6 Environmental Evaluation

The environmental evaluation criteria used in the evaluation of the transit modes are:

- Consistency with land use plans.
- Residential and commercial acquisitions/displacements.
- Transit-oriented development (TOD) potential.
- Wetlands.
- Parklands.
- Historic and archaeological resources.
- Hudson River habitat disturbance.
- Air quality.
- Energy and greenhouse gases.

The analysis focuses on direct impacts only (e.g., acquisition of a property), not indirect impacts (e.g., secondary economic effects). In addition, direct construction impacts are addressed for a limited number of critical locations (e.g., Lyndhurst and the Hudson River). Construction staging impacts and access easements are not addressed at this stage. In general, given the significant overlap in transit mode alignments, environmental factors are not substantial differentiators in the selection of a transit mode.

6.1 Consistency with Land Use Plans

This subchapter evaluates the consistency of transit mode alternatives/options with local land use plans as expressed in zoning and other land use policy documents, such as master plans, coastal zone management plans, urban renewal plans, etc. Zoning is also considered, to the extent that it regulates permitted uses, bulk, and other attributes of projects (site layout, design, parking, etc.). Transit projects may have land use consequences, both direct and indirect. For example, land uses may be displaced, and alignments may alter the character of a neighborhood or induce new development, desired or otherwise. Acquisition and displacement is addressed separately in Subchapter 6.2.

6.1.1 Description of Criterion

The land use criterion is focused on the project's consistency with land use plans. The plans and zoning codes reviewed include the following: Westchester County and Rockland County comprehensive plans; the towns of Clarkstown, Orangetown and Ramapo, and the villages of Nyack, South Nyack, Upper Nyack, Grand View on Hudson, Chestnut Ridge, Montebello, Spring Valley, Hillburn, and Suffern in Rockland County; and the cities of Rye and White Plains, the towns of Greenburgh and Harrison, and the villages of Rye Brook, Port Chester, Elmsford, Irvington, and Tarrytown in Westchester County. Other types of comprehensive plans of affected jurisdictions (e.g., Waterfront Revitalization Plans) that were determined to be applicable to the alternatives/options under consideration were also reviewed.

Relatively rarely do local plans address the provision of transit directly, although a few (e.g., Ramapo) have language in their comprehensive plan that encourages more effective transit service and land use patterns that encourage concentration where transit and other infrastructure exist. Waterfront revitalization plans typically express a desire for more public access to the waterfront, a feature that will be enhanced by the provision of pedestrian/bikeways on the Tappan Zee Bridge under all bridge and transit alternatives/options.

6.1.2 Comparison of Transit Modes

The absence of specific transit policies in local land-use policy documents permits little or no differentiation between the transit alternatives/options with respect to their consistency with these policies. One exception would be transit alternatives/options that require the conversion of existing general-traffic lanes to dedicated bus or light-rail use (e.g., in downtown White Plains), which, in addition to transportation impacts, have the potential for localized land-use impacts that may be inconsistent with local policy documents.

6.2 Residential and Commercial Acquisitions/Displacements

Project options that extend beyond the existing ROW are likely to require the acquisition of private or public property. Acquisition that is of a minor character (e.g., a sliver alongside a rear yard) may not require the displacement of the property's occupants, but when an acquisition is of a scale that affects structures or denies access to the property, displacement may be a necessary consequence. Therefore, linear projects such as this may involve displacement of existing property uses and/or acquisition of a portion of a property while enabling the use to continue.

There are also situations where property acquisition is required but may be only in the form of an easement, which may be either permanent (e.g., for a tunnel below ground) or temporary, lasting only for the period of construction (e.g., to gain access to build a retaining wall). Owners of properties subject to acquisitions and easements are compensated at fair market rates, and those displaced are also eligible for relocation assistance.

6.2.1 Description of Criterion

The criterion for displacement applies to those properties where there is a potential for displacement of occupants and/or activities. Therefore, residential displacements represent the number of structures and displaced units; and commercial displacements represent the number of commercial uses displaced. With regard to acquisitions, the linear nature of the project warrants identifying impacts in terms of linear feet of acquisitions along the ROW. Thus, criteria for acquisitions include an estimation of the linear feet of sliver-taking on property impacted, and not the individual number of properties so affected. In addition, underground easements are required for most alternatives/options, and they too have been calculated in terms of linear feet of underground easements.

6.2.2 Comparison of Transit Modes

Displacement of residences varies from an estimated 38 units under Option 3B to as few as nine units under Alternatives 4B, 4C and Full-Corridor LRT (Table 6-1). The number of residential structures displaced, however, is quite small for such a major transit project, ranging from five to 12 among the alternatives/options. (Option 3B displaces the highest number of units because of an affected apartment building adjacent to I-287 in White Plains).

Commercial displacements are also relatively small in number for all alternatives/options, ranging from 10 in Option 3A to 23 in Alternative 4B (Table 6-1). Of the eight alternatives/options, six (all except 3A and 3B), cluster at between 20 and 23 displaced businesses, so there is little differentiation among them on this metric. None of the

affected businesses would be characterized as large employers, and most are small retail and highway-oriented businesses.

Table 6-1

Displacements, Acquisitions, and Easements

Criterion	Alternative/Option							
	3A Full-Corridor BRT Enhanced	**3B** Full-Corridor BRT HOT Lanes in Rockland, Busway in Westchester	**4A** Full-Corridor CRT with Hudson Line (HL) Connection	**4A-X** Full-Corridor CRT without HL Connection	**4B** CRT in Rockland, HL Connection, LRT in Westchester	**4C** CRT in Rockland, HL Connection, BRT in Westchester	**4D** CRT in Rockland, HL Connection, Full-Corridor BRT (3A)	Full-Corridor LRT
Estimated Residential Displacements	5 structures 17 units	10 structures 38 units	12 structures 15 units	12 structures 15 units	6 structures 9 units	6 structures 9 units	7 structures 21 units	6 structures 9 units
Estimated Commercial Displacements	10	11	20	20	23	22	20	22
Estimated Total Acquisitions (linear feet of sliver-taking)	17,900	21,000	8,300	8,300	16,600	8,200	11,500	16,600
Underground Easements (linear feet)	0	0	9,400	5,300	4,400	4,100	4,100	4,400

Acquisition that does not require the displacement of residences, businesses, or institutions is typically of slivers of property adjacent to the proposed ROW in instances where the existing ROW is insufficient and/or topography necessitates acquisition for a specific transit alignment. In terms of linear feet, such acquisitions range from 8,200 feet under Alternative 4C to 21,000 feet under Option 3B (Table 6-1). Three of the CRT alternatives/options – 4A, 4A-X, and 4C – have the smallest acquisition totals because they utilize tunnels more than do the other alternatives/options, thereby avoiding many sliver-takings. The alternatives/options with the largest linear acquisitions are 3A and 3B, which involve enhanced BRT and busways, followed by the two LRT alternatives/options – 4B and Full-Corridor LRT – which have similar acquisition requirements, and which have somewhat smaller acquisition totals than the enhanced-busway alternatives/options. Option 4D has a smaller acquisition total than the other BRT alternatives/options because it plans for buses to merge into general traffic east of the Hutchinson River Parkway.

Underground easements are estimated separately, and are primarily associated with CRT alternatives/options (4A, 4A-X, and 4C). The largest underground easements are estimated for Alternative 4A – 9,400 linear feet. At the other extreme are the BRT alternatives/options with no CRT or LRT (Options 3A and 3B), which have no underground easements.

When acquisition of property is required for federally-funded transportation projects, there are formal procedures that require the fair market compensation of property owners for their loss of property value. In addition, displaced residents and businesses (whether owners or tenants) are eligible for additional relocation assistance under the procedures of the federal Uniform Relocation Assistance Act.

6.3 Transit-Oriented Development (TOD) Potential

Development induced by transit – usually rail transit – is commonly referred to as transit-oriented development (TOD). Typical TOD developments consist of high-density, mixed-use, pedestrian-oriented communities, usually within one-quarter mile of a transit station. The goal of TOD is to provide an environment in which people can live, work, shop, or be entertained within walking distance of a transit station. The proposed transit mode alignments have the potential to induce TOD.

6.3.1 Description of Criterion

Possible station locations have been considered in the transit service plans but final locations are not available at this project stage. Therefore, in this report, only generalized TOD potential in proximity to possible station areas can be assessed. Alternatives/options are rated in terms of minor, moderate, or major potential for generating TOD.

6.3.2 Comparison of Transit Modes

The TOD potential of the various transit alternatives/options is anticipated to vary by mode, with CRT stations usually associated with a greater potential than the other options. The reason for this is that the greater public investments required for CRT, together with the typically greater passenger usage, tend to assure private investors that less risk attaches to such development. At the other extreme is a simple bus stop, which requires little public investment and, hence, is likely to be perceived as a less-permanent feature, creating more risk for private investment. Some bus stations, however, can be major features, requiring significant public investment, and can generate significant private TOD investment, although this is much less common. LRT stations are generally considered to fall somewhere between CRT and BRT – although LRT stations may often be quite modest, they typically require more public investment than bus stops, and their fixed-rail character contributes to their perception as permanent. Consequently, the alternatives/options with more CRT stations are considered to have moderate to major TOD potential, those only with BRT to have minor to moderate TOD potential, and those with LRT to have moderate TOD potential. However, it should be noted that the impact of BRT systems on land use patterns is not well established given the relative "newness" of such systems in the US.

6.4 Wetlands

The corridor ecological study area is approximately 30 miles in length. Within the study area can be found a wide range of ecosystems, from the Rockland highland region near Suffern, to the Hudson River Estuary, to the Westchester coastal plain near Long Island Sound. Within the study area, there are more than 20 notable waterbodies and numerous wetlands. Among the significant watercourses are the Ramapo, Mahwah, Hackensack, Saw Mill, Bronx, and Mamaroneck Rivers. Wetlands that occur within the study area are highly variable, ranging from small, disturbed, low-ecological-value roadside ditches to large, undisturbed, high-ecological-value wetlands. The boundaries of most study-area wetlands typically extend beyond the I-287 ROW, particularly along the banks of streams that cross the highway corridor.

Wetlands provide critical ecological functions and values (e.g., floodflow alteration, nutrient/toxicant removal, groundwater recharge/discharge and wildlife habitat, etc.). As such, wetlands are managed under a variety of federal and state statutes and programs, including Section 404 of the Clean Water Act, US Executive Order 11990, and New York State's Environmental Conservation Law, Articles 24 and 25.

The New York State Department of Environmental Conservation (NYSDEC) regulates all wetlands in New York State that are either larger than 12.4 acres or of unusual local importance. The New York State wetland protection program also defines a regulated area adjacent to NYSDEC-regulated wetlands; this area is normally 100 feet beyond the wetland boundary for freshwater wetlands and up to 300 feet for tidal wetlands. The NYSDEC ranks wetlands in one of four classes ranging from Class I to Class IV. Class I wetlands provide the greatest ecological value and receive the highest level of protection under NYSDEC's regulations.

Six NYSDEC-regulated wetlands occur within the study area. In Rockland County, one Class I wetland and three Class II wetlands are located within and/or adjacent to the I-287 ROW. One Class II wetland is located within the Piermont Railroad ROW. In Westchester County, one Class II wetland is located within the I-287 ROW.

6.4.1 Description of Criterion

Construction of any of the proposed transit modes can impact wetland resources either directly or indirectly. Based on the level of engineering information available for this analysis, only direct impacts are considered. Such impacts would occur when the limits of transit-mode development extend directly onto a mapped resource. The direct impact is then the area (in square feet or acres) resulting from the intersection of the mapped resource and the transit mode.

The use of a direct-impact approach for this analysis may underestimate the extent of actual wetland loss, since indirect impacts and construction impacts are not considered. However, these additional effects are expected to occur in proportion to the direct losses and, therefore, the results presented here are generally indicative of the relative scale of impacts for the various modes. Furthermore, wetland resources such as those found along the Hackensack River, a source of drinking water, have greater ecological value than resources that serve as highway drainage channels. Thus, to the extent possible at this stage in project development, note will be made of those instances wherein the resource potentially impacted is considered to have high value.

6.4.2 Comparison of Transit Modes

Within the study area the wetland boundaries were mapped using federal and New York State methodologies. The wetland boundaries were established by means of a GPS system with +/- 1-meter accuracy. In those areas where wetlands extended beyond the limits of the study area, wetland boundaries were estimated by interpreting infra-red photographs. Ultimately, once a preferred alternative has been established, a formal delineation of wetlands will be undertaken so that permit applications for the use of wetlands can be submitted to the appropriate federal and state agencies. Unavoidable impacts to wetlands would require mitigation, either through the creation of new wetlands, the enhancement of existing wetlands, and/or the purchase of wetland mitigation credits from an existing wetland mitigation bank.

The estimated aerial extent of wetland impacts for each transit mode is shown on Table 6-2. The estimates were generated by overlaying the limits of development for the transit modes on a geographically referenced map of the study area's GPS-mapped wetland resources. As can be noted from the results of the analysis, at approximately 8 acres, the BRT mode generally has the least impact. This is largely due to the smaller development footprint presented by BRT in Rockland County in comparison to CRT options. Modes that include an LRT component are estimated to be intermediate to BRT and CRT in terms of direct wetland loss.

A significant percentage of the mapped wetlands impacted by the transit modes are highway drainage courses, which are typically wetlands of low ecological value. However, all modes also impact NYSDEC Class I areas adjacent to the Hackensack River. Since the CRT mode would have the largest footprint in Rockland County, it would also have the greatest impact to the Class I wetlands that abut the Hackensack River.

Table 6-2

Wetlands

Criterion	Alternative/Option							
	3A Full-Corridor BRT Enhanced	**3B** Full-Corridor BRT HOT Lanes in Rockland, Busway in Westchester	**4A** Full-Corridor CRT with Hudson Line (HL) Connection	**4A-X** Full-Corridor CRT without HL Connection	**4B** CRT in Rockland, HL Connection, LRT in Westchester	**4C** CRT in Rockland, HL Connection, BRT in Westchester	**4D** CRT in Rockland, HL Connection, Full-Corridor BRT (3A)	Full-Corridor LRT
Wetlands (acres)	8	8	14	14	12	12	12	12

While Options 3A and 3B are estimated to have the least impact to wetland resources, the BRT mode has the potential to uniquely impact Talleyrand Marsh (Option 3B), a Class II NYSDEC wetland. Also, both BRT and LRT could cross the Bronx River Park Reservation on structure and both modes would have impacts to wetlands along Blind Brook, east of the Hutchinson River Parkway. CRT would run in a tunnel beneath the Bronx River and also has a tunnel option that avoids Blind Brook.

6.5 Parklands

Potential effects to parklands are an important consideration because they would typically require an analysis under Section 4(f) of the Transportation Act. Such analysis would require, among other elements, an assessment of avoidance alternatives. A requirement that no other feasible and prudent alternative exists is required, unless the park operator concurs that the impacts to the affected resource are *de minimis* and/or that there would be a net benefit to the resource as a result of the project.

6.5.1 Description of Criterion

Parklands with potential direct impacts have been identified, and the location and significance of the impacted resources are described, as appropriate. The discussion of Section 4(f) requirements for affected historic and archaeological resources is provided in Subchapter 6.6.

6.5.2 Comparison of Transit Modes

Table 6-3 shows the affected park resources by alternative/option. Certain parks are affected by all alternatives/options, in particular Elizabeth Place Park, a small (approximately one acre) neighborhood resource in South Nyack adjacent to the Thruway; the adjacent rail trail would be affected by the widening of the highway and reconstruction of Interchange 10 (US 9W). The anticipated construction would require acquisition of a sliver of the park and relocation of the rail trail onto a new bridge crossing the Thruway. The other park resources potentially affected by all alternatives/options are the north-south parkways (the Palisades Interstate Parkway, the Saw Mill River Parkway, etc.) that would be crossed.

Table 6-3

Parklands

Criterion	Alternative/Option							
	3A Full-Corridor BRT Enhanced	**3B** Full-Corridor BRT HOT Lanes in Rockland, Busway in Westchester	**4A** Full-Corridor CRT with Hudson Line (HL) Connection	**4A-X** Full-Corridor CRT without HL Connection	**4B** CRT in Rockland, HL Connection, LRT in Westchester	**4C** CRT in Rockland, HL Connection, BRT in Westchester	**4D** CRT in Rockland, HL Connection, Full-Corridor BRT (3A)	Full-Corridor LRT
Parklands (direct impacts)	Elizabeth Pl. & adjacent rail trail Tibbits Park (slivers) Parkways	Elizabeth Pl. & adjacent rail trail Parkways Tibbits Park (slivers)	Elizabeth Pl. & adjacent rail trail Yosemite (sliver) Lyndhurst footbridge Old Croton Aqueduct Trail Parkways	Elizabeth Pl. & adjacent rail trail Yosemite (sliver) Parkways	Elizabeth Pl. & adjacent rail trail Yosemite (sliver) Lyndhurst footbridge Old Croton Aqueduct trail Tibbits Park (major) Parkways	Elizabeth Pl. & adjacent rail trail Lyndhurst footbridge Old Croton Aqueduct trail Tibbits Park (slivers) Parkways	Elizabeth Pl. & adjacent rail trail Old Croton Aqueduct Trail Lyndhurst footbridge Tibbits Park (slivers) Parkways	Elizabeth Pl. & adjacent rail trail Yosemite (sliver) Lyndhurst footbridge Old Croton Aqueduct trail Tibbits Park (major) Parkways

Additional park resources are affected under specific alternatives/options. Thus, Tibbits Park in White Plains is affected by the BRT and LRT alternatives/options. For the BRT alternatives/options (Options 3A, 3B, and 4D and Alternative 4C) only slivers of the park are required, but the LRT alternatives/options – Alternative 4B and Full-Corridor LRT – would require major acquisition at this park. The CRT options do not impact Tibbits Park because they would be in tunnel. Most CRT alternatives/options, however, would affect other resources. In particular, those that would connect to the Hudson Line – Alternatives 4A and 4B and Option 4D – would affect a closed footbridge across the Metro-North Railroad tracks at Lyndhurst and use an alignment beneath the Old Croton Aqueduct, which is a trail as well as an historic resource. All cross-Westchester CRT and LRT alternatives/options – 4A, 4A-X, 4B and Full-Corridor LRT – have the potential to require a sliver of Yosemite Park in Greenburgh.

While the alignments of all transit alternatives/options have been designed to avoid or minimize park impacts, some parks are affected by all alternatives/options, so that no differentiation among them is possible. Other resources are affected by specific alternatives/options, mostly as minor sliver acquisitions. The LRT alternatives/options in White Plains, however, would have the potential for the greatest impact to a park resource, namely, Tibbits Park, an important downtown public space. When park resources are potentially affected by transportation projects involving federal funding, all efforts to avoid or minimize impacts must be made. New Section 4(f) rules, however, do offer more opportunities to provide mitigation that results in a "net benefit" to the park resource, or a waiver when the impacts are *de minimis*, although in either case, the park operator must concur.

6.6 Historic and Archaeological Resources

Analysis of impacts of transit-mode alignments on historic and archaeological resources (cultural resources) are based on relevant federal and state cultural resources regulations. The federal and state regulations include:

- Section 106 of the National Historic Preservation Act (NHPA) (16 USC 470 *et seq.*; and 36 CFR Part 800 – Protection of Historic Properties).
- Section 14.09 of the New York State Historic Preservation Act (SHPA) (Chapter 354 of the Parks, Recreation and Historic Preservation Law).
- Section 110 of NHPA.
- Section 4(f) of the US Department of Transportation Act of 1966 (as amended in 2005).

Section 106 and Section 14.09 have similar requirements. For this project, Section 106 and Section 4(f) are the most relevant federal regulations. Section 106 requires lead agencies to identify an Area of Potential Effect (APE) that takes into account the potential direct and indirect impacts of project implementation on National Historic Landmarks (NHLs); National Register-listed (NRL) resources; National Register-eligible (NRE) resources; and recommended NRE resources. Significant cultural resources (buildings, structures, sites, objects and historic districts) are eligible for listing in the National Register if they are over 50 years old and possess local, state or national significance for their association with historic events; individuals or groups; design/construction; or information potential. Following identification of significant cultural resources, Section 106 requires analysis of direct and indirect impacts on those resources, and coordination with consulting parties to minimize harm as much as practical.

Section 110 of NHPA requires that federal agencies exercise a higher standard of care when considering undertakings that may directly and adversely affect NHLs. The law requires that agencies, to the maximum extent possible, undertake such planning and actions as may be necessary to minimize harm to such landmarks. Furthermore, agencies should consider all prudent and feasible alternatives to avoid an adverse effect on an NHL.

Section 4(f) stipulates that federal transportation agencies cannot approve the use of a significant cultural resource (i.e., NHL; NRL property; NRE property; recommended NRE property) or public park unless there is no feasible and prudent alternative to the use, and the action includes all possible planning to minimize harm.

6.6.1 Description of Criterion

The goal of this report is to determine whether there are critical differences and/or benefits among transit-mode alignments being evaluated for this project. While Section 106 and Section 110 require analysis of direct and indirect impacts on significant cultural resources, Section 4(f) is primarily limited to analysis of direct impacts on such resources. Using aspects of Section 106, Section 110 and Section 4(f) as a point of departure, this report will only focus on potential temporary and permanent direct impacts that transit-mode alignments may have on such resources because such impacts could function as a differentiator among mode alignments, and assist in the selection of preferred mode alignments.

Section 106 defines a project's direct impacts that result in adverse effects as activities that may alter characteristics of a cultural resource that qualifies it for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Temporary activities

associated with construction may result in adverse effects and therefore are considered part of the environmental evaluation criteria. Direct impacts that result in adverse effects to cultural resources include:

- Physical destruction or damage to all or part of a property.
- Alteration of a property that is not consistent with the Secretary of the Interior's Standards for Treatment of Historic Properties.
- Removal of a property from its historic location.
- Change of the character of the property's use or physical features within the property's setting that contribute to its historic significance.

Similarly, under Section 4(f), direct impacts to significant cultural resources may be considered a use, and therefore must also be analyzed to ensure that there is not a feasible and prudent alternative to such a use.

Historic Architectural Resources

In terms of historic architectural resources, this analysis examined temporary and permanent direct impacts of transit-mode alignments on five categories of resources:

- NHLs.
- NRL resources.
- Resources determined eligible for listing in the National Register by the New York State Historic Preservation Office (NYSHPO).
- Resources surveyed for this project in accordance with Section 106 and recommended eligible for listing in the National Register, pending NYSDOT and NYSHPO review.
- Resources surveyed for this project in accordance with Section 106, which must also be evaluated for National Register eligibility (hereafter referred to as yet-to-be-evaluated properties).

Archaeological Resources

The potential for direct impacts is the principal screening criterion employed to measure the effects of each transit-mode alignment on archaeological resources. This analysis examined direct impacts of transit-mode alignments on previously identified archaeological resources as well as on areas determined to be archaeologically sensitive as a result of research conducted to date as part of the Section 106 compliance survey for this project. It should be noted that for areas determined to be archaeologically sensitive, the Phase 1B presence-or-absence subsurface-testing survey is in progress and has not yet been completed in either Rockland County or Westchester County. The purpose of the Phase 1B subsurface testing is to determine whether the location *actually* contains archaeological resources, as opposed to whether such resources may *potentially* exist at the location.

6.6.2 Comparison of Transit Modes

Historic Architectural Resources

In general, direct impacts to historic architectural resources are analyzed to determine whether they constitute an adverse effect in accordance with Section 106. If adverse effects result, mitigation would be developed by lead agencies in conjunction with NYSHPO, consulting parties, and the Advisory Council on Historic Preservation (ACHP), as appropriate. In compliance with Section 4(f), direct impacts to historic architectural resources would also be analyzed to determine whether the impacts constitute a Section 4(f) use, and whether there are feasible and prudent alternatives to such uses.

Table 6-4 compares the impacts that the alternatives/options would have on historic architectural resources. All alternatives/options would impact the NRE Tappan Zee Bridge because the bridge would be rehabilitated or replaced under all. Options 3A and 3B (the full-corridor BRT transit modes) would have direct impacts on multiple categories of resources, as indicated in the table. The impacts include acquisition of land from individual properties and historic districts and utilization, bisection and/or tunneling across historic railroad ROWs and/or roadways. In addition, Option 4A-X has similar impacts to Options 3A and 3B. However, as noted in Table 6-4, the exact number of impacts to the various categories of resources would differ slightly between these three options. Direct impacts caused by Options 3A, 3B and 4A-X would be analyzed in accordance with Section 106 and Section 4(f), as noted above.

Options which include CRT with the Hudson Line connection, either full corridor or in combination with BRT and LRT transit modes (Alternatives 4A, 4B, 4C, Full-Corridor LRT, and Option 4D) result in similar impacts to multiple categories of resources caused by the BRT and CRT options described above (Options 3A, 3B and 4A-X). However, these five alternatives/options also result in temporary and direct impacts to nationally significant NHLs caused by construction of the Hudson Line connection. As indicated in Table 6-4, these impacts include temporary construction impacts to waterfront parcels associated with Lyndhurst and Sunnyside. Direct impacts include removal of a pier and a thru-truss footbridge associated with Lyndhurst, and construction of a tunnel in the vicinity of the Old Croton Aqueduct. Impacts to the three NHLs would be analyzed in accordance with Section 106 and Section 4(f) to determine whether they result in adverse effects and whether such impacts constitute a Section 4(f) use. NHLs are overseen by the Secretary of the Interior. Therefore, in accordance with Section 110, mitigation of potential adverse effects to these properties would also require coordination with the Secretary of the Interior and ACHP. This would result in a more involved and complex consultation process to devise methods to minimize direct effects to such resources.

Archaeological Resources

Table 6-4 compares the direct impacts that the eight alternatives/options would have on archaeological resources. The direct impacts indicated on Table 6-4 refer to previously identified archaeological resources listed in the New York State Museum (NYSM) and NYSHPO site files and those located during reconnaissance walkover surveys of targeted portions of the study area.

All eight alternatives/options would create comparable impacts to archaeological resources in Rockland County. No differences in impacts are seen between alternatives/options that utilize either full- or partial-corridor BRT, CRT, or LRT modes in Rockland County.

In Westchester County, the options that include a full-corridor BRT mode – 3B and 4D – would create the greatest number of direct impacts to previously identified archaeological resources when compared to alternatives/options that utilize a LRT mode (Alternative 4B and Full-Corridor LRT), a full-corridor CRT mode (Alternative 4A and Option 4A-X), or a partial CRT mode (Alternative 4C).

Table 6-4

Historic and Archaeological Resources

Criterion	Alternative/Option							
	3A Full-Corridor BRT Enhanced	**3B** Full-Corridor BRT HOT Lanes in Rockland, Busway in Westchester	**4A** Full-Corridor CRT with Hudson Line (HL) Connection	**4A-X** Full-Corridor CRT without HL Connection	**4B** CRT in Rockland, HL Connection, LRT in Westchester	**4C** CRT in Rockland, HL Connection, BRT in Westchester	**4D** CRT in Rockland, HL Connection, Full-Corridor BRT (3A)	Full-Corridor LRT
Historic Resources (direct impacts)	2 NRL 2 NRE 5 rec. NRE 5 yet-to-be-evaluated resources	2 NRL 2 NRE 2 rec. NRE 6 yet-to-be-evaluated resources, including potential historic districts	2 NHLs (Old Croton Aqueduct; Lyndhurst) Temporary impacts on 2 NHLs (Lyndhurst; Sunnyside) 2 NRL 3 NRE 2 rec. NRE 6 yet-to-be-evaluated resources	2 NRL 3 NRE 2 rec. NRE 4 yet-to-be-evaluated resources	2 NHLs (Old Croton Aqueduct; Lyndhurst) Temporary impacts on 2 NHLs (Lyndhurst & Sunnyside) 3 NRL 2 NRE 2 rec. NRE 6 yet-to-be-evaluated resources	2 NHLs (Old Croton Aqueduct; Lyndhurst) Temporary impacts on 2 NHLs (Lyndhurst & Sunnyside) 2 NRL 2 NRE 3 rec. NRE 5 yet-to-be-evaluated resources	2 NHLs (Old Croton Aqueduct; Lyndhurst) Temporary impacts on 2 NHLs (Lyndhurst & Sunnyside)) 2 NRL 2 NRE 2 rec. NRE 6 yet-to-be-evaluated resources	2 NHLs (Old Croton Aqueduct; Lyndhurst) Temporary impacts on 2 NHLs (Lyndhurst & Sunnyside) 3 NRL 2 NRE 2 rec. NRE 6 yet-to-be-evaluated resources
Archaeological Resources (direct impacts)	Piermont ROW Five sites in Rockland Old Croton Aqueduct One site in Westchester	Piermont ROW Five sites in Rockland Old Croton Aqueduct Three sites in Westchester	Piermont ROW Five sites in Rockland Old Croton Aqueduct One site in Westchester	Piermont ROW Five sites in Rockland Old Croton Aqueduct	Piermont ROW Five sites in Rockland Old Croton Aqueduct One site in Westchester	Piermont ROW Five sites in Rockland Old Croton Aqueduct One site in Westchester	Piermont ROW Five sites in Rockland Old Croton Aqueduct Two sites in Westchester	Piermont ROW Five sites in Rockland Old Croton Aqueduct One site in Westchester

Notes:

NHL = National Historic Landmark
NRL = National Register Listed
NRE = National Register Eligible

Direct impacts to archaeological resources caused by the selected transit mode would be analyzed to determine whether they constitute an adverse effect in accordance with Section 106. If adverse effects result, mitigation would be developed by lead agencies in conjunction with the NYSHPO.

6.7 Hudson River Habitat Disturbance

The project area of the Hudson River is a productive estuary that provides regionally significant ecological values and functions for many species, including anadromous, estuarine, and certain marine species that are dependent on the river for spawning, feeding, and overwintering activities. The proposed Tappan Zee Bridge options are within a US Fish and Wildlife Service-designated Significant Habitat of the New York Bight Watershed and upriver from a New York State Significant Coastal Habitat (i.e., Piermont Marsh). These adjoining habitats are of regional importance based on the ecological values they provide to fish, invertebrates, birds, and wildlife. Striped bass, American shad, Atlantic tomcod, white perch, Atlantic sturgeon, bay anchovy, shortnose sturgeon, blue crab, several species of herring, bluefish, and peregrine falcons are among the important fauna in this reach of the Hudson River.

The river's ecological resources are managed under a variety of federal programs, including the Clean Water Act, the Fish and Wildlife Coordination Act, the Magnuson-Stevens Fishery Conservation and Management Act, the Emergency Striped Bass Act, Executive Order 11990 (Protection of Wetlands), the Coastal Zone Management Act, and the Endangered Species Act. Relevant New York programs are based on the State's Environmental Conservation Law and its implementing regulations and on the Waterfront Revitalization & Coastal Resources Act.

6.7.1 Description of Criterion

Impacts of the transit modes to Hudson River habitats are estimated in terms of the area of river bottom that would be impacted either permanently or for an interim period (during project construction). Loss of bottom habitat, as presented in this report, is a surrogate for a range of in-river effects that may occur as a result of developing a transit mode across the Hudson River, including sediment resuspension, acoustic emissions, shading and others. Thus, the comparisons provided here should be considered relative indicators of potential impacts and not absolute impact levels. In addition, no inference should be made as to whether the indicated loss of bottom habitat will ultimately prove significant from an ecological perspective, since the significance of the various effects associated with a transit crossing will not be established until the DEIS analysis is completed.

Thus, transit mode impacts on Hudson River resources are compared using the following two criteria:

- Permanent impacts (in acres) associated with the modified or new bridge foundations (for bridge rehabilitation or replacement).
- Temporary impacts (in acres) associated with such construction support features as platforms that provide access to in-river work sites or that support construction equipment. Temporary impacts may last for several years but would be removed once construction is completed and the impacted area is restored.

6.7.2 Comparison of Transit Modes

Comparative impacts of the transit modes on Hudson River resources are presented in Table 6-5. In terms of temporary impacts to the river bottom, modes that require a rail connection to Metro North's Hudson Division potentially have a greater temporary impact since construction of the connection is likely to involve placement of a two acre work platform in the river to facilitate construction. This two acre work platform is in addition to the four acres of temporary work platforms that all modes would require over the river to facilitate construction of a rehabilitated or new bridge.

Table 6-5

Hudson River Habitat Disturbance

Criterion	Alternative/Option							
	3A Full-Corridor BRT Enhanced	**3B** Full-Corridor BRT HOT Lanes in Rockland, Busway in Westchester	**4A** Full-Corridor CRT with Hudson Line (HL) Connection	**4A-X** Full-Corridor CRT without HL Connection	**4B** CRT in Rockland, HL Connection, LRT in Westchester	**4C** CRT in Rockland, HL Connection, BRT in Westchester	**4D** CRT in Rockland, HL Connection, Full-Corridor BRT (3A)	Full-Corridor LRT
Hudson River Habitat Disturbance (acres of river bottom)	10-11 permanent 4 temporary	10-11 permanent 4 temporary	12-15 permanent 6 temporary	11-14 permanent 4 temporary	12- 15 permanent 6 temporary	12-15 permanent 6 temporary	12-15 permanent 6 temporary	12-15 permanent 6 temporary
Note: The transit modes can be accommodated on more than one bridge option.								

With regard to long-term or permanent impacts to bottom habitats, a crossing that accommodates the BRT mode uses somewhat less of the river's bottom habitat, since its in-river foundations are less extensive than those needed for a commuter rail-capable crossing. The difference in potential impacts between BRT and CRT modes ranges from less than one acre (e.g., comparing 3B to 4A-X the difference in potential impacts can be approximately 0 acres depending on bridge option) to approximately 5 acres (e.g., comparing Option 3B to Alternative 4A, the difference in potential impact can be up to 5 acres depending on bridge option). Since actual construction methods and work locations are not known at this time, it is not possible to ascertain the significance of the bottom disturbances shown on Table 6-5.

6.8 Air Quality

Because the various transit alternatives/options would cause changes in travel patterns (i.e., volume, speed and mix) in the region, an evaluation of potential air-pollutant emissions effects on a mesoscale level was conducted. The analysis addresses direct operational effects. The mesoscale network considered included those counties where the roadway and transit network would be impacted by the proposed project, including Rockland, Westchester, Orange, and Bronx Counties in New York and Bergen County in New Jersey. The VMT within the network including the BRT component were used as the main inputs for the analysis. The VMT were forecasted by the BPM for the 2035 AM peak period (6 AM to 10 AM during a typical weekday).

The US Environmental Protection Agency (USEPA) has established National Ambient Air Quality Standards (NAAQS) for six contaminants, referred to as criteria pollutants (40 CFR 50). These are carbon monoxide (CO), nitrogen oxides (NO_x), ozone (O_3), particulate matter (PM_{10} and $PM_{2.5}$), lead (Pb), and sulfur dioxide (SO_2). Areas that meet the NAAQS are designated as being "in attainment." Areas where criteria pollutant levels exceed the NAAQS are designated as "nonattainment." O_3 nonattainment areas are further classified, based on the severity of the pollution problem, as marginal, moderate, serious, severe, or extreme. CO and PM_{10} nonattainment areas are classified as either moderate or serious. A maintenance area is an area that has been redesignated as an attainment area from a former nonattainment area. The current designations for the five counties considered in the mesoscale analysis are as follows:

Westchester, Bronx, and Bergen Counties:

- Moderate nonattainment area for the O_3 standard.
- Nonattainment area for the $PM_{2.5}$ standard.
- CO maintenance area.
- Attainment area for all other criteria pollutants.

Rockland and Orange Counties:

- Moderate nonattainment area for the O_3 standard.
- Nonattainment area for the $PM_{2.5}$ standard.
- Attainment area for all other criteria pollutants.

The 2035 mesoscale emissions analysis was performed for ozone precursors (NO_x and Volatile Organic Compounds [VOC]), PM (PM_{10} and $PM_{2.5}$) and CO. The NYSDOT-provided MOBILE6.2 emission factors based on roadway type and county were used for predicting emissions within New York State. The emission factors for Bergen County were assumed to be the same as those applicable for Westchester County.

Criteria pollutant emissions from LRT and CRT components were assumed to be negligible compared to motor vehicles within the network, particularly for those new trains that would be principally electric-powered. The BRT component merging into the highway mix was also taken into account.

6.8.1 Description of Criterion

The mesoscale effects of air emissions from each transit alternative/option are described through the determination of the net change as compared to the 2035 No Build condition. The net effects among these alternatives/options were evaluated through the net mesoscale increase or decrease in terms of tons of NO_x and VOC, PM (PM_{10} and $PM_{2.5}$) and CO emissions.

6.8.2 Comparison of Transit Modes

Table 6-6 summarizes the mesoscale changes in NO_x and VOC, PM (PM_{10} and $PM_{2.5}$) and CO emissions during a typical weekday AM peak period (i.e., 6 AM to 10 AM), as compared to the 2035 No Build condition, under each alternative/option. The predicted overall emissions reductions under each alternative/option are primarily due to slight improvements in highway traffic within the analyzed mesoscale network. The levels of reduction are comparable among the analyzed alternatives/options, with no discerning differences.

Table 6-6

Mesoscale Air Emissions

Criterion	Alternative/Option							
	3A Full-Corridor BRT Enhanced	**3B** Full-Corridor BRT HOT Lanes in Rockland, Busway in Westchester	**4A** Full-Corridor CRT with Hudson Line (HL) Connection	**4A-X** Full-Corridor CRT without HL Connection	**4B** CRT in Rockland, HL Connection, LRT in Westchester	**4C** CRT in Rockland, HL Connection, BRT in Westchester	**4D** CRT in Rockland, HL Connection, Full-Corridor BRT (3A)	Full-Corridor LRT
Net Air Emissions Reduction (Tons) Compared to No Build, 2035 AM Peak Period in the Five-County Area								
CO	2.306	1.989	2.585	2.258	2.606	2.491	2.513	2.328
NOx	0.052	0.049	0.061	0.052	0.059	0.060	0.061	0.055
VOC	0.151	0.133	0.154	0.157	0.173	0.154	0.153	0.153
PM_{10}	0.004	0.004	0.005	0.004	0.005	0.005	0.005	0.005
$PM_{2.5}$	0.002	0.002	0.003	0.002	0.003	0.003	0.003	0.003

Notes:

Mesoscale emissions are those that occur on a sub-regional basis, in this case, the five counties of Westchester, Rockland, Orange, Bronx, and Bergen.

6.9 Energy/Greenhouse Gases

The United States depends almost entirely on petroleum to fuel its transportation sector, and transportation accounts for approximately 67 percent of all the petroleum consumed in the US (NYSDOT, *Draft Energy Analysis Guidelines for Project-Level Analysis*, November 2003). Therefore the conservation of energy is one of the planning concerns for a regionally significant transportation project such as the proposed action. Moreover, the level of greenhouse gas emissions is directly related to the level of energy consumption, since the majority of greenhouse-gas emissions result from fossil-fuel combustion. The greenhouse-gas emissions further contribute to global warming, which occurs from the emission into the upper atmosphere of carbon dioxide (CO_2) and other gases that trap heat and warm the earth. Therefore, for a regionally significant transportation project, a mesoscale analysis of potential effects on energy consumption and associated greenhouse-gas emissions is necessary.

The energy and greenhouse-gas estimates were conducted using the Urban Fuel Consumption Method based on NYSDOT's energy analysis guidance (December 2003). The BPM-predicted highway VMT along each roadway link was divided into various vehicle classes using the NYSDOT-defined county- and roadway-specific classification mix. In order to apply fuel type-specific CO_2 emission factors, the VMT associated with various vehicle classes were further divided into two fuel-powered categories: gasoline and diesel. For the transit component, the BPM-predicted net changes in transit VMT over the No Build condition were used to predict the net changes in transit-related energy and CO_2 levels under each studied alternative/option. The VMT reductions from the LRT and CRT alternatives/options were further divided into two power categories: electric and diesel. The associated energy components were calculated based on the energy rates published in *Conserving Energy and Preserving the Environment: the Role of Public Transportation* (July 2002), the report commissioned by the American Public Transportation Association (APTA). The calculated energy in British thermal unit (BTU) was further converted to equivalent diesel-fuel gallons. It was also assumed that BPM-predicted BRT VMT net changes are all diesel-related.

6.9.1 Description of Criterion

The mesoscale effects of energy consumption and greenhouse gas emissions from each transit alternative/option are described through the determination of the net change as compared to the 2035 No Build condition. The net effects among these alternatives/options were evaluated through the net mesoscale increase or decrease in terms of fuel gallons for energy consumption and tons of carbon emitted for greenhouse gases.

6.9.2 Comparison of Transit Modes

Table 6-7 summarizes the mesoscale changes in energy consumption and greenhouse-gas emissions during a typical weekday AM peak period (i.e., 6 AM to 10 AM) compared to the 2035 No Build condition under each alternative/option. The net effects among these alternatives/options were evaluated through the net mesoscale increase or decrease in terms of:

- Fuel (in gallons) for energy consumption.
- Total carbon (CO2) emissions (in tons) for greenhouse gases (which were calculated based on the change in energy consumption.

The predicted energy and greenhouse-gas emissions under the 2035 No Build condition are as follows:

- Gasoline: 891,747 gallons.
- Diesel: 112,820 gallons.
- Total fuel: 1,004,567 gallons.
- CO_2 emissions: 2,695 tons.

The net increase in diesel fuel consumption over the 2035 No Build condition is due to the increase in usage by the proposed transit systems. The net decrease in gasoline fuel consumption reflects the expected decrease in energy consumption as a result of Build highway traffic improvements. The overall combined energy consumption and associated greenhouse-gas emissions under each alternative/option were predicted to be lower than the No Build condition. Although the LRT mode would likely achieve the greatest energy savings and greenhouse-gas reductions, the benefit levels are comparable among the analyzed alternatives/options, with no discerning differences over the analyzed mesoscale network. For example, the greatest difference in benefit between two alternatives/options (Full-Corridor LRT and Option 3B) would reflect an approximate 0.4 percent change in 2035 No Build levels for both total fuel consumption (gallons) and CO_2 emissions (tons).

Table 6-7

Energy and Greenhouse Gases

Criterion	Alternative/Option							
	3A Full-Corridor BRT Enhanced	**3B** Full-Corridor BRT HOT Lanes in Rockland, Busway in Westchester	**4A** Full-Corridor CRT with Hudson Line (HL) Connection	**4A-X** Full-Corridor CRT without HL Connection	**4B** CRT in Rockland, HL Connection, LRT in Westchester	**4C** CRT in Rockland, HL Connection, BRT in Westchester	**4D** CRT in Rockland, HL Connection, Full-Corridor BRT (3A)	Full-Corridor LRT
Net Energy Savings (Fuel Gallons) Compared to No Build, 2035 AM Peak Period in the Five-County Area								
Gasoline	22,417	21,108	24,994	22,373	25,215	24,591	25,598	23,059
Diesel[1]	-92	-723	-2,077	994	-737	-2,210	-3,479	2,783
Electric Equivalent Diesel[2]	n/a	n/a	-941	-323	-1,254	-693	-693	-1,541
Total Net Fuel Savings	22,325	20,385	21,976	23,044	23,224	21,688	21,426	24,301
Net Greenhouse-Gas Reduction (Tons) Compared to No Build, 2035 AM Peak Period in the Five-County Area								
CO_2	59	54	57	62	61	56	55	65

Notes:
1. The diesel fuel component includes contributions from highway vehicles and, where applicable, BRT and CRT diesel components.
2. Electric energy was equated to diesel fuel usage for the LRT and CRT electric component.

The five counties are Westchester, Rockland, Orange, Bronx, and Bergen.

6.10 Summary of Environmental Evaluation

An environmental evaluation of the transit modes was conducted using the criteria described above. Implications for the natural and built environment were considered and the results were tabulated for each environmental resource category considered.

For the majority of resource categories, modes that include CRT tend to have greater estimated impacts than modes that include only BRT. This is particularly the case where impacts were estimated by overlaying the transit development footprint on geo-referenced maps of environmental resources identified along the transit alignments. In such cases, the mode with the largest development footprint shows the greatest potential to impact resources. One exception to this is the potential for the Option 3B alignment to result in displacement of a relatively large residential structure along the I-287 corridor in Westchester County that would be avoided by other transit alignments.

A set of unique impacts potentially occurs for transit modes that involve a connection to the Metro-North Hudson Division at the Hudson River near Lyndhurst. These alignments would entail obtaining extensive underground easements, would potentially have impacts to several NHLs, and could create some temporary and permanent disturbance of Hudson River habitats. Should avoidance prove infeasible, extensive mitigation measures would need to be considered as components of these alignments.

With regard to air emissions within the five-county area that includes Rockland and Westchester Counties, only a minor difference was found among the transit modes, with modes that include CRT having a small advantage for all pollutants evaluated. Also, no significant difference was discerned among the transit alternatives/options in terms of their potential to reduce fuel consumption or to emit greenhouse gases.

BRT

LRT

CRT