     |     |     |
| Transect Totals                  |                   |     |     |     |     |
| Artemisia tridentata             | 35                | 84  | 78  | 197 |
| Chrysothamnus nauseosus          | 2                 | 0   | 0   | 2   |
| TOTAL                            | 37                | 84  | 78  | 199 |
| Average Height (dm)              |                   |     |     |     |     |
| Artemisia tridentata             | 4.2               | 4.6 | 6.4 | 5.1 |
| Chrysothamnus nauseosus          | 5                 | 0   | 0   | 5   |
| # Stems Per Acre                 |                   |     |     |     |     |
| Artemisia tridentata             | 3049              | 7318| 6795| 17162|
| Chrysothamnus nauseosus          | 174               | 0   | 0   | 174 |
| TOTAL                            | 3233              | 7318| 6795| 17336|

N = 50; Mean = 4.0 stems per 10 ft²; SD = 2.2; Nm 90/10 = 81.86; Nm 80/10 = 49.72

**INCORPORATED EFFECTIVE:**

MAY 27, 1978

Utah Division Oil, Gas and Mining
<table>
<thead>
<tr>
<th>Vegetation Type</th>
<th>Transect (%)</th>
<th>Total</th>
<th>Mean</th>
<th>Comp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grasses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELTR</td>
<td>7 3 1 12 11 1 3 5 0 0 0 0 13 4 4 5</td>
<td>69</td>
<td>4.31</td>
<td>26.44</td>
</tr>
<tr>
<td>ELSA</td>
<td>0 0 0 0 0 0 0 0 0 4 9 4 9 0 0 0</td>
<td>26</td>
<td>1.63</td>
<td>9.96</td>
</tr>
<tr>
<td>STHY</td>
<td>0 0 0 0 0 0 0 0 8 0 0 0 0 0 0</td>
<td>8</td>
<td>0.5</td>
<td>3.06</td>
</tr>
<tr>
<td>Subtotal</td>
<td>7 3 1 12 11 1 3 5 12 9 4 9 13 4 4 5</td>
<td>103</td>
<td>6.44</td>
<td>39.46</td>
</tr>
<tr>
<td>Forbs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ERIOG</td>
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<td>21</td>
<td>1.31</td>
<td>8.05</td>
</tr>
<tr>
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<td>0.19</td>
<td>1.15</td>
</tr>
<tr>
<td>SENEC</td>
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<td>0.19</td>
<td>1.15</td>
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<tr>
<td>ASTER</td>
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<td>2</td>
<td>0.13</td>
<td>0.77</td>
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<tr>
<td>Subtotal</td>
<td>2 0 3 1 4 5 0 1 2 4 1 0 0 6 0 0</td>
<td>29</td>
<td>1.81</td>
<td>11.12</td>
</tr>
<tr>
<td>Shrubs</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>ATCO</td>
<td>0 7 12 6 4 5 19 13 5 0 4 5 0 8 5 13</td>
<td>106</td>
<td>6.63</td>
<td>40.61</td>
</tr>
<tr>
<td>CHVI</td>
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<td>13</td>
<td>0.81</td>
<td>4.98</td>
</tr>
<tr>
<td>PIED</td>
<td>0 0 0 0 0 7 0 0 0 0 0 0 0 0 0 0</td>
<td>7</td>
<td>0.44</td>
<td>2.68</td>
</tr>
<tr>
<td>ARTRW</td>
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<td>2</td>
<td>0.13</td>
<td>0.77</td>
</tr>
<tr>
<td>AMUT</td>
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<td>1</td>
<td>0.06</td>
<td>0.38</td>
</tr>
<tr>
<td>Subtotal</td>
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<td>129</td>
<td>8.06</td>
<td>49.42</td>
</tr>
<tr>
<td>Total</td>
<td>9 10 24 19 19 18 22 19 20 13 9 16 13 20 12 18</td>
<td>261</td>
<td>16.31</td>
<td>100</td>
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</tbody>
</table>

N = 16; Mean = 16.31; SD = 4.72; Nm 90/10 = 22.66; Nm 80/10 = 13.76
<table>
<thead>
<tr>
<th></th>
<th>Transect (%)</th>
<th>TOTAL</th>
<th>MEAN</th>
<th>COMP.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grasses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELTR</td>
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<td>109</td>
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<td>41.45</td>
</tr>
<tr>
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<td>0</td>
<td>0.8</td>
<td>4.56</td>
</tr>
<tr>
<td>STHY</td>
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<td>1</td>
<td>0.07</td>
<td>0.38</td>
</tr>
<tr>
<td>SUBTOTAL</td>
<td>7 3 17 4 9 10 12 8 9 6 8 6 2 6 15</td>
<td>122</td>
<td>8.14</td>
<td>46.39</td>
</tr>
<tr>
<td>Forbs</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AFORB</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0</td>
<td>1</td>
<td>0.07</td>
<td>0.38</td>
</tr>
<tr>
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<td>1</td>
<td>0.07</td>
<td>0.38</td>
</tr>
<tr>
<td>STPI</td>
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<td>1</td>
<td>0.07</td>
<td>0.38</td>
</tr>
<tr>
<td>SUBTOTAL</td>
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<td>3</td>
<td>0.21</td>
<td>1.14</td>
</tr>
<tr>
<td>Shubs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATCO</td>
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</tr>
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<td>0.67</td>
<td>3.8</td>
</tr>
<tr>
<td>ERIOG</td>
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<td>10</td>
<td>0.67</td>
<td>3.8</td>
</tr>
<tr>
<td>CHVI</td>
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<td>1</td>
<td>0.07</td>
<td>0.38</td>
</tr>
<tr>
<td>EPVI</td>
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<td>1</td>
<td>0.07</td>
<td>0.38</td>
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<td>263</td>
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<td>100</td>
</tr>
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N = 15; Mean = 17.53; SD = 4.53; Nm 90/10 = 18.07; Nm 80/10 = 10.98
### TABLE 321.1001
Saltbush Vegetation Type Predisturbance Woody Plant Density

<table>
<thead>
<tr>
<th>Species</th>
<th>Transect (# plants /m²)</th>
<th>TOTAL</th>
<th>AVERAGE</th>
<th>COMP.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATCO</td>
<td>0.2 0.2 0.1 0.1 0 0 0 0 0.2 0 0 0 0 0 0 0 0 1 0 1 1 0 0 0 0 0 0 0 0 0</td>
<td>6.36</td>
<td>0.227</td>
<td>38.69</td>
</tr>
<tr>
<td>ARLO</td>
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<td>3.38</td>
<td>0.121</td>
<td>20.56</td>
</tr>
<tr>
<td>ATGAC</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>2.92</td>
<td>0.104</td>
<td>17.76</td>
</tr>
<tr>
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<td>1.26</td>
<td>0.045</td>
<td>7.66</td>
</tr>
<tr>
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<td>0.78</td>
<td>0.029</td>
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<td>CEMO</td>
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<td>0.026</td>
<td>4.38</td>
</tr>
<tr>
<td>TARA</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0.4</td>
<td>0.014</td>
<td>2.34</td>
</tr>
<tr>
<td>AMUT</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0.26</td>
<td>0.009</td>
<td>1.58</td>
</tr>
<tr>
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<td>0.16</td>
<td>0.006</td>
<td>0.97</td>
</tr>
<tr>
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<td>0.1</td>
<td>0.004</td>
<td>0.61</td>
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<tr>
<td>JUOS</td>
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<td>0.003</td>
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<tr>
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<td>0.02</td>
<td>0.001</td>
<td>0.12</td>
</tr>
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</table>

N = 28, X = 588; SD = 215; Nm 90/10 = 36.18; Nm 80/10 = 21.97

Exhibit 321.100a
<table>
<thead>
<tr>
<th>Species</th>
<th>Transect (# plants/m²)</th>
<th>TOTAL</th>
<th>MEAN</th>
<th>COMP.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATCO</td>
<td>0.37 0.4 0.1 0.5 0.7 0.6 0 0.8 0.6 0.4 0 0 0 0.1 0.2 0.2 0.2 0.1</td>
<td>7.82</td>
<td>0.391</td>
<td>64.16</td>
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<tr>
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<td>1.31</td>
<td>0.066</td>
<td>10.75</td>
</tr>
<tr>
<td>ERIOG</td>
<td>0.07 0 0 0 0 0 0 0 0 2 0.3 0 0 0 0 0 0 0 0</td>
<td>1.18</td>
<td>0.059</td>
<td>9.68</td>
</tr>
<tr>
<td>ATGAC</td>
<td>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>1.31</td>
<td>0.066</td>
<td>10.75</td>
</tr>
<tr>
<td>CHVI</td>
<td>0.01 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
<td>0.27</td>
<td>0.014</td>
<td>2.21</td>
</tr>
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<td>34</td>
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N = 12; Mean = 22.50; SD = 4.52; Nm 90/10 = 10.92; Nm 80/10 = 6.63

| Trees (#/200m²) |   |   |   |   |   |   |   |   |   |    |    |    |        |         |       |
|-----------------|---|---|---|---|---|---|---|---|---|----|----|----|        |         |       |
| POTR            | 22| 24| 22| 22| 18| 25| 24| 24| 24| 21 | 23 | 19 | 0      | 244     | 22.18 |
| SAMB            | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0  | 0  | 5   | 5      | 0.45    | 1.99  |
| **TOTAL**       | 25| 24| 24| 22| 18| 25| 24| 24| 24| 21 | 23 | 19 | 0      | 249     | 22.64 |

N = 12; Mean = 22.64; SD = 2.38; Nm 90/10 = 2.99; Nm 80/10 = 1.82
**TABLE 322.200a**
Mammals that occur or are likely to occur on the CPMC Permit Area.

<table>
<thead>
<tr>
<th>Species</th>
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<th>Scientific name</th>
<th>Relative Status</th>
<th>Relative Abundance</th>
<th>Habitat Preference</th>
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**KEY**

**STATUS**
- **PO** = Potential
- **L** = Likely
- **S** = Summer
- **W** = Winter

**RELATIVE**
- **PR** = Present
- **O** = Observed
- **R** = Resident
- **M** = Migrant

**ABUNDANCE**
- **C** = Common
- **R** = Rare
- **U** = Uncommon
- **I** = Irregular
- **E** = Endangered

Exhibit 322.200a
Table 322.200b
Birds That are Occur or are Likely to Occur on the CPMC Permit Area.

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<th>Species</th>
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<th>Scientific Name</th>
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<td>O/S</td>
<td>C</td>
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<td>M. melodia</td>
<td>O/R</td>
<td>C</td>
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<td>E = Endangered</td>
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13 Exhibit 322.200a
### Table 322.200c
Reptiles and Amphibians that occur or are likely to occur on the CPMC Permit Area.

<table>
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<tr>
<th>Common Name</th>
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<th>Status</th>
<th>Relative Abundance</th>
<th>Habitat Preference</th>
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<td>U</td>
<td>Conifers, Sagebrush</td>
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<td><strong>BUFONIDAE</strong></td>
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<td>U</td>
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<td>Pseudacris triseriata</td>
<td>O</td>
<td>U</td>
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<td>C</td>
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<td>C</td>
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**CROTALIDAE**

| Western Rattlesnake          | Crotalus viridis      | L/S    | C,R                | Rocky or | Open Areas |

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Exhibit 322.200a
### TABLE 322.200d
Estimated Population Densities

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* See Terrestrial Resources, Methodology, for a description of transects.
### TABLE 322.200e
Impacts of Mining on High Interest Mammals

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19 Exhibit 322.200a
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Raptor Nest Sites Activity (Continued)

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* Peregrine Falcon observed nesting in 1996 through 1999 where Prairie Falcon previously nested. DWR stated that they did not find Peregrine during 2000 monitoring, conducted during River Gas’s Survey.

A - ACTIVE    N - NO NEST    IY - NUMBER OF YOUNG D - DILAPIDATED
I - INACTIVE IN - INCUBATING OR PROTECTING YOUNG
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Raptor Nest Sites Activity (Continued)

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* Peregrine Falcon observed nesting in 1996 through 1999 where Prairie Falcon previously nested. DWR stated that they did not find Peregrine during 2000 monitoring, conducted during River Gas's Survey.

A - ACTIVE    N - NO NEST    IY - NUMBER OF YOUNG    D - DILAPIDATED
I - INACTIVE  IN - INCUBATING OR PROTECTING YOUNG

Exhibit 322.200a
Table 322.220a
Relative Biological Value of Special Concern Animals by Habitat Type within the CPMC Permit Area.

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**KEY**
- C = Critical
- H = High Priority
- S = Substantial
- L = Limited
GOLDEN EAGLE (AQUILA CHRYSAETOS) POPULATION ECOLOGY IN EASTERN UTAH

J. William Bates and Miles O. Moretti

Reprinted from the GREAT BASIN NATURALIST Volume 54, No. 3 July 1994
GOLDEN EAGLE (AQUILA CHRYSAETOS) POPULATION ECOLOGY IN EASTERN UTAH

J. William Bates1 and Miles O. Moretti1

ABSTRACT—Golden Eagle population ecology was studied from 1982 to 1992 in eastern Utah where over 47% of 233 territories monitored during the study period were active. Golden Eagle use of four habitat types was compared. Talus territories were used less often than expected; valley, aspen-conifer, and pinyon-juniper territories were used as expected. Number of young produced per territory averaged 0.612 and was correlated with rabbit abundance. Observations on the impacts of coal mining at two locations are discussed.

Key words: Aquila chrysaetos, Golden Eagle, population, habitat use, prey relationships.

The Golden Eagle (Aquila chrysaetos) is a year-round resident of eastern Utah but is most common during the nesting season. Golden Eagle nests in the area are found at elevations of 1546 m (5070 ft) to 3000 m (9800 ft). Most are located on cliffs, while others are located in cottonwood (Populus fremontii) and Douglas fir (Pseudotsuga menziesii) trees. Golden Eagle eyries are found in riparian areas, shadscale-clay hills, pinyon-juniper (Pinus edulis, Juniperus osteosperma), and mixed aspen-conifer.

Many nests are located on prominent escarpments found in the Castle Valley area. These escarpments are part of the Castle Gate and Hiawatha formations, which are rich in coal deposits (McGregor 1985). Coal mining is a major industry in the area, and mining activities have the potential to impact nesting Golden Eagles. As a result, federal land-management agencies have required mining companies to monitor eagle nests on their properties.

The primary objective of this project was to monitor Golden Eagle and eagle prey populations in a variety of habitats in eastern Utah. The secondary objective was to summarize data collected by mining companies required to monitor raptor nests.

STUDY AREA

Golden Eagle nests monitored during this study were located in Carbon and Emery counties in eastern Utah (Fig. 1). The study area includes territories from Scofield and Emma Park south to Quitchipah Creek, and from Horse Canyon on the east to Huntington Canyon on the west. Elevations in the study area range from 1546 m (5070 ft) to 3000 m (9800 ft). Vegetative zones include riparian, saltbush (Atriplex sp.), sagebrush (Artemisia sp.), pinyon-juniper (Pinus edulis, Juniperus osteosperma), and mixed aspen-conifer.

The study area was classified into four habitat types that typify eagle use in the area: (1) valley territories, located on saltbush flats, on clay hills, or along riparian areas, with nests in cottonwood trees, on conglomerate pinnacles, or on clay ledges; (2) pinyon-juniper territories, with nests found on sandstone cliffs; (3) talus territories, where eyries were located on thick sandstone cliffs; and (4) aspen-conifer territories, where one nest was located in a Douglas fir and all others were on sandstone cliffs.

METHODS

The U.S. Fish and Wildlife Service, in cooperation with the Utah Division of Wildlife Resources (UDWR), conducted extensive helicopter surveys in 1981 and 1982 to locate Golden Eagle nests in the area. Over 250 nests were located and monitored during these surveys. Beginning in 1986 several mining companies were required to monitor approximately 26 territories within a 10-mile radius of the areas affected by mining to assess the impacts of coal mining on the local Golden Eagle population. In 1990 the UDWR began monitoring...
an additional 13 territories beyond the 10-mile radius impact area. A total of 39 territories were monitored in 1992.

A Bell Jet Ranger helicopter with a pilot and two observers was used to check all known nests in the area affected by mining. Previously unknown nests occasionally were found and recorded during these flights. Normally, the helicopter was able to fly close enough to allow direct observation of the nest. Adult eagles usually would remain in the nest as the helicopter passed, although occasionally they flushed. Adult eagles also left the nest area when they were viewed from the ground.

Eyries in nonimpacted areas were observed from a distance to determine whether eagles were present. If adult eagles, greenery, or fresh mutes were present, the nest site was classified as occupied. If young or eggs were present, it was classified as active. The nest was classified as inactive if no sign of eagle use was present. If eggs were present but failed to hatch, or if all nestlings were observed to die before fledging, it was classified as failed. Due to commitments to other projects, we had insufficient time to return to each territory to determine the number of successfully fledged young. Therefore, these data cannot be interpreted to indicate Golden Eagle recruitment or nesting success.

Rabbit populations were monitored in the area to determine prey base trends during 1986–91. Eleven 5-mile transects were completed each year in the study area. Transects were conducted just after dusk or just before dawn by mounting a spotlight on a vehicle and recording all rabbits seen on one side of the road. Transects were completed in desert shrub, pinyon-juniper, sagebrush, and aspen-conifer habitat types.

Data were analyzed using descriptive statistics, contingency table analysis, and linear regression in the Number Cruncher Statistical System (Hintze 1990). The Bonferroni Z test (Neu et al. 1974) was used to analyze utilization data.

**RESULTS**

**Habitat Use**

Of 233 Golden Eagle territories checked from 1981 to 1992 (average/year = 26), 109 (47%) were active and produced young. Almost 78% of the territories were occupied. The year with the most active territories (56%) was 1990 (Fig. 2). In that same year 94% of monitored territories were occupied. The year with the fewest known active territories (33%) was 1988.
Of 185 territories checked in consecutive years, over 28% (52) were active. Five territories were observed to produce young for 3 consecutive years. One territory was active 4 consecutive years, while another produced young 5 consecutive years. One territory failed 3 years in a row. Generally, eagles use different nest sites within the same territory in consecutive years, but in our study eagles used the same nest as the previous year 11 times (21%).

Golden Eagle nesting activity was analyzed by habitat type. A significant difference was found between the four habitat types (chi-square = 20.6, P < .015). The number of active territories in each habitat type was compared to the expected number active using the Bonferroni Z statistic (Neu et al. 1974). Talus territories were active less frequently than expected, accounting for almost 37% of available habitat, but only 24% of active territories (Table 1, Fig. 3). The number of active nests in valley, pinyon-juniper, and aspen-conifer territories did not differ significantly from the number expected.

Talus eyries had their highest incidence of use in 1982, 1987, 1990, and 1991, with over 40% of territories active. In 1989 only one of nine talus territories was active. Over 75% were active in 1986, 1987, 1989, 1991, and 1992. Six of nine were active in 1990, seven of nine in 1991 (although two eyries failed), and seven of nine in 1992. Two or fewer valley territories were checked in 1981, 1982, and 1988. Over 57% of aspen-conifer territories were active each year, with the exception of 1982, 1986, and 1992, when only one of three, one of four, and three of nine, respectively, were active.

Nesting was relatively late in 1991 because of an unusually wet and cold spring; precipitation was 4.34 cm (1.71 in) greater than normal and temperatures were 1.65°C (3°F) cooler than the 30-year average at the Hiawatha weather station. Golden Eagles also showed a shift in habitat use in 1991. All known valley tree nests were active (n = 9). Talus territories were used less than expected and were initiated up to 4 weeks later in 1991 than in 1990. In spite of the cool spring, all four known aspen-conifer territories over 2400 m in elevation near Joe's Valley Reservoir were active and began incubation earlier than lower talus territories and close to the time incubation began at this elevation in previous years.
TABLE 1. Active Golden Eagle eyries by habitat type in eastern Utah, 1982–92.

<table>
<thead>
<tr>
<th>Habitat type</th>
<th>Sample points</th>
<th>Proportion of habitat</th>
<th>Territories active</th>
<th>Expected active</th>
<th>Prop. of active territories</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valley</td>
<td>51</td>
<td>0.219</td>
<td>32</td>
<td>24</td>
<td>0.294</td>
<td>0.196 &lt; p &lt; 0.392</td>
</tr>
<tr>
<td>Pinyon/juniper</td>
<td>41</td>
<td>0.176</td>
<td>22</td>
<td>19</td>
<td>0.202</td>
<td>0.116 &lt; p &lt; 0.288</td>
</tr>
<tr>
<td>Talus</td>
<td>85</td>
<td>0.364</td>
<td>26</td>
<td>40</td>
<td>0.239</td>
<td>0.147 &lt; p &lt; 0.331*</td>
</tr>
<tr>
<td>Aspen/conifer</td>
<td>56</td>
<td>0.241</td>
<td>29</td>
<td>26</td>
<td>0.266</td>
<td>0.171 &lt; p &lt; 0.361</td>
</tr>
<tr>
<td>Total</td>
<td>233</td>
<td></td>
<td>109</td>
<td>109</td>
<td>1.001</td>
<td></td>
</tr>
</tbody>
</table>
* Fewer territories active than expected.

Fig. 3. Active Golden Eagle eyries by habitat type in eastern Utah.

Only 2 of the maximum 39 territories monitored in any one year were documented as being impacted by mining activities. Energy West Mining applied for and received a permit from the U.S. Fish and Wildlife Service to 'take' eagle nests in Newberry Canyon. This was necessary because of coal removal directly under a major escarpment that had four eagle nests on it; a major spauling was a possibility. Plateau Mining faced a similar situation at Star Point and also obtained a U.S. Fish and Wildlife Service permit to take two nests because of escarpment failure.

To keep Golden Eagles from using the two nests at Star Point, both nests were covered with chain-link fencing in 1989. From 1985 to 1988 this territory was active twice, occupied once, and inactive one year. In 1989 the eagle pair built a new nest in a pine tree about 300 m from the cliff nests but produced no young. In 1990 and 1992 the pair used an alternative cliff nest about 500 m from the fenced cliff nests and produced one young each year. In 1992 this nest was tended, but nesting did not occur. This territory produced young 2 of 4 years before and 2 of 4 years after the nests were fenced.

Escarpment failure in Newberry Canyon resulted in the loss of three nests in 1989. One nest remained in 1989 and was used to produce one young. This nest fell before the spring of 1990. This territory produced young...
2 of 4 years before the nests were lost and 1 of 4 years after the escarpment failure. Five other Golden Eagle territories are located within 8 km airline distance of Newberry Canyon. These territories produced young 39% of the time before the spauling, compared to 55% after. Although Newberry Canyon territory was not active again until 1993, these territories averaged 2.25 pairs active/year producing young before the nests fell, and 3 active/year after the spauling.

Productivity

Rabbit transects were conducted in the area from 1986 to 1991 (Bates 1989). Data on rabbit populations prior to 1986 are available through harvest statistics compiled by the UDWR (Mitchell and Roberson 1992). Number of cottontail rabbits harvested per hunter day was highest in 1982 and declined dramatically in 1984 (Table 2). Rabbit populations remained low until 1987, when they began to increase.

Average number of eaglets produced per territory was 0.612 (SE = 0.059) over the period 1981–92. Number of young produced per territory was above average in 1982, 1989, 1990, and 1991 (Fig. 4), although there was not a significant difference in number of young produced among years (P = .27). Except for 1991, these years coincided with increased rabbit populations (Table 2). Years with the highest number of young produced per active territory were 1982 and 1989, which were years with peak rabbit numbers. Although, based on transects, rabbit populations declined in 1990 and 1991, the number of young per territory was above average (Fig. 4) because the percentage of active territories was above average (Fig. 2).

<table>
<thead>
<tr>
<th>Year</th>
<th>Cottontails per hunter day</th>
<th>Cottontails and jackrabbits/mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982</td>
<td>1.81</td>
<td></td>
</tr>
<tr>
<td>1983</td>
<td>1.79</td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>1986</td>
<td>0.93</td>
<td>0.17</td>
</tr>
<tr>
<td>1987</td>
<td>1.37</td>
<td>0.39</td>
</tr>
<tr>
<td>1988</td>
<td>1.55</td>
<td>0.75</td>
</tr>
<tr>
<td>1989</td>
<td>0.93</td>
<td>0.86</td>
</tr>
<tr>
<td>1990</td>
<td>1.28</td>
<td>0.56</td>
</tr>
<tr>
<td>1991</td>
<td>1.5</td>
<td>0.43</td>
</tr>
</tbody>
</table>

Fig. 4. Average number of young per territory in eastern Utah.
Linear regression was used to determine if there was a relationship between number of rabbits seen per mile during rabbit transects in 1986–91 and number of eaglets per territory. A weak relationship was found ($R^2 = .33, P = .24$), indicating that part of the variability in Golden Eagle productivity was explained by rabbit population levels. The data indicated a lag effect, with productivity higher the year after rabbit populations increased (Fig. 5). By using linear regression to test this hypothesis, we found a near-significant relationship between number of rabbits the previous year and number of eaglets per territory ($R^2 = .63, P = .058$; Fig. 6). A significant relationship was also found between number of rabbits/mile and number of young produced per active territory in the same year, indicating higher production in years when rabbits were more abundant ($R^2 = .83, P = .01$; Fig. 7). These data demonstrate that Golden Eagles produce more young in the same year that rabbit populations increase, but a higher proportion of territories are active the year following an increase in rabbits (Fig. 5).

**DISCUSSION**

Number of young produced per territory and proportion of active territories in southeastern Utah were similar to those of other studies. Phillips et al. (1990) found 0.78 young produced per occupied territory in Montana and Wyoming from 1975 to 1985, compared to 0.82 in this study. They also found 1.46 young produced per successful territory, compared to 1.39 per active eyrie in this study. Results from southeastern Utah are inflated as the Phillips study was based on number of fledged birds and this study recorded only the number present in nests. However, most eaglets in this study were approaching fledging age when observed. Murphy (1975) found 0.69 young fledged per occupied territory in central Utah.

Number of eaglets produced was associated with rabbit population densities in the study area. Although other prey, such as white-tailed prairie dogs, are available, correlations with rabbit populations were quite high.

High rabbit populations seemed to influence Golden Eagle nesting in two ways. First, number of young produced per active nest was
affected by number of rabbits in the area that year; i.e., more eaglets were produced in years with higher rabbit populations. This relationship has also been found in other studies (Murphy 1975, Phillips et al. 1990). Second, there appeared to be a lag effect on number of eagles that attempted to nest. There was a significant correlation between number of young produced per territory and number of rabbits the previous year. High rabbit populations may have allowed more pairs in the area to nest, or enticed more eagles into the area, resulting in an increased number of active territories.

Use of valley territories increased in years with higher rabbit populations. Golden Eagles may have selected nest location to minimize the energy required to obtain food. In years with higher rabbit populations, eagles may have spent more time hunting in valley locations. The 2 years with the fewest active talus eyries, 1988 and 1989, were years of relatively high rabbit abundance. Eagles possibly avoided talus eyries in years of high rabbit populations because they were too far from an abundant food source. In years with fewer cotton-tail and jackrabbits they may have used these territories to take advantage of other prey, such as snowshoe hares or woodrats.

Data on mining impacts caused by cliff spaulings are too few to draw empirical conclusions. However, we offer some observations. When ample suitable habitat is nearby, there appeared to be no net loss in production. The territory at Star Point was active 2 of 4 years before and after the escarpment failure. Although the pair at Newberry Canyon did not re-nest in the canyon for 3 years after the original nests fell, they may have been using alternate nests of adjoining pairs. The five territories in the area averaged 2.25 pairs active/year before and 3 active/year after the escarpment failure.

In consideration of these observations, we offer several recommendations to protect against loss of birds or territories. First, if spauling can be controlled, it should be done in the nonnesting season. Otherwise, physically fencing may help prevent loss of nestlings. The two fenced nests were not used; however, the pair built a new nest below a fenced nest on a cliff that was failing. The pair did not attempt to raise young in that nest. Second, there must be ample suitable nesting habitat to allow other nests to be built. In Newberry Canyon a sheer wall was the result of escarpment failure and may not provide suitable nesting structure. This pair built a new nest 150 m east of a
Fig. 7. Eaglets per active eyrie as a function of rabbits, eastern Utah.

fallen nest on a ledge that did not fail. Loss of nesting structure could be a consideration in areas with limited cliff habitat where the whole face fails.

ACKNOWLEDGMENTS

We thank Energy West Mining and Cyprus Plateau Mining for providing helicopter flight time to obtain much of these data. We also extend special thanks to V. Payne and B. Grimes for their interest and support. J. Bingham of Helicopter Services proved to be a skilled pilot and a valuable observer. Appreciation is also given to E. Howe and J. Felice for reviewing this manuscript.

LITERATURE CITED


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Exhibit
322.210a
25 April, 2000

Johnny Pappas
Sr. Environmental Engineer
Plateau Mining Corp Willow Creek Mine
847 NW Hwy 191
Helper, UT 84526

RE: Authorization to discontinue Raptor Surveys at the Star Point Mine.

Dear Johnny,

The Utah Division of Wildlife Resources (UDWR) has appreciated the raptor monitoring that Plateau Mining Corporation has done at the Star Point Mine. If mine portal reclamation is conducted after July 15th (typical fledging date of raptors in the area), we feel that raptor monitoring can be discontinued at the Star Point Mine. The Star Point peregrine eyrie will be monitored during the River Gas Corporation in the future.

If you have any questions about future wildlife stipulations or raptor monitoring, please contact Chris Colt at 435-636-0279.

Sincerely,

Miles Moretti
Regional Supervisor
PLATEAU MINING CORPORATION

April 10, 2000

Mr. Chris Colt
Division of Wildlife Resources
475 West Price River Drive, Suite C
Price, Utah 84501

RE: Discontinuation of Raptor Surveys, Star Point Mine, ACT/007/006, Plateau Mining Corporation, Carbon County, Utah

Dear Mr. Colt:

Plateau Mining Corporation (PMC) is requesting authorization to discontinue raptor surveying at its Star Point Mine now that it has ceased mining operations as of February 11, 2000. Prior to that time, PMC conducted raptor surveys of all cliff faces, including those not affected by active mining operations. The Star Point permit states that annual raptor surveys are conducted to study the effects of the operation on birds of prey in the area. Therefore, since the only operational activity to be conducted at the mine is reclamation related, PMC does not see the need to conduct further raptor surveys.

 PMC believes that it has done more surveys than actually necessary, and that the nests of particular interest, i.e., peregrine falcon and golden eagle, are being surveyed, for the most part, by the active coal bed methane projects in the area. As you may recall, you and River Gas Corporation were unable to locate the peregrine falcon nest, and it wasn’t until you and I did the Star Point survey that I showed you the location of the nesting peregrine.

PMC is planning to initiate reclamation activities sometime in July, on its Corner Canyon and Mudwater Canyon Fan sites. During the 1999 raptor survey, eagle nests were located in both Canyons, but are far removed from where the active reclamation is scheduled. In addition to being at least one mile away, there is no direct line of sight from the nests to the working areas.

Reclamation activities will begin at the Corner Canyon fan with the disassembling of the fan facility and retrieval through the mine. Once the fan is disassembled and recovered, work will initiate on the Mudwater fan.

Once the fan sites are reclaimed and mine portals sealed this year, reclamation activities will then commence in 2001 on the surface facilities associated with the Star Point Mine. All reclamation activities associated with the surface facilities are at least one mile away from the nearest nest and not in any line of sight.
If you have any questions or need additional information, please do not hesitate to contact me at 472-4741.

Sincerely,

Johnny Pappas
Sr. Environmental Engineer

cc: Bill Malencik - DOGM
Map 322.200a

WILDLIFE HABITAT TYPE

Moved to "Confidential Permit Information"
CHAPTER X

AQUATIC RESOURCES OF
PLATEAU MINE PERMIT AREA

9 DECEMBER 1980

prepared for

Kaiser Engineers, Inc.
300 Lakeside Drive
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Oakland, California 94623

prepared by:

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Environmental Consultants
483 East 1834 South
Orem, Utah 84057
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10.1 SCOPE

The selected property designated as the Plateau Mining Company's Starpoint Mine is located within T 15 S and R 7 and 8 E, Wattis, Utah, USGS quadrangle (map N3930-W1100/75, 1979). This area includes the headwaters of 2 small perennial streams - Miller and Tie Fork Creeks. Other streams in the immediate permit area are intermittent (dry at least part of most years) and of low water quality. No surface waters in the permit area are considered as important game fisheries resources by the Utah Division of Wildlife Resources. Tie Fork Creek is important as a tributary to a quality trout stream, Huntington Creek, and as such should be protected from any water quality or physical degradation.

The following aquatic resource descriptions address: 1) Miller Creek using information from a 1976 study (Southeast Association of Governments; 208 water quality study, by Vaughn Hansen Associates) and a 1979 study (USBLM water quality study of the EMRIA fossil fuel lease lands, by GeoScientific); and 2) Tie Fork Creek using information from a 1971 survey (UP&L Company Huntington Canyon Generating Station impact study, by BYU Aquatic Ecology Laboratory) and a 1980 survey as part of this report. Water quality, physical habitat and stream biota are all important components of aquatic resources.

Water quality and hydrology are discussed in more detail in another chapter. In this chapter resource quality is based mainly upon aquatic macroinvertebrate community data with water quality and habitat descriptions used in a supporting role.

Even in streams not capable of supporting fisheries, stream macroinvertebrates are excellent indicators of stream quality (Cairns, 1970, 1977; Cairns, Dickson and Herricks, 1975; Cairns, Lanza, Sparks and Waller, 1973; Ghetti and Bonazzi, 1977; Hunt, 1976; Olive, 1976; Reichert, 1973; Resh and Unzicker, 1975; Wilhm and Dorris, 1968). Aquatic macroinvertebrate taxa each respond to environmental conditions according to their individual morphology, physiology and behavior. Differences in macroinvertebrate communities result from differences in water quality (Altman and Dittmer, 1966; Cairns, Dickson and Herricks, 1977; Hart and Fuller, 1974; Hynes, 1961; Macan, 1974); water temperature (Altman and Dittmer, 1966; AFS, 1976; Hooper, 1973; Hynes, 1972; Jones, 1972; Williams and Winget, 1979); upstream land and/or water use (Bakke, 1977; Cairns et al., 1975; Platts, 1979; Ringler and Hall, 1975); stream gradient and/or elevation (Baumann, Gaufin and Surdick, 1977; Hynes, 1972; Macan, 1973; Reice, 1977; Stoneburner, 1977; STout and Vandermeer, 1975); or a combination of these and other factors. The range of environmental conditions each taxon can inhabit has been called that taxon's niche width or breadth (Colwell and Futuyma, 1971; Pielou, 1972).
Stream quality characteristics are often not fully or accurately evaluated using physical or chemical analyses alone. Biological evaluations using macroinvertebrates verify a stream's quality by defining the stream's suitability for supporting life, including a trout fishery. The biota are also the best indicators of subtle changes over time in water quality or physical stream habitat, including reduced flows, increased sedimentation or degraded water quality.
10.2 METHODOLOGY

**Miller Creek**

The aquatic resource description of Miller Creek consists of a review of available information from previous surveys. Water quality determinations were conducted by certified laboratories (Ford Chemical and BYU Environmental Analysis Laboratories). Biological samples were taken (1976 and 1979) with a modified Surber sampler (Figure 1) according to standard methods (stratified random method, EPA, 1973). Analyses of data were made by the Aquatic Ecology Laboratory under the direction of Dr. Robert N. Winget, Department of Zoology, Brigham Young University. Sampling station locations are shown in Figures 2 and 3: Station MC1 - Miller Creek at U-10 bridge; Station MC2 - Miller Creek at Wattis Bridge; Station MC3 - Miller Creek above Hiawatha, Utah and below mouth of Middle Fork.

**Tie Fork Creek**

Tie Fork Creek is the combination of Gentry Hollow and Wild Cattle Hollow Forks, both arising within possible future subsidence areas. Impacts on either fork should show up as impacts on the community of Tie Fork Creek below their confluence. Since this stream has little potential of being impacted, at least in the near future, only Station TF01 (Figure 4) was selected for the present study.

Aquatic macroinvertebrate samples were taken using a modified Surber sampler (Figure 1) using the stratified random method (EPA, 1973). Four replicate samples were taken on 30 October 1980. Stream habitat condition was assessed using a combination of US Forest Service, Intermountain Region and Utah State Office, USBLM stream survey methods. Stream channel width; water width, depth and velocity; total channel width; bank stability, gradient, vegetative type and cover; channel substrate composition; stream gradient; ungulate damage; riparian zone width; and percent stream shaded were all evaluated and recorded.

Aquatic macroinvertebrate samples taken from Tie Fork Creek in 1971 were taken at a point near the mouth of the stream before it entered Huntington Creek. Data from these samples are used in this report only to compare the community of the stream in 1971 with that of 1980. 1971 data are presented merely as presence or absence of taxa rather than quantified densities (Table 3).
10.3 EXISTING FISH AND WILDLIFE RESOURCES

10.3.2.1 AQUATIC WILDLIFE AND HABITAT AND VALUE DETERMINATION

Miller Creek

Miller Creek below Hiawatha has a wide stream channel (mean width 23 ft) and on 8 April 1976 water width was only 8 feet with a mean depth of less than 0.3 ft. Stream substrates were relatively evenly distributed over rubble, gravel, sand and silt. There was a considerable amount of coal dust evident in the substrate materials. Stream banks were moderately stable with sparse willow and grass cover.

Water quality in Miller Creek was very poor in 1976 and 1979 with TDS ranging from 2,000 to over 6,000 mg/l. Sulfate levels ranged from 1,100 to over 3,800 mg/l. Dissolved oxygen was always high but BOD was from 1 to 2 mg/l, oxygen was maintained by turbulence of the water. The high levels of dissolved solids comes from the Mancos Shale formations at the stream source and along a considerable portion of its reach. Ammonia nitrogen was present on several occasions in excess of 7 mg/l. During 1976 nitrate nitrogen levels ranged from 0.4 to 1.4 mg/l N and phosphorous levels in the form of ortho-phosphorous were as high as 0.2 mg/l. This coupled with high levels of total and fecal coliform bacteria (>1,000 and >70 MPN/100ml, respectively) indicated a strong source of organic pollution tied in closely to fecal contamination. In 1979 there was less evidence of organic pollution in Miller's Creek — lower numbers of bacteria.

Station MCI. Macroinvertebrate samples taken on 8 April 1976 showed an extremely high dominance by chironomid midge larvae with numbers of 11,800/m² (Table 1). The next dominant form was oligochaete worms, at 344/m². The community at this station was definitely under heavy stress.

In August 1979 there were 12 taxa of aquatic macroinvertebrates collected (Table 1) — all tolerant to sedimentation and moderately poor water quality. Chironomids were the dominant taxa collected as during 1976 but the low numbers indicated less organic enrichment in 1979 or some physical factor/s was limiting the numbers of macroinvertebrates.

This stream section has historically been under both water quality and habitat stress from natural as well as man caused factors. Potential for improvement is almost non-existent due to the extensive Mancos Shale and related formations of the area and limited water resources.

Station MC2. Miller Creek at Wattis Bridge had 16 taxa of aquatic macroinvertebrates in samples collected August 1979 (Table 1). All of the taxa sampled are tolerant to
sedimentation and moderate to poor water quality. The mean number/m² was only 847 which is quite low even for a small stream. This indicates that this stream has been under stress probably from low flows in the summer/fall/winter, scouring spring flows, sedimentation, low gradient including low water velocity, and a lack of quality riffle habitat in most of the stream. This was indicated by the presence of stratiomyids, ceratopogonids and oligochaetes. Compared with Station MCl, this station was somewhat better biologically speaking but still poor quality.

Station MC3. The aquatic macroinvertebrate samples taken from this station on 8 April 1976 had approximately equal dominance by oligochaete worms and chironomid midge larvae, together comprising over 88% of the total number (Table 1). The mayfly Baetis was next in abundance. Dominance by any of these 3 taxa is indicative of a stressed situation and their high numbers would indicate heavy organic enrichment as well a significant siltation of the stream.

This station, like the lower stations on Miller Creek has been, and still is, under stress from both poor water quality and habitat.

Tie Fork Creek

Tie Fork Creek in the region of the confluence of Gentry and Wild Cattle Hollow shows signs of habitat stress - steep stream banks with sloughing of bank materials common. Stream banks in some areas are as high as 30 to 40 feet vertical with no vegetative cover. There are areas where past sloughs had occurred but vegetative cover has become established indicating an improving condition. The forest service has reduced allowable cattle days/acre in several areas of the Manti LaSal National Forest -- e.g. upper Huntington Canyon is in much better condition than it was 10 years ago through improved range management. This could be the case in Tie Fork Canyon accounting for the evident healing of stream banks in some areas.

Water quality at Station TF01 (Figure 4) is reportedly good quality with TDS less than 300 mg/l and sulfate less than 50 mg/l (personal communication with Vaughn Hansen). The taxa of aquatic macroinvertebrates collected from the stream, both in 1971 and 1980, confirm this conclusion (Table 3) with several taxa each of mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) commonly collected. Near the mouth of Tie Fork Creek several low quality ground water discharges enter Tie Fork causing a deterioration of water quality. The area affected is small enough that the biotic community does not show significant impacts from these small springs.

Table 2 presents a summary of habitat characteristics for Tie Fork Creek at Station TF01. Of special interest is
the relative lack of sands and silts considering the significant areas of unstable stream banks. The healing of the erosional scars has reduced the sediment input to the stream and the high stream gradient (4% average slope) allows water velocities great enough to carry sediments out of the canyon keeping substrates relatively clean. It is obvious that size (amount of water discharge) is presently the major factor preventing a quality fishery from becoming established in Tie Fork Creek.

As shown in Table 3, the macroinvertebrate community sampled in 1971 and 1980 was a highly diverse community with many representatives of all major groups present in all sample sets. Table 4 gives quantitative density values for each taxon collected on 30 October 1980. Note the high numbers compared with the 1979 Miller Creek samples. *Baetis* and chironomids were dominant illustrating the stress from flow extremes - low summer/fall/winter flows and scouring spring flows.

Also given in Table 4 are TQ values or tolerance quotients for each taxon of a community. The tolerance quotient is a value assigned each taxon based upon its tolerance and selectivity for various substrate materials, stream gradients, levels of alkalinity and sulfate concentrations. TQ's range from 2 (very fragile, narrow tolerance limits) to 108 (wide tolerance limits for all 4 parameters). Note the presence of several fragile taxa (TQ's of 6, 16, 18, 21, and 24) indicating good water quality and relatively good habitat, at least in specific areas if not generally throughout the stream.

At the bottom of the Table 4 are 3 values, CTQ_a, CTQ_p and BCI. The CTQ_a is the arithmetic mean of the tolerance quotients (TQ) of the actual taxa of macroinvertebrates sampled from the stream station on the given date. The higher the CTQ_a value the larger the ratio of tolerant species to more environmentally fragile species. The CTQ_p is a predicted community tolerance quotient indicating what can be expected from a community inhabiting a stream such as Tie Fork Creek. The BCI is merely an indication of percent of predicted for the actual community. Thus on 30 October 1980, the condition of the aquatic community sampled was 90 percent of the predicted potential, given existing water quality and habitat characteristics. The TQ, CTQ_a and CTQ_p was taken from a US Forest Service publication authored by Winget and Mangum (1979).
10.3.3 SPECIES OF SPECIAL SIGNIFICANCE

10.3.3.1 THREATENED AND ENDANGERED SPECIES

Official USF&WS Section 7 opinions relating to the aquatic resources of Huntington and Eccles Canyon drainages have indicated that no threatened or endangered species of fish or other aquatic organisms have been found in waters upstream of the lowest 2 or 3 miles of the Price or San Rafael Rivers. The organisms of Miller Creek, as presently known are all common and widely distributed throughout streams of Utah. The aquatic organisms of Tie Fork Creek have representatives of several taxa limited to high quality environs, but none, as far as is presently known, are rare in the intermountain region.

10.4 EXPECTED IMPACTS OF MINING OPERATIONS ON FISH AND AQUATIC WILDLIFE

The Plateau is an existing mine and as such should have no additional impacts on Miller Creek. Miller Creek is of little value to the aquatic resources of the area, natural conditions would be stressful to the aquatic life of Miller Creek even if existing mining activities were removed.

Tie Fork Creek is a quality stream and as such should be protected from impacts of the Plateau Mine Project. The only foreseeable impact on Tie Fork Creek would be from subsidence of source aquifers causing a reduction in the total flow of Tie Fork Creek. There are no planned surface disturbances adjacent to Tie Fork Creek or its tributaries so added sedimentation should not be a problem. Subsidence, if it should occur, would not happen for several years in the Tie Fork drainage area.
10.5 MITIGATION AND MANAGEMENT PLANS

Since no impacts are expected to the perennial waters of the Plateau Mine area in the near future, no special mitigation plan concerning Miller or Tie Fork Creek is presented here. Tie Fork will be monitored for habitat value and biotic community condition for the next 2 years, spring and fall samplings, in order to acquire a baseline description of the resource. This baseline will provide solid grounds for future impact analysis and mitigation planning if the need arises.

10.7 FISH AND WILDLIFE MONITORING

Miller Creek does not warrant a biological or habitat monitoring effort in the area of the Plateau Mine lands.

Tie Fork Creek is a quality stream and as such should have a baseline description of its habitat and biota. Aquatic macroinvertebrate samples will be taken each spring (April-May) and fall (October-November) during 1981 and 1982. Habitat measurements as presented in Table 2 of this report will be made at the same time as the biological samples. Data collected will be correlated with water quality and hydrology measurements discussed under another chapter of this report. If subsidence should become evident in the drainage area of Tie Fork Creek in the future, monitoring of aquatic macroinvertebrates and habitat changes will be started again, using previously collected data as the base for impact evaluation. Beginning the spring of 1981, two new sampling stations will be established to replace TF01. There will be a station each established on Gentry Hollow and Wild Cattle Hollow near the confluence. Since other projects in the area may impact Tie Fork Creek before the Plateau Mine extends into Tie Fork drainage, baseline data on both forks may prove valuable in assigning sources and extent of impacts as they arise.


Benthic samples were taken with a Surber sampler (Surber, 1937), modified by Winget (1971) as shown. The intake opening is 30 cm (12 inches) wide by 45 cm (18 inches) high and the bag is 91 cm (3 feet) long. The standard Surber sampler is only 30 cm (12 inches) high with a 62 cm (2 feet) long bag. The modified sampler was designed with a larger collecting bag to prevent excessive backwash and loss of contents when collecting in deep, swift streams.

Figure 1. Modified Surber Sampler.
Table 1. Description of the aquatic macroinvertebrate communities of Miller Creek, Carbon County, Utah in April 1976 and August 1979 at 3 stations.

<table>
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<tr>
<th></th>
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<td>Nanatoda</td>
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<td>—</td>
</tr>
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<td>Oligochaeta</td>
<td>—</td>
<td>—</td>
<td>4</td>
<td>—</td>
</tr>
<tr>
<td>Hydracarina</td>
<td>—</td>
<td>—</td>
<td>7</td>
<td>—</td>
</tr>
<tr>
<td>Copepoda</td>
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<td>—</td>
<td>4</td>
<td>—</td>
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<tr>
<td>Ostracoda</td>
<td>—</td>
<td>—</td>
<td>7</td>
<td>—</td>
</tr>
<tr>
<td>Collembola</td>
<td>—</td>
<td>—</td>
<td>4</td>
<td>—</td>
</tr>
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<td>Ephemeroptera</td>
<td>—</td>
<td>—</td>
<td>4</td>
<td>2410</td>
</tr>
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<td>Baetis</td>
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<td>—</td>
<td>4</td>
<td>—</td>
</tr>
<tr>
<td>Tricopterythodes minutus</td>
<td>—</td>
<td>4</td>
<td>4</td>
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<td>Ephemerella</td>
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<td>4</td>
<td>—</td>
<td>—</td>
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<td>—</td>
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<td>Isoperla</td>
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</tr>
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<td>Ambyrus mormon</td>
<td>—</td>
<td>—</td>
<td>4</td>
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<td>Trichoptera</td>
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<td>43</td>
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<td>43</td>
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<td>Hydrotilla</td>
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<tr>
<td>Limnephilidae</td>
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<td>—</td>
<td>—</td>
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<td>Coleoptera</td>
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<tr>
<td>Hydropsorus</td>
<td>—</td>
<td>—</td>
<td>4</td>
<td>—</td>
</tr>
<tr>
<td>Helophorus</td>
<td>—</td>
<td>—</td>
<td>4</td>
<td>—</td>
</tr>
<tr>
<td>Hydreaea</td>
<td>—</td>
<td>—</td>
<td>4</td>
<td>—</td>
</tr>
<tr>
<td>Diptera</td>
<td>—</td>
<td>11</td>
<td>43</td>
<td>11,018</td>
</tr>
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<td>Holorusia grandis</td>
<td>11</td>
<td>—</td>
<td>—</td>
<td>43</td>
</tr>
<tr>
<td>Simuliidae</td>
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<td>—</td>
<td>57</td>
<td>—</td>
</tr>
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<td>233</td>
<td>488</td>
<td>43</td>
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<td>Ceratopogonidae</td>
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<td>11</td>
<td>22</td>
<td>11,018</td>
</tr>
<tr>
<td>Euparyphus</td>
<td>—</td>
<td>—</td>
<td>4</td>
<td>—</td>
</tr>
<tr>
<td>Hemerodromia</td>
<td>108</td>
<td>—</td>
<td>11</td>
<td>—</td>
</tr>
</tbody>
</table>

| mean number/m²           | 12,580             | 336                 | 847                 | 24,577            |
| standard deviation       | —                  | 236                 | 564                 | —                 |
| mean dry wt, g/m²        | —                  | 0.03                | 0.07                | —                 |
| number of taxa           | 8                  | 12                  | 17                  | 10                |
| H (Shannon–Weaver)       | 0.43               | 1.29                | 1.59                | 1.15              |
Table 2. Resource description of Tie Fork Creek, Emery County, Utah, at Stn TF01 on 30 October 1980.

<table>
<thead>
<tr>
<th>Water Surface (Q=0.6 cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean water width: 3.4 ft</td>
</tr>
<tr>
<td>mean water depth: 0.3 ft; range 0.1 to 1.1 ft</td>
</tr>
<tr>
<td>mean water velocity: 0.6 ft/sec; range 0 to 1.4 ft/sec</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total width: mean 14 ft</td>
</tr>
<tr>
<td>Substrates: bedrock</td>
</tr>
<tr>
<td>boulder (&gt;12 in diam) 20%</td>
</tr>
<tr>
<td>rubble (3-12 in diam) 30%</td>
</tr>
<tr>
<td>gravel (.1-3 in diam) 25%</td>
</tr>
<tr>
<td>sand 10%</td>
</tr>
<tr>
<td>silt 5%</td>
</tr>
<tr>
<td>organic debris 15%</td>
</tr>
<tr>
<td>Gradient: mean 4.0%; range 3 to 7%</td>
</tr>
<tr>
<td>Percent Stream Shaded: 45%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Left Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>cover 75%</td>
</tr>
<tr>
<td>stability 75%</td>
</tr>
<tr>
<td>class trees + shrubs</td>
</tr>
<tr>
<td>gradient 24% (20-38%)</td>
</tr>
<tr>
<td>ungulate damage 50%</td>
</tr>
<tr>
<td>riparian zone 11 ft (5-20 ft)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Right Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>cover 75%</td>
</tr>
<tr>
<td>stability 75%</td>
</tr>
<tr>
<td>class shrubs + trees</td>
</tr>
<tr>
<td>gradient 36% (23-48%)</td>
</tr>
<tr>
<td>ungulate damage 50%</td>
</tr>
<tr>
<td>riparian zone 15 ft (5-25 ft)</td>
</tr>
</tbody>
</table>
Table 3. Description of the aquatic macroinvertebrate communities of Tie Fork Creek, Carbon County, Utah, as presence (x) or absence (—) of taxa in samples taken during 1971 (near the mouth of the canyon) and 1980 (below confluence of Gentry and Wild Cattle Hollows).

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Nematoda</td>
<td>—</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Gastropoda</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Pelecypoda</td>
<td>x</td>
<td>—</td>
<td>x</td>
<td>—</td>
</tr>
<tr>
<td>Oligochaeta</td>
<td>x</td>
<td>x</td>
<td>—</td>
<td>x</td>
</tr>
<tr>
<td>Turbellaria</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>x</td>
</tr>
<tr>
<td>Hydracarina</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Copepoda</td>
<td>x</td>
<td>—</td>
<td>x</td>
<td>—</td>
</tr>
<tr>
<td>Ostracoda</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Collombola</td>
<td>—</td>
<td>—</td>
<td>x</td>
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</tr>
<tr>
<td>Ephemeroptera</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Baetis</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Cinygmula</td>
<td>x</td>
<td>—</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Epeorus</td>
<td>—</td>
<td>—</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Paraleptophlebia</td>
<td>x</td>
<td>—</td>
<td>—</td>
<td>x</td>
</tr>
<tr>
<td>Ephemarella grandis</td>
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<td>Ephemarella inermis</td>
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<td>x</td>
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<tr>
<td>Plecoptera</td>
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<td>Carnia</td>
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<td>x</td>
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<tr>
<td>Pteronarcella badia</td>
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<td>—</td>
<td>x</td>
<td>—</td>
</tr>
<tr>
<td>Megarcys signata</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>x</td>
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<tr>
<td>Isogenoides zionensis</td>
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<td>Isoperla</td>
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<tr>
<td>Chloroperlidae</td>
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<td>x</td>
<td>—</td>
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<td>Trichoptera</td>
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<td>x</td>
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<tr>
<td>Hyacophila</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>x</td>
</tr>
<tr>
<td>Hydropsyche</td>
<td>—</td>
<td>—</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Parapsyche</td>
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<td>—</td>
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<td>x</td>
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<tr>
<td>Limnephilidae</td>
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<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Oligophlebodes</td>
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<td>—</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Lepidostoma</td>
<td>—</td>
<td>—</td>
<td>x</td>
<td>—</td>
</tr>
<tr>
<td>Brachycentrus americanus</td>
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<td>—</td>
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<tr>
<td>Micrasema</td>
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Table 3. Continued (Tie Fork Creek, 1971 and 1980)

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<td>Hydrophilidae</td>
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<tr>
<td>Diptera</td>
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<tr>
<td>Tipulidae</td>
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<td>x</td>
</tr>
<tr>
<td>Antocha monticola</td>
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<td>x</td>
</tr>
<tr>
<td>Dicranota</td>
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<td>x</td>
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<tr>
<td>Tipula</td>
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<td>Eriocera</td>
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<td>Pericoma</td>
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<td>Simuliidae</td>
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<td>Chironomidae</td>
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<td>Ruparyphus</td>
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Table 4. Description of the aquatic macroinvertebrate community of Tie Fork Creek, Carbon County, Utah, as mean number/m². Samples were taken on 30 October 1980 below the confluence of Gentry and Wild Cattle Hollows.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>30 Oct 1980</th>
<th>TQ</th>
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</thead>
<tbody>
<tr>
<td>Nematoda</td>
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<tr>
<td>Oligochaeta</td>
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<td>108</td>
</tr>
<tr>
<td>Tubellaria</td>
<td>237</td>
<td>108</td>
</tr>
<tr>
<td>Hydracarina</td>
<td>659</td>
<td>108</td>
</tr>
<tr>
<td>Ostracoda</td>
<td>65</td>
<td>108</td>
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<tr>
<td>Ephemeroptera</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baetis</td>
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<td>72</td>
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<td>Cinygmula</td>
<td>175</td>
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<tr>
<td>Epeorus</td>
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<td>21</td>
</tr>
<tr>
<td>Paraleptophlebia</td>
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<td>24</td>
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<tr>
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mean dry wt, g/m² 1.00
number of taxa 29
H (Shannon-Weaver) 2.48
CTQ 61
CTQa 55
BCP 90
Exhibit
322.220b
AQUATIC RESOURCE DESCRIPTION OF
TIE FORK CREEK AND TRIBUTARY STREAMS,
GENTRY AND WILD CATTLE HOLLOWS,
EMERY COUNTY, UTAH

MONITORING RESULTS

8 December 1982

prepared for:
Plateau Mining Company
Post Office Drawer PMC
Price, Utah 84501
P. O. W-26136 (3/22/82)

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INTRODUCTION

This report is an update of a report submitted on 1 March 1982 containing a summary of habitat survey and aquatic macroinvertebrate sampling results from 1980 and 1981 ("Aquatic Resource Description of Tie Fork Creek, Emery County, Utah - 1980 and 1981 Monitoring Results", Winget, R. N. 1982). Due to evidence indicating a degradation trend in the biota of Tie Fork Creek and the two tributaries coming off the Plateau Mine permit area, it was decided that monitoring should continue through 1982. The three sampling points are shown on Figure 1 and are located near the boundary of the property designated as the Plateau Mining Company's Starpoint Mine (located within T 15 S and R 7 and 8 E, Wattis, Utah, USGS quadrangle map N3930-W11100/75, 1979).

Even in streams not capable of supporting fisheries, stream macroinvertebrates are excellent indicators of stream quality. Each taxon of aquatic macroinvertebrate responds to environmental conditions according to its individual morphology, physiology and behavior. Differences in water quality, water temperature, upstream land or water use, elevation, or a combination of these and other factors all influence the structure of the aquatic community at any point in a stream. The range of environmental conditions each taxon can inhabit has been called that taxon's niche width or breadth. In this report the niche width is expressed as the tolerance quotient (TQ) of each taxon as reported by Winget and Mangum (1979) and Winget (1982).
Stream quality characteristics are often not fully or accurately evaluated using physical or chemical analyses alone. Biological evaluations using macroinvertebrates verify a stream's quality by defining the stream's suitability for supporting life, including a trout fishery. The biota are also the best indicators of subtle changes over time in water quality or physical stream habitat, including reduced flows, increased sedimentation or degraded water quality.

The following information will help provide an accurate description of the biota of the streams sampled and will form the basis of future environmental impact assessment.
Tie Fork Creek is the combination of Gentry Hollow and Wild Cattle Hollow Forks, both arising within possible future subsidence areas. Impacts on either fork should show up as impacts on the community of Tie Fork Creek below their confluence, thus Station TF-01 (Figure 1) was selected for the main stream and Stations TF-WCH (Wild Cattle Hollow above confluence with Tie Fork Creek) and TF-GH (Gentry Hollow above confluence with Tie Fork Creek) were chosen to obtain baseline data for both of the tributary streams.

Macroinvertebrate samples were taken using a Surber sampler (Surber 1937) modified by Winget in 1971 (Reichert 1976) as shown in Figure 2. The intake opening was 30 cm (12 in) by 45 cm (18 in) high and the bag was 91 cm (3 ft) long. [The standard Surber sampler is only 3 cm (12 in) high with a 62 cm (2 ft) long bag.] The modified sampler was designed with a larger collecting bag to prevent excessive backwash and loss of contents when collecting in deep, swift streams. The netting used was 280 um mesh, much smaller than that of the standard Surber sampler. The finer mesh allowed collection of smaller instar larvae increasing total numbers and diversity of samples collected.

Sample points were selected in each stream so as to obtain maximum information while minimizing sample variance. The stratified random method described by Weber (1973) in which environmental variance is minimized by selecting for only one habitat type to take samples from was used. Rubble (cobble) riffles were selected as the optimal stream habitat sites to sample. Rubble and gravel riffles are characterized "...by a unique physical stability which makes them a desirable habitat for stream fauna [and] possesses a temporal stability (DeMarch 1976). Each individual sampling site within the riffle was visually selected to insure sampling only substrate from about 6 to 25 cm (2-10 inches) in diameter. Cummins (1962) refers to this size as "cobble," however, we refer to it as rubble, since "cobble" denotes rounded rocks and much of the substrates encountered in this study were angular.
Samples were taken during spring and fall because they appear to have less variability from year to year than do summer samples. DeMarch (1976) noted similar findings from a study relating seasonal substrate composition changes with changes in species distribution among substrates. Grant and MacKay (1969) concluded that species with similar habitat and trophic requirements avoided direct competition by staggering seasonal occurrence of their stages of development. Best results are obtained when comparing samples taken from the same season each year.

From a comparison of numerous sample sets taken over the past 12 years, the number of samples required at each station per date has been determined statistically (Elliott, 1971). Four samples per date per station have generally been sufficient. Total numbers and weights per sample were compared and the standard error (S.E.) was generally less than 20 percent of the mean and the coefficient of variation was generally less than 50 percent.

Samples were collected and processed in the following manner. The sampler was placed on the stream bottom and all rocks within the one-square-foot (0.093 m²) area were lifted off the bottom and scrubbed to remove all organisms and debris which were then carried by the current into the net. The stream bottom within the square-foot area was then stirred up with penetration between 10 to 15 cm (4-6 in) into the substrate. The sample was then washed into a plastic dish pan and covered with a saturated sodium chloride (NaCl) solution (specific gravity 1.20) which caused macroinvertebrates and organic debris to float above the inorganic sediments. The floating organic material was poured off through a U.S.A. Standard Testing Sieve with 250 micrometer opening mesh size (Tyler equivalent 60 mesh). The sample was then preserved in 10% formalin solution and taken to the laboratory for analysis.

A preliminary set of samples (four replicates) was taken on 30 October 1980 at station TF01. On 1 May and 15 October 1981 and 16 June and 21 October 1982 four replicate samples were taken from each of the three stations, TF01, TF-WCH, and TF-GH.
Samples were processed by the Aquatic Ecology Laboratory, Department of Zoology, Brigham Young University. At the laboratory, the samples were divided into eight equal parts using a subsampler (Waters, 1969). Two to four subsamples, depending on the estimated total number of insects in the sample, were selected from the eight using a random numbers table and processed as explained below. The remaining parts of the sample were preserved for later reference. Using a Nikon dissecting scope (10x eyepiece and 1 to 4x objective), the organisms were picked out, sorted as to taxonomic groups, identified, and counted. The portion of the sample not picked under the dissecting scope was scanned beneath a magnifying glass to make sure that representatives from all taxa present in the sample were accounted for.

Dry weight of the combined taxa of each sample was measured. The organisms were placed in a small aluminum dish (60x27 mm) and dried for 8 to 10 hours at 80°C. Organisms were then weighed to the nearest tenth of a milligram (plus or minus 0.2 mg) using a Mettler H10T balance. The weight was then computed and recorded as grams per square meter for each sample.

Sample data analyses included mean number per meter square of total sample and individual taxa, mean dry weight as grams per meter square, a dominance diversity index (H, Shannon-Weaver), and a representation of community tolerance as CTQₐ, CTQₚ, and BCI.

Dominance diversity indices, collectively referred to as H, are based upon the information theory - maximum sample information exists when each individual in the sample belongs to a different species, and conversely, minimum information exists when all individuals belong to the same species. More information is supposedly contained in a natural than a polluted community. The polluted system is supposedly simplified and those species that survive encounter less competition and are usually able to increase in numbers. Redundancy in this case increases since the probability that an individual belongs to a previously recognized species increases and information per individual is reduced.
Several workers have proposed various indices based upon the
tolerance-intolerance of species to environmental perturbations. Only
recently have biological classification systems been proposed that have the
capabilities to synthesize a wide variety of ecological parameters and have
predictive value for decision making and management. The biotic condition
index (BCI) classification system of Winget and Mangum (1979) was selected
for this project.

The purpose of the (BCI) is to provide a methodology for evaluating
existing condition of stream macroinvertebrate communities based upon their
biological potential. Evaluations are based upon water quality, physical
habitat and aquatic biota data. The (BCI) is designed to be used in
conjunction with water quality, physical habitat and hydrological studies.

Four independent variables were selected for use in the BCI because:
1) there were strong relationships between them and community structure;
and 2) each represented a different type of influence on the community
structure or function. The independent variables selected were stream
channel percent gradient (stream maintenance and recovery component),
substrate roughness (microhabitat heterogeneity component), total
alkalinity (density and biomass component) and sulfate concentrations
(water quality component).

Based upon responses to the four selected independent variables, taxa
were assigned tolerance quotients indicating their environmental hardiness.
The tolerance quotient (TQ) is the product of four component values derived
from a taxon's tolerance to low stream gradients, fine substrate materials
and high total alkalinity and sulfate levels.

The predicted community tolerance quotient (CTQp) is the mean of the
TQ's for a predicted macroinvertebrate community. Each stream section, due
to its individual water quality and physical habitat characteristics, is
expected to support a community reflective of those traits. Similarity
index matrices, correlation coefficient analyses and Jaccard similarity
coefficient clustering analyses were used to select representative taxa
likely to occur together under various combinations of habitat and water
quality conditions. Tolerance quotients for the taxa in the predicted community were summed and then divided by the number of representative taxa giving an arithmetic mean tolerance quotient for that community (CTQp).

Actual community tolerance quotients (CTQa) are simply the arithmetic means of the TQ's of sampled macroinvertebrates from a given station on a given date. The CTQa is directly affected by any change in species composition. If a fragile species (low TQ) is replaced by a moderately tolerant species, the CTQa will increase even though the number of species may remain the same. This is especially helpful under moderate environmental stresses that often result in increased density and/or evenness (increased H values) - conditions that have been misinterpreted as no impact or increased community condition.

In order compare actual macroinvertebrate community condition against a predicted potential condition, divide the CTQp by the CTQa and multiply by 100. The result is the biotic condition index (BCI). The BCI is actually an index of percent of predicted. The CTQa is usually greater than the CTQp due to impacts from factors not considered in the four independent variables of this model. These other factors are usually related to perturbations, the extent of impact being reflected in the numerical BCI. If the BCI for a given set of samples was 90, that would indicate the actual macroinvertebrate community condition was 90 percent of the predicted. That stream section, with its gradient, substrate, total alkalinity and sulfate was meeting only 90 percent of the predicted potential.

The methodology used in the BCI: 1) is sensitive to all types of environmental stress; 2) is applicable to various types of streams; 3) gives a linear assessment from unstressed to highly stressed conditions; 4) is independent of sample size providing the sample contains a representative assemblage of species; 5) is based upon water quality and physical habitat data readily available or easily acquired; and 6) meshes readily with existing stream habitat and water quality management programs.
Stream habitat condition was assessed using a combination of occular and measured observations. Stream channel width; water width, depth and velocity; total channel width; bank stability, gradient, vegetative type and cover; channel substrate composition; stream gradient; ungulate damage; riparian zone width; and percent stream shaded were all evaluated and recorded.

Water quality data were obtained from other investigators (report of Vaughn Hansen Associates, presented to Kaiser Engineers of Oakland, California, 1981).
RESULTS AND DISCUSSION

Historically, Tie Fork drainage has been under heavy grazing impacts. Tie Fork Creek in the region of the confluence of Gentry and Wild Cattle Hollow shows signs of habitat stress - steep stream banks with sloughing of bank materials common. Stream banks in some areas are as high as 30 to 40 feet vertical with no vegetative cover. Unstable stream banks are devastating to small streams such as Tie Fork and its tributaries where flows range from lows of <1cfs to over 50 cfs during storm occurrences or spring runoff. During low flow years, such as 1981, sedimentation plus accumulated leaf fall builds up in the stream sealing off interstitial spaces between the rocky substrates. Chemical deposition helps seal these materials into a hard crusty deposit that aquatic organisms cannot penetrate. Spawning fish also are unable to move the gravels making the stream unsuitable for spawning. It takes a real "gully washer" of a flow to move these substrates once they have become settled and cemented together.

With the chemical deposition, Tie Fork Creek probably has never been important to spawning fish but it has been, and still is, an important producer of fish food organisms for Huntington Creek. It is an important source of organisms for repopulating Huntington Creek following scouring high flow events - aquatic macroinvertebrates commonly drift with the current downstream in search of new food sources and/or habitats.

There are areas where sloughs have occurred but vegetative cover is becoming re-established indicating an improving condition. The forest service has reduced allowable cattle days/acre in several areas of the Manti LaSal National Forest -- e.g. upper Huntington Canyon is in much better condition than it was 10 years ago through improved range management. This could be the case in Tie Fork Canyon accounting for the evident healing of stream banks in some areas.
Tie Fork Creek

Water quality at Station TF01 is reportedly good with TDS less than 300 mg/l and sulfate less than 50 mg/l (personal communication with Vaughn Hansen). The taxa of aquatic macroinvertebrates collected from the stream, in 1971, and also during this survey, 1980 to 1982, confirm this conclusion (Table 1) with several taxa each of the three major aquatic insect orders - mayflies (Ephermeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) commonly collected. Near the mouth of Tie Fork Creek several low quality ground water discharges enter Tie Fork causing a deterioration of water quality. The area affected is small enough that the biotic community does not show significant impacts from these small springs. There appears to be little or no change in species composition of the macroinvertebrate community since 1971.

Table 2 presents a summary of habitat characteristics for Tie Fork Creek at Station TF01. Of special interest is the relative lack of sands and silts considering the significant areas of unstable stream banks. Chemical cementing of these fine sediments into larger "chunks" would be partially responsible for the lack of fines. The recovery of riparian vegetation has probably reduced the sediment input to the stream. Also, the high stream gradient (4% average slope) produces water velocities great enough to carry the very fine sediments out of the canyon and move the slightly heavier sediments, thus keeping surface substrates relatively free of fine sediments.

As shown in Table 1, the macroinvertebrate community sampled in 1971, 1980, 1981 and 1982 was a highly diverse community with numerous representatives of the major groups of aquatic macroinvertebrates. Table 3 gives quantitative density values for each taxon collected on 30 October 1980, 1 May and 15 October 1981, and 16 June and 21 October 1982. *Baetis* and chironomids were dominant in all collections illustrating physical stress, such as seasonal flow extremes - low summer/fall/winter flows and scouring spring flows. The high number of taxa collected indicates a resilient community with a diversified energy flow through the system. High
diversity also confirms relatively good water quality.

Also given in Table 3 are TQ values or tolerance quotients for each taxon of the community. TQ's range from 2 (very fragile, narrow tolerance limits) to 108 (wide tolerance limits for). Note the presence of fragile taxa (TQ's of 6, 16, 18, 21, and 24) in all samples indicating good water quality and relatively good habitat, at least in specific areas if not generally throughout the stream.

On 30 October 1980, the condition of the aquatic community sampled was 90 percent (BCI = 90) of the predicted potential, given existing water quality and habitat characteristics. In 1981 the BCI had dropped to 86 in May and 85 in October reflecting a change in community composition toward a more tolerant community. The drop of the BCI to only 74 in June of 1982 gave further evidence of a significant change in the aquatic community. There was almost no spring runoff in the spring of 1981 allowing fine sediments and organic material to build up in the stream. The impacts of this sedimentation of the stream substrates became more pronounced as the season progressed, especially during the winter of 1981-82. There was a normal, or greater, snowfall during the 1981-82 winter resulting in average, or above, spring runoff the spring of 1982. Fine sediments were cleaned out of the stream bed allowing previously eliminated fragile taxa to become re-established. This recolonization takes time though, so the sample in June 1982 showed the worst impact of the low flows from the low 1980-81 winter snowfall. Several heavy summer thunderstorms during 1982 also helped clean out the stream system, aiding recovery. By October 1982 the community had largely returned to condition equal to that of October 1980 with a BCI of 92.

Between October 1980 and October 1981 samples, the number of taxa per sample increased by 5 but the increase was due to more tolerant taxa being found in 1981 plus the absence of several of the more fragile taxa such as Nemouridae, Megarcys signata and Oligophlebodes. The number of taxa remained high in the October 1982 samples, but there were more fragile taxa present such as Ameletus, Rhithrogena, Nemouridae, Skwala parallela and Diura knowltoni, resulting in a decreased CTQa and increased BCI.
It is assumed that the October 1980 and 1982 sample results are indicative of the normal community condition in Tie Fork Creek and that the 1981 and May 1982 samples depict a normal community response to infrequent natural environmental extremes.

Gentry Hollow

The macroinvertebrate communities of Gentry Hollow and Wild Cattle Hollow are significantly different and each will be discussed separately.

In Gentry Hollow *Baetis* and *chironomidae* dominated the community in the spring and fall samples of both years, dominance greater in October (see table 4). These two taxa often dominate communities subject to frequent physical environmental stress such as spring scouring and fall-winter low flows. Due to the steep gradient in Gentry Hollow the bottom of the stream remains free from silt. Water quality at this station is high and water temperatures remain low throughout the year due to high elevation and good stream riparian vegetative cover. The stream's high water and habitat quality are reflected in the presence of *Brachycentrus americanus* and *Micrasema* caddisflies (TQ values 24, 24, respectively) and the stoneflies, *Amphinemura, Megarcys signata,* and *Diura knowltoni,* (TQ's = 6, 24, 24, respectively). The presence of *Parapsyche* (TQ = 6) and *Neothremma* (TQ = 8) caddisflies indicate that this is a high quality, cool, headwater stream.

The macroinvertebrate community showed a degradation trend in 1981 similar to that seen in Tie Fork Creek below the confluence of Gentry and Wild Cattle Hollows. The BCI was 89 in May of 1981 and then dropped to 83 in October. In 1982 it had dropped even further to only 70 by June but recovery had begun by October as evidenced by a return of the BCI to 89.
Wild Cattle Hollow

The macroinvertebrate community in Gentry Hollow was very similar to the communities of Wild Cattle Hollow and Tie Fork and was dominated by Baetis and chironomidae with the dominance greater in October than May or June (see Table 5). The impact from the low flows of 1981 are evident with the BCI dropping from 82 in May 1981, to 80 by October of the same year and down to 77 by June 1982. The increase to 90 by October 1982, again shows the recovery process in operation.
CONCLUSIONS AND RECOMMENDATIONS

Tie Fork Creek is a quality tributary to Huntington River and as such should be protected. Subsidence of source aquifers could cause a reduction in the total flow of Tie Fork Creek, but if this occurs it will not be for several years. Tie Fork Creek and Gentry and Wild Cattle Hollows are small streams and as such quickly reflect changing environmental conditions, both natural (low spring runoff and thunderstorm occurrences) and unnatural (increased grazing, decreased stream flow from diversion or subsidence of aquifer strata, road construction, etc.).

Data gathered to date illustrate community conditions under a near drought condition (winter of 1980-1981, spring-fall 1981), and a natural recovery during 1982. These data will be important in evaluating future conditions as they relate to natural weather conditions as well as project operations. It is not known whether the October 1980 and 1982 samples reflect "natural" conditions or not but should be close. A spring 1983 set of samples, assuming a near normal water year with good spring runoff, would help confirm the "natural" community condition. One year before anticipated subsidence begins of any of the Gentry or Wild Cattle Hollow drainage areas, another set of spring and fall samples should be collected and processed to: 1) confirm the baseline that impact analysis will be based upon; and 2) insure that stream condition has not deteriorated because of other causes between October 1982 and start of subsidence.
REFERENCES CITED


Figure 1. Map showing locations of stations TF-01, TF-GH and TF-WCH on Tie Fork Creek and its two tributaries. 17

Figure 2. Modified Surber Sampler. 18

Table 1. Description of the aquatic macroinvertebrate communities of Tie Fork Creek, as presence or absence. 19

Table 2. Description of Tie Fork Creek below Gentry and Wild Cattle Hollows at 1 cfs. 20

Table 3. Description of the aquatic macroinvertebrate community of Tie Fork Creek, as mean number/m². 21

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Table 5. Description of the aquatic macroinvertebrate community of Wild Cattle Hollow, as mean number/m². 23
Figure 1. Map showing locations of stations TF-01, TF-GH and TF-WCH on Tie Fork Creek and its two tributaries - Gentry Hollow and Wild Cattle Hollow.
Fig. 2: Modified Surber Sampler, modified by Winget (Reichert, 1976).

Modified Surber Sampler

Nitex 280 micron mesh netting

Vinyl sides

Vinyl bottom

1" x 3/16" aluminum frame
Table 1. Description of the aquatic macroinvertebrate communities of Tie Fork Creek, Carbon County, Utah, as presence (X) or absence (--) of taxa in samples taken during 1971 (near the mouth of the canyon) and 1980-1981 and 1982 (below confluence of Gentry and Wild Cattle Hollows).

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<th>1982</th>
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<tr>
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<tr>
<td>Isopoda</td>
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**NUMBER OF TAXA SAMPLED** 42 44 45

RAW TEXT END
Table 2. Description of Tie Fork Creek below Gentry and Wild Cattle Hollows with mean summer flows of approximately 1 cfs.

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<tr>
<th>Water Surface (Q = 1.0 cfs)</th>
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<tr>
<td>mean water width: 3.5 ft</td>
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<tr>
<td>mean water depth: 0.3 ft; range 0.1 to 1.1 ft</td>
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<tr>
<td>mean water velocity: 0.6 ft/sec; range 0 to 2.5 ft/sec</td>
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**Channel**

**Total width:** 9-21 ft (normal channel high bank)  
20-35 ft (high flood channel)

**Substrates:** (substrates cemented together by chemical deposition)

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<thead>
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<th>Substrates</th>
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<tr>
<td>bedrock</td>
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<tr>
<td>boulder (&gt;12 in diam.)</td>
<td>25%</td>
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<tr>
<td>rubble (3-12 in diam.)</td>
<td>30%</td>
<td>15-55%</td>
</tr>
<tr>
<td>gravel (0.1-3 in diam)</td>
<td>15%</td>
<td>0-25%</td>
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<tr>
<td>sand</td>
<td>13%</td>
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<tr>
<td>silt</td>
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<tr>
<td>organic debris</td>
<td>5%</td>
<td>2-14%</td>
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**Gradient:** mean 4.0%; range 3 to 7%

**Percent Stream Shaded:** mean 45%; range 20-65%

**Left Bank**

- cover: 55-85%
- stability: 40-75%
- class: trees + shrubs
  - aspen and fir upper, pinion and juniper lower
- gradient: 20-40%
- ungulate damage: 40-65%
- riparian zone: 5-20 ft

**Right Bank**

- cover: 35-75%
- stability: 35-75%
- class: shrubs + trees
  - road parallels right bank, riparian width mostly narrow
- gradient: 23-53%
- ungulate damage: 35-70%
- riparian zone: 5-25 ft
Table 3. Description of the aquatic macroinvertebrate community of Tie Fork Creek, Carbon County, Utah, as mean number/m². (Samples were taken below the confluence of Gentry and Wild Cattle Hollows).

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RNW-PMC-TIE FORK-82 / PAGE 21
The aquatic macroinvertebrate community of Gentry Hollow, mean number/m², above confluence with Wild Cattle Hollow as described in Table 4.

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CTQa:  67  69  71  61

CITP:  55  55  16  25

CIC:  82  80  77  90
Refer to Exhibit 731.110a for a copy of "Hydrologic Response to Land Subsidence Caused by Underground Coal Mining, Miller Creek Drainage, Carbon County, Utah".
NOTE:
Because of the limited availability and/or reproducible quality of this exhibit, it is requested that this exhibit be removed from the 1991 permit submittal and be inserted herein.
EXHIBIT 342.100a

GOLDEN EAGLE CLIFF NESTING AND SUBSIDENCE MONITORING AND MITIGATION PLAN

Moved to "Confidential Permit Information"