

NH LAND USE MAPPING STANDARD GRANIT/EARTH SYSTEMS RESEARCH CENTER

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Introduction

The NH Land Use Mapping Standard describes a classification scheme and mapping protocols for generating detailed land use data from high resolution, remotely sensed data sources. The standard was developed by GRANIT staff at Earth Systems Research Center (ESRC), University of New Hampshire, in consultation with the NH Office of Energy and Planning(OEP) and the nine Regional Planning Commissions in the state. It was informed by prior land use mapping projects conducted by Planning Commissions and GRANIT staff, as well as a series of discussions hosted by the NH Department of Environmental Services. This broad input yielded a standard which is designed to meet the land use mapping needs of a diverse community of users.

The standard was originally developed under the auspices of the I-93 Corridor/Community Technical Assistance Program in southern New Hampshire to guide the production of land use data for the 26 towns in that Corridor. Since its initial application, it has been revised to incorporate and/or modify several land use classes.

The NH Land Use Mapping Standard is recommended for all NH land use data sets derived from high resolution image sources that are to be archived in the GRANIT database. It should be noted that while land use and land cover are at times simultaneous, the standard does not necessarily apply to land cover data sets.

Data Sources

The primary data source for detailed land use data is high-resolution (1 ft. GSD or better), true color, leaf-off, digital orthophotography (Figure 1). Additional data sources referenced in the standard include:

- NH Department of Transportation road centerlines
- NH National Hydrography Dataset (NHHD)
- NH Department of Environmental Services water distribution areas, depicting water and sewer service zones
- US Fish & Wildlife Service National Wetlands Inventory (NWI)
- USGS town boundaries

Data on water distribution areas are available from the NH Department of Environmental Services. All other sources listed above are available from the GRANIT GIS repository (www.granit.unh.edu).

In addition to these existing data sources, project-specific field data collection is required to meet the standard.

Figure 1. Image extract – 1-ft. resolution imagery, UNH campus, Durham, NH. collected April 2005.



Land Use Classification

The standard utilizes a classification structure that represents an enhancement of the USGS Anderson Level II land use coding (USGS Professional Paper 964, 1976). This hierarchical coding structure assigns a Level I (1-digit) code as follows:

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 New Hampshire)

Within the Anderson classification, Level II (2-digit) codes expand to provide more detailed information.

Efforts by OEP in the mid 1990's to coordinate a NH land use mapping standard resulted in the incorporation of Level III (3-digit) and IV (4-digit) codes to the USGS structure, thereby creating a comprehensive, detailed land use categorization (Appendix II). The following illustrates the 4 classification levels for one type of land use:

<u>Level</u>	<u>Code</u>	<u>Category Description</u>
I	1	Urban and built-up land
II	14	Transportation, communication, and utilities
III	144	Road transportation
IV	1441	Limited & controlled highway right-of-way

More recently, the OEP standard was further modified to reflect current data sources and current mapping needs. Appendix I reports the amended, comprehensive land use categorization.

Table 1 below presents the 4-digit land use categories, extracted from Appendix I, which will be used for the I-93 Corridor land use mapping effort. To maintain consistency in assigning codes and to facilitate subsequent use of the data, all codes have been extended to 4 digits although they represent a combination of Levels I, II, III, and IV categories. Mappers will benefit from using Table 1 as a quick reference, while relying on Appendix I to provide the full framework for the coding scheme and to offer explanatory notes on the intended contents of selected categories.

Because the project land use classes represent a combination of mapping levels, it is important for users of the 60-category classification to recognize the context for selected codes in order to apply the correct code to a land use feature. Typically, at any level of mapping, there is a final code ending in the digit '9' that collects all miscellaneous uses within that category. However, that catchall category is only appropriately used when all preceding codes at the same level of specificity are used.

For example, within the Industrial category, a full mapping of all Level III categories would result in the use of code 139 (other industrial) to map miscellaneous industrial uses. However, for the 58-category subset, only code 137 (mining) is being mapped at Level III. All other industrial uses are mapped at a generalized level and should therefore be assigned a code of 1300. Similarly, in the road transportation codes, note that 1440 is used to collect all codes that are not specifically identified in the subsequent detailed road classes.

Table 1. Target land use categories.

Urban and Built-Up Land (1)		
Residential (11)		
	1110	Multi-family, medium to high rise apartments and condominiums (4 or more stories)
	1120	Multi-family, low rise apartments and townhouses, but not duplexes (1-3 stories)
	1130	Single family/duplex
	1140	Mobile home parks
	1150	Group and transient quarters
	1190	Other residential
Commercial, Services, and Institutional (12)		
	1210	Commercial retail
	1220	Commercial wholesale
	1230	Services
	1240	Lodging
	1250	Government
	1260	Institutional
	1270	Educational
	1280	Indoor cultural/public assembly
	1290	Other commercial, services, and institutional
Industrial (13)		
	1300	Industrial
	1370	Mining
Transportation, Communications, and Utilities (14)		
	1410	Air transportation
	1420	Rail transportation
	1430	Water transportation
	1440	Road transportation
	1441	Limited & controlled highway right-of-way
	1442	Road right-of-way
	1445	Park & ride lot
	1446	Parking structure/lot
	1447	Auxiliary transportation
	1449	Other road transportation
	1450	Communication
	1460	Electric, gas, and other utilities
	1470	Water and wastewater utilities
	1480	Solid waste utilities
	1490	Other transportation, communications, and utilities
Industrial and Commercial Complexes (15)		
	1510	Industrial park
	1520	Office park
	1530	Shopping mall
	1580	Other industrial complexes
	1590	Other commercial complexes
Mixed Developed Uses (16)		
	1610	Multiple stories, residential in upper stories only
	1690	Other mixed uses
Outdoor and Other Urban and Built-Up Land (17)		
	1710	Outdoor cultural
	1720	Outdoor public assembly
	1730	Outdoor recreation
	1740	Cemeteries
	1780	Maintained open areas

	1790	Other outdoor and other urban or built-up land
Vacant Land (18)		
	1800	Vacant Land
Agriculture (2)		
	2000	Agricultural Land
	2900	Other Agricultural Land
Transitional (3)		
	3000	Brush or Transitional between Open and Forested
Forest (4)		
	4000	Forest Land
Water (5)		
	5000	Water (see code 1430 for transportation uses)
Wetlands (6)		
	6000	Wetlands
Barren (7)		
	7100	Salt Flats
	7200	Beaches and River Banks
	7300	Sand Areas (non-beaches)
	7400	Bare/Exposed Rock
	7500	Strip Mine/Quarry or Gravel Pit
	7600	Disturbed Land
	7900	Other Barren Lands
Tundra (8)		
	8000	Tundra

Mapping Parameters

This section describes basic mapping parameters governing the development of data in all land use classes:

1. Coordinate reference system: New Hampshire State Plane Coordinate System, North American Datum of 1983, units - feet.
2. Minimum mapping unit: .25 acres. Smaller features that result from automated processes to map surrounding land uses may also be included in the data.
3. Map unit purity: For areas with complex mixes of land use, a map unit purity of 85% or greater is required, indicating that up to 15% of a coded map feature may comprise a different land use type.
4. Data format: Preferred format - personal geodatabase (.mdb or .gdb). If this is not an option, shapefiles will be accepted. The feature class must be polygons.
5. Topological requirements: All data must be "topologically clean". If using ArcGIS 9.x, apply appropriate topology rules to ensure that there are no overlapping polygons, no sliver polygons, and no gaps in the data. If you do not have access to ArcGIS, use available tools to ensure that topology can be constructed from your data.
6. Image display scale: For land use digitizing purposes, imagery should be displayed at a minimum scale of 1:2,400 (1"=200'). For quality control/verification purposes, a smaller display scale (e.g. 1:5,000) may be used.

- The Page Left/Right/Up/Down tools (under Customize>Commands>Zoom/Pan in ArcMap) may be used to systematically step across an image one screen at a time while preserving a viewing scale.
 - If digitizing new roads, zoom into 1:1,200 (1"=100') to delineate the centerline. Return to the standard viewing scale for all land use polygon delineations.
7. Naming conventions for the land use datafile: LU_<RPC acronym>, e.g. LU_NRPC, with the following fields:
- LU – integer, width: 4 – based on Table 1 codes. (Note that all codes should be carried out to the full 4 digits.)
 - ID – integer, width: 4 – sequentially assigned ID used during data development/QC phases. This field will likely be eliminated once the composite is finalized.
8. Documentation: ESRC staff will generate an FGDC-compliant metadata record that includes the general procedures and protocols contained in this document. RPC staff should submit to ESRC documentation that describes any data sources or mapping techniques that deviate from and/or extend these general project standards.

Data Development Protocols

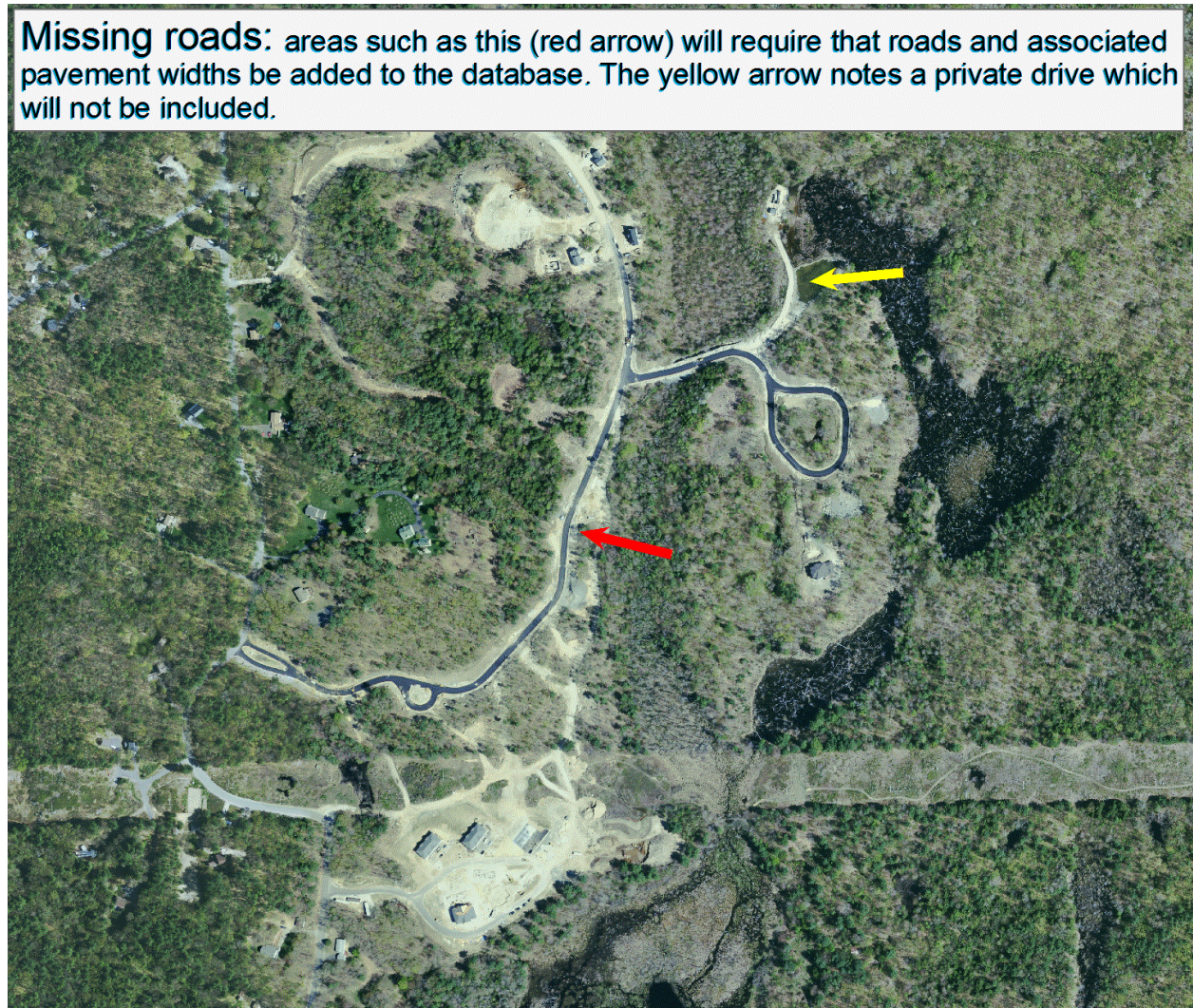
This section describes methodologies for generating and/or delineating individual land use features.

1. Town Bounds: Start with the GRANIT town boundary layer (PBNH) and select all towns in your study area. Eliminate any internal town bounds so that you have only the outer boundary as a starting point.
2. Roads: Clip out roads for your study area from the December, 2006 (or most recent available) NH DOT road centerline file. For the purposes of this project, the only required field is the pavement width. Display the roads on top of the imagery, and review to ensure that spatial alignments are satisfactory, that all roads are captured, and that all pavement width fields are populated. Screen-digitize/enter any new data as necessary (Figure 2). Populate pavement width fields, if necessary, based on visual estimation.

Select out the limited & controlled highways, and buffer based on the pavement width field. (Local knowledge may be required to select out the appropriate road segments.) Generate a second roads buffer data set based on the remaining roadways and their pavement widths. Combine the two buffered data sets, ensuring that the limited & controlled highways take precedence over the local roads where there is overlap.

3. Railroads: Digitize all railroads from the imagery as linear features, then buffer by 12' to generate the land use polygons. (This buffer width is based on a visual assessment of the average railroad bed in the 1998 DOQ's.)
4. Composite: Generate a composite of the town bounds, the buffered roads, and the buffered railroads. Review and clean up the data at this point, ensuring that:
 - Where railroads cross road ways, the railroad feature supersedes in the data unless the road crosses over the rail bed on a bridge.
 - Any buffer polygons that extend beyond the study area are eliminated.
 - Any slivers resulting from the overlay process are removed.

Figure 2. Review of road centerline data.



The composite data set constitutes the starting point for the individual land use feature delineation. All remaining land use features should be incorporated into the layer by screen-digitizing boundaries visible in the source photography and should be coded based on the visible feature characteristics and/or by field data collection. The following protocols are provided to guide the on-screen delineation, with categories grouped where mapping protocols are the same:

Residential (1110, 1120, 1130, 1140, 1150, and 1190): Digitize residential features to visible use boundaries when possible, using yard edges/natural features to guide the delineation (Figure 3, Example 1; Figure 4, Example 1). However, where boundaries (or partial boundaries) are indistinct, use one of several approaches:

- 1a) For indistinct boundaries of houses within 250' of one another and within public water/sewer zones (i.e. water, sewer, or both), a .5-acre circle centered on the structure edge furthest from the associated road is used as a guide for the polygon delineation (Figure 4, Example 4).

1b) For indistinct boundaries of houses within 250' of one another and outside of public water/sewer zones, the 1a) protocol is applied using a 1-acre circle (Figure 4, Example 3).

2a) For indistinct boundaries of houses greater than 250' apart and within public water/sewer zones, a .5-acre box is generated, centered on the structure (Figure 5, Example 1) or centered in the approximate midpoint of multiple structures on what appears to be a single parcel. If the structure(s) is within 700' of a road, the box is oriented parallel to the nearest road. In cases where the rotated box intersects the road edge, it is repositioned further away from the road to preserve as much of the box area as possible and the road edge becomes the polygon edge (Figure 5, Example 2). In these cases, the box becomes somewhat smaller than the original .5-acre (or 1-acre when outside the water/sewer zones). If the house is further than 700' from the road, or does not appear to be associated with a nearby road, the box is not rotated.

2b) For indistinct boundaries of houses greater than 250' apart and outside of public water/sewer zones, the 2a) protocol is applied using a 1-acre box (Figure 3, Example 2).

Note that ESRC has developed a VBA tool to assist in applying the approaches described above. Contact GRANIT staff for access to this tool. *(7/24/2017 update – the VBA tool that was developed in 2007 will not run in current versions of the software.)*

Figure 3. Application of residential digitizing rules.

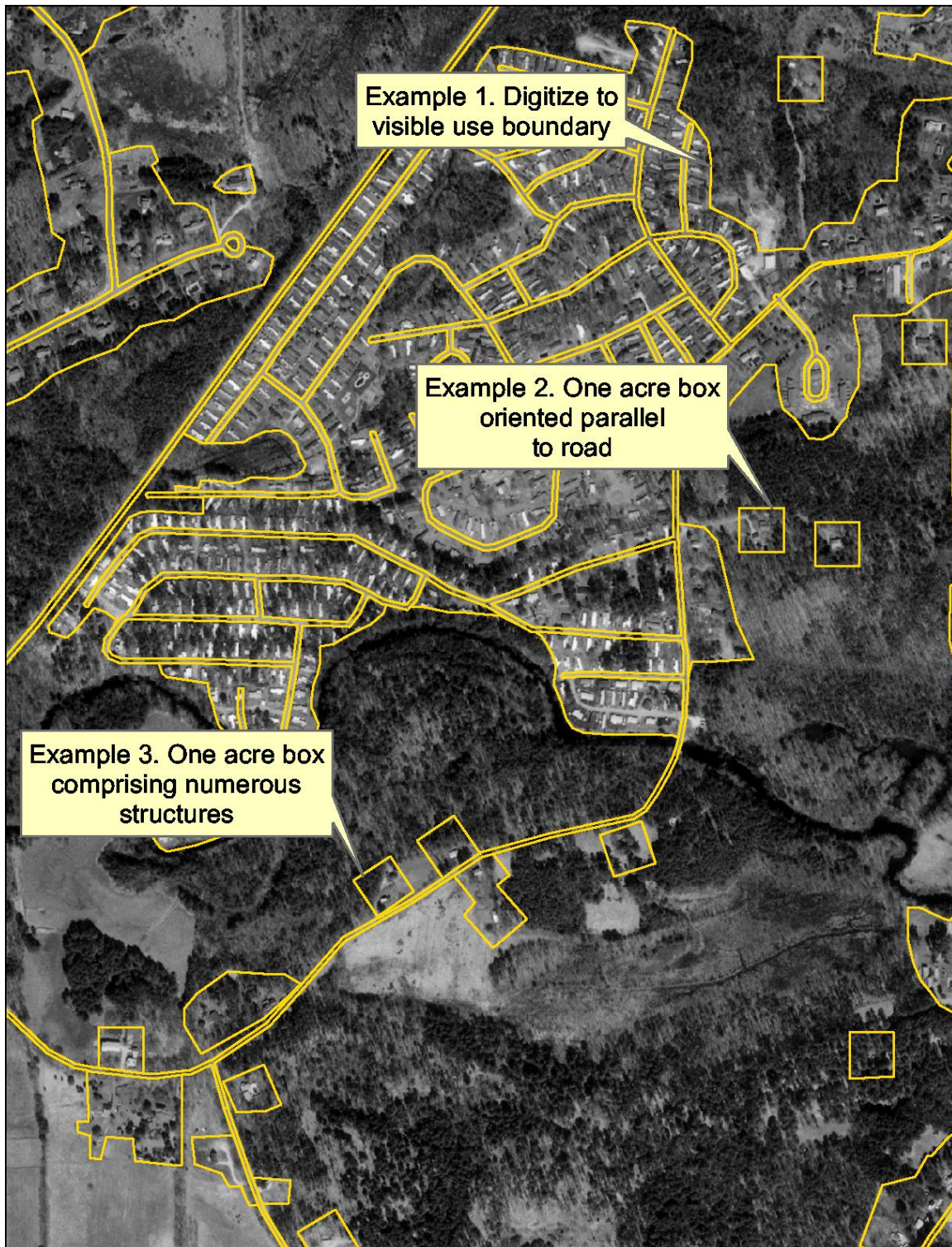


Figure 4. Additional application of residential digitizing rules.



Figure 5. Application of residential digitizing rules within water service areas.



Commercial, services, and institutional (1210, 1220, 1230, 1240, 1250, 1260, 1270, 1280, and 1290):
Digitize features to visible use boundaries (Figure 6).

Figure 6. Mapping features in the Commercial, services, and institutional category.



Industrial (1300, 1370): Digitize features to visible use boundaries. Use 1370 to map mining activities (including only the portion where there is a structure/processing facility), and 1300 for all other industrial land uses. (Note that other mining activities are mapped under code 7500.)

Air transportation (1410): Digitize features to visible use boundaries. Note that this category includes airline terminals, hangars, and grassy areas between and around runways.

Rail transportation (1420): These features are developed by buffering the railroad arcs (12 ft/side, for a total width of 24 ft.). The category may also include adjacent narrow strips that are ≤ 20 ft. in width and that are generated during the buffer process.

Water transportation (1430): Digitize features to visible use boundaries.

Road transportation (1440): Digitize features to visible use boundaries. This category includes all transportation features not explicitly mapped into individual categories, including truck terminals, bus terminals, and other road transportation features.

Limited & controlled highway right-of-way (1441): This category is developed by buffering the DOT road centerline based on pavement width. It may also include adjacent narrow strips that are ≤ 20 ft. in width and that are generated during the buffer process.

Road right-of-way (1442): This category will be developed by buffering the DOT road centerline data based on the pavement width. This includes any public road that is already in the DOT road database, unless it is clearly a Class VI unmaintained segment that isn't a traveled roadway but is kept in the database for legal purposes. It also includes any paved surfaces that are visible in the imagery but not in the DOT layer unless the roadway is used primarily for parking and/or it's impractical to determine its width. It may also include adjacent narrow strips that are ≤ 20 ft. in width and that are generated during the buffer process. Roads contained within mobile home parks will not be buffered and coded as 1442, rather, they will be considered part of the Mobile Home Park class (1140).

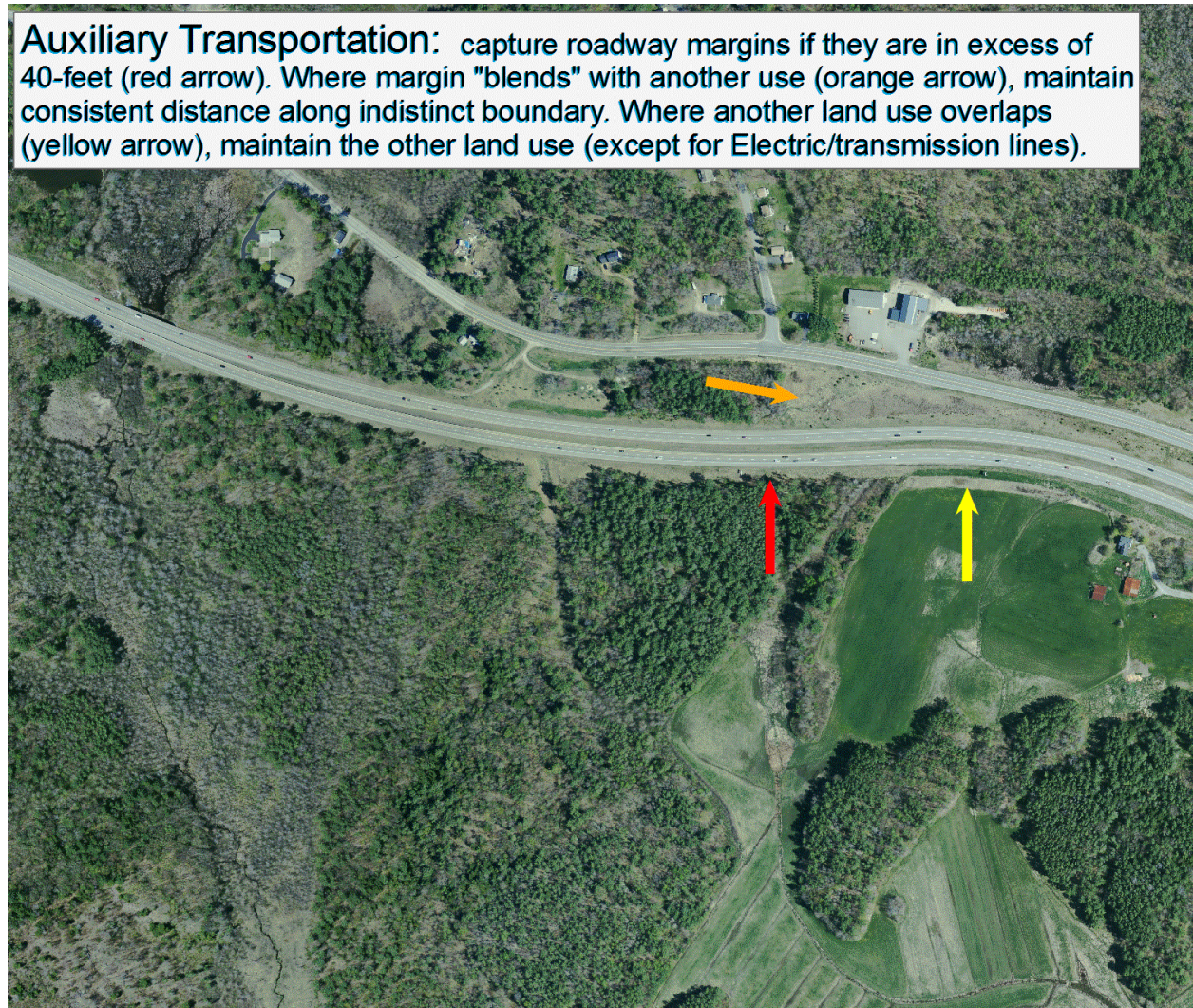
Park & ride lot (1445): Digitize features to visible use boundaries. Only designated park and ride lots are mapped in this category. Other parking lots are mapped in category 1446.

Parking structure/lot (1446): Digitize features to visible use boundaries. These include public areas in mixed use commercial areas, i.e. downtowns. Parking lots should not be separately delineated for single-use activities, such as a shopping mall.

Auxiliary transportation (1447): Digitize to visible extent of the feature. Margins along roadways in excess of 40-feet will be captured (Figure 7). This category also includes limited access highway medians and on/off ramps or cloverleaves and the interior of cul-de-sacs.

Other Road transportation (1449): Digitize features to visible use boundaries.

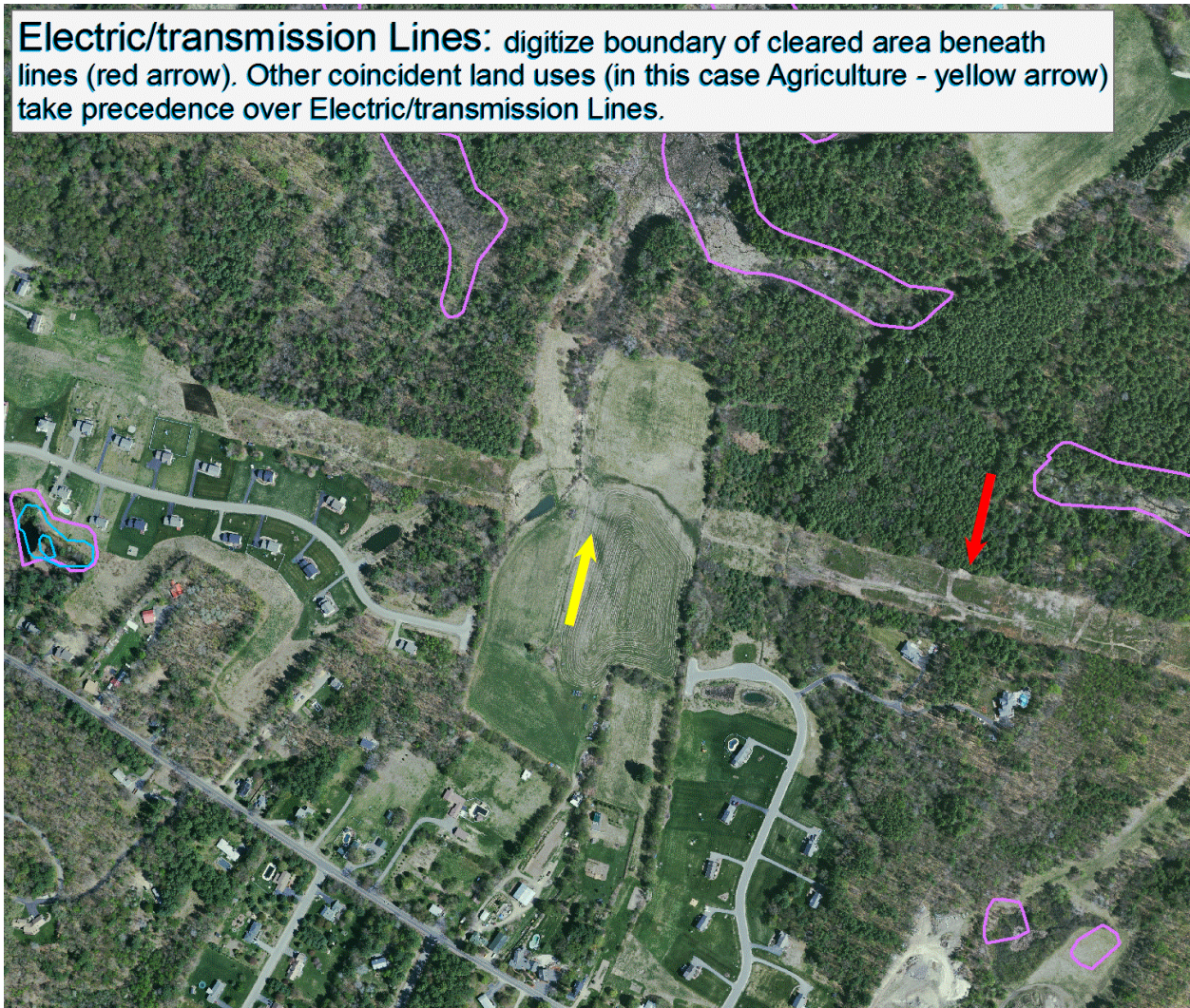
Figure 7. Potential auxiliary transportation issues.



Communication (1450): Digitize to visible extent of the feature.

Electric/transmission lines (1460): Digitize width of cleared area under the line. Where these clearings traverse another land use, the other land uses take precedence (Figure 8).

Figure 8. Potential electric/transmission line issues.



Water and wastewater utilities (1470): Digitize to visible extent of the feature.

Solid waste utilities (1480): Digitize to visible extent of the feature.

Other transportation, communications, and utilities (1490): Digitize to visible extent of the feature.

Industrial park (1510): Digitize to visible extent of the feature, including associated parking lots.

Office park (1520): Digitize to visible extent of the feature, including associated parking lots.

Shopping mall (1530): Digitize to visible extent of the feature, including associated parking lots.

Other industrial complexes (1580): Digitize to visible extent of the feature. This includes industrial sites > 25 acres with multiple occupants, including associated parking lots. Otherwise, map in Industrial category (13).

Other commercial complexes (1590): Digitize to visible extent of the feature. This includes multiple concerns with a shared parking lot. Otherwise, map in Commercial category (12).

Mixed residential-commercial (1610): Digitize to visible extent of the feature. This includes areas where level II uses are mixed. A typical example might be a structure containing a business on the ground level with residences on the upper levels, with no single use predominating.

Other mixed use (1690): Digitize to visible extent of the feature.

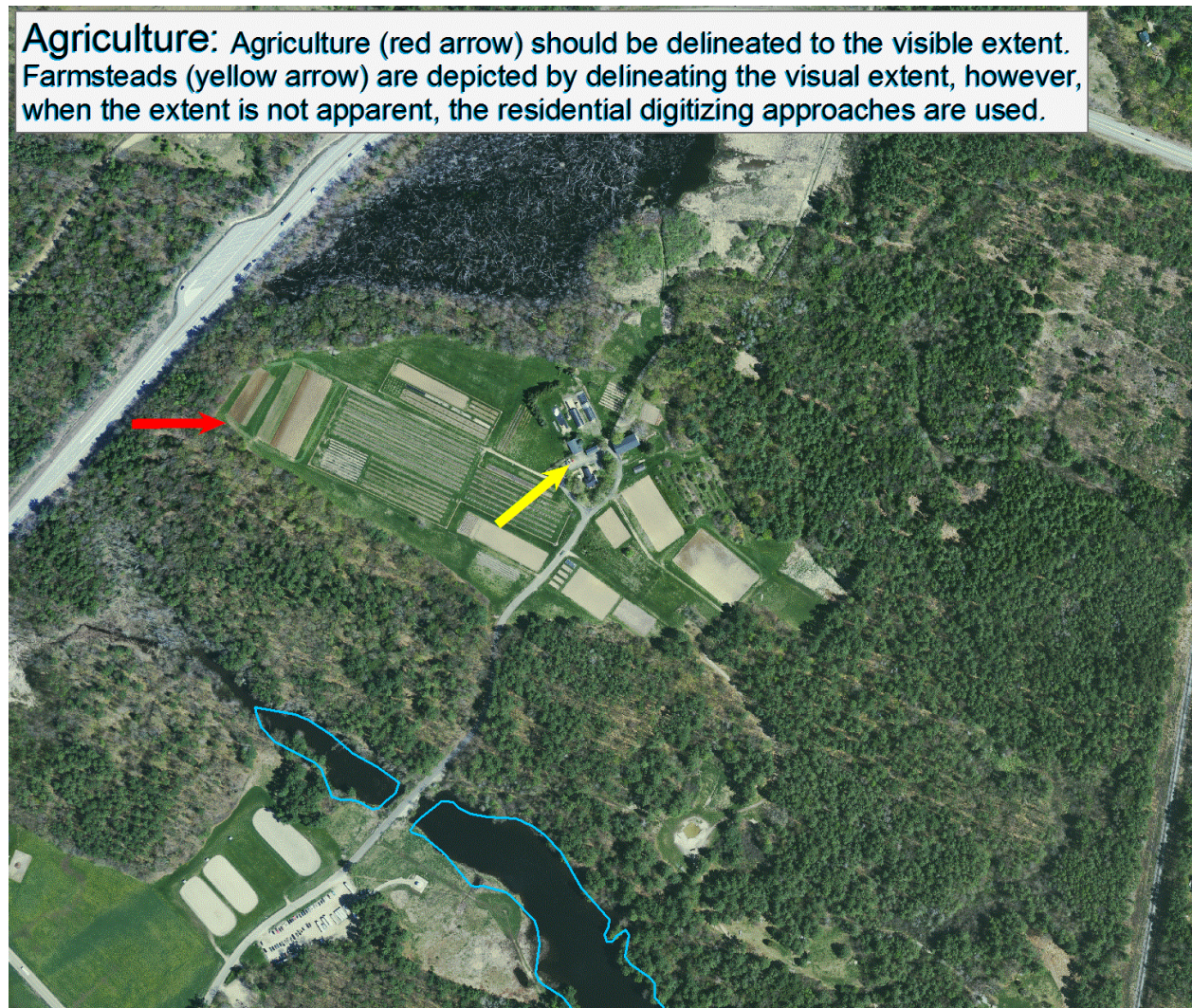
Outdoor and other urban built-up land (1710, 1720, 1730, 1740, and 1790): Digitize to visible extent of the feature. Include only the developed areas within park/recreation and other outdoor areas.

Vacant (1800): Digitize to visible extent of the feature. Include all vacant, developed land (e.g. empty shopping center).

Agricultural land (2000): Digitize to visible extent of the feature. This category includes fields, pastures, row crops, orchards, etc. It does not include farm buildings (Figure 9).

Other agricultural land (2900): Digitize to visible extent of the feature. This category should be used to capture farm buildings. Where the visible extent is vague or undefined, use the residential digitizing approaches described above (Figure 9).

Figure 9. Examples of agricultural land and other agricultural land (farmsteads).



Transitional (3000): Digitize to visible extent of the feature (Figure 10).

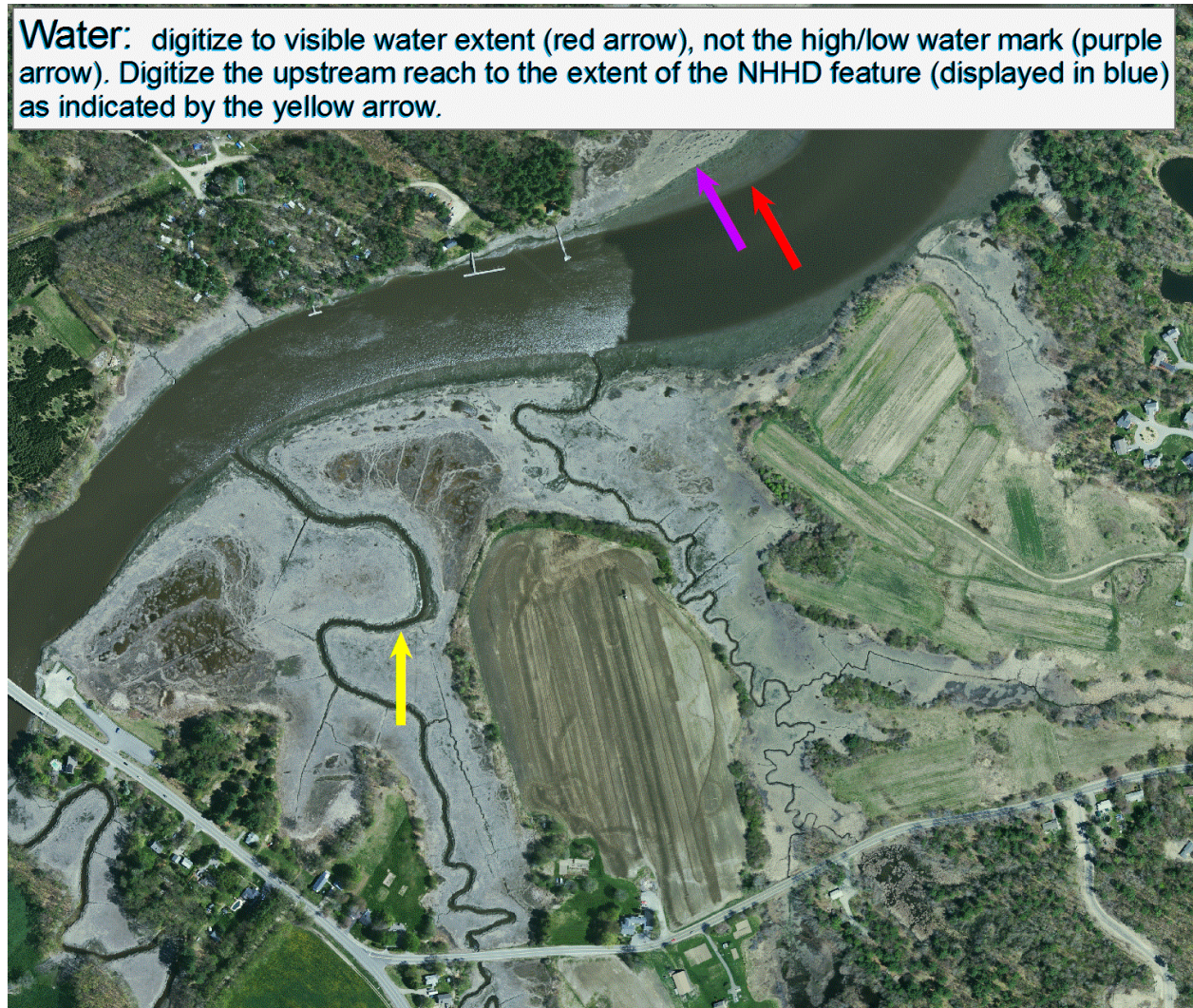
Figure 10. Illustration of abandoned or idle land in the transitional class.



Forest (4000): Digitize to visible extent of the feature. Small forested areas (less than 5 acres) that are completely enclosed within a developed polygon are assumed to "belong" to the developed polygon, and are generally not distinguished. There may be instances, however, where inclusions of forest less than 5 acres result from mapping multiple surrounding uses. These may remain in the data.

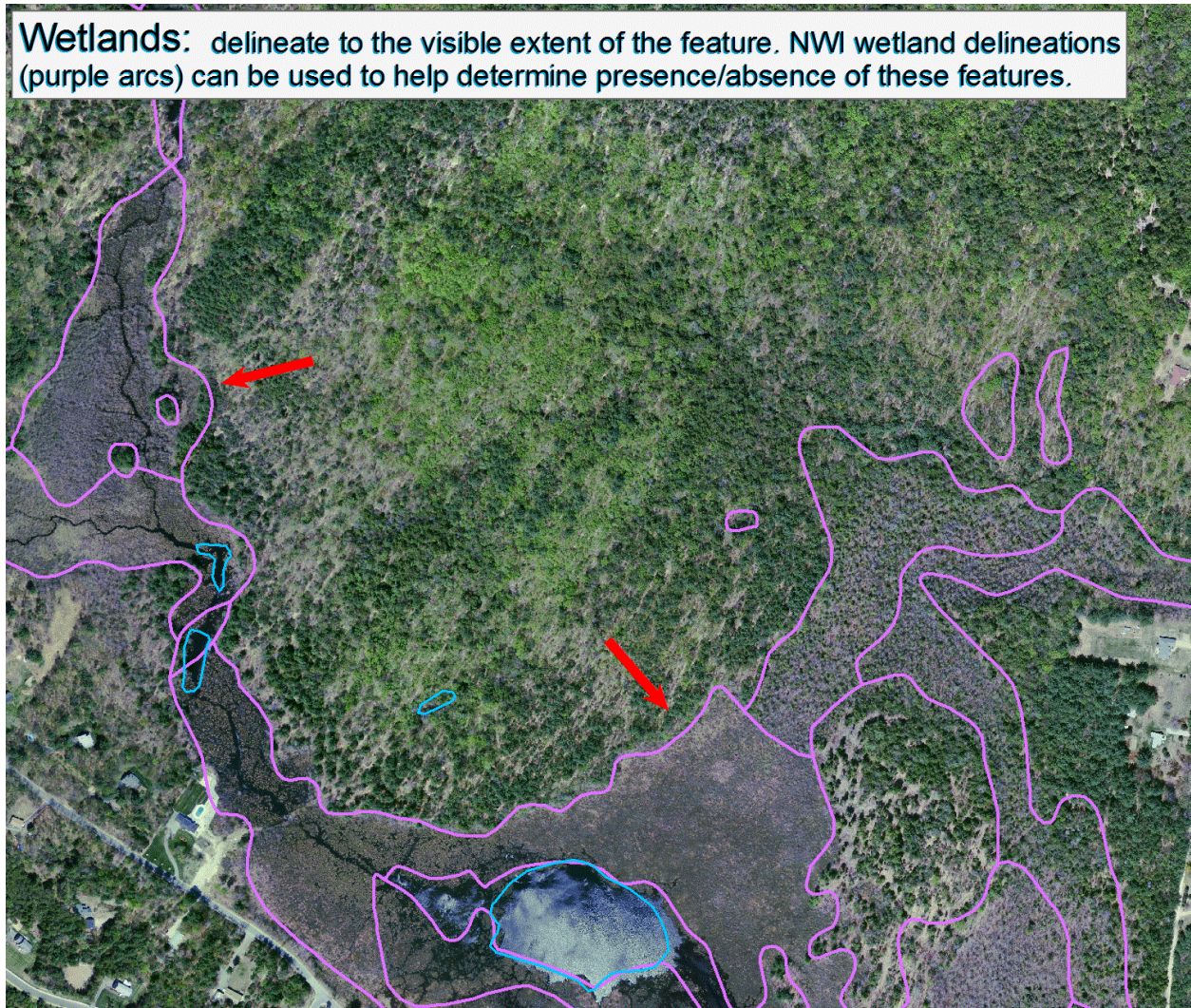
Water (5000): Delineate all surface water feature polygons from the imagery using NHHHD as a reference. If a feature is presented as a polygon in NHHHD, it should be delineated as a land use polygon (Figure 11). This approach provides a means of standardizing the set of surface water features mapped. Also, capture water to visible extent in image, not high or low water mark (as seen in tidal regions).

Figure 11. Illustration of digitizing standard for defining double line streams.



Wetlands (6000): Digitize to visible extent of the feature. This category includes all wetlands visible in the image (recognizing that some forested wetlands will be indistinguishable). NWI datasets may be used to identify the presence/absence of wetlands (Figure 12).

Figure 12. Illustration of forested and open wetland classes.



Barren (7100, 7200, 7300, 7400, 7500, 7600, and 7900): Digitize to visible extent of the feature. With respect to mining, this category includes only developed areas within mining activities, and does not include mining buildings/machinery (which should be assigned a category of 1370, Figure 13). Construction sites for new development provide an example of “disturbed” uses.

Figure 13. Illustration of the barren category.



Tundra (8000): Digitize to visible extent of the feature. This category is rare and probably only occurs at high elevations in Carroll, Coos, and Grafton counties.

It is expected that secondary data sources will be required to code some of the categories. In particular, many of the developed categories will require either field visits or access to digital parcel data in order to correctly classify the use or density of use. Additionally, transitional categories can be difficult to identify from aerial photography, making field visits a necessary step. Typically, these sites can be determined via “windshield surveys” after the feature has been defined on-screen. Ultimately, it is left to the analyst’s discretion as to the most appropriate procedure used to code a given land use.

Quality Control

Review all feature data for topological integrity by using standard GIS tools to check for polygon closure, sliver polygons, etc.

Review attribute integrity by confirming that all polygons are coded, and by checking all codes against an attribute domain list. In addition, a “dissolve” operation should be applied to confirm that there are no adjacent polygons with identical land use codes.

The quality of the feature interpretation and delineation should also be reviewed during the quality control phase. The delineated land use polygons may be mapped, using transparent symbology, on the source imagery displayed at a minimum scale of 1:5,000. Linework and attribute coding should be modified, as necessary.

Appendix I. Comprehensive 4-digit land use classification scheme. Yellow cells indicate the 58 categories extracted for the I93 Corridor land use mapping project. (7/24/2017 update - two land uses have been added since the original publication of this document.)

Level I		Level II		Level III		Level IV		Notes/Description
1	Urban or Built-Up Land	11	Residential	111	Multi-family, medium to high rise apartments and condominiums (4 or more stories)	1111	More than 50 units per acre	
						1112	36 to 50 units per acre	
						1113	21 to 35 units per acre	
						1114	10 to 20 units per acre	
						1115	1 to 10 units per acre	
				112	Multi-family, low rise apartments and townhouses, but not duplexes (1 -3 stories)	1121	More than 18 units per acre	
						1122	12 to 18 units per acre	
						1123	8 to 12 units per acre	
						1124	Less than 8 units per acre	
				113	Single family/duplex	1131	More than 8 units per acre	
						1132	5 to 8 units per acre	
						1133	3 or 4 units per acre	
						1134	1 or 2 units per acre	
						1135	Less than 1 unit per acre	
				114	Mobile home parks	1141	More than 9 units per acre	
						1142	6 to 9 units per acre	
						1143	2 to 5 units per acre	
						1144	Less than 2 units per 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 and sororities	
						1159	Other group and transient quarters	
				119	Other residential			
		12	Commercial, Services, and Institutional	121	Commercial retail	1211	Building materials, hardware, and farm equipment	
						1212	General merchandise/department store	
						1213	Food/groceries	

Level I	Level II	Level III	Level IV	Notes/Description
			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 commercial retail	
		122 Commercial wholesale	1221 Food/sundries/beverages	
			1222 Agricultural products/supplies	
			1223 Lumber/hardware/building supplies/paper	
			1224 Industrial products/chemical/petroleum	
			1225 Motor vehicles/parts/supplies	
			1229 Other commercial wholesale	
		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	
			1243 Seasonal rentals	
			1249 Other lodging	
		125 Government	1251 Correctional	
			1252 Military	
			1253 Courthouse	
			1254 Postal service	
			1255 Administrative offices	
			1256 Emergency services	
			1257 Public works	
			1259 Other government	
		126 Institutional	1261 Religious	
			1262 Hospital	
			1263 Medical clinics	

Level I	Level II	Level III	Level IV	Notes/Description		
			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 Theater			
			1283 Amusement parks			
			1284 Sports arena			
			1289 Other indoor cultural/public assembly			
		129 Other commercial, services, and institutional				
		13 Industrial	131 Primary metal production and fabricated metal products			
			132 Petrochemicals, chemicals and allied products			
			133 Wood and lumber products; paper and allied products			
			134 Stone, clay, glass products			
			135 Industrial machinery, electronic and other electric products			
			136 Food processing			
			137 Mining		1371 Hard rock	
					1372 Quarry	Portion where there is a structure/processing facility only. Remainder coded as 75.
					1373 Sand/gravel	Portion where there is a structure/processing facility only. Remainder coded as 75.
					1379 Other mining	
			138 Electronics			
			139 Other industrial			

Level I	Level II	Level III	Level IV	Notes/Description
	14 Transportation, Communications, and Utilities	141 Air transportation	1411 Commercial	Includes grassy areas around runways.
		142 Rail transportation	1412 Non-commercial	
			1413 Heliports	
			1419 Other air transportation	
			1421 Rail yard	
			1422 Station or terminal	
			1423 Active rail line	
			1424 Inactive rail line	
		143 Water transportation	1429 Other rail transportation	
			1431 Port facilities	
		144 Road transportation	1439 Other water 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	For public areas in mixed use commercial areas, i.e. downtowns. Parking lots should not be separately delineated for single-use activities, such as a shopping mall.
			1447 Auxiliary transportation	Includes grassy areas along highways - median strips, inside cloverleaves, etc.
		145 Communication	1449 Other road transportation	
			1451 Radio station	
			1452 Telecommunications facilities	
			1453 Television station	
			1454 Transmitters/towers	
		146 Electric, gas and other utilities	1459 Other communication	
			1461 Electric transmission lines	
			1462 Electric power generation facilities	
			1463 Gas or oil pipelines (natural, propane, or other)	
			1464 Gas or oil storage facilities	
			1469 Other utilities	
			147 Water and wastewater utilities	1471 Water treatment plant
1472 Aqueduct				
1473 Water storage tanks				
1474 Wastewater treatment				

Level I	Level II	Level III	Level IV	Notes/Description
			1475 Interceptors	
			1479 Other water/wastewater utilities	
		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	
			1489 Other solid waste facilities	
		149 Other transportation, communications, and utilities		
	15 Industrial and Commercial Complexes	151 Industrial park		
		152 Office park		
		153 Shopping mall		
		158 Other industrial complexes		
		159 Other commercial complexes		
	16 Mixed Developed Uses	161 Multiple stories, residential in upper stories only		
		169 Other mixed 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		
		1732 Sports area		
		1733 Water recreation/marina/launch		
		1734 Ski area		
		1735 Golf course		
			Industrial site > 25 acres with multiple occupants. Otherwise, map in Industrial category (13).	
			Multiple concerns with shared parking lot. Otherwise, map in Commercial category (12).	
			Areas where level 2 uses are mixed with no single use predominating.	

Level I		Level II		Level III		Level IV		Notes/Description
						1736	Campground	
						1737	Parks and recreation	Developed area within park/recreation area only
						1738	Private camps	
						1739	Other outdoor recreation	
				174	Cemeteries			
				179	Other outdoor and other urban or built-up land			Developed only
		18	Vacant Land					Other vacant, developed land (e.g. empty shopping center)
2	Agricultural Land	21	Cropland and Pasture	211	Row crops (not including orchards and berries, code 22)	2111	Corn	
						2112	Silage (corn and grasses)	
						2113	Potatoes	
						2114	Soybeans	
						2115	Alfalfa	
						2118	Other root crops	
						2119	Other non-root crops	
				212	Hay/rotation/permanent pasture	2121	Hay	
						2122	Rotation pasture	
						2123	Permanent pasture	
						2124	Idle agricultural land	
						2129	Other pasture	
				213	Grains (not including row crops)	2131	Wheat	
						2132	Oats	
						2133	Sorghum	
						2134	Barley	
						2139	Other grains (not including row crops)	
		22	Orchards, Bush Fruits, Vineyards, and Ornamental Horticulture	221	Tree fruits, regularly spaced (planted)	2211	Apples	
						2212	Pears	
						2219	Other tree fruits	
				222	Bush and vine fruits (in rows)	2221	Strawberries	
						2222	Raspberries	
						2223	Blueberries	
						2224	Grapes	
						2229	Other bush and vine fruits	

Level I	Level II	Level III	Level IV	Notes/Description
		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 Sugar bush		
		229 Other orchards, etc.		
	23 Confined Feeding Operations	231 Livestock	2311 Beef	
			2312 Dairy	
			2313 Swine	
			2314 Lamb	
			2319 Other livestock	
		232 Poultry	2321 Chicken	
			2322 Turkeys	
			2329 Other	
		233 Pisciculture	2331 Aquaculture	
			2332 Fish hatchery	
			2339 Other pisciculture	
		239 Other confined feeding operations		
	29 Other Agricultural Land	291 Farmsteads		
		292 Greenhouses and mushroom houses		
		293 Stables and racetracks (non-commercial training areas)		
		294 Sod		
		299 Other other agricultural lands		
3	Brush or Transitional Between Open and Forested	31 Herbaceous, Non-Woody Vegetation		
		32 Shrub/Brush		
		33 Mixed Herbaceous and Shrub/Brush		
4	Forest Land ([nn]=Society of American Foresters type number)	41 Broadleaf Forest	411 Boreal hardwoods	4111 Aspen [16]
				4112 Pin cherry [17]
				4113 Paper birch [18]

Level I	Level II	Level III	Level IV	Notes/Description
			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 [25]	
			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]	
			4149 Other other hardwoods	
	42 Coniferous Forest	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/Fraser fir [34]	
			4224 Northern white cedar [37]	
			4229 Other spruce-fir types	
		423 Pine and hemlock	4231 Red pine [15]	
			4232 White pine [21]	
			4233 White pine/Hemlock [22]	
			4234 Eastern hemlock [23]	
			4235 Eastern red cedar [46]	
			4239 Other pine and hemlock	
	43 Mixed Coniferous-Broadleaf Forest	431 Mixed spruce-fir types	4311 Red spruce/Yellow birch [30]	

Level I	Level II	Level III	Level IV	Notes/Description
			4312 Red spruce/Sugar maple/Beech [31]	
			4313 Paper birch/Red spruce/Balsam fir [35]	
		432 Mixed pine/hemlock types	4321 White pine/Red oak/Red maple [20]	
			4322 White pine/Chestnut oak [51]	
5	Water (see 143 for transportation uses and 233 for agricultural uses)	51 Rivers, Canals and Other Waterways	511 Canal	4323 Hemlock/Yellow birch [24]
		512 River or stream		
		519 Other waterways		
	52 Lakes and Pond			
	53 Reservoirs (and other artificial water surfaces)			
	54 Bays and Estuaries			
6	Wetlands	61 Forest Wetland	611 Broad-leaved deciduous	
			612 Needle-leaved deciduous	
			613 Broad-leaved evergreen	
			614 Needle-leaved evergreen	
			615 Dead	
		619 Mixed deciduous and coniferous forested wetlands		
	62 Non-forested Wetland	621 Aquatic bed	6211 Algal	
			6212 Aquatic moss	
			6213 Rooted vascular	
			6214 Floating	
			6221 Moss dominant (bogs and fens)	
		622 Moss-lichen	6222 Lichens dominant	
			6231 Wet meadow	
		623 Emergent wetland	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	
		629 Other non-forested, non-tidal wetland		
	63 Tidal Wetlands	631 Saltmarsh		
		632 Tidal flat		
		639 Other tidal wetland		

Level I		Level II		Level III		Level IV		Notes/Description
7	Barren Land or Idle Land	71	Salt Flats					
		72	Beaches and River Banks	721	Sand beach			
				722	Gravel beach			
				723	River banks			
				729	Other beaches/river banks			
		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					undeveloped
		76	Disturbed Land					e.g. construction sites for new development
		79	Other Barren Lands					
8	Tundra	81	Shrub and Brush					
		82	Herbaceous					
		83	Bare Ground					
		84	Wet					
		85	Mixed					
9	Perennial Snow & Ice (no known examples in NH)							

¹In the original land use standards (Appendix II), the 3-digit code of 111 was defined as residential units with 3 or more stories, while 112 was defined as residential units with 1-2 stories. However, pilot testing using the classification indicated that modifying the thresholds to 4 or more stories (111) and 1-3 stories (112) was more appropriate when mapping established residential areas in larger cities (e.g. Manchester).

Appendix II. NEW HAMPSHIRE LAND USE/LAND COVER CLASSIFICATION

The first two levels of land use and land cover classification employed in the statewide GRANIT system taken from the US Geological Survey (J.R.Anderson, E.E.Hardy, J.T.Roach, and R.E.Witmer) and detailed in USGS Professional Paper 964, 1976. This classification system is hierarchical in design and has been expanded to a third and fourth level of detail by the State of Vermont. Levels III and IV of the land use and land cover classification system for New Hampshire are the same as Vermont's (VGIS Part 2 - Standards Section C) with minor additions.

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 per acre
- 1112 36 to 50 units per acre
- 1113 21 to 35 units per acre
- 1114 10 to 21 units per acre
- 1115 1 to 10 units per acre

112 Multi-family, low rise apartments and town houses, but not
duplexes; (1 or 2 stories)

- 1121 more than 18 units per acre
- 1122 12 to 18 units per acre
- 1123 8 to 12 units per acre
- 1124 less than 8 units per acre

113 Single family/duplex

- 1131 more than 8 units per acre
- 1132 5 to 8 units per acre
- 1133 3 to 4 units per acre
- 1134 1 to 2 units per acre
- 1135 less than 1 unit per acre

114 Mobile home parks

- 1141 more than 9 units per acre
- 1142 6 to 9 units per acre
- 1143 2 to 5 units per acre
- 1144 less than 2 units per acre

115 Group and transient quarters

- 1151 Rooming and boarding houses
- 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

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 recorded)

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

12 COMMERCIAL, SERVICES AND INSTITUTIONAL

125 Government

- 1251 Correctional
- 1252 Military
- 1253 Courthouse
- 1254 Postal service
- 1255 Administrative offices
- 1256 Emergency services
- 1257 Public works
- 1259 Other government

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
- 1289 Other indoor cultural assembly

129 Other commercial, services and institutional

13 INDUSTRIAL

- 131 Primary metal production
- 132 Petrochemicals/chemicals
- 133 Primary wood processing and paper mills
- 134 Stone, clay, glass
- 135 Metal and non-metal fabrication
- 136 Food processing
- 137 Mining (active operations)
 - 1371 Hard rock
 - 1372 Quarry
 - 1373 Sand/gravel
 - 1379 Other mining
- 138 Electronics
- 139 Other industrial

14 TRANSPORTATION, COMMUNICATIONS & UTILITIES

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

14 TRANSPORTATION, COMMUNICATIONS & UTILITIES (continued)

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

- 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
 - 1489 Other solid waste facilities

149 Other communications, utilities

15 INDUSTRIAL AND COMMERCIAL COMPLEXES

151 Industrial park

- 152 Office park
- 153 Shopping center/mall
- 158 Other industrial complexes
- 159 Other 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
 - 1713 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
 - 1732 Sports areas
 - 1733 Water recreation/marina/launch
 - 1734 Ski area
 - 1735 Golf course
 - 1736 Campground
 - 1737 Parks and recreation
 - 1739 Other outdoor recreation

174 Cemeteries

179 Other outdoor urban, built-up and developed

2 AGRICULTURAL LAND

21 CROPLAND AND PASTURE

- 211 Row crops (not including orchards and berries, code 22)
 - 2111 Corn (land cover includes silage corn)
 - 2112 Silage (corn and grasses)

- 2113 Potatoes
- 2114 Soybeans
- 2115 Alfalfa
- 2118 Other root crops
- 2119 Other non-root crops

- 212 Hay/rotation/permanent pasture
 - 2121 Hay
 - 2122 Rotation pasture
 - 2123 Permanent pasture
 - 2124 Idle agricultural land; use level 3 for land cover
 - 2129 Other pasture

- 213 Grains (not including row crops)
 - 2131 Wheat
 - 2132 Oats
 - 2133 Sorghum

- 21 CROPLAND AND PASTURE
 - 213 Grains (not including row crops)
 - 2134 Barley
 - 2139 Other grains (not including row crops)

- 22 ORCHARDS, BUSH FRUITS, VINEYARDS AND ORNAMENTAL HORTICULTURE
 - 221 Tree fruits, regularly spaced (planted)
 - 2211 Apples
 - 2212 Pears
 - 2219 Other tree fruits

 - 222 Bush and vine fruits (in rows)
 - 2221 Strawberries
 - 2222 Raspberries
 - 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 Chicken
- 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

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/Fraser fir [34]
- 4224 Northern white cedar [37]
- 4229 Other spruce-fir types

423 Pine and hemlock

- 4231 Red pine [15]
- 4232 White pine [21]
- 4233 White pine/Hemlock [22]
- 4234 Eastern hemlock [23]
- 4235 Eastern red cedar [46]
- 4239 Other pine and hemlock

43 MIXED CONIFEROUS-BROADLEAF FOREST

431 Mixed spruce-fir types

- 4311 Red spruce/Yellow birch [30]
- 4312 Red spruce/Sugar maple/Beech [31]
- 4313 Paper birch/Red spruce/Balsam fir [35]

432 Mixed pine/hemlock types

- 4321 White pine/Red oak/Red maple [20]
- 4322 White pine/Chestnut oak [51]
- 4323 Hemlock/Yellow birch [24]

5 WATER (see 143 for transportation uses and 233 for agricultural uses)

- 51 RIVERS, CANALS AND OTHER WATERWAYS
 - 511 Canal
 - 512 River or Stream
 - 519 Other waterways
- 52 LAKES AND PONDS
- 53 RESERVOIRS (and other artificial water surfaces)
- 54 BAYS/ESTUARIES

6 WETLANDS (not including open water)

- 61 FORESTED WETLAND
 - 611 Broad-leaved deciduous
 - 612 Needle-leaved deciduous
 - 613 Broad-leaved evergreen
 - 614 Needle-leaved evergreen
 - 615 Dead
 - 619 Mixed deciduous and coniferous forested wetland
- 62 NON-FORESTED WETLAND
 - 621 Aquatic bed
 - 6211 Algal
 - 6212 Aquatic moss
 - 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
 - 629 Other non-forested, non-tidal wetland

63 TIDAL WETLANDS

- 631 Saltmarsh
- 632 Tidal flat
- 639 Other tidal wetland

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
- 76 DISTURBED LAND
- 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 New Hampshire)