Introduction

The NH Land Use Mapping Standard describes a classification scheme and mapping protocols for generating land use data from high resolution, remotely sensed data sources. The standard was developed by GRANIT staff at Complex Systems Research Center (CSRC), University of New Hampshire, in consultation with the Office of Energy and Planning 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 developed under the auspices of the CTAP/I-93 Corridor Project in southern New Hampshire, and will govern the production of land use data for the 26 towns in that Corridor.   While developed for that project, it 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 land use data is high-resolution (1 ft.), color, leaf-off, digital orthophotography (Figure 1). Additional data sources 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.sr.unh.edu**).

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

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

Land Use Classification

The data will utilize a classification structure that represents an enhancement of the standard 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:

Level	Code	Category Description
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

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 58 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 58-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
	1790	Other outdoor and other urban or built-up land
	Vacant (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 143 for transportation uses and 233 for agricultural uses)
Wetlands (6)		
	6000	Wetlands
Barren (7)		
	7100	Salt Flats
	7200	Beaches and River Banks
	7300	Sandy 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: CSRC staff will generate an FGDC-compliant metadata record that includes the general procedures and protocols contained in this document. RPC staff should submit to CSRC documentation that describes any data sources or mapping techniques that deviate from and/or extend these general project standards.
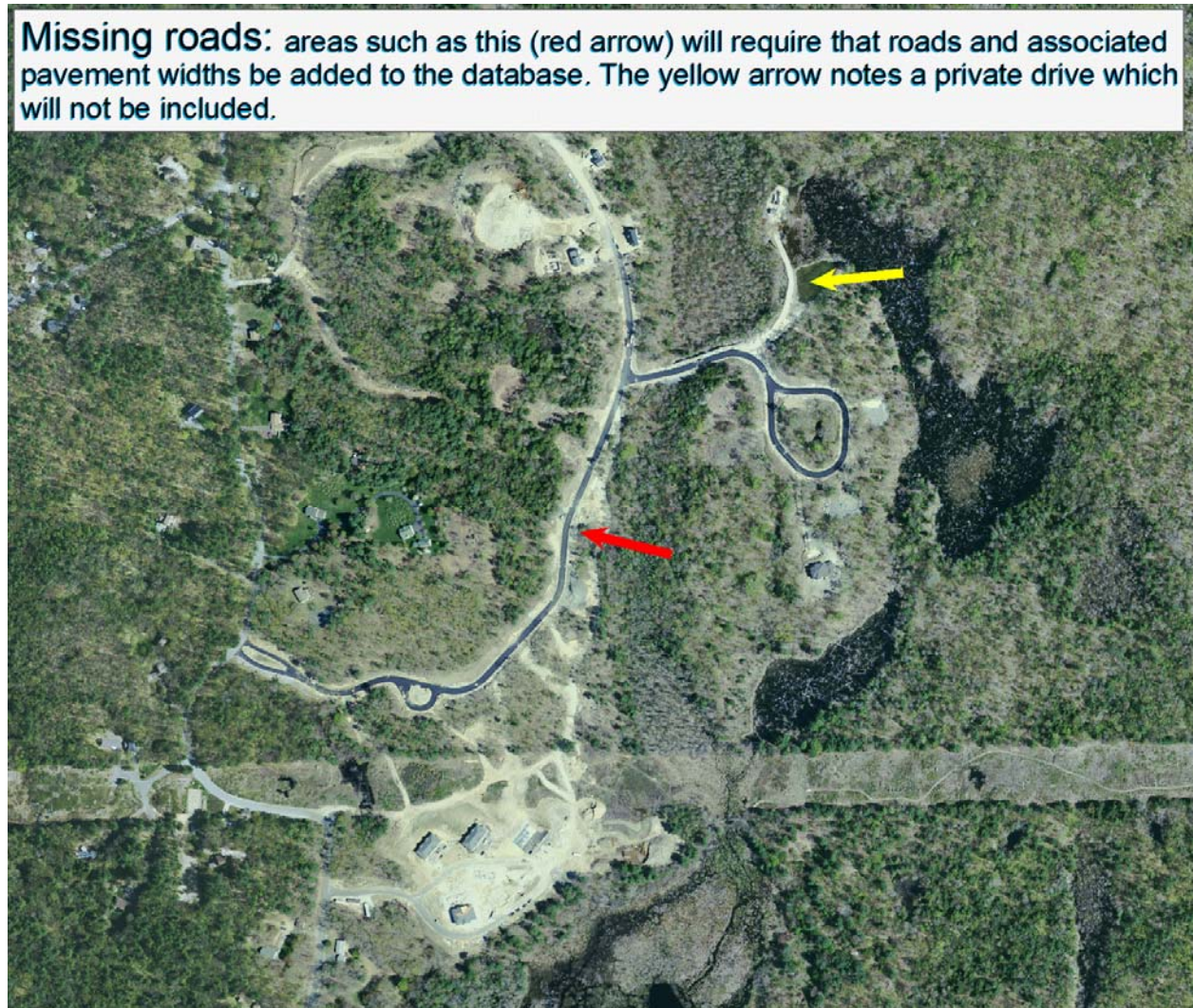
Data Development Protocols

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 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.

Missing roads: areas such as this (red arrow) will require that roads and associated pavement widths be added to the database. The yellow arrow notes a private drive which will not be included.

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 CSRC has developed a VBA tool to assist in applying the approaches described above. Contact GRANIT staff for access to this tool.

Figure 3. Application of residential digitizing rules.

Example 1. Digitize to visible use boundary

Example 2. One acre box oriented parallel to road

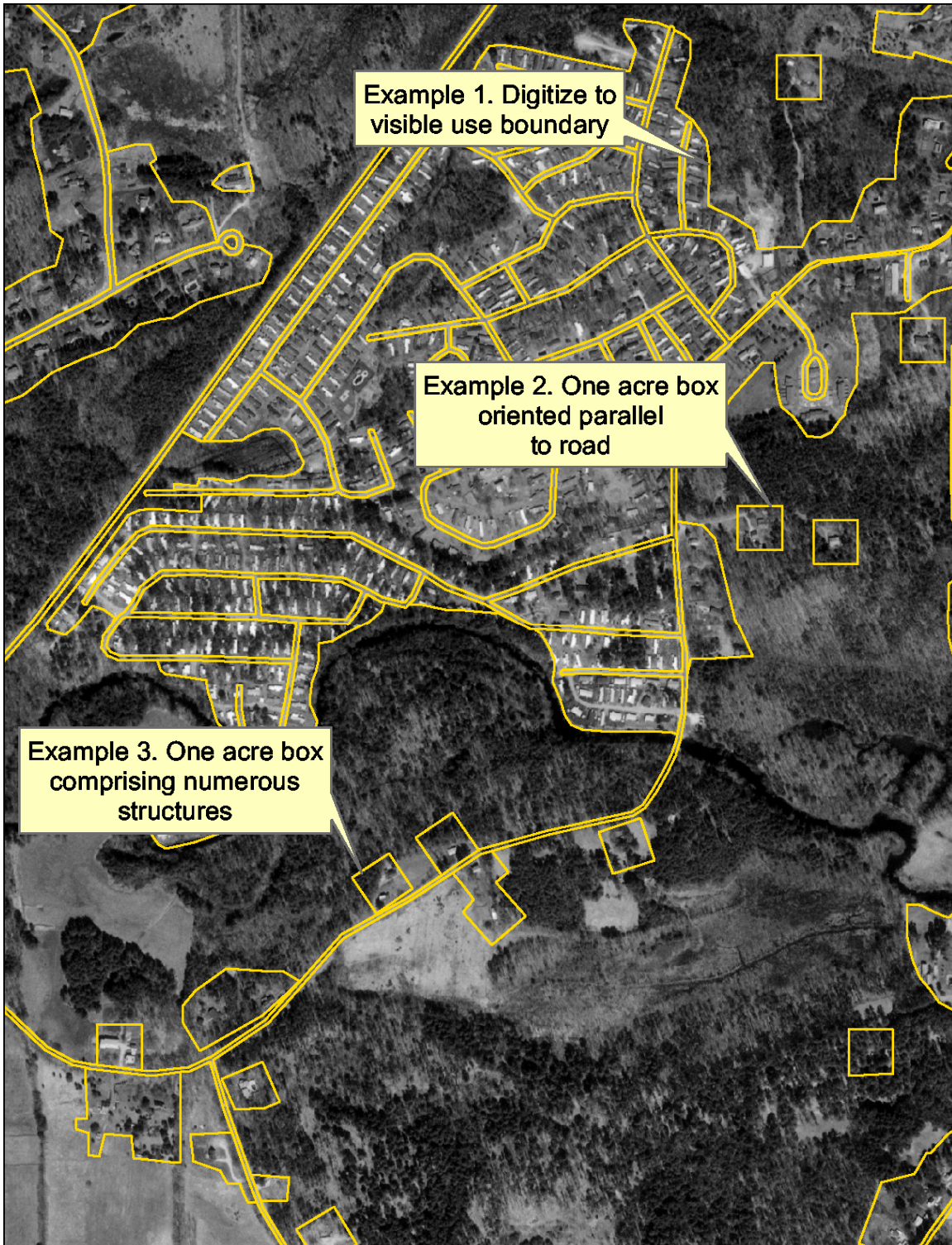Example 3. One acre box comprising numerous structures

Figure 4. Additional application of residential digitizing rules.
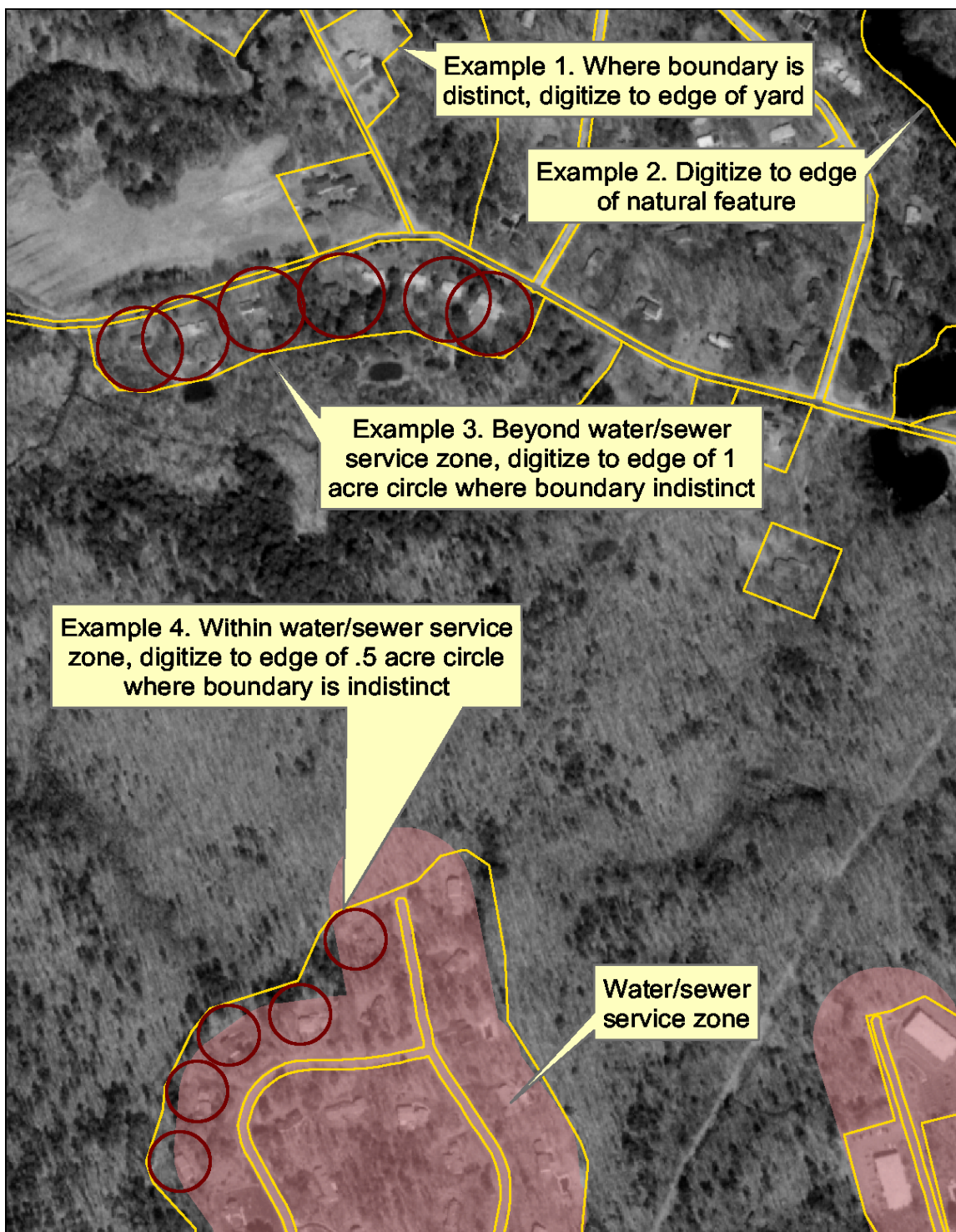
Figure 5. Application of residential digitizing rules within water service areas.

Water/sewer service zone

Example 1. .5-acre box defining residential structure within water/sewer zone

Example 2. .5-acre box defining residential structure where road becomes polygon edge
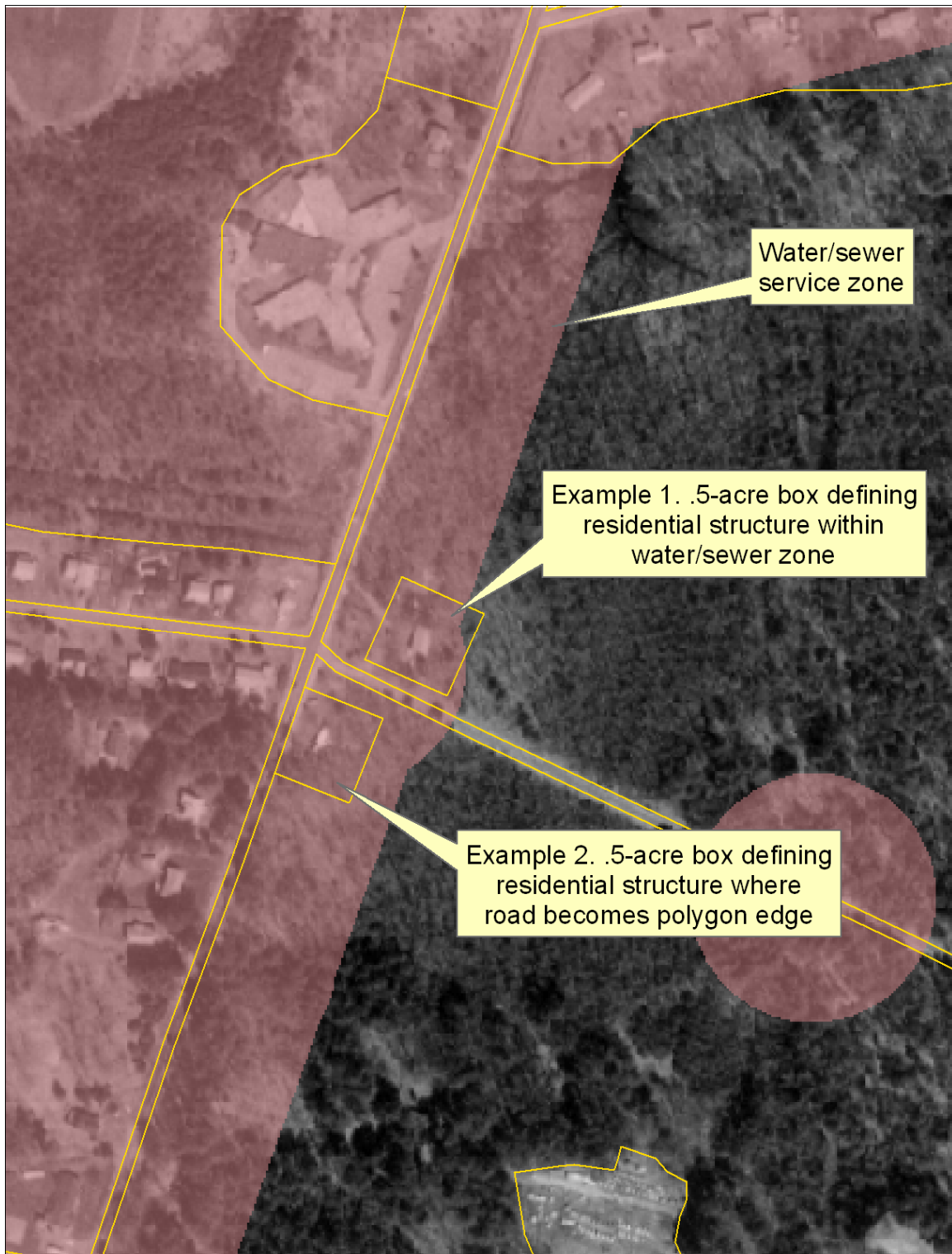
Commercial, services, and institutional (1210, 1220, 1230, 1240, 1250, 1260, 1270, 1280, and 1290):
Digitize features to visible use boundaries (Figure 6).

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, hangers, 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. Also, 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 cloverleafs and the interior of cul-de-sacs.

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

Figure 7. Potential auxiliary transportation issues.
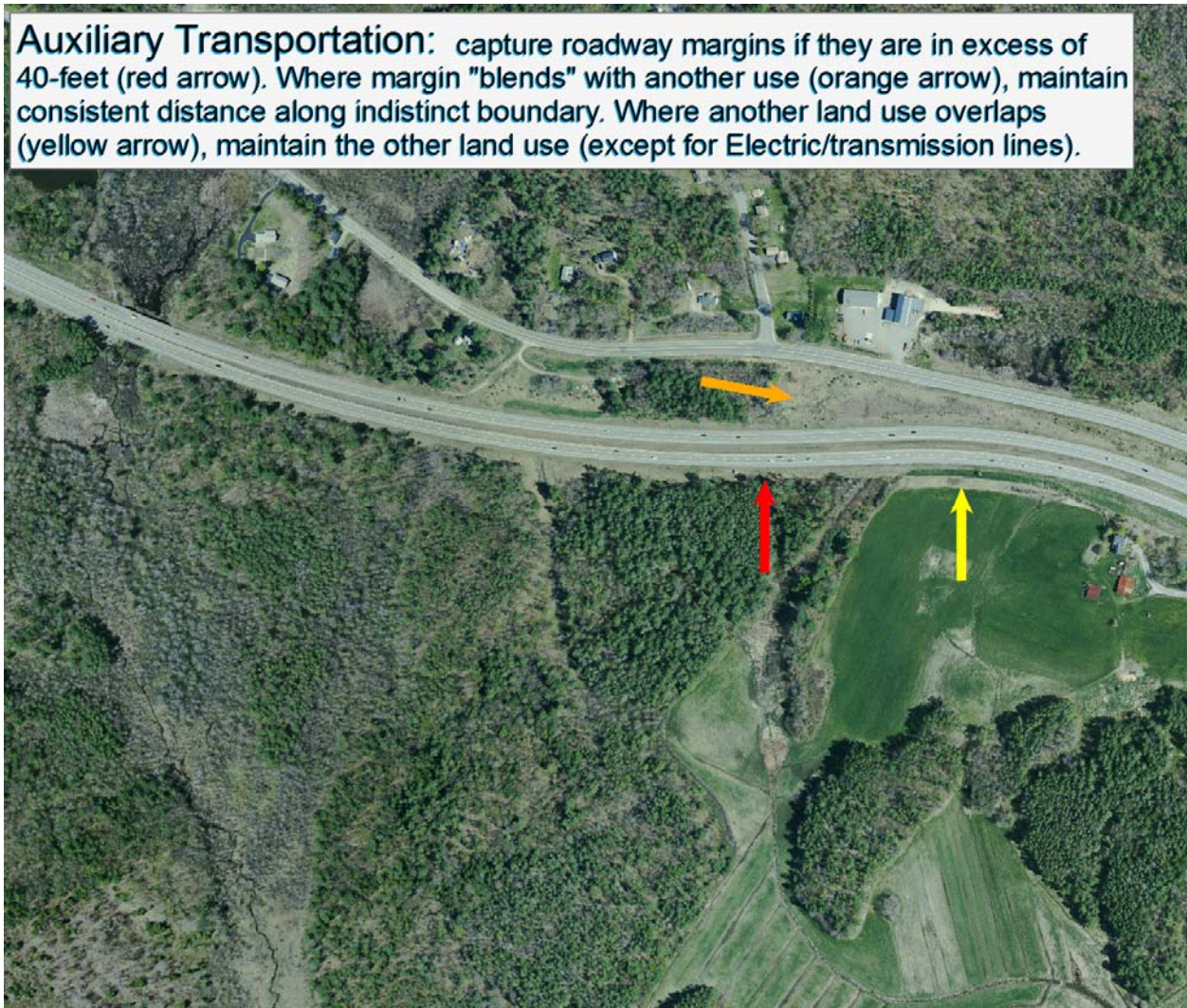
Communication (1450): Digitize to visible extent of the feature.

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.

Electric/transmission Lines: digitize boundary of cleared area beneath lines (red arrow). Other coincident land uses (in this case Agriculture - yellow arrow) take precedence over Electric/transmission Lines.
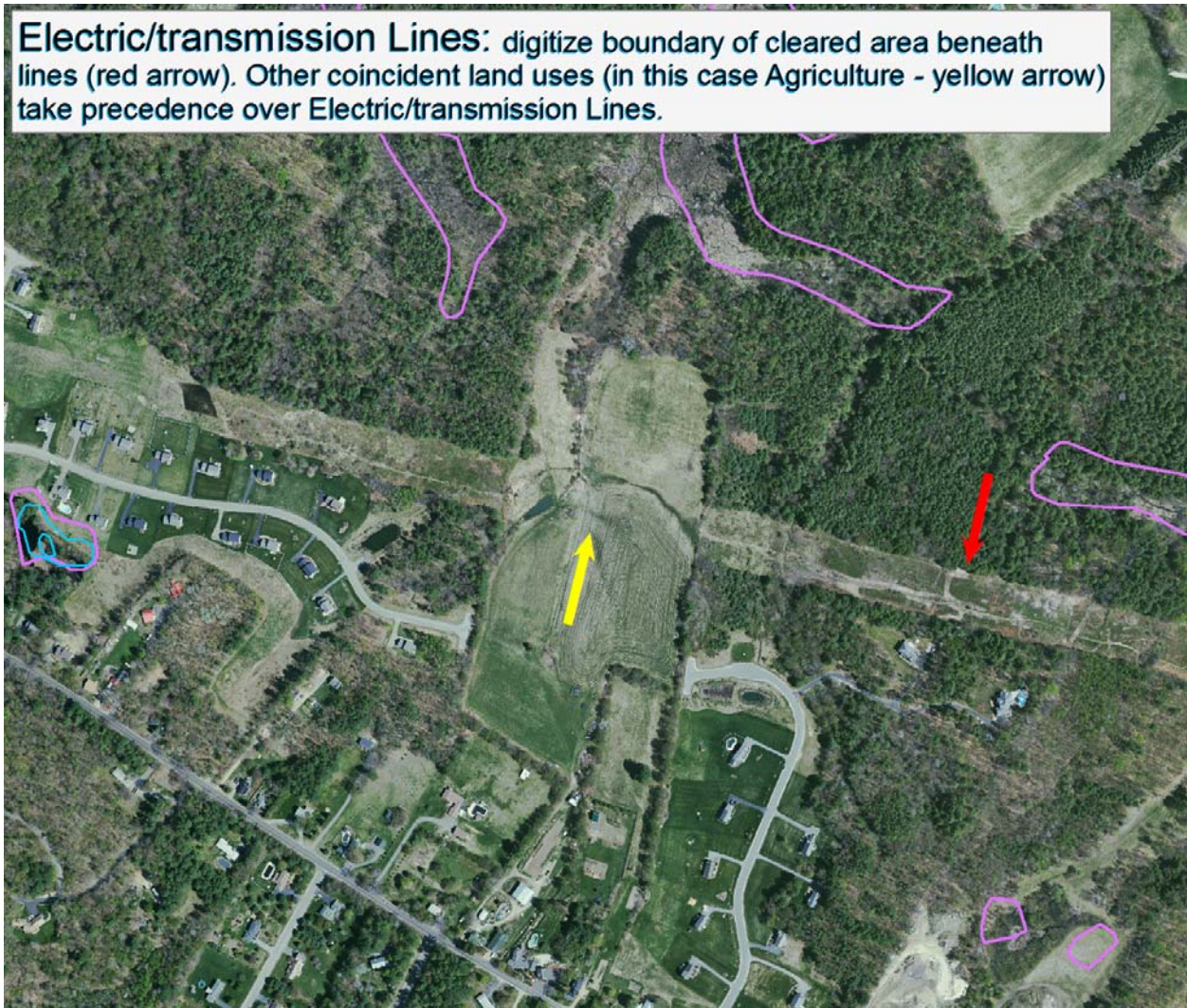
Water and wastewater utilities (1470): Digitize to visible extent of the feature.

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).

Agriculture: Agriculture (red arrow) should be delineated to the visible extent. Farmsteads (yellow arrow) are depicted by delineating the visual extent, however, when the extent is not apparent, the residential digitizing approaches are used.
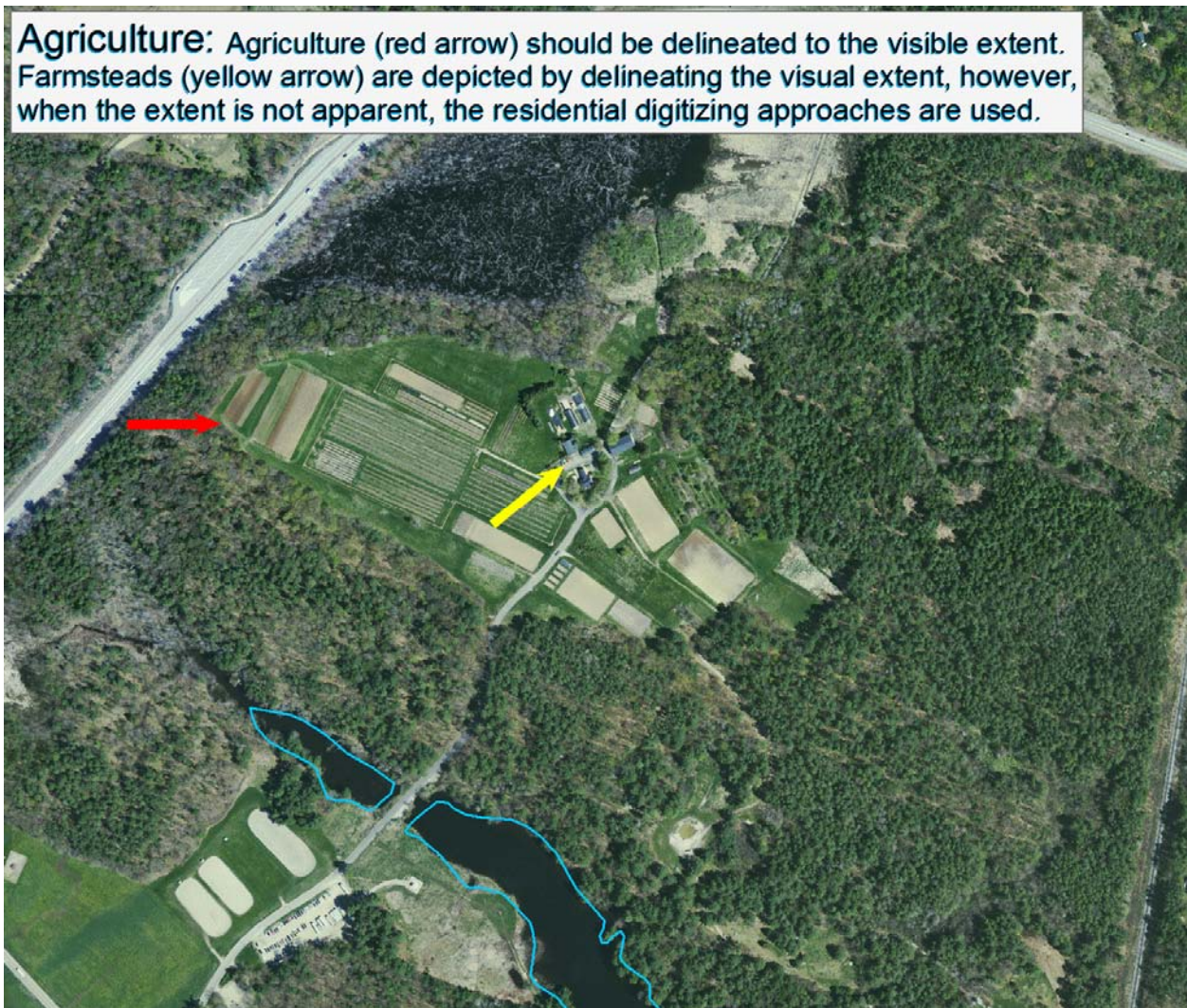
Transitional (3000): Digitize to visible extent of the feature (Figure 10).

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

Transitional: by their nature, these areas tend to "grade" into the forest category and therefore, defining boundaries can be difficult. In this example, the fence-line (yellow arrow) is a good reference for delineation.

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 NHNHD as a reference. If a feature is presented as a polygon in NHNHD, 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.

Water: digitize to visible water extent (red arrow), not the high/low water mark (purple arrow). Digitize the upstream reach to the extent of the NHHD feature (displayed in blue) as indicated by the yellow arrow.
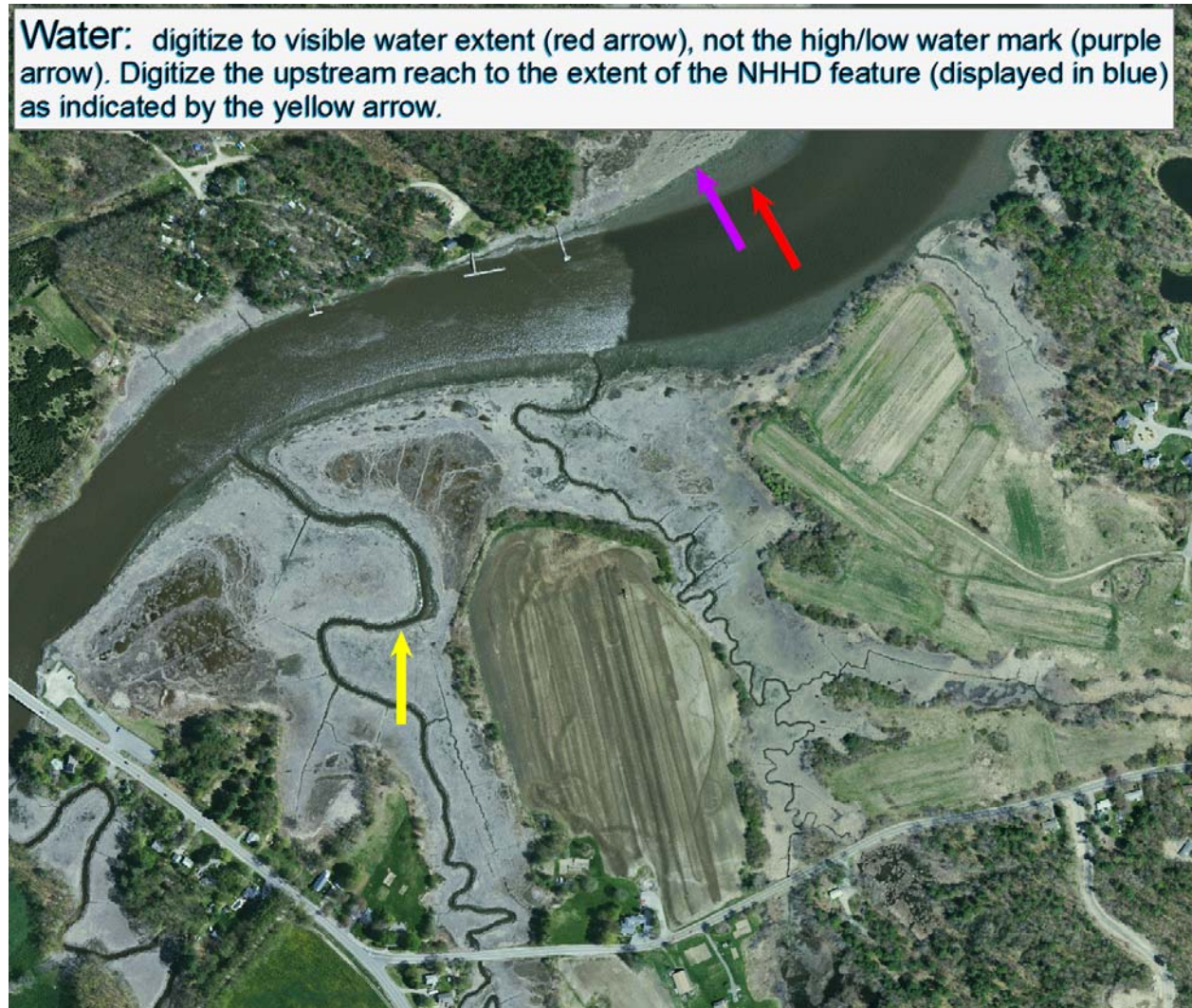
Wetlands (6000): Digitize to visible extent of the feature. This category includes all wetlands visible in the image (recognizing that some forested wetlands will be indistinguishable). NWI datasets may be used to identify the presence/absence of wetlands (Figure 12).

Figure 12. Illustration of forested and open wetland classes.

Wetlands: delineate to the visible extent of the feature. NWI wetland delineations (purple arcs) can be used to help determine presence/absence of these features.
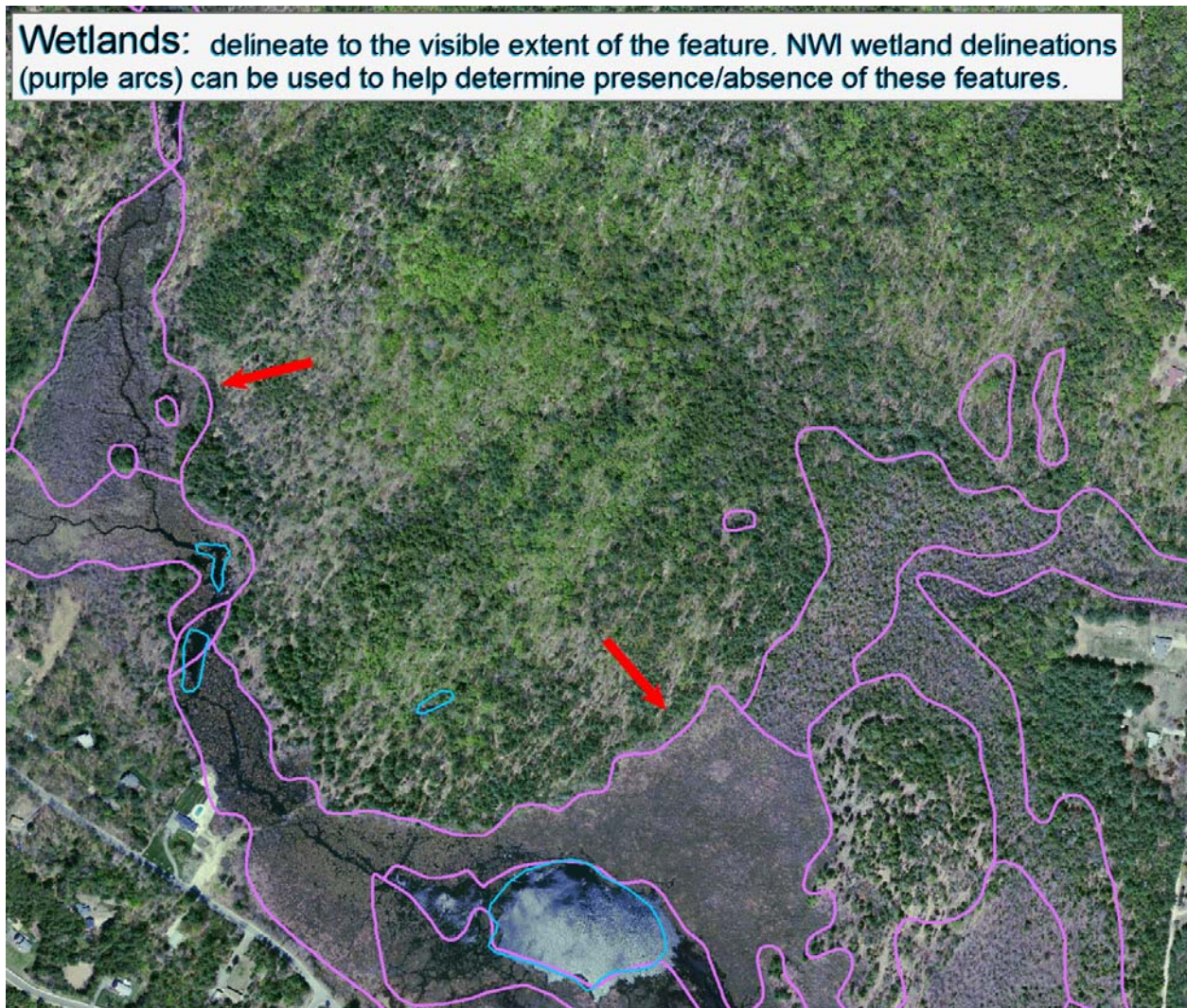
Barren (7100, 7200, 7300, 7400, 7500, 7600, and 7900): Digitize to visible extent of the feature. With respect to mining, this category includes only developed areas within mining activities, and does not include mining buildings/machinery (which should be assigned a category of 1370, Figure 13). Construction sites for new development provide an example of "disturbed" uses.

Figure 13. Illustration of the barren category.

Barren: digitize to visible extent (red arrow). Note that buildings, crushers, sorting machinery, etc. (yellow arrow) are assigned as mining (code 1370).
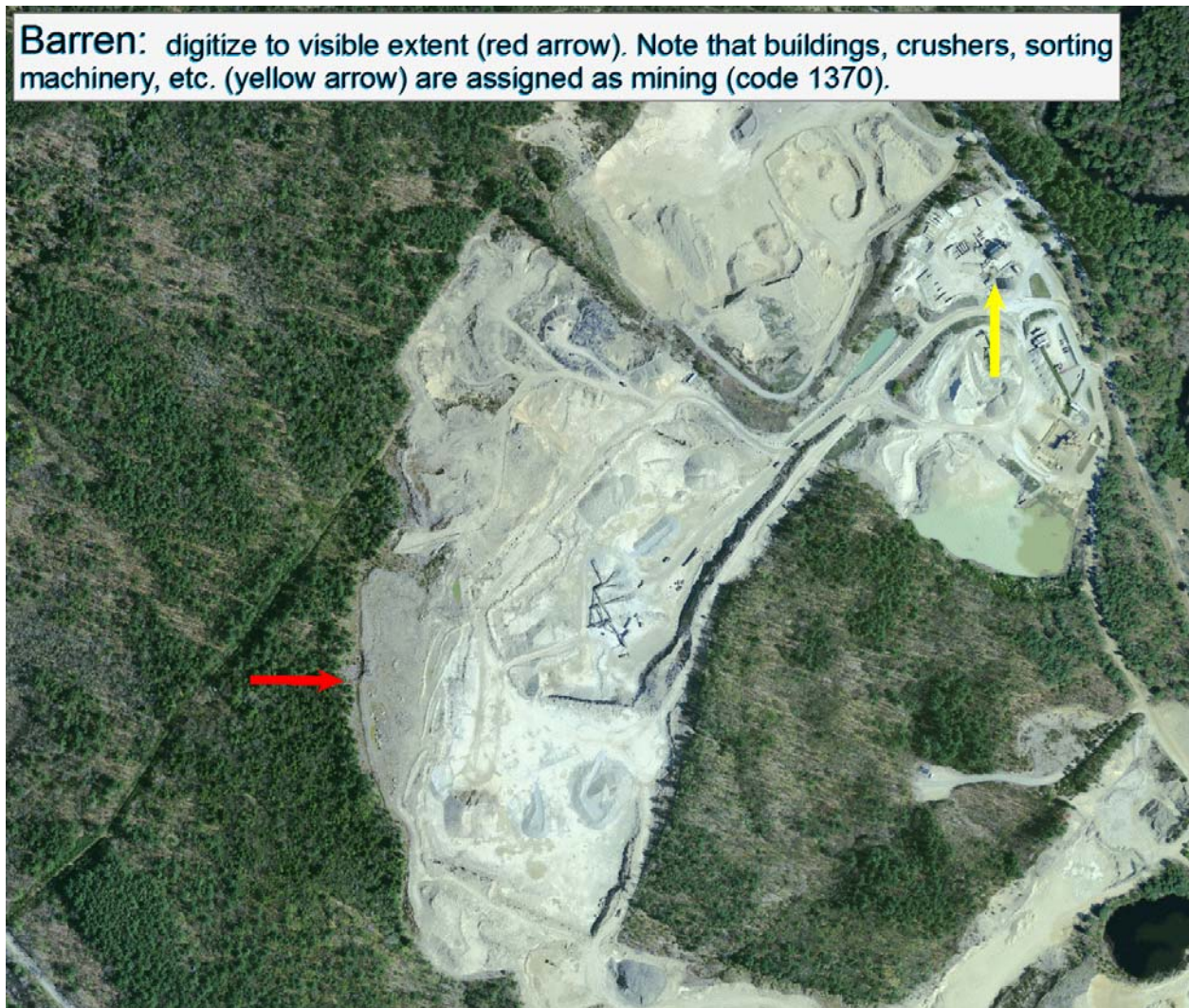
Tundra (8000): Digitize to visible extent of the feature. This category is rare and probably only occurs at high elevations in Carroll, Coos, and Grafton counties.

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.

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	

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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.
			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	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 cloverleafs, etc.
			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 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		Industrial site > 25 acres with multiple occupants. Otherwise, map in Industrial category (13).
		159 Other commercial complexes		Multiple concerns with shared parking lot. Otherwise, map in Commercial category (12).
	16 Mixed Developed Uses	161 Multiple stories, residential in upper stories only		Areas where level 2 uses are mixed with no single use predominating.
		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	

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	Applies	
						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]	

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)						

[1]In 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   Ampitheaters
         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 (continued)
        213 Grains (not including row crops) (continued)
            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 VEGATION
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)