PART 2: STANDARDS - SECTION C

LAND USE/LAND COVER CODES

I. PURPOSE

Maps of land use and land cover are fundamental tools for natural resource management and planning. These land use/cover codes provide a standard system by which units of land can be categorized. Land use/cover maps serve to:

- assess the area and distribution of individual land use/cover categories (such as cropland and pasture, code 21)
- show the diversity of the landscape
- contrast the land diversity of different regions
- monitor changes in land use and/or cover over time

The VGIS Land Use/Land Cover Codes have been developed to:

- provide compatibility with existing USGS codes,
- provide codes tailored to Vermont's landscape,
- permit land coding at a various resolutions (local, regional and state),
- avoid and clarify redundant classifications which depend on interpretation.

II. LAND USE AND LAND COVER

GIS provides new tools for mapping the landscape. Although land use and land cover are quite different, they are frequently lumped together on a single map. Land use and land cover, however, are very different ways of looking at the land:

**Land Cover:**
- The vegetative, barren, liquid or artificial (human-made) material covering the land.
- Land cover can be interpreted from aerial photographs or satellite imagery with varying degrees of accuracy.

**Land Use:**
- The actual use of the land by its human inhabitants.
- Land use may at times be based on property boundaries (as in a municipal park), but the actual use of the land will not necessarily correspond to land ownership.

In a GIS it is feasible to view land use and land cover in a combined data layer, or as separate data layers. Some individual land categories will be developed as GIS data layers completely separate from land use/cover mapping. For example, surface waters and wetlands, both components of a land cover map, are being developed as separate data
layers. A land use/cover mapping project should make use of existing data layers when possible.

Land use is the actual human activity for which the land is used, which may differ from the promoted use of the land. For example, zoning is generally not considered a land use since an area with "three acre zoning" may actually have much less than one unit per three acres. The delineation of residential areas may be particularly tricky. Mappers should be systematic in their methods, which should be well documented to enable proper interpretation of their maps in the future. Documentation might include language such as: "Land use and cover were photo-interpreted from 1:5000 orthophotos. Residential areas were delineated at the boundaries between homesteads (including yards or gardens) and the surrounding woods and fields. The density of residential single family/duplex areas (code 113) was determined by assigning a number of homes to residential area polygons, and computing the number of units per acre."

III. THE CODING HIERARCHY

VGIS Land Use/Land Cover Codes are an expansion of USGS land categories developed by Anderson and others (1976) for use with remotely sensed images. The codes are organized into four hierarchical levels. At the top of the hierarchy, first level includes:

1. Urban and built-up land
2. Agricultural land
3. Brush or transitional between open and forest
4. Forest
5. Water
6. Wetlands
7. Barren land
8. Tundra
9. Permanent snow and ice (no known examples in Vermont)

Each sub-level contains at most 9 categories (1 through 9). Level one has the lowest resolution, or detail of the landscape, while level four has the highest resolution. For example, a permanent pasture would be coded as follows at each of the four levels:

<table>
<thead>
<tr>
<th>Level</th>
<th>Code</th>
<th>Category</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>Agricultural land</td>
<td>Low</td>
</tr>
<tr>
<td>2</td>
<td>21</td>
<td>Cropland and Pasture</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>212</td>
<td>Hay/rotation/permanent pasture</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2123</td>
<td>Permanent pasture</td>
<td>High</td>
</tr>
</tbody>
</table>

The USGS level 1 and level 2 codes were used for the VGIS codes with these changes:
Rangeland (3) was changed to Brush or Transitional Between Open and Forested, since there are no real rangelands in Vermont.
- a Mixed Herbaceous and Shrub/Brush code (33) was added,
- level 2 codes were added for Tundra (8).

### IV. Resolving Conflicts Between Codes

For some land units, more than one code will be possible. The recommended rule for resolving conflicts is to use the code that comes first in the numbering sequence. This rule is meant to be used for a combined land use/land cover map. For example, a grove of maples used for producing maple syrup may be considered either a Sugarbush (code 225) or as Northern Hardwoods, Sugar Maple (code 4121). In this case, the lower code (225) would be used. Likewise, a campground with mixed woods would be coded as Campground (1936) instead of as a Mixed Coniferous-Broadleaf Forest (43), because 1936 precedes 43 in the numbering sequence.

Only levels 1 and 2 (Urban/built-up and Agricultural land) emphasize land use, while levels 3 to 9 are almost exclusively land cover categories. If the rule above is used to resolve coding conflicts, the resulting map will emphasize land use over land cover. Land cover can be emphasized by selecting the code that is higher in the numbering sequence when conflicts occur. Whichever method is used, it should be followed systematically and clearly documented.

### V. Use of the Codes

Mappers will choose how to use the codes to best suit their needs. Maps can be made in which:
- only land use is coded
- only land cover is coded
- a single code is used for mixed land use/land cover
- separate land use and land cover codes are assigned to each unit of land (thus to each GIS polygon)

It will not always be feasible to code land for land use only, because remote areas often will not have appropriate land use codes. Land use maps will generally be restricted to developed areas when using these codes. More extensive land use coding schemes exist, however, and can be provided by VCGI.

If land use and land cover are separately coded, it is likely that some boundaries will be shared between land use and land cover maps. The following ARC/Info polygon attribute table (PAT) items are recommended for a combined land use/land cover GIS map:
<table>
<thead>
<tr>
<th>Item</th>
<th>Type</th>
<th>Width</th>
<th>For</th>
</tr>
</thead>
<tbody>
<tr>
<td>LUSEyy</td>
<td>I</td>
<td>4</td>
<td>Land use only</td>
</tr>
<tr>
<td>LCOVERyy</td>
<td>I</td>
<td>4</td>
<td>Land cover only</td>
</tr>
<tr>
<td>LULCyy</td>
<td>I</td>
<td>4</td>
<td>Combined land use/land cover</td>
</tr>
</tbody>
</table>

"yy" refers to the year of interpretation, so that LCOVER90 would be the land cover interpreted for 1990. All item types are I (integer).

VI. LAND USE/LAND COVER CODES

1 URBAN AND BUILT-UP LAND

11 RESIDENTIAL

111 Multi-family, medium to high rise apartments & condominiums (3 or more stories)
   - 1111 more than 50 units/acre
   - 1112 36 to 50 units/acre
   - 1113 21 to 35 units/acre
   - 1114 10 to 21 units/acre
   - 1115 1 to 10 units/acre

112 Multi-family, low rise apartments and town houses, but not duplexes; (1 or 2 stories)
   - 1121 more than 18 units/acre
   - 1122 12 to 18 units/acre
   - 1123 8 to 12 units/acre
   - 1124 less than 8 units/acre

113 Single family/duplex
   - 1131 more than 8 units/acre
   - 1132 5 to 8 units/acre
   - 1133 3 to 4 units/acre
   - 1134 1 to 2 units/acre
   - 1135 less than 1 unit/acre

114 Mobile home parks
   - 1141 more than 9 units/acre (legal Vermont maximum of 9 units/acre)
   - 1142 6 to 9 units/acre
   - 1143 2 to 5 units/acre
   - 1144 less than 2 units/acre

115 Group and transient quarters
   - 1151 Rooming and boarding houses
   - 1152 Shelters
   - 1153 Residence halls and dormitories
   - 1154 Retirement homes and orphanages
   - 1155 Religious quarters
   - 1156 Residential hotels
   - 1157 Fraternities/sororities
   - 1159 Other group & transient quarters

119 Other residential
VI. LAND USE/LAND COVER CODES (continued)

1 URBAN AND BUILT-UP LAND (continued)

12 COMMERCIAL, SERVICES AND INSTITUTIONAL

121 Commercial retail
   1211 Building materials, hardware and farm equipment
   1212 General merchandise/department store
   1213 Food/groceries
   1214 Automotive, marine craft, aircraft and accessories/dealers
   1215 Furniture, home furnishings and equipment
   1216 Eating and drinking (restaurants)
   1217 Gasoline/petroleum
   1218 Farm stand
   1219 Other (Not elsewhere)

122 Commercial wholesale
   1221 Food/sundries/beverages
   1222 Agricultural products/supplies
   1223 Lumber/hardware/building supplies/paper
   1224 Industrial product/chemical/petroleum
   1225 Motor vehicles/parts/supplies
   1229 Other

123 Services
   1231 Banking
   1232 Personal services
   1233 Professional services
   1234 Self-storage
   1235 Day care
   1236 Contract construction services
   1237 Automotive services/car washes
   1238 Agricultural sales/services
   1239 Other services

124 Lodging
   1241 Hotel/motel
   1242 Bed and breakfast
   1249 Other lodging

125 Government
   1251 Correctional
   1252 Military
   1253 Courthouse
   1254 Postal service
   1255 Administrative offices
   1256 Emergency services
   1257 Public works

1 URBAN AND BUILT-UP LAND (continued)
VI. LAND USE/LAND COVER CODES

12 COMMERCIAL, SERVICES AND INSTITUTIONAL (continued)

126 Institutional
   1261 Religious
   1262 Hospital
   1263 Medical clinics
   1264 Nursing
   1265 Social organizations/associations
   1269 Other institutional

127 Educational
   1271 Preschool
   1272 Elementary
   1273 Middle
   1274 High school
   1275 College/university
   1276 Vocational/trade
   1279 Other educational

128 Indoor cultural/public assembly
   1281 Museum
   1282 Theatre
   1283 Amusement
   1284 Sport

129 Other commercial, services and institutional

13 INDUSTRIAL

131 Primary metal production
132 Petrochemicals
133 Primary wood processing and paper mills
134 Stone, clay, glass
135 Metal & non metal fabrication
136 Food processing
137 Mining
   1371 Hard rock
   1372 Quarry
   1373 Sand/gravel
   1379 Other mining

138 Home/cottage industries
139 Other industrial

1 URBAN AND BUILT-UP LAND (continued)
VI. LAND USE/LAND COVER CODES (continued)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>TRANSPORTATION, COMMUNICATION AND UTILITIES</td>
</tr>
</tbody>
</table>

141 Air transportation
   1411 Commercial
   1412 Non-commercial
   1413 Heliports
   1419 Other air transportation

142 Rail transportation
   1421 Rail yard
   1422 Station or terminal
   1423 Active rail line
   1424 Inactive rail line
   1429 Other rail transportation

143 Water transportation
   1431 Port facilities
   1439 Other water transportation

144 Road transportation
   1441 Limited & controlled highway right-of-way
   1442 Road right-of-way
   1443 Truck terminal
   1444 Bus terminal
   1445 Park/ride lot
   1446 Parking structure/lot
   1449 Other road transportation

145 Communication
   1451 Radio station
   1452 Telecommunications facilities
   1453 Television station
   1454 Transmitters/towers
   1459 Other communication

146 Electric, gas and other utilities
   1461 Electric transmission lines
   1462 Electric power generation facilities
   1463 Gas or oil pipeline (natural, propane or other)
   1464 Gas or oil storage facilities
   1469 Other utilities

147 Water & wastewater utilities
   1471 Water treatment plant
   1472 Aqueduct
   1473 Water storage tanks
   1474 Wastewater treatment
   1475 Interceptors
   1479 Other water/wastewater utilities

1 URBAN AND BUILT-UP LAND (continued)
VI. LAND USE/LAND COVER CODES
(continued)

14 TRANSPORTATION, COMMUNICATION AND UTILITIES (Continued)

148 Solid waste utilities
   1481 Active landfills
   1482 Inactive dump sites
   1483 Recycling/transfer stations
   1484 Incinerator
   1485 Composting facility
   1486 Sludge processing facility
   1487 Hazardous waste collection/processing facility
   1488 Junkyards
   1489 Other solid waste facilities

149 Other communication, utilities

15 INDUSTRIAL AND COMMERCIAL COMPLEXES

151 Industrial park
152 Office park
153 Shopping center/mall
159 Other industrial/commercial complexes

16 MIXED (areas where level 2 uses are mixed with no one use predominating)

161 Multiple stories, residential in upper stories only
   1621 Commercial lower level
   1622 Services lower level
   1623 Mixed commercial/services lower level
   1629 Other mixed uses in lower level
169 Other mixed level 2 uses

17 OUTDOOR AND OTHER URBAN AND BUILT-UP LAND

171 Outdoor cultural
   1711 Botanical gardens and arboretums
   1712 Zoos
   1719 Other outdoor cultural

172 Outdoor public assembly
   1721 Amphitheaters
   1722 Drive-in movies
   1723 Stadiums
   1724 Racetracks
   1725 Fairgrounds
   1726 Amusement parks
   1729 Other outdoor public assembly

173 Outdoor recreation
   1731 Playground or play field
VI. LAND USE/LAND COVER CODES

1 URBAN AND BUILT-UP LAND (continued)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1732</td>
<td>Sports areas</td>
</tr>
<tr>
<td>1733</td>
<td>Water recreation/marina/launch</td>
</tr>
<tr>
<td>1734</td>
<td>Ski area</td>
</tr>
<tr>
<td>1735</td>
<td>Golf course</td>
</tr>
<tr>
<td>1736</td>
<td>Campground</td>
</tr>
<tr>
<td>1737</td>
<td>Parks and recreation</td>
</tr>
<tr>
<td>1739</td>
<td>Other outdoor recreation</td>
</tr>
<tr>
<td>174</td>
<td>Cemeteries</td>
</tr>
<tr>
<td>179</td>
<td>Other outdoor urban, built-up and developed</td>
</tr>
</tbody>
</table>

2 AGRICULTURAL LAND

21 CROPLAND AND PASTURE

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>211</td>
<td>Row crops (not including orchards and berries, code 22)</td>
</tr>
<tr>
<td>2111</td>
<td>Corn (land cover includes silage corn)</td>
</tr>
<tr>
<td>2112</td>
<td>Silage (corn or grasses)</td>
</tr>
<tr>
<td>2113</td>
<td>Potatoes</td>
</tr>
<tr>
<td>2114</td>
<td>Soybeans</td>
</tr>
<tr>
<td>2115</td>
<td>Alfalfa</td>
</tr>
<tr>
<td>2118</td>
<td>Other root crops</td>
</tr>
<tr>
<td>2119</td>
<td>Other non-root crops</td>
</tr>
<tr>
<td>212</td>
<td>Hay/rotation/permanent pasture</td>
</tr>
<tr>
<td>2121</td>
<td>Hay</td>
</tr>
<tr>
<td>2122</td>
<td>Rotation pasture</td>
</tr>
<tr>
<td>2123</td>
<td>Permanent pasture</td>
</tr>
<tr>
<td>2124</td>
<td>Idle agricultural land; use level 3 for land cover</td>
</tr>
<tr>
<td>2129</td>
<td>Other pasture</td>
</tr>
<tr>
<td>213</td>
<td>Grains (not including row crops)</td>
</tr>
<tr>
<td>2131</td>
<td>Wheat</td>
</tr>
<tr>
<td>2132</td>
<td>Oats</td>
</tr>
<tr>
<td>2133</td>
<td>Sorghum</td>
</tr>
<tr>
<td>2134</td>
<td>Barley</td>
</tr>
<tr>
<td>2139</td>
<td>Other grains (not including row crops)</td>
</tr>
</tbody>
</table>

22 ORCHARDS, BUSH FRUITS, VINEYARDS AND ORNAMENTAL HORTICULTURE

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>221</td>
<td>Tree fruits, regularly spaced (planted)</td>
</tr>
<tr>
<td>2211</td>
<td>Apples</td>
</tr>
<tr>
<td>2212</td>
<td>Pears</td>
</tr>
<tr>
<td>2219</td>
<td>Other tree fruits</td>
</tr>
<tr>
<td>222</td>
<td>Bush and vine fruits (in rows)</td>
</tr>
<tr>
<td>2221</td>
<td>Strawberries</td>
</tr>
<tr>
<td>2222</td>
<td>Raspberries</td>
</tr>
</tbody>
</table>
2223 Blueberries
2224 Grapes
2229 Other bush and vine fruits
223 Ornamental horticulture & nurseries (floriculture, etc.)
224 Tree farms
   2241 Christmas tree farms
   2242 Other coniferous trees
   2243 Deciduous trees
   2249 Other tree farms
225 Sugarbush
229 Other orchards, etc.

23 CONFINED FEEDING OPERATIONS

231 Livestock
   2311 Beef
   2312 Dairy
   2313 Swine
   2314 Lamb
   2319 Other livestock
232 Poultry
   2321 Chickens
   2322 Turkeys
   2329 Other
233 Pisciculture
   2331 Aquaculture
   2332 Fish hatchery
239 Other confined feeding operations

24 OTHER AGRICULTURAL LAND

241 Farmsteads
242 Greenhouses and mushroom houses
243 Stables & racetracks (non-commercial training areas)
244 Sod
249 Other

3 BRUSH OR TRANSITIONAL BETWEEN OPEN AND FORESTED

31 HERBACEOUS, NON-WOODY VEGETATION
32 SHRUB/BRUSH
33 MIXED HERBACEOUS AND SHRUB/BRUSH
34 RECENTLY LOGGED, PARTIAL CANOPY (UP TO 25%)
35 RECENTLY CLEAR CUT
4 FOREST ([nn] = Society of American Foresters type number)

41 BROADLEAF FOREST (generally deciduous)

411 Boreal hardwoods
   4111 Aspen [16]
   4112 Pin cherry [17]
   4113 Paper birch [18]
   4119 Other boreal hardwoods

412 Northern hardwoods
   4121 Sugar maple [27]
   4122 Sugar maple/Beech/Birch [25]
   4123 Sugar maple/Basswood [26]
   4124 Black cherry/Maple [28]
   4125 Beech/Sugar maple [60]
   4126 Red maple [28]
   4129 Other northern hardwoods

413 Upland oaks
   4131 Chestnut oak [44]
   4132 White oak/Black oak/Northern red oak [52]
   4133 White oak [53]
   4134 Black oak [110]
   4135 Northern red oak [55]
   4136 Northern pin oak [14]
   4139 Other upland oaks

414 Other hardwoods
   4141 Gray birch/Red maple [19]
   4142 Black ash/Elm/Red maple [39]
   4143 Hawthorn [104]

42 CONIFEROUS FOREST (generally evergreen)

421 Boreal conifers
   4211 Jack pine [1]
   4212 Balsam fir [5]
   4213 Black spruce [12]
   4214 Black spruce/Tamarack [13]
   4215 White spruce [107]
   4216 Tamarack [38]
   4219 Other boreal conifers

422 Spruce-fir types
   4221 Red spruce [32]
   4222 Red spruce/Balsam fir [33]
   4223 Red spruce/Alberta fir [34]
   4224 Northern white ceder [37]
   4229 Other spruce-fir types

423 Pine and hemlock
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4233</td>
<td>White pine/Hemlock [22]</td>
<td>4312</td>
<td>Red spruce/Sugar maple/Beech [31]</td>
</tr>
<tr>
<td>4235</td>
<td>Eastern red ceder [46]</td>
<td>432</td>
<td>Mixed pine/hemlock types</td>
</tr>
<tr>
<td>4239</td>
<td>Other pine and hemlock</td>
<td>4321</td>
<td>White pine/Red oak/Red maple [20]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4322</td>
<td>White pine/Chestnut oak [51]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4323</td>
<td>Hemlock/Yellow birch [24]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>WATER (see 143 for transportation uses and 233 for agricultural uses)</td>
</tr>
<tr>
<td>51</td>
<td>RIVERS, CANALS AND OTHER WATERWAYS</td>
</tr>
<tr>
<td>511</td>
<td>Canal</td>
</tr>
<tr>
<td>512</td>
<td>River or Stream</td>
</tr>
<tr>
<td>519</td>
<td>Other waterways</td>
</tr>
<tr>
<td>52</td>
<td>LAKES AND PONDS</td>
</tr>
<tr>
<td>53</td>
<td>RESERVOIRS (and other artificial water surfaces)</td>
</tr>
<tr>
<td>54</td>
<td>BAYS/ESTUARIES</td>
</tr>
<tr>
<td>61</td>
<td>FORESTED WETLAND</td>
</tr>
<tr>
<td>651</td>
<td>Broad-leaved deciduous</td>
</tr>
<tr>
<td>652</td>
<td>Needle-leaved deciduous</td>
</tr>
<tr>
<td>653</td>
<td>Broad-leaved evergreen</td>
</tr>
<tr>
<td>654</td>
<td>Needle-leaved evergreen</td>
</tr>
<tr>
<td>655</td>
<td>Dead</td>
</tr>
<tr>
<td>62</td>
<td>NON-FORESTED WETLAND</td>
</tr>
<tr>
<td>621</td>
<td>Aquatic bed</td>
</tr>
<tr>
<td>6211</td>
<td>Algal</td>
</tr>
<tr>
<td>6212</td>
<td>Aquatic moss</td>
</tr>
</tbody>
</table>
6213  Rooted vascular
6214  Floating
622  Moss-lichen
   6221  Moss dominant (bogs and fens)
   6222  Lichens dominant
623  Emergent wetland
   6231  Wet meadow
   6232  Shallow marsh
   6233  Deep marsh
624  Scrub-shrub wetland
   6241  Broad-leaved deciduous
   6242  Needle-leaved deciduous
   6243  Broad-leaved evergreen
   6244  Needle-leaved evergreen
   6245  Dead

7  BARREN LAND

71  SALT FLATS

72  BEACHES AND RIVER BANKS

   721  Sand beach
   722  Gravel beach
   723  River banks
   729  Other beaches/riverbanks

73  SANDY AREAS (NON-BEACHES)

   731  Sand dunes
   732  Sand pits
   739  Other sandy areas

74  BARE/EXPOSED ROCK

   741  Rock knobs
   742  Escarpments/Cliffs
   743  Shoreline rock outcrop
   744  Riverbank rock outcrop
   749  Other bare/exposed rock

75  STRIP MINE/QUARRY OR GRAVEL PIT

79  OTHER BARREN LANDS

8  TUNDRA
81 SHRUB AND BRUSH
82 HERBACEOUS
83 BARE GROUND
84 WET
85 MIXED

9 PERMANENT SNOW & ICE (no known examples in Vermont)