5.0 Indirect Effects and Cumulative Impacts

5.1 INTRODUCTION

MassDOT's stated purpose of the South Coast Rail alternatives is to more fully meet the existing and future demand for public transportation between Fall River/New Bedford and Boston, Massachusetts to enhance regional mobility, while supporting smart growth planning and development strategies in affected communities.

The South Coast region includes 31 Massachusetts communities with a combined population of approximately 740,000. The regional population is projected to grow to more than 900,000 by 2030, making the South Coast one of the fastest growing regions of the state. As documented in the South Coast Rail Economic and Land Use Corridor Plan (June 2009), the South Coast Rail alternatives are anticipated to result in economic benefits and growth in jobs and households within the South Coast region. While these changes are economically beneficial, the induced growth is likely to affect land use and other resources. MassDOT has therefore incorporated smart growth planning into the project to provide communities with the opportunity to organize new growth and direct it away from sensitive areas of ecological value. The region envisions a future with renewed and expanded urban centers, new walkable neighborhoods, and natural areas that are preserved for future generations.

The indirect and cumulative impact analysis provided in this chapter is consistent with Council on Environmental Quality (CEQ) and other agency guidance documents, including:

- Considering Cumulative Effects Under the National Environmental Policy Act[1] (CEQ 1997)
- Guidance on the Consideration of Past Actions in Cumulative Effects Analysis[2] (CEQ 2005)
- Secondary and Cumulative Impact Assessment in the Highway Project Development Process[3] (FHWA 1992)
- Interim Guidance: Questions and Answers Regarding Indirect and Cumulative Impact Considerations in the NEPA Process[4] (FHWA 2003)
- Consideration of Cumulative Impacts in EPA Review of NEPA Documents[5] (EPA 1999)

The indirect (or secondary) effects analysis is focused on induced household and employment growth that may result from increased transportation access in the South Coast area. The cumulative impact analysis evaluates changes within the study area as a result of past and reasonably foreseeable future actions combined with the South Coast Rail alternatives.

[1] Council on Environmental Quality. 1997. *Considering Cumulative Effects Under the National Environmental Policy Act.* Executive Office of the President, Council on Environmental Quality: Washington, D.C. January 1997.

[2] Council on Environmental Quality. 2005. *Guidance on the Consideration of Past Actions in Cumulative Effects Analysis.* , Executive Office of the President, Council on Environmental Quality: Washington, D.C. June 24, 2005.

[3] Federal Highway Administration. 1992. NEPA and Transportation Decisionmaking: *Secondary and Cumulative Impact Assessment in the Highway Project Development Process.* US Department of Transportation, Federal Highway Administration Project Development Branch, HEP-31: Washington, D.C. April 1992.

[4] Federal Highway Administration. 2003. *Interim Guidance: Questions and Answers Regarding Indirect and Cumulative Impact Considerations in the NEPA Process*. US Department of Transportation, Federal Highway Administration: Washington, D.C. January 31, 2003.

[5] Environmental Protection Agency. 1999. *Consideration of Cumulative Impacts in EPA Review of NEPA Documents.* EPA 315-R-99-02. US Environmental Protection Agency, Office of Federal Activities: Washington, D.C. May 1999.

5.1.1 REGULATORY CONTEXT AND DEFINITIONS

The requirement to analyze the direct, indirect and cumulative impacts of proposed federal actions was established in the CEQ regulations implementing the National Environmental Policy Act (NEPA). This section summarizes key definitions and requirements related to indirect effects and cumulative impacts from the CEQ NEPA regulations; agency guidance documents; and court decisions. It should be noted that "effects" and "impacts" as used in the CEQ regulations are synonymous and can be positive or negative (40 CFR 1508.8).

5.1.1.1 DIRECT EFFECTS

According to the CEQ NEPA regulations, direct effects are "caused by the action and occur at the same time and place" (40 CFR 1508.8). Direct effects are typically well understood and predictable. Examples of common direct effects for transportation projects include residential and business displacements, the fill of wetlands to construct roadway or rail infrastructure, or the removal of a historic structure.

5.1.1.2 INDIRECT EFFECTS

Indirect effects "are caused by the action and are later in time and farther removed in distance, but are still reasonably foreseeable." Indirect effects "may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems."(40 CFR 1508.8). NCHRP Report 466: Desk Reference for Estimating the Indirect Effects of Proposed Transportation Projects identifies two primary types of indirect effects— induced growth (or growth influencing) and encroachment-alteration.

Induced growth type indirect effects are changes in the location and/or magnitude of future development attributed to changes in accessibility caused by the transportation project. Accessibility is the ease of movement from an origin (to all other places) or as a destination (from all other places). Transportation improvements change accessibility by reducing the time cost of travel between destinations. Changes in accessibility can affect the location decisions of residents and businesses if favorable economic, regulatory and infrastructure conditions are also supportive of new development. An example of an induced growth type indirect effect is commercial development occurring around a new rail station and the environmental impacts associated with this development. The transportation project is a necessary condition for this development to occur (by providing new or improved access), but is not a sufficient condition. In order for the development to occur, it also requires favorable conditions that may include:

- economic conditions that support development (e.g., markets, acceptable rate of return on investment in land purchase, design, construction, and other costs).
- zoning and other land use controls and policies suitable for the type of development suggested by market conditions.
- other infrastructure that supports development (e.g., water and sewer service).
- amenities (e.g., good schools, access to recreational opportunities).

Encroachment-alteration indirect effects are physical, chemical or biological changes in the environment as a result of the project removed in time or distance from the direct effects. An example of an

encroachment-alteration indirect effect would be a long term decline in the viability of a population of a particular species as a result of habitat fragmentation caused by the project. Encroachment-alteration effects such as habitat fragmentation or changes in water quality are addressed in the resource-specific chapters of this DEIS/DEIR (e.g. Biodiversity, Wildlife and Vegetation, Water Resources etc.).

Regardless of the type of indirect effect, case law has established that NEPA documents need to address indirect effects that are likely or probable.[6] Speculation on indirect effects that are merely possible is not required. In Sierra Club v Marsh 769 F. 2d 763 (1985), the Court set forth a three-part test to determine if a particular set of impacts is definite enough to take into account, or too speculative to warrant consideration:

1. With what confidence can one say that the impacts are likely to occur?
2. Can one describe them now with sufficient specificity to make their consideration useful?
3. If the decision maker does not take them into account now, will the decision maker be able to take account of them before the agency is so firmly committed to the project that further environmental knowledge, as a practical matter, will prove irrelevant to the government's decision?

For projects where economic development is an explicit part of the project purpose, several court cases have concluded that the indirect effects analysis is expected to consider the environmental effects of this development.

5.1.1.3 CUMULATIVE IMPACTS

A cumulative impact is "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." (40 CFR 1508.7). According to the FHWA's *Interim Guidance: Questions and Answers Regarding the Consideration of Indirect and Cumulative Impacts in the NEPA Process*[7], cumulative impacts include the total of all impacts to a particular resource that have occurred, are occurring, and will likely occur as a result of any action or influence, including the direct and reasonably foreseeable indirect impacts of a proposed project.

Cumulative impact analysis is inherently resource-specific and frequently regional in scale. CEQ's *Considering Cumulative Effects under the National Environmental Policy Act* envisions cumulative impact analysis as a tool for evaluating for evaluating the implications of project-level decisions on the status or health of regional resources. According to EPA, an adequate cumulative effects analysis of impacts that are due to past, present, and reasonably foreseeable future actions needs to consider the following factors: 1) whether the environment has been degraded, and if so, to what extent; 2) whether ongoing activities in the area are causing impacts; and 3) the trends for activities and impacts in the area.[8]

To determine what information is relevant to include in a cumulative impact analysis, sufficient scoping and research should reveal those actions that are "relevant to reasonably foreseeable significant

[6] See NCHRP 25-25 Task 43 Legal Sufficiency Criteria for Adequate Indirect Effects and Cumulative Impacts Analysis as Related to NEPA Documents, 2008

[7] http://www.environment.fhwa.dot.gov/projdev/qaimpact.asp

[8] U.S. Environmental Protection Agency, "Consideration of Cumulative Impacts in EPA Review of NEPA Documents," Office of Federal Activities (2252A). Document No. EPA 315-R-99-002. May, 1999.

adverse impacts" and are "essential to a reasoned choice among alternatives," and can be obtained without exorbitant cost.[9]

Case law has established some guidelines on the required components of a cumulative impacts assessment. Fritiofson v Alexander, 772 F.2d 1225 (5th Cir. 1985) determined that a cumulative impact analysis must identify:

1. the area in which the effects of the proposed project will be felt;
2. the impacts that are expected in that area from the proposed project;
3. other past, present, and reasonably foreseeable actions that have or are expected to have impacts in the area;
4. the impacts or expected impacts from these other actions; and
5. the overall impact that can be expected if the individual impacts are allowed to accumulate.

Courts have also ruled on what constitutes “reasonably foreseeable future actions” for the purpose of cumulative impact analysis. Similar to interpretations of the “reasonably foreseeable” standard for indirect effects, future actions are reasonably foreseeable if they are probable or likely, not merely possible.

5.1.2 MEPA REQUIREMENTS

The Massachusetts Environmental Policy Act regulations at 301 CMR 11.07(6) (h) require that an EIR evaluate the cumulative effects of a proposed project. The Secretary’s Certificate on the ENF required that the DEIR include several specific analyses and information, listed below.

- The DEIR should present an analysis of the secondary and cumulative impacts, both positive and negative, related to induced growth in communities affected by the rail and bus alternatives, and explain how implementation of the Land Use and Economic Development Corridor Plan is expected to mitigate potential adverse impacts.
- Each of the alternatives should be evaluated under three different scenarios, including the full build with mitigation, i.e., implementation of the Land Use and Economic Development Corridor Plan. The full range of potential environmental impacts associated with implementation of this plan should be evaluated including impacts to biodiversity, wetlands, endangered species, air quality and greenhouse gas emissions, transportation, municipal infrastructure, and water resources.
- The DEIR should define the study area for evaluation of secondary growth impacts and explain the rationale for the boundaries selected.
- The DEIR should discuss different scenarios for induced growth and explain how this has been incorporated in modeling for the alternatives analysis
- The DEIR should discuss different scenarios and include projections of where growth is expected to occur, and at what rate, under each of the alternatives.
- The DEIR should identify areas where sprawl may occur under certain alternatives and include mitigation plans to concentrate development and protect natural resources.
- The DEIR should evaluate the alternatives on the basis of other smart growth principles, including conservation of open space and use of existing infrastructure.
- The DEIR should discuss the trade-offs inherent in project alternatives, such as increased impacts on certain resources for environmental benefits in other areas.

[9] Connaughton, James L., “Guidance on the Consideration of Past Actions in Cumulative Effects Analysis.” Memorandum to Heads of Federal Agencies. June 24, 2005.

- The DEIR should include details on specific mechanisms that will be used to ensure that the smart growth goals of the project will be realized, including funding commitments and mechanisms for conservation of PPAs and acquisition and development of PDAs.
- The DEIR should describe in detail how land use will be controlled and priority conservation areas permanently protected.
- The DEIR should clarify indicators and metrics to be used for evaluation of smart growth, and propose a long-term monitoring and evaluation plan.
- The DEIR should describe specific strategies and resources, including state funding commitments, to ensure successful implementation of the proposed Land Use and Economic Development Corridor Plan.
- The DEIR should describe the tools and resources needed by individual communities to take advantage of the economic development potential of the proposed rail line in a manner that protects critical resources and is consistent with the Commonwealth's Sustainable Development Principles.
- The DEIR should also include information on any municipal land use or policy commitments that have been made.
- With respect to secondary growth impacts, each alternative should be analyzed under three different scenarios: (1) the baseline condition, which evaluates environmental conditions in the absence of the proposed rail under the assumption that current travel and development patterns continue and there are no changes in municipal zoning, (2) build without mitigation, which evaluates impacts, including induced growth, associated with each alternative in the absence of transit-oriented development, green building, zoning changes, transfer of development rights, wetlands restoration, habitat protection, or other mitigation measures, and (3) build with mitigation, which evaluates impacts associated with the alternatives assuming implementation of the Land Use and Economic Development Corridor Plan, transit-oriented development in and around the stations, habitat protection (including priority protection areas, PPAs) and other proposed mitigation.
- The DEIR should include an assessment of costs associated with implementation of the smart growth aspects of the project for each alternative, to fully understand the overall costs and rationale for selection of alternatives.

5.1.3 ORGANIZATION OF THIS CHAPTER

Section 5.2 presents the methods used to assess indirect effects and cumulative impacts for each of the alternatives. Section 5.3 presents indirect effects assessment for the No-Build alternative and for each of the build alternatives (the Attleboro Alternatives, the Stoughton Alternatives, the Whittenton Alternatives, and the Rapid Bus Alternative) under two scenarios – without smart growth measures, and with the implementation of the South Coast Rail Economic Development and Land Use Corridor Plan (the Plan). Section 5.4 also provides a description of the Plan and the smart growth measures that are included in the South Coast Rail alternatives. Section 5.5 provides an analysis of the cumulative impacts of the South Coast Rail alternatives on natural, social, cultural, and physical resources.

5.2 METHODOLOGY

5.2.1 INDIRECT EFFECTS

This section identifies the methodology and assumptions for the analysis of indirect effects.

5.2.1.1 INTRODUCTION

The potential indirect effects (beneficial and adverse) of the proposed alternatives were evaluated with, and without, smart growth measures (including transit-oriented development [TOD]). The Corridor Plan was the guiding land use development plan for this analysis. The Commonwealth provides a number of grant programs that support smart growth from economic development to land preservation. The Massachusetts Executive Office of Energy and Environmental Affairs (EEA) has developed a Smart Growth/Smart Energy Toolkit[10], with applications suitable to control sprawl that may inadvertently result from transportation projects.

The induced growth, which would result from the proposed alternatives, includes the creation of new housing and new jobs. In order to assess the indirect effects of this induced growth, two scenarios were developed to allocate the growth in the South Coast region. The first scenario, Scenario 1, allocates induced growth under business as usual conditions, in the absence of any smart growth policies. The second scenario, Scenario 2, reallocates growth under a theoretical method that estimates how zoning changes and other smart growth incentives would yield different development patterns. The allocation of each growth scenario was then viewed in terms of its impact on natural and social resources. The following sections describe how the three scenarios were developed and analyzed, including:

- How growth projections were developed;
- How growth was allocated within the region and within communities; and
- How the environmental impacts of each scenario were evaluated.

The analyses consider reasonably foreseeable indirect effects, from project initiation in 2016 through the planning period ending in 2030, from implementing the South Coast Rail alternatives. Three scenarios are evaluated:

- The No-Build Alternative is described to establish a baseline to which selected build alternatives were compared.
- Scenario 1 describes the indirect effects of implementing selected build alternatives without smart growth measures. It includes the baseline growth and the project-induced growth.
- Scenario 2 describes the indirect effects of implementing selected build alternatives with smart growth measures. It includes the baseline growth and the project-induced growth.

Each analysis relies on data provided in the Corridor Plan, information provided by regional planning agencies, and information developed by MassDOT. The analysis identifies, for each alternative and each scenario, the potential changes in land use, infrastructure requirements (water, sewer, etc.), and the social and economic environment that would likely result from growth induced by the new transit system. Based on the anticipated changes in land use, the potential impacts to selected environmental resources are estimated.

Each of the two build scenarios have been evaluated regionally for a range of potential impacts, based on the option (for each rail alignment) with the largest projected ridership:

- Attleboro Electric Alternative
- Stoughton Electric Alternative
- Rapid Bus Alternative

[10] EOEEA. 2009. Website address: http://www.mass.gov/?pageID=eoeeamodulechunk&L=1&L0=Home&sid=Eoeea&b=terminalcontent&f=eea_sgse_toolkit&csid=Eoeea. Accessed 27 May 2009.

The Whittenton Alternative was not evaluated, because its effects would be similar in magnitude and location to the Stoughton Alternatives.

5.2.1.2 STUDY AREA

The study area for the indirect effects assessment is based on the area where induced growth would be likely to occur as a result of the South Coast Rail alternatives (the "commuteshed"). The commuteshed includes the 31 Massachusetts communities in the *South Coast Rail Economic Development and Land Use Corridor Plan*[11] (the Corridor Plan), and four communities in southeastern Rhode Island that could potentially be served by a rail or bus station in Fall River. All communities are within a reasonable commuting distance of the proposed alternatives and transit stations.

Table 5-1 Indirect Effects Study Area Municipalities

Regional Planning Agency	Municipalities	
Metropolitan Area Planning Council	*Canton*[1]	*Sharon*
	Foxborough	*Stoughton*
Old Colony Planning Council	*Bridgewater*	
	Easton	
	Stoughton[2]	
Southeast Regional Planning and Economic Development District	Acushnet	New Bedford
	Attleboro	*North Attleborough*
	Berkley	*Norton*
	Dartmouth	Raynham
	Dighton	Rehoboth
	Fairhaven	Rochester
	Fall River	Seekonk
	Freetown	Somerset
	Lakeville	Swansea
	Mansfield	Taunton
	Marion	Wareham
	Mattapoisett	Westport
	Middleborough	
Rhode Island	Bristol	Tiverton
	Portsmouth	Warren

1 Communities in italics are the "SCR 10" northern communities.
2 Stoughton is shared between MAPC and OCPC.

5.2.1.3 NO-BUILD (ENHANCED BUS) ALTERNATIVE

The future No-Build Alternative conditions (in 2030), based on the regional plans of the Metropolitan Area Planning Council (MAPC), the Old Colony Planning Council (OCPC), and the Southeastern Region Planning and Economic Development District (SRPEDD), have been developed to establish a baseline to assess the effects of the build alternatives in the scenarios discussed below. Any smart growth

[11] Goody Clancy 2009. South Coast Rail Economic Development and Land Use Corridor Plan. Goody Clancy: Boston, MA. June 2009.

measures already adopted by communities, irrespective of the South Coast Rail alternatives, have also been incorporated in this baseline.

5.2.1.4 SCENARIO 1 – INDIRECT EFFECTS WITHOUT SMART GROWTH MEASURES

The analysis considers reasonably foreseeable indirect effects from implementing the South Coast Rail alternatives without smart growth strategies, including TOD. Induced growth, both in the immediate vicinity of each station (the station area) and in the nearby communities that are served by each station, has been estimated based on literature review and regional growth projections:

- Growth projections of jobs and households from SRPEDD, OCPC, and MAPC;
- Induced growth estimates of jobs and households from the TREDIS Model; and
- Distribution of jobs and households in the region from the Corridor Plan and SRPEDD, MAPC, OCPC, and Regina Villa Associates.

The induced growth in households and jobs that would result from the South Coast Rail alternatives is small when compared to overall projected growth for the South Coast Region. This scenario evaluates the growth that is induced by the SCR alternatives, distributed at the municipal level, for 2030. Scenario 1 evaluates only the additional effects of growth induced by the South Coast Rail alternatives. The induced growth in households and jobs has been identified, and distributed, as outlined below.

MassDOT has developed projections for induced growth in jobs and households broken down into three regions: Suffolk County/Cambridge, SCR 10[12] (northern portion of the South Coast Corridor), and SCR 21. Projections were also made for the four Rhode Island communities that are expected to have commuters utilizing the potential new transit service. This is growth that would not happen without the transit investment. In order to better evaluate the indirect effects of this induced growth, these projections were allocated to the municipal level. This was done by staff from the three RPAs and the consultant team after receiving guidance from a panel of experts, who met in a working session on August 26, 2009, with expertise in land use and demographics in this region including state and federal agency staff.

Induced Jobs

The TREDIS model[13] provides projections for new jobs according to the North American Industry Classification System (NAICS) employment classification system. Comparisons between the location quotients of the current distribution of jobs by consolidated NAICS job codes with the estimated distribution of the induced jobs allowed for projections to be made for the number and sub-regional geographic distribution of new jobs.

Data used to inform the allocation include:

- CTPS ridership data, RPA demographic projections, and regional economic data sets;
- Existing employment centers by sector: for example, the communities with the highest regional share of manufacturing jobs are expected to attract the majority of new manufacturing jobs;
- Current trends: communities that have strong growth in particular job sectors are expected to continue attracting jobs from those sectors; and

[12] SCR 10 Communities: Attleboro, Bridgewater, Canton, Easton, Foxborough, Mansfield, North Attleborough, Norton, Sharon, and Stoughton.

[13] The Transportation Economic Development Impact System Model (TREDIS) is a web-based analysis system used to analyze planned transportation investments. The model works by utilizing a series of modules that compare project impacts and project benefits.

- Zoning, infrastructure capacity, land availability, and transportation access: industrial parks and other job centers that have the appropriate zoning, infrastructure, and land available for expansion are likely to capture a significant share of this new growth.

To estimate the number of induced jobs under Scenario 1, total jobs were first projected by the model for the sub-regions and then distributed to the municipal level.

Unlike housing, which tends to be distributed more diffusely throughout the region, jobs are more strongly tied to existing job centers and less so to proposed station sites. Manufacturing jobs will not locate anywhere, but will be clustered in industrial parks and other areas so zoned. Similarly, health occupations tend to congregate in hospitals and other medical campus settings. Consolidated NAICS job sector codes were used to group jobs into larger categories. For example, the NAICS codes between 541 and 551 were combined to create the Professional, Scientific, and Technical Services category— one of the sectors estimated to experience significant growth related to the restoration of transit service. A job share for each consolidated NAICS sector was then calculated for each city and town.

SRPEDD analyzed Labor and Workforce data for the consolidated job sectors for all communities between 2001 and 2008. An eight-year sector average was developed for each category for each municipality. These data reveal which communities have clusters of industry and, because it is an average over the eight-year time period, smoothes out any anomalous years and captures recent trends. The eight-year jobs sector average by community was used to allocate the induced jobs in SCR 10 (the northern communities) and SCR 21 (the South Coast communities).

To incorporate the expected influence of the transportation routes, a normative scoring system was used to take into account the relative influence the route alternative is likely to have on a given municipality. This system was developed by a working team consisting of the RPAs and project consultants. A community designated as likely to be strongly influenced, moderately influenced, or to experience limited influence. Communities were designated as strongly influenced if they would contain a new station or if the access to transportation service is improved. Moderate influence designations went to communities likely to experience less significant influence— those that are reasonably close to greatly expanded service or those communities that would see modest improvements in service. Finally, communities were assigned to limited influence if little or no change is expected to existing transportation service or if they are remotely located from new service.

Fifty percent of the induced jobs assigned to the communities that would experience a limited influence were then reassigned equally to the strongly influenced communities. The limited influence communities are the farthest away from the service improvements and would have the least benefit from transit improvements. On the other hand, the strongly influenced communities are expected to see more housing development and job opportunities as a result of the South Coast Rail alternatives.

Because the TREDIS model's study area did not include any communities in Rhode Island, an estimate of the induced job growth for the Rhode Island communities was made by calculating the proportional growth the communities' Massachusetts neighbors would receive. Bristol and Portsmouth were assigned the same growth rate as Swansea; Tiverton to Westport; and Warren to Seekonk.

Induced Households

Similar to the effects on job creation, expanded and improved transportation access would increase the potential for new households to locate in the region. Some households are likely to be attracted to the

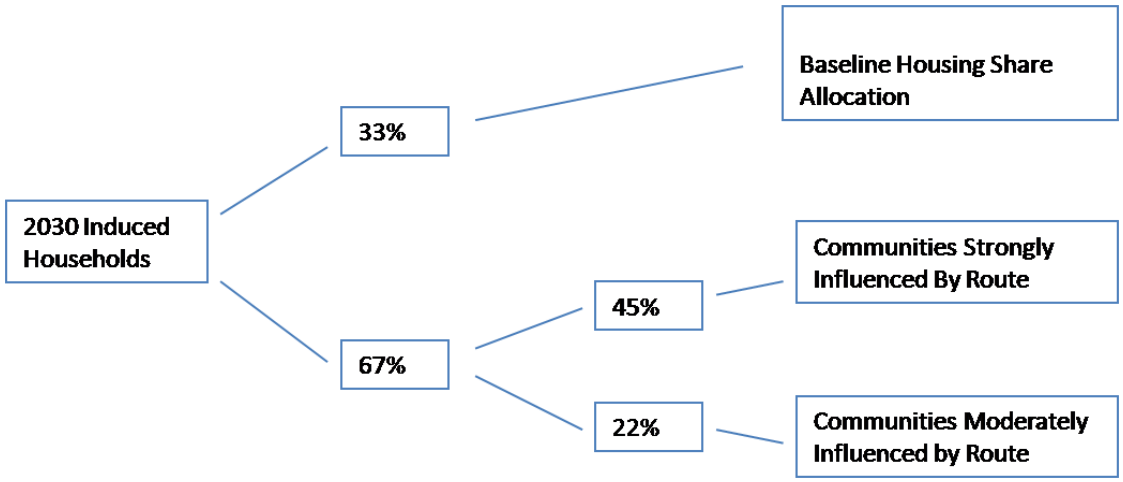
new employment opportunities. Other households would be attracted to the relatively less expensive housing markets farther south from the Greater Boston area. Expected household growth for each of the alternatives was calculated by the Economic Development Research Group, Inc. A summary report, including a description of their methodology, is included in Appendix 5.2-A.

Factors considered in allocating the induced households included:

- Ridership origination: using ridership data produced by CTPS, areas that are now within a 20-minute drive of new stations are expected to generate new households. Communities within the northern portion of the corridor are already within a 20-minute commute to the stations of the Old Colony Line to the east and the Northeast Corridor to the west. The induced growth in this geography is more likely to be concentrated closer to the new stations.
- Service time: train and bus service times double in frequency north of the Southern Triangle (in Taunton).
- Housing costs. Housing costs generally decrease south of Mansfield providing more opportunity for home ownership and for larger homes.
- Employment Center midpoints: Large concentrations of jobs are found in Greater Boston, Providence, Fall River, New Bedford, Taunton, and Attleboro. Households with two workers often seek to live in the midpoint for the two commutes.
- Population concentration and growth trends: New household locations are likely to follow existing growth trends and are less likely to be absorbed into communities approaching build out.
- Zoning, infrastructure and land availability: The availability of land zoned for residential development and the infrastructure capacity to support new development are other important factors. Some communities have zoning and capacity for additional multifamily units, while the more semi-rural communities are zoned for large lots and rely on private wells and septic tanks for wastewater disposal.

An expert team of RPA representatives and project consultants arrived at a general agreement at a working session on August 26, 2009 on how to use household concentrations over time to capture trends in housing location throughout the South Coast region. Similar to the jobs allocation, it uses a normative assessment of how likely each community is to be affected by the various transportation routes. Communities were designated as likely to be strongly influenced, moderately influenced, or to experience limited influence.

The following flowchart illustrates how households were allocated under Scenario 1.



As the household growth estimates are broken into the two SCR sub-regions, the allocation to municipal level was undertaken for the SCR-10 and SCR-21 communities separately. First, each municipality's share of the households in 2000 was calculated based on U.S. Census data. Second, each municipality's share of projected growth in households from 2000 – 2030 was calculated. These two shares were averaged to create a baseline housing share that captures existing housing concentrations and projected growth in households. One-third (33 percent) of the induced households were allocated according to this baseline share. This part of the allocation depends on existing and projected regional housing characteristics and not on any specific alternative. The remaining two-thirds (67 percent) were allocated according to the expected influence of the routes. This process takes into account residential development opportunities in some communities within easy drive-time distances of the new stations. At the same time, this approach discounts the expected impacts for the communities farther from a particular route.

Each community was assigned a designation of strongly influenced, moderately influenced, or limited influence for each of the three selected alternatives (Attleboro Electric, Stoughton Electric, and Rapid Bus). The RPAs and project consultants assigned these values to the South Coast cities and towns. Communities were designated as strongly influenced if they would contain a new station or if the access to transportation service is improved. Moderate influence designations went to communities likely to experience less significant impacts— those that are reasonably close to greatly expanded service or those communities that would see modest improvements in service. Finally, communities were assigned to limited influence if little or no change is expected due to local transportation service or if they are remotely located from new service. The remaining two-thirds of the households were allocated based on these designations— 45 percent of the original total went to the strongly influenced communities and the remaining 22 percent of the original total were allocated to the moderately influenced communities. Previously, 33 percent of the households were allocated according to the baseline share, which results in a 100 percent allocation of households.

An estimate of the induced household growth for the Rhode Island communities was made by calculating the proportional growth the communities' Massachusetts neighbors would receive. Bristol and Portsmouth were assigned the same growth rate as Swansea; Tiverton to Westport; and Warren to Seekonk.

5.2.1.5 SCENARIO 2 – INDIRECT EFFECTS WITH SMART GROWTH MEASURES

The Corridor Plan[14] outlines a future of more sustainable development patterns in the South Coast region. This smart growth plan envisions housing and jobs clustered in areas appropriate for development, while preserving important natural resource lands such as fields, forests, and wetlands. Outcomes of the Corridor Plan would include the creation of new multifamily housing developments and neighborhoods of tightly clustered single family homes in closer proximity to transportation options and mixed use centers that contain professional offices, retail stores, restaurants, and employment opportunities. A more dense, mixed use development pattern would yield measurable benefits for the environment as will be addressed later in this section. Local governments can support the smart growth vision by altering current zoning laws to permit denser development and streamline permitting requirements. The Commonwealth supports smart growth efforts through grant programs and technical

[14] EOT. 2009. *South Coast Rail Economic Development and Land Use Corridor Plan.* Commonwealth of Massachusetts, Executive Office of Transportation and Public Works, and Executive Office of Housing and Economic Development. Prepared by Goody Clancy: Boston.

advice. Information on their Smart Growth/Smart Energy Program can be found at http://www.mass.gov/envir/smart_growth_toolkit/.

The Corridor Plan identifies Priority Development Areas (PDAs) and Priority Protection Areas (PPAs), capturing the strongest candidates for development and preservation, respectively as shown on the Corridor Map. This map can be realized through coordinated state investments and local actions, such as rezoning and regulatory changes.

As part of the environmental review process, MassDOT has been asked to compare the impacts between the No-Build Scenario, Scenario 1, and Scenario 2 (smart growth). There are many potential smart growth scenarios that could unfold through 2030. In addition, it is impossible to predict with any certainty the future development or preservation outcomes for particular priority areas. However, it is possible to explore one theoretical smart growth scenario for the purposes of comparing the impacts between the No-Build, Scenario 1, and Scenario 2. Any such exercise necessarily requires a series of assumptions to be made regarding the character and location of future growth. The following assumptions were made before constructing the smart growth model:

- Infrastructure constraints will be overcome within reason; the Commonwealth help will support investments in infrastructure to realize more compact development;
- Local rezoning can be expected to occur for PDAs to accommodate higher levels of development and different permitted uses;
- A greater mix of multi-family and smaller-lot single-family units will be developed under the smart growth scenario.

This analysis considers the reasonably foreseeable indirect effects from selected South Coast Rail alternatives with smart growth strategies (i.e., measures that MassDOT can implement and/or growth management strategies that are anticipated to be adopted by Study Area communities by 2030). It was assumed that proposed stations are designed to optimize TOD opportunities with the full range of smart growth measures as provided in the Corridor Plan and regional long-range plans.

The smart growth scenario includes all projected baseline (No-Build) and induced growth in jobs and households in the South Coast Region. A working group of consultants and planners from the three RPAs constructed this theoretical model with the assistance of GIS mapping techniques and ground truthing by regional planners.

Under the smart growth scenario, jobs were allocated by the RPAs into TAZs based on the share of jobs projected in 2030. This allocation will permit future impact analyses of the induced jobs in the context of traffic and GHG emissions.

Scenario 2 evaluates the future 2030 growth within the Study Area (both the projected No-Build growth and the induced growth) with implementation of the Corridor Plan. This scenario re-distributed this growth using the process described in this section. The re-distribution was done by the MAPC in an iterative process using a GIS-spreadsheet model.

At the heart of the Corridor Plan is the Corridor Map, which identifies appropriate places for development and preservation: Priority Development and Priority Protection Areas. The smart growth model uses these districts as the base geographies for the reallocation of housing and jobs. All of the state-endorsed Priority Development Areas were designated to receive a portion of the reallocation, as were some regionally identified PDAs. Regional PDAs were included in the model if they were particularly well suited for smart growth development, such as downtowns. If a community did not have a state-endorsed PDA, the regional

planning agency included a regional priority area from the community that represented the strongest opportunity for smart growth development, in their professional judgment.

The literature examining smart growth policies and planning has shown that approximately 30 percent of households[15] are attracted to the characteristics that comprise smart growth development— chiefly, compact, mixed-use development, and proximity to public transit among other benefits. Originally, MassDOT proposed to reallocate 30 percent of the projected growth from the Priority Protection Areas and Neutral Areas into Priority Development Areas. Reflecting the proposed state and local smart growth actions as identified in the Corridor Plan focus on the priority areas, the 30 percent reallocation assumption was modified to reflect this more nuanced approach to development and preservation activities. The working assumption is to shift 50 percent of the current predicted growth (baseline plus induced) of households and jobs in Priority Protection Areas and 25 percent of the current predicted growth (baseline plus induced) of households and jobs in the neutral areas to the Priority Development Areas. This actually results in slightly less than the original 30 percent reallocation because less growth has been projected for the outlying protection areas.

The flowchart on the following page illustrates how households and jobs were allocated under Scenario 2. The following "rules" were used in the Scenario 2 re-allocations.

- Acres of developable land were calculated for the PDAs.
- Only PDAs that have potential for residential or mixed-use development were considered for the reallocation of households and PDAs that are solely residential did not receive any reallocated jobs.
- The RPA current trends projections from 2000 to 2030 include households at the TAZ level. For each TAZ that falls outside a PDA, 30 percent of the projected growth from 2000 to 2030 under the No-Build scenario was redirected to the PDAs.
- A TAZ was considered within a PDA if 50 percent or more of its land area falls within the PDA border.
- If a municipality cannot hold projected growth in its PDA, a transfer was made to another PDA. The first transfer was intra-municipal. New households were shifted from non-PDA TAZs to the PDAs within a municipal boundary.

5.2.1.6 SUMMARY OF ANALYSIS SCENARIOS

The results of the allocation of induced households and jobs to the municipal level are presented in Tables 5-2 and 5-3. Only the induced growth, without No-Build, is listed under Scenario 1. The Scenario 2 growth includes some No-Build growth since it was included in the smart growth model.

Table 5-2 shows the Projected Change in Household Growth by Community by 2030. It shows that in the absence of the South Coast Rail alternatives, population growth in the Study Area is anticipated to be 74,371 households. The Attleboro Alternative is predicted to increase regional households by 2,057; the Stoughton Alternative by 1,972; and the Rapid Bus Alternative by 1,310. Under Scenario 2, some communities would gain households, while others would lose households, in a reallocation of the No-Build and Scenario 1 growth that equals out in the Total row at the bottom of the table.

Scenario 2 retains these totals (of baseline and induced growth) on a regional basis, but re-allocates some of that growth among the communities based on the principles outlined above. The process of transferring households from sending to receiving areas resulted in some communities losing growth to

[15] Leinberger, Christopher B. *The Option of Urbanism: Investing in a New American Dream*. Washington, DC: Island Press, 2008. p 92-101.

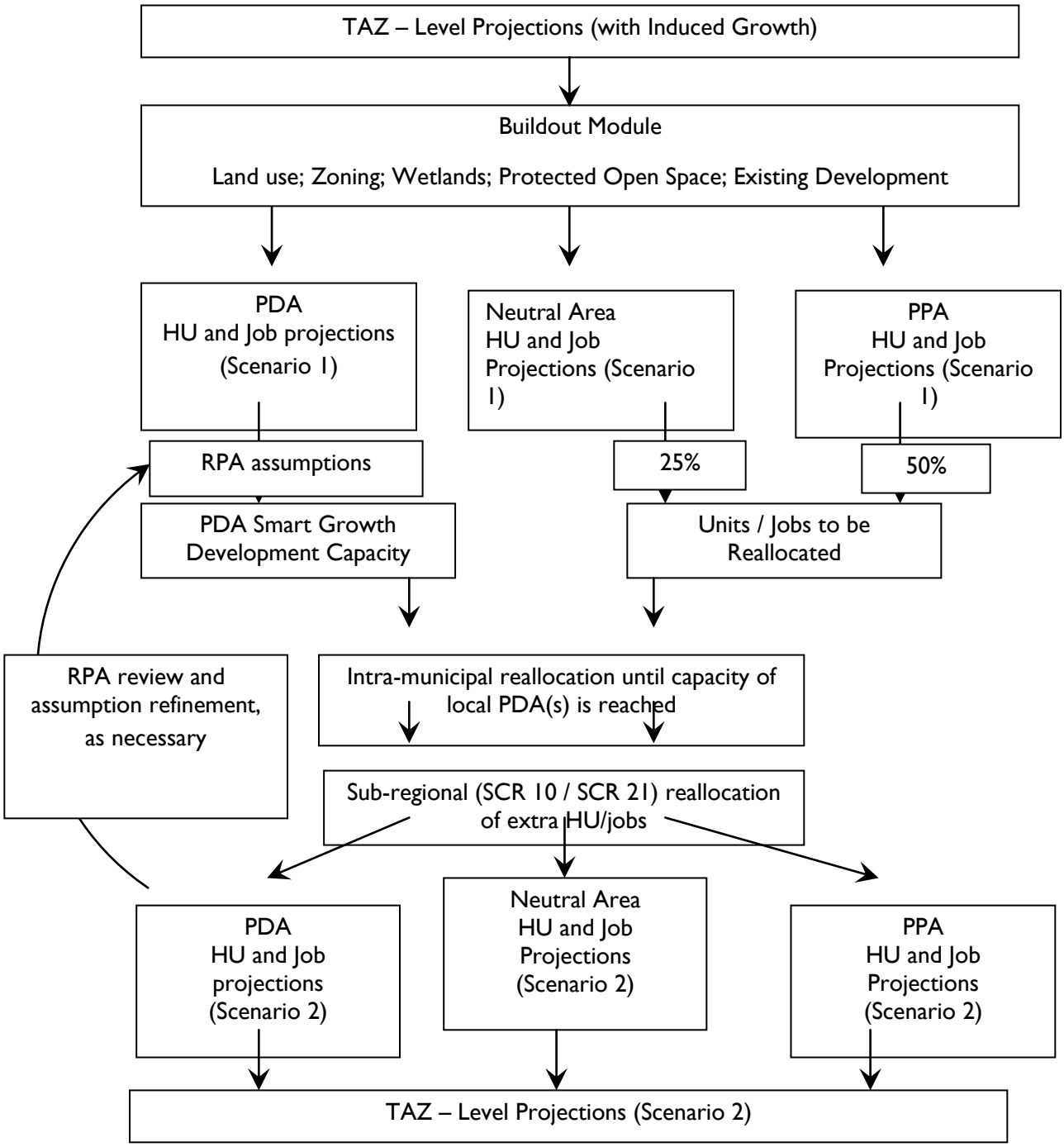

TAZ – Level Projections (with Induced Growth)
Buildout Module
Land use; Zoning; Wetlands; Protected Open Space; Existing Development
PDA
HU and Job projections
(Scenario 1)
Neutral Area
HU and Job
Projections (Scenario
1)
PPA
HU and Job
Projections (Scenario
1)
RPA assumptions
25%
50%
PDA Smart Growth
Development Capacity
Units / Jobs to be
Reallocated
RPA review and
assumption refinement,
as necessary
Intra-municipal reallocation until capacity of
local PDA(s) is reached
Sub-regional (SCR 10 / SCR 21) reallocation
of extra HU/jobs
PDA
HU and Job
projections
(Scenario 2)
Neutral Area
HU and Job
Projections
(Scenario 2)
PPA
HU and Job
Projections
(Scenario 2)
TAZ – Level Projections (Scenario 2)

Table 5-2 Projected Change in Household Growth by Community (2030)

Municipality	No-Build Scenario Household Growth	Scenario 1 Change in Household Growth from No-Build			Scenario 2 Change in Household Growth from No-Build		
		Attleboro	Stoughton	Rapid Bus	Attleboro	Stoughton	Rapid Bus
Acushnet	1,541	45	43	30	-405	-404	-401
Attleboro	4,620	122	23	28	406	398	394
Berkley	2,378	103	90	73	-244	-239	-234
Bridgewater	3,474	14	60	16	410	397	395
Canton	2,116	11	11	13	24	23	23
Dartmouth	3,603	67	65	45	291	290	286
Dighton	1,278	96	83	68	-274	-270	-266
Easton	5,541	19	111	21	370	357	356
Fairhaven	160	39	38	26	57	57	56
Fall River	-1,481	123	109	87	792	788	776
Foxborough	1,405	8	8	10	670	651	645
Freetown	1,333	97	84	69	141	141	139
Lakeville	2,343	49	48	33	-346	-345	-340
Mansfield	5,639	68	18	22	-1,451	-1,428	-1,429
Marion	818	38	37	25	-56	-56	-53
Mattapoisett	485	36	35	24	3	3	3
Middleborough	3,482	32	31	22	86	86	84
New Bedford	-1,283	123	109	88	570	567	558
N. Attleborough	2,835	64	14	17	-267	-251	-252
Norton	3,359	110	58	14	-275	-256	-240
Raynham	2,478	23	94	35	19	18	19
Rehoboth	2,756	52	51	35	-259	-258	-254
Rochester	1,445	41	40	27	-383	-382	-378
Seekonk	1,461	16	15	11	78	78	77
Sharon	1,186	8	7	9	39	38	37
Somerset	791	44	42	29	5	5	5
Stoughton	3,434	16	109	19	74	70	71
Swansea	1,601	48	46	32	67	67	66
Taunton	6,026	152	137	108	555	552	545
Wareham	883	16	15	11	-236	-236	-235
Westport	1,466	101	88	72	-463	-459	-455
Bristol RI	1,943	58	56	39	58	56	39
Portsmouth RI	2,386	72	69	48	72	69	48
Tiverton RI	1,976	136	119	97	136	119	97
Warren RI	893	10	9	7	10	9	7
Total	74,371	2,057	1,972	1,310	-	-	-

Table 5-3 Projected Change in Job Growth by Community (2030)

Municipality	No-Build Scenario Job Growth	Scenario 1 Change in Job Growth from No-Build			Scenario 2 Change in Job Growth from No-Build		
		Attleboro	Stoughton	Rapid Bus	Attleboro	Stoughton	Rapid Bus
Acushnet	637	13	13	10	0	0	0
Attleboro	2,352	162	40	30	336	332	329
Berkley	465	34	23	20	0	0	0
Bridgewater	1,989	13	24	9	340	332	330
Canton	3,376	46	45	32	20	19	19
Dartmouth[16]	-	163	157	118	118	118	117
Dighton	546	42	32	25	-322	-321	-320
Easton	1,353	24	136	17	307	298	298
Fairhaven	2,410	67	66	48	-262	-262	-258
Fall River	3,083	410	395	290	322	321	318
Foxborough	2,251	32	31	22	555	543	539
Freetown	3,093	59	49	38	57	57	57
Lakeville	2,459	44	42	31	0	0	0
Mansfield	4,744	62	30	22	0	0	0
Marion	1,213	30	28	22	-201	-200	-199
Mattapoisett	1,090	22	21	16	-249	-248	-247
Middleborough	4,686	48	47	34	35	35	35
New Bedford	3,235	378	362	267	232	231	229
N. Attleborough	6,042	51	25	19	-856	-849	-848
Norton	4,165	104	24	9	-796	-765	-760
Raynham	4,842	52	117	74	8	7	8
Rehoboth	687	22	20	16	0	0	0
Rochester	788	10	10	7	-12	-12	-11
Seekonk	3,880	52	50	37	32	32	31
Sharon	411	10	10	7	32	32	31
Somerset	870	43	43	31	-11	-11	-9
Stoughton	4,432	35	158	26	62	59	60
Swansea	3,257	61	60	44	27	27	27
Taunton	10,066	345	332	243	226	225	223
Wareham[17]	-	52	52	38	0	0	0
Westport	1,167	67	56	44	0	0	0
Bristol RI	640	12	12	9	-	-	-
Portsmouth RI	902	17	17	12	-	-	-
Tiverton RI	249	14	5	9	-	-	-
Warren RI	235	4	3	2	-	-	-
Total	**81,615**	**2,600**	**2,535**	**1,678**	**-**	**-**	**-**

[16] The No-Build job projection for Dartmouth is not available.
[17] The No-Build job projection for Wareham is not available.

other communities that potentially have the necessary developable land in their designated priority development areas. It should be noted again this model was created as part of a theoretical exercise to demonstrate how development patterns could be shifted if the Commonwealth and local municipalities work together to further the goals of the Corridor Plan, in conjunction with local support in the form of zoning and permitting changes.

Figures 5-1 through 5-11 show the projected household growth according to the various alternatives and growth scenarios outlined in this Chapter. Figure 5-1 displays the locations of the Priority Development and Priority Protection Areas. Figure 5-2 shows the distribution of household growth under the No-Build Alternative. Figures 5-3 through 5-5 shows the distribution of induced household growth under the Attleboro, Stoughton, and Rapid Bus Alternatives. Figures 5-6 through 5-9 display the distribution of household growth under Scenario 1 for each of the selected alternatives. Figures 5-9 through 5-11 show the distribution of household growth under the Scenario 2, smart growth approach.

Table 5-3 shows Projected Change in Job Growth by Community in 2030 and indicates that in the absence of the South Coast Rail alternatives, job growth in the Study Area is anticipated to be 81,615 jobs. The Attleboro Alternatives are predicted to increase regional jobs by 2,600; the Stoughton Alternatives by 2,535; and the Rapid Bus Alternative by 1,678. Scenario 2 retains these totals (of baseline and induced growth) on a regional basis, but re-allocates the growth among communities based on the principles outlined above. Since some communities would gain jobs, while others would lose jobs, the reallocation of the No-Build and Scenario 1 growth under Scenario 2 equals out in the Total row at the bottom of the table.

5.2.1.7 ENVIRONMENTAL CONSEQUENCES METHODOLOGY

This section describes the methods used to assess the potential impact of induced jobs and housing on the South Coast region's land use, farmland, wetlands, biodiversity, water and sewer infrastructure, and air quality. Table 5-4 contains the metrics that are used to estimate the environmental impacts.

Assumptions for Future Growth Scenario

The potential impacts on environmental resources that could be attributed to induced growth in the Study Area include:

- Land use: Land development and associated impacts depend on general regional and statewide economic conditions, state permitting requirements, local zoning and land use ordinances and their administration, and the decisions of individual landowners. Given these influences and changing conditions over time, it is difficult to forecast with real confidence specific areas that may be developed or not, and the impacts of such development, under the No-Build and Build Alternatives. However, recent trends on the conversion of undeveloped land to developed land provided an indication of how land use might change given induced development from the project alternatives.
- Farmland: Future land development in the South Coast will likely involve the conversion of farmlands to residential and commercial uses. MassAudubon's *Losing Ground*[18] study undertook an analysis of the conversion of farmland for new housing from 1999-2005 for all of Massachusetts. This recent trend data provided an estimate of how much farmland might be consumed in each town as they absorb new residential growth. A forecast was then made of the potential loss of farmland due to future development, based on development history and the size of a typical lot in each community. Since similar data for the Rhode Island communities was not readily available, an

[18] DeNormandie, J. (2009). *Losing Ground: Beyond the Footprint*. Lincoln, MA. Massachusetts Audubon Society.

estimate of the potential loss of farmland there was made based on the experience of Massachusetts towns with similar residential densities

- Wetlands: Residential housing development typically results in minor impacts to wetlands because of local, state, and federal legal protections. However, the construction of a subdivision might include new roadways, which could fill wetlands. In most cases, a developer would be required to mitigate the wetland loss by creating a wetland on another part of the property. To estimate the extent of wetland loss that could result from new residential growth, data were reviewed from a MassGIS analysis showing how land use changed between 1999 and 2005. Smart Growth developments, which are generally more dense and feature multi-family housing, would reduce wetlands impacts. It is expected that the development of a typical housing unit would disturb 0.00017 acres of wetlands.
- Biodiversity: The potential effects of growth on biodiversity are difficult to quantify, but it is known that development destroys habitat and has a disruptive effect on ecological processes. The protection of land as open space is an important strategy. An assessment of the mixture of habitat and natural community types across a region provides insight into biodiversity. MassAudubon in their *Losing Ground* report conducted an analysis of habitat fragmentation in EPA ecoregions across Massachusetts. This analysis was used to estimate the direct and indirect impacts on biodiversity as a result of new development in the South Coast region. It is expected that for every one acre of development, three acres of biodiversity are impacted.
- Infrastructure: Residential housing growth will have a direct effect on communities' needs to supply or support water and wastewater infrastructure. The Massachusetts Department of Environmental Protection estimates that household water demand is approximately 65 gallons per person per day though demand does fluctuate by community. It was assumed that as new residential growth occurs, similar ratios of water and wastewater use per household will hold. Communities that rely on private wells and septic systems are not expected to bear new public costs for growth, but growth could still increase demands on constrained resources.
- Air Quality: Induced growth will result in the additional greenhouse gas (GHG) emissions in the South Coast region. An analysis was conducted for a typical house constructed in the year 2030. The model provided estimated carbon dioxide emissions related a prospective home's electric and gas consumption. An analysis of the mobile source GHG emissions will be presented for the FEIR based on a reallocation of population and employment to the TAZ level.

Assumptions for the Smart Growth Scenario

The potential impacts on environmental resources that could be attributed to induced growth under the smart growth scenario in the Study Area include:

- Land use: Development that is outlined in the Corridor Plan would be considered part of the smart growth scenario. It was assumed that compact, mixed-use, and infill housing development is expected to account for approximately 30 percent of induced growth, which is expected to reduce new land development by approximately 21 percent[19] for the "low" scenario and 30 percent for the "high" scenario. It is anticipated that communities which support the development of dense multi-family, clustered single-family housing, and transit-orientated development and utilize other smart growth incentives could reduce land use impacts up to 30 percent and achieve the "high" scenario. The "low" scenario entails a sizeable improvement over traditional growth patterns, but assumes that not all communities will implement all smart growth policies enumerated in the Corridor Plan.

[19] Burchell, Robert W. and Mukherji, Sahan (2003). Conventional Development Versus Managed Growth: The Costs of Sprawl. *American Journal of Public Health*, 93 (9), 1537.

- Farmland: Under the smart growth allocation, it is estimated that 21 percent fewer acres of agricultural land would be converted for development.
- Wetlands: Smart growth development, which is generally more dense and features clustered and multi-family housing, would reduce wetlands impacts by an estimated 21 percent per a previous study.
- Biodiversity: To estimate how compact development patterns would reduce impacts on biodiversity, it was assumed that a 21 percent reduction in land consumption for development would have a commensurate benefit in land to support biodiversity in the South Coast region.
- Infrastructure: Smart growth development patterns are expected to reduce the consumption of water for use outdoors. However, multi-family and clustered housing are built on smaller lots and would have smaller lawns for watering and fewer paved areas to wash. It is estimated that smart growth would reduce household water consumption by approximately 13 percent.
- Air Quality: The model provided estimated carbon dioxide emissions related a prospective home's electric and gas consumption.

Metrics Used to Assess Impacts

In order to estimate the potential effect of growth on environmental resources in the Study Area, metrics were obtained from published sources and applied to each community in the study area, for each scenario and selected alternative. The metrics under Scenario 1, induced growth, were assumed to be a continuation of the business as usual development patterns. The Scenario 2 impacts assume that the smart growth measures are fully implemented in all of the 31 Study Area communities.

Table 5-4 lists the primary metrics used for the study area. The "high" scenario metrics were based on a 30 percent reduction in land consumption, while the "low" scenario metrics were based on a 21 percent reduction in land consumption. The metrics were adjusted by community for certain variables such as land use, forest land, and farmland.

5.2.2 CUMULATIVE IMPACTS

This section describes the methodology used to evaluate the cumulative impacts of the South Coast Rail alternatives.

5.2.2.1 INTRODUCTION

The South Coast Rail alternatives are anticipated to result in direct or indirect, adverse and/or beneficial effects to a range of resources, as described in Chapter 4. Additional effects may result from induced growth, as described in the indirect effects portion of this Chapter. Some of the minor or major effects of the South Coast Rail alternatives may, when combined with the effects of other past, present, or future actions, result in substantive impacts to environmental or social (human) resources. These combined effects are referred to as cumulative impacts. This section provides the scope of the cumulative impact analysis, a summary of the direct and indirect effects of the build alternatives and conclusions regarding cumulative impacts.

5.2.2.2 SCOPE

The cumulative impacts of the South Coast Rail alternatives were analyzed for each of the alternatives, as compared to the baseline condition (the No-Build Alternative) under two scenarios: a "Business as Usual" model and with Smart Growth measures. Section 5.2.1 describes these scenarios and their

Table 5-4 Metrics Used to Evaluate Environmental Impacts of Induced Growth (per household)

	Metric[20]			
Resource	Scenario 1: No Smart Growth	Scenario 2: Smart Growth (high scenario)	Scenario 2: Smart Growth (low scenario)	Sources
GHG Emissions	11.83 tpy	-	11.83 tpy	eQUEST
Land Conversion[21]	0.56 acres	0.39 acres	0.44 acres	*Losing Ground* and *American Journal of Public Health*
Loss of Farmland[22]	0.13 acres	0.91 acres	0.10 acres	*Losing Ground* and *American Journal of Public Health*
Loss of Forest Land[23]	0.30 acres	0.21 acres	0.24 acres	*Losing Ground* and *American Journal of Public Health*
Loss of Wetland	7.35 sf	5.15 sf	5.81 sf	MassGIS
Biodiversity Impact	3:1 ratio	2.10:1 ratio	2.37:1 ratio	*Losing Ground* and *American Journal of Public Health*
Water Demand	162.5 gal	-	141.4 gal	*MassDEP* and *U.S. EPA*[24]
Traffic	43 VMT/day	-	26 VMT/day	*Growing Cooler*[25]

indirect effects. In summary, the Business as Usual scenario would consist of traditional transit line and station construction without consideration of surrounding land use planning. The Smart Growth scenario would include the planning initiatives outlined in the Corridor Plan, including Transit-Oriented Development [TOD], to the extent that these can be defined at this time. Certain effects resulting from the South Coast Rail alternatives may vary depending upon which scenario is implemented. The cumulative impacts evaluation was therefore conducted for these two scenarios. The evaluation was conducted for a selected set of resources within certain temporal and spatial boundaries, in reference to historical trends or effects from specific other projects, and that are (for the most part) regulated by various governmental agencies. The following paragraphs describe the methodology used to define this scope.

Resources Evaluated

Chapter 4 describes the potential direct and indirect encroachment-alteration effects of the South Coast Rail alternatives for a broad range of resources, including environmental media (e.g., air, water), ecosystems (e.g., biodiversity, wetlands), and human communities (e.g., historical and archaeological resources, the economy). Some resources are expected to be little affected by any of the project alternatives; others may be substantively affected positively or negatively, either directly or indirectly, or through induced growth. Some resources have experienced substantial historical impact from other projects or human activity, may experience substantial future impact from other projects or activities, or are of specific interest to decision-makers, regulators, and the residents of the South Coast region. A cumulative impacts evaluation of certain resources was also required by the MEPA Certificate on the ENF. The cumulative impacts evaluation focuses on:

[20] The number of households per community would be multiplied by this metric to estimate the potential future impacts, for each scenario.
[21] These factors are averaged across the South Coast region. Community-specific factors are presented in Chapter 3.
[22] These factors are averaged across the South Coast region. Community-specific factors are presented in Chapter 3.
[23] These factors are averaged across the South Coast region. Community-specific factors are presented in Chapter 3.
[24] U.S. Environmental Protection Agency. How to Conserve Water and Use it Effectively. http://www.epa.gov/nps/chap3.html (November 2009).
[25] Ewing, B., Bartholomew, K., Winkleman, S., Walters, J., Chen, D., (2008). Growing Cooler. Washington, DC. Urban Land Institute

- Air quality;
- Biodiversity;
- Economy;
- Land use;
- Protected open space;
- Threatened and endangered species;
- Water quality; and
- Wetlands.

The other resources evaluated in Chapter 4 did not meet the selection criteria: are expected to be little affected by any of the project alternatives and/or do not hold specific interest to stake-holders.

Temporal and Spatial Boundaries

The cumulative impacts analysis defines a time frame and geographic range for the evaluation, and takes into account changes from other projects within this time frame that contribute to cumulative impacts on the resources listed above. Historical impacts have been evaluated for two time periods:

- For most resources, prior changes have been evaluated for the period 1990 to 2008. The year 1990 was selected as the starting date because this is a prior census year, it was in the midst of a period of economic downturn, and it establishes a reasonable baseline condition.
- Some resources have been evaluated over a longer time period where useful data are available. For example, prior impacts to wetlands have been evaluated to 1983, the year that the Massachusetts Wetlands Protection Act regulations were established. The Massachusetts Audubon Society (MassAudubon) has published a series of reports documenting changes in land use from 1981.

Current impacts have been evaluated based on conditions in 2008/2009, taking into consideration publication delays for the availability of the most recent data. Future impacts have been evaluated to the year 2030, the planning year used for all South Coast Rail analyses.

Spatial boundaries for the analysis varied by resource, according to the specific characteristics of the resource, regulatory jurisdictions, and the availability of meaningful data.

- Air quality was evaluated on an airshed basis. The air quality of the South Coast area is strongly influenced by predominant winds from the southwest and west, bringing air pollutants from upwind states Connecticut, Rhode Island, and New York.[26] Based on regulatory agency jurisdictions and reporting conventions, the three counties within the South Coast Rail study area (Bristol, Norfolk, and Plymouth) are considered to constitute the airshed.
- Biodiversity was evaluated at the ecosystem level (the Bristol Lowlands Ecoregion), considering the biotic communities present in the South Coast region but using the geographic boundaries of the 31 South Coast communities.
- The economy was evaluated at three levels: local (community), regional (South Coast Rail study area), and state.
- Land use was evaluated at the local (municipal) and regional levels.
- Protected open space was evaluated at the local and regional levels.
- Threatened and endangered species were evaluated at the ecosystem level, but also considering the range of each identified species.
- Water quality was evaluated at the watershed level.

[26] DEP. 2008. *Final Massachusetts State Implementation Plan to Demonstrate Attainment of the National Ambient Air Quality Standard for Ozone*. Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs, Department of Environmental Protection: Boston.

- Wetlands were evaluated at the watershed level when useful data were available. State or regional data were used for historical perspective.

Trends and Reasonably Foreseeable Future Actions

The analysis used readily available data sources for past and future changes, including the MassAudubon *Losing Ground* report series, EEA data and publications, DEP wetland change mapping, federal and state agency major permit applications, and other readily available resources. For each resource, the analysis took into consideration:

- Past changes to the selected resources that resulted from development trends or major projects within the study area such as:
  - Fall River Airport closure,
  - Amtrak electrification,
  - New Bedford Wastewater Treatment Plant remediation,
  - Freetown industrial development, and
  - Great Woods development.
- Future changes to the selected resources from anticipated growth based on historic or recent trends, or specific projects, including all reasonably foreseeable projects (i.e., those that are undergoing or have completed major environmental permitting actions or MEPA and/or NEPA reviews), such as:
  - Fall River Executive Park,
  - Route 24 Exit 8 ½,
  - New Bedford Airport safety improvements,
  - Other proposed developments,
  - Mashpee Wampanoag Casino, and
  - Weaver's Cove Liquefied Natural Gas (LNG) Terminal and Offshore Berth.

Regional transportation planning was taken into consideration to the extent possible. The most current regional plan covers the period from 2010 to 2013, and is mostly composed of road and bridge resurfacing and reconditioning projects.[27] None of the projects in the plan include new road construction. Although several are identified as congestion relief projects, and specifically reference air quality improvements, quantified impacts to the resources evaluated in this cumulative impacts analysis are not provided. Some projects, identified as "congressional earmarks waiting for project approval and full funding" are also listed, and include projects such as Route 79 boulevard improvements in Fall River, highway interchange improvements throughout the South Coast region, and some freight rail infrastructure improvements. The potential future impacts from these projects are incorporated in the general resource trends described in the cumulative impact assessment.

Although not a "reasonably foreseeable future action" in the traditional sense of cumulative impacts analysis, the possible effects of climate change on resources such as biodiversity, threatened and endangered species, and wetlands has been taken into consideration to the extent possible.

The cumulative impacts evaluation analyzes the past and future changes to the selected resources from development trends and other specific projects within the resource-specific study areas, together with the added impacts of the South Coast Rail alternatives for each alternative and for the two scenarios.

[27] Southeastern Massachusetts Metropolitan Planning Organization. 2009. *FFY 2010-2013 Transportation Improvement Program (Draft)*. Prepared by the Southeastern Regional Planning and Economic Development District: Taunton, MA.

Federal, state, or local governmental agencies regulate most of the resources evaluated for cumulative impacts. The regulatory programs drive many of the trends for improving resource values (e.g., air quality, water quality, and wetlands area) and are thus important in figuring resource impacts of the South Coast Rail and other regional projects. The regulatory programs typically prohibit impacts except as authorized by a permit. Regulatory agencies are charged with reviewing permit applications and, generally, only authorize activities that provide the least impact to the resource while still meeting the proposed project's purpose and need. For this cumulative impacts evaluation, the existing permitted facilities and proposed actions indicate the current and likely future impacts to the resources.

The agencies responsible for administering these programs are typically charged with managing the resources on a project-by-project basis but in the context of the common good. For example, the federal government has a "no net loss" policy on wetlands: project proponents seeking permits to fill wetland areas are commonly required to offset losses by replacing filled wetlands at a negotiated ratio, such as 2:1 or 3:1. These replacement ratios partly make up for historical wetland loss in addition to the project-specific loss. Thus, certain regulated resources experience improvements, rather than degradations, over time.

5.3 INDIRECT EFFECTS

This section provides an evaluation of the impacts of induced growth on the South Coast region. It contrasts the impacts of baseline growth (the No-Build Alternative) in 2030 to the impacts of this baseline growth with the added impacts of the growth induced by the South Coast Rail Alternatives with, and without, smart growth measures.

The alternatives evaluated are the No-Build Alternative, the Attleboro Alternative, the Stoughton Alternative, and the Rapid Bus Alternative. The electric options were evaluated for both rail alternatives, as these would result in more induced growth than the diesel alternatives. The Whittenton Alternative was not evaluated, as its impacts would be similar to the Stoughton Alternative.

This analysis looks at the impacts of growth on a range of natural and social resources, including land use, farmland, wetlands, biodiversity, infrastructure, air quality, and traffic. The application of various metrics in this chapter is designed to model potential impacts and benefits of the selected alternatives and permit a level of informed comparison among them. The projections and metrics were drawn from the literature and reviewed by subject matter experts, but must be considered theoretical estimates.

5.3.1 DESCRIPTION OF IMPACT SCENARIOS

This section describes the three scenarios evaluated in this Chapter: the No-Build Baseline, Scenario 1 (business as usual, the baseline plus induced growth without smart growth measures), and Scenario 2 (the baseline plus induced growth, with smart growth measures). Tables 5-5 and 5-6 present the results of the allocation of induced households and jobs to the municipal level. This model was created as part of a theoretical exercise to demonstrate how development patterns could be shifted if the Commonwealth and local municipalities work together to further the goals of the Corridor Plan, in conjunction with local support in the form of zoning and permitting changes.

Table 5-5 Projected Total Household Growth by Community (2030)

Municipality	No-Build Scenario	Scenario 1			Scenario 2		
		Attleboro	Stoughton	Rapid Bus	Attleboro	Stoughton	Rapid Bus
Acushnet	1,541	1,586	1,584	1,571	1,181	1,180	1,170
Attleboro	4,620	4,742	4,643	4,648	5,148	5,041	5,042
Berkley	2,378	2,481	2,468	2,451	2,237	2,229	2,217
Bridgewater	3,474	3,488	3,534	3,490	3,898	3,931	3,885
Canton	2,116	2,127	2,127	2,129	2,151	2,150	2,152
Dartmouth	3,603	3,670	3,668	3,648	3,961	3,958	3,934
Dighton	1,278	1,374	1,361	1,347	1,100	1,091	1,080
Easton	5,541	5,560	5,652	5,562	5,930	6,009	5,918
Fairhaven	160	199	198	186	256	255	242
Fall River	-1,481	-1,358	-1,372	-1,394	-566	-584	-618
Foxborough	1,405	1,413	1,413	1,415	2,083	2,064	2,060
Freetown	1,333	1,430	1,417	1,402	1,571	1,558	1,541
Lakeville	2,343	2,392	2,391	2,376	2,046	2,046	2,036
Mansfield	5,639	5,707	5,657	5,661	4,256	4,229	4,232
Marion	818	856	855	843	800	799	790
Mattapoisett	485	521	520	509	524	523	512
Middleborough	3,482	3,514	3,513	3,504	3,600	3,599	3,588
New Bedford	-1,283	-1.160	-1,174	-1,195	-590	-607	-637
N. Attleborough	2,835	2,899	2,849	2,852	2,632	2,598	2,600
Norton	3,359	3,469	3,417	3,373	3,149	3,161	3,133
Raynham	2,478	2,501	2,572	2,513	2,520	2,590	2,532
Rehoboth	2,756	2,808	2,807	2,791	2,549	2,549	2,537
Rochester	1,445	1,486	1,485	1,472	1,103	1,103	1,094
Seekonk	1,461	1,477	1,476	1,472	1,555	1,554	1,549
Sharon	1,186	1,194	1,193	1,195	1,233	1,231	1,232
Somerset	791	835	833	829	840	838	825
Stoughton	3,434	3,450	3,543	3,453	3,524	3,613	3,524
Swansea	1,601	1,649	1,647	1,633	1,716	1,714	1,699
Taunton	6,026	6,178	6,163	6,134	6,733	6,715	6,679
Wareham	883	899	898	894	663	662	659
Westport	1,466	1,567	1,554	1,538	1,104	1,095	1,083
Bristol RI	1,943	2,001	1,999	1,982	2,001	1,999	1,982
Portsmouth RI	2,386	2,458	2,455	2,434	2,458	2,455	2,434
Tiverton RI	1,976	2,112	2,095	2,073	2,112	2,095	2,073
Warren RI	893	903	902	900	903	902	900
Total	**74,371**	**76,428**	**76,343**	**75,681**	**76,428**	**76,343**	**75,681**

Table 5-6 Projected Total Job Growth by Community (2030)

Municipality	No-Build Scenario	Scenario 1			Scenario 2		
		Attleboro	Stoughton	Rapid Bus	Attleboro	Stoughton	Rapid Bus
Acushnet	637	650	650	647	650	650	647
Attleboro	2,352	2,514	2,392	2,382	2,850	2,723	2,711
Berkley	465	499	488	485	499	488	485
Bridgewater	1,989	2,002	2,013	1,998	2,342	2,345	2,329
Canton	3,376	3,422	3,420	3,408	3,441	3,440	3,427
Dartmouth[28]	-	-5,430	-5,436	-5,475	-5,312	-5,318	-5,358
Dighton	546	588	578	571	266	257	251
Easton	1,353	1,377	1,489	1,370	1,683	1,787	1,668
Fairhaven	2,410	2,477	2,476	2,458	2,215	2,214	2,200
Fall River	3,083	3,493	3,478	3,373	3,815	3,799	3,691
Foxborough	2,251	2,282	2,281	2,273	2,837	2,825	2,812
Freetown	3,093	3,152	3,142	3,131	3,210	3,199	3,188
Lakeville	2,459	2,503	2,501	2,490	2,503	2,501	2,490
Mansfield	4,744	4,806	4,774	4,766	4,806	4,774	4,766
Marion	1,213	1,243	1,241	1,235	1,042	1,041	1,036
Mattapoisett	1,090	1,112	1,111	1,106	863	863	859
Middleborough	4,686	4,734	4,733	4,720	4,769	4,768	4,755
New Bedford	3,235	3,613	3,597	3,502	3,844	3,828	3,731
N. Attleborough	6,042	6,093	6,067	6,061	5,237	5,217	5,213
Norton	4,165	4,269	4,189	4,174	3,473	3,423	3,414
Raynham	4,842	4,894	4,959	4,916	4,901	4,966	4,924
Rehoboth	687	709	707	703	709	707	703
Rochester	788	798	798	795	786	786	784
Seekonk	3,880	3,932	3,930	3,917	3,964	3,962	3,948
Sharon	411	421	421	418	453	452	450
Somerset	870	913	913	901	902	902	892
Stoughton	4,432	4,467	4,590	4,457	4,529	4,648	4,517
Swansea	3,257	3,318	3,317	3,301	3,345	3,344	3,328
Taunton	10,066	10,411	10,398	10,309	10,637	10,623	10,532
Wareham[29]	-	-3,531	-3,531	-3,545	-3,531	-3,531	-3,545
Westport	1,167	1,234	1,223	1,211	1,234	1,223	1,211
Bristol RI	640	652	652	649	652	652	649
Portsmouth RI	902	919	919	914	919	919	914
Tiverton RI	249	263	254	258	263	254	258
Warren RI	235	239	238	237	239	238	237
Total	**81,615**	**75,038**	**74,972**	**74,117**	**75,038**	**74,972**	**74,117**

5.3.1.1 NO-BUILD (ENHANCED BUS) ALTERNATIVE

This alternative assumes that growth in the South Coast region, by 2030, occurs as projected by the three regional planning agencies. These growth projections were developed in 2007, prior to the economic downturn. Although recent economic events indicate that the actual rates of growth and trends may be lower, and slower, than projected, the No-Build Alternative baseline used in this analysis provides a reasonable comparison of the effects of the Build Alternatives. The No-Build Alternative projects that the study area would gain 74,371 households by 2030, with the largest increases in Taunton (6,026), Mansfield (5,639) and Easton (5,541). New Bedford and Fall River are predicted to lose

[28] The No-Build job projection for Dartmouth is not available.
[29] The No-Build job projection for Wareham is not available.

households (1,283 and 1,481, respectively). Table 5-6 shows that in the absence of the South Coast Rail alternatives, job growth in the Study Area is anticipated to be 81,615 jobs.

5.3.1.2 SCENARIO 1

Scenario 1 considers the induced growth from each of the Build alternatives, added to the baseline growth. It assumes that no additional smart growth measures are implemented other than those measures already incorporated into municipal zoning or state planning.

Attleboro Alternative

As shown in Table 5-5, the Attleboro Alternative is expected to result in a total induced growth of 2,057 households, a 2.8 percent increase over the No-Build Alternative regional growth of 74,371 households. New induced growth would be largest in Taunton (152), Tiverton RI (136), Fall River and New Bedford (123 each), and Attleboro (122). Induced growth would be low in the northern communities, particularly in those not directly served by this alternative (Bridgewater, Foxborough). Some relatively undeveloped rural communities would also see higher growth in households, such as Berkley (103), Dighton (96), Freetown (97) and Westport (101). The Attleboro Alternatives are predicted to increase regional jobs by 2,600.

Stoughton Alternative

As shown in Table 5-5, the Stoughton Alternative is expected to result in a total induced growth of 1,972 households, a 2.7 percent increase over the No-Build Alternative regional growth of 74,371 households. New induced growth would be largest in Taunton (137), Tiverton RI (119), Easton (111), and Fall River and New Bedford (109 each). Induced growth would be low in the northern communities, particularly in those not directly served by this alternative (Bridgewater, Foxborough, Sharon). Some relatively undeveloped rural communities would also see higher growth in households, such as Berkley (90), Dighton (83), Freetown (84) and Westport (88). The Stoughton Alternatives are predicted to increase regional jobs by 2,535.

Rapid Bus Alternative

As shown in Table 5-5, the Rapid Bus Alternative is expected to result in a total induced growth of 1,310 households, a 1.8 percent increase over the No-Build Alternative regional growth of 74,371 households. New induced growth would be largest in Taunton (108), Tiverton RI (97), Fall River (87) and New Bedford (88). Induced growth would be low in the all other communities. Some relatively undeveloped rural communities would also see higher growth in households, such as Berkley (73), Dighton (68), Freetown (69) and Westport (72). The Rapid Bus Alternative is predicted to increase regional jobs by 1,678.

5.3.1.3 SCENARIO 2 (SMART GROWTH)

Scenario 2 considers the induced growth from each of the Build alternatives, added to the baseline growth. It assumes that smart growth measures are implemented in each municipality within the study area, and that station area development occurs as envisioned in the Corridor Plan. As described in Section 5.2.1, the anticipated growth from both the No-Build Alternative and the induced growth from each Build alternative has been re-distributed in accordance with the Proposed Development Areas (PDAs) and Proposed Preservation Areas (PPAs) defined in the Corridor Plan.

Smart Growth Measures Common to All Alternatives

The smart growth scenario (Scenario 2) assumes that the measures outlined in Chapter 7, Implementation of the Corridor Plan (from the South Coast Rail Corridor Plan, June 2009) are fully implemented by the state and the study area municipalities. These measures have been adopted by the Development Cabinet of the administration and include implementation commitments from all Secretariats. Measures include strategic investments of discretionary state funding consistent with the Corridor Map, providing ongoing technical assistance to South Coast Communities to aid in changing local land use codes and regulations, creating a regional transfer of development rights program, and capturing new tax revenues to balance state and local needs. Specific elements of the smart growth plan are described below.

Strategic investments of discretionary state funding to encourage zoning and land use changes to support the Corridor Plan. Significant funding flows from the state to municipalities through a variety of grant and loan programs. By using the Corridor Plan priorities as the guide for these investments, state agency investments will be better coordinated and will serve as an incentive that will prompt local actions consistent with the Corridor Plan.

- Steer investments in state buildings, office leases and infrastructure to support priority development areas.
- Align discretionary grant funds targeted to municipalities with the Corridor Plan's priority areas;
- Allocate South Coast Rail as discretionary growth-management investments to support the Corridor Plan;
- Establish a regional mitigation bank for private projects to support the Corridor Plan;

Provide technical assistance to expand affordable housing and economic development opportunities, open space preservation, and station area planning.

- Assist South Coast communities with preparing and implementing Housing Production Plans, Chapter 40R zoning, station area plans and zoning, and economic development plans and zoning.
- Assist communities with developing a range of housing types at station areas, and planning to prevent displacement of low-income families.
- Work with municipalities to adopt Open Space Residential Development (OSRD) bylaws, Low Impact Development (LID) bylaws, open space plans, and other strategies to protect important natural resources.

Create a regional transfer of development rights (TDR) program to steer growth into areas appropriate for development (the PDAs) and out of sensitive areas (the PPAs). Elements include:

- Providing technical assistance to adopt streamlined TDR bylaws; and
- Establishing a TDR bank to provide funding for the permanent protection of regionally-significant land.

The Commonwealth will help to support the Massachusetts Division of Fish and Wildlife's Eastern Box Turtle Conservation Plan by providing technical assistance to communities within critical areas for habitat protection. This assistance could include providing model conservation subdivision bylaws (cluster development or open space residential design bylaws) or transfer of development rights bylaws to protect critical habitat areas.

Scenario 2 also includes implementing the Station Area Plans that are outlined in the Corridor Plan. Transit Oriented Development (TOD) will cluster jobs and housing around the stations, creating new green neighborhoods.

- Providing technical assistance to communities to develop more detailed station plans, including visualizations, market studies, and new zoning necessary to create TOD districts.
- Creating multi-modal and public realm connections to the stations, through investments in biking and pedestrian facilities and access improvements.
- Incorporating renewable energy, energy efficiency, and environmentally sensitive design into the station areas. Station facilities will strive to achieve the Zero Net Energy goal and opportunities for wind and solar power will be incorporated where feasible.
- Coordinate job creation, green job incubators, and employer-attraction initiatives with station area development.

Attleboro Alternative

The total induced growth for the Attleboro Alternative under Scenario 2 (Smart Growth) would be the same as in Scenario 1. As shown in Table 5-5, the Attleboro Alternative is expected to result in a total induced growth of 2,057 households, a 2.8 percent increase over the No-Build Alternative regional growth of 74,371 households. The distribution of the growth (induced and baseline) would shift to be concentrated in the PDAs. New growth would be largest in Fall River, Foxborough, New Bedford, and Taunton. The Smart Growth scenario would shift growth (induced and baseline) out of rural communities such as Acushnet, Berkley, Lakeville, Rehoboth, Wareham and Westport, as well as more developed communities (Mansfield).

The Attleboro Alternative would include transit-oriented development at six stations (Downtown Taunton, Fall River Depot, Freetown, King's Highway, Downtown Taunton, Taunton Depot, and Whale's Tooth).

Stoughton Alternative

The total induced growth for the Stoughton Alternative under Scenario 2 (Smart Growth) would be the same as in Scenario 1. As shown in Table 5-5, the Stoughton Alternative is expected to result in a total induced growth of 1,972 households, a 2.7 percent increase over the No-Build Alternative regional growth of 74,371 households. The distribution of the growth (induced and baseline) would shift to be concentrated in the PDAs. New growth would be largest in Fall River, Foxborough, New Bedford, and Taunton. The Smart Growth scenario would shift growth (induced and baseline) out of rural communities such as Acushnet, Berkley, Lakeville, Rehoboth, Wareham and Westport, as well as more developed communities (Mansfield).

The Stoughton Alternative would include transit-oriented development at ten stations (Easton Village, Fall River Depot, Freetown, King's Highway, North Easton, Raynham Place, Stoughton, Taunton, Taunton Depot, and Whale's Tooth).

Rapid Bus Alternative

The total induced growth for the Rapid Bus Alternative under Scenario 2 would be the same as in Scenario 1. As shown in Table 5-5, the Rapid Bus Alternative is expected to result in a total induced growth of 1,310 households, a 1.8 percent increase over the No-Build Alternative regional growth of

Table 5-7 Station Area Development Under Scenario 2[30]

Station	Alternative	Residential (units)	Commercial (sf)
	Attleboro	0	0
Battleship Cove	All	0	0
Downtown Taunton	Attleboro	500	100,000
Easton Village	Stoughton	150-200	15,000 – 30,000
Fall River Depot	All	200	200,000
Freetown	All	200	25,000
	Rapid Bus	0	0
King's Highway	All	350	250,000
North Easton	Stoughton	125	0
Raynham Place	Stoughton	400-600	90,000 – 200,000
Stoughton	Stoughton	300-350	10,000 – 25,000
Taunton	Stoughton	125-175	Complementary uses
Taunton Depot	All	150-200	0
Whale's Tooth	All	1,400	500,000

74,371 households. The distribution of the growth (induced and baseline) would shift to be concentrated in the PDAs. New growth would be largest in Fall River, Foxborough, New Bedford, and Taunton. The Smart Growth scenario would shift growth (induced and baseline) out of rural communities such as Acushnet, Berkley, Lakeville, Rehoboth, Wareham and Westport, as well as more developed communities (Mansfield).

The Rapid Bus Alternative is not anticipated to result in station area TOD development at any of the stations.

5.3.2 INDIRECT EFFECTS

This section describes the environmental impacts of the three scenarios evaluated in this Chapter: the No-Action Baseline (as represented by the No-Build Alternative), Scenario 1 (business as usual, the baseline plus induced growth without smart growth measures), and Scenario 2 (the baseline plus induced growth, with smart growth measures).

This analysis presents a hypothetical comparison of the potential impacts and benefits of the selected alternatives. Several estimations and projections were made throughout this process- from the induced growth by communities and the smart growth redistribution model, but they were informed by a working group of the RPAs and project consultants. The metrics that following in this section are not intended to be exact predictions of indirect effects, but are intended to enable informed comparison and contrast between the selected alternatives.

The impacts of development under Scenario 1 are expected to be the same as under the No-Build condition. The indirect effects under the smart growth scenario, Scenario 2 are based on two levels- a "high" and "low" scenario. Because the implementation of smart growth measures cannot be assumed in all communities, the analysis evaluates two future scenarios. Under the "high" scenario, all of the Corridor Plan's smart growth measures are fully achieved by each community, while under the "low" scenario, a lesser degree of smart growth implementation would occur.

[30] Goody Clancy 2009. South Coast Rail Economic Development and Land Use Corridor Plan. Goody Clancy: Boston, MA. June 2009.

5.3.2.1 LAND USE

Future development is anticipated to convert undeveloped land to developed areas, including residential, retail, commercial and industrial uses. Although some redevelopment of previously-developed areas is anticipated for each alternative, this analysis evaluates the loss of undeveloped land based on the anticipated increase in households, using the metrics identified in Table 5-4. Table 5-8 provides the anticipated loss of land in each South Coast community for each alternative, using the community-specific metrics for land loss. A complete table for land use impacts is provided in Appendix 5.3-A.

Table 5-8 Land Use Impacts (Acres of Loss)

Alternative	Scenario 1	Scenario 2 (low)	Scenario 2 (high)
No-Build	44,995	-	
Attleboro	46,165	35,349	31,168
Stoughton	46,121	35,321	31,297
Rapid Bus	45,756	35,051	31,058

No-Build Alternative

The No-Build Alternative is anticipated to result in the loss of 44,995 acres of land for new residential development. The largest losses would occur in Taunton (2,712), Rehoboth (2,756), and Middleborough (2,612), while the smallest losses would occur in Fall River and New Bedford (0), Fairhaven (72), and Somerset (316).

Scenario 1

Under Scenario 1, the growth induced by each alternative was distributed by the RPAs and project consultants according to the process outlined in Section 5.2.1. The following sections identify the land use changes associated with each alternative (the total of the induced growth plus the No-Build Alternative).

Attleboro Alternative

The Attleboro Alternative is anticipated to result in the loss of 46,165 acres of undeveloped land to new residential development, an increase of 1,170 acres from the No-Build Alternative. The largest losses would occur in Lakeville (2,942), Taunton (2,780), and Rehoboth (2,696).

Stoughton Alternative

The Stoughton Alternative is anticipated to result in the loss of 46,121 acres of undeveloped land to new residential development, an increase of 1,126 acres from the No-Build Alternative. The largest losses would occur in Lakeville (2,941), Taunton (2,773), and Rehoboth (2,695).

Rapid Bus Alternative

The Rapid Bus Alternative is anticipated to result in the least loss of undeveloped land, with a projected loss of 45,756 acres of undeveloped land to new residential development, an increase of 761 acres from the No-Build Alternative. The largest losses would occur in Lakeville (2,922), Taunton (2,760), and Rehoboth (2,679).

Scenario 2

Under Scenario 2, the implementation of smart growth measures is anticipated to shift new development from certain undeveloped areas (the PPAs) to targeted development areas, and to allow more dense residential development in these PDAs. Because the implementation of these measures cannot be assumed in all communities, the analysis evaluates two future scenarios – the "high" scenario, in which all smart growth measures are fully achieved by each community, and a "low" scenario with a lesser degree of successful smart growth implementation.

Attleboro Alternative

The Attleboro Alternative is anticipated to result in the loss of 31,168 to 35,349 acres of land for new residential development. The largest losses would occur in Lakeville, Middleborough, and Taunton. Implementing the Smart Growth measures would reduce the overall loss of undeveloped land by 10,816 to 14,997 acres in comparison with Scenario 1.

Stoughton Alternative

The Stoughton Alternative is anticipated to result in the loss of 31,297 to 35,321 acres of land for new residential development. The largest losses would occur in Lakeville, Middleborough, and Taunton. Implementing the Smart Growth measures would reduce the overall loss of undeveloped land by 10,800 to 14,824 acres in comparison with Scenario 1.

Rapid Bus Alternative

The Rapid Bus Alternative is anticipated to result in the loss of 31,058 to 35,051 acres of land for new residential development. The largest losses would occur in Taunton, Rehoboth, and Middleborough. Implementing the Smart Growth measures would reduce the overall loss of undeveloped land by 10,705 to 14,698 acres in comparison with Scenario 1.

5.3.2.2 FOREST LAND

Under Scenario 2, the implementation of smart growth measures is anticipated to shift new development from certain undeveloped areas (the PPAs) to targeted development areas, and to allow more dense residential development in these PDAs. Because the implementation of these measures cannot be assumed in all communities, the analysis evaluates two future scenarios – the "high" scenario, in which all of the smart growth measures are fully achieved by each community, and a "low" scenario with a lesser degree of successful smart growth implementation (Table 5-9).

Table 5-9 Forest Land Impacts (Acres of Loss)

Alternative	Scenario 1	Scenario 2 (low)	Scenario 2 (high)
No-Build	23,736	-	
Attleboro	24,331	18,747	16,611
Stoughton	24,311	18,734	16,600
Rapid Bus	24,117	18,589	16,471

No-Build Alternative

The No-Build Alternative is anticipated to result in the loss of 23,736 acres of forest land for new residential development. The largest losses would occur in Taunton, Middleborough, and Mansfield.

Scenario 1

Under Scenario 1, the growth induced by each alternative was distributed by the RPAs and project consultants according to the process outlined in Section 5.2.1. The following sections identify the forest land use changes associated with each alternative (the total of the induced growth plus the No-Build Alternative).

Under Scenario 1, the growth induced by each alternative was distributed by the RPAs and project consultants according to the process outlined in Section 5.2.1. The following sections identify the forest land use changes associated with each alternative (the total of the induced growth plus the No-Build Alternative).

Attleboro Alternative

The Attleboro Alternative is anticipated to result in the loss of 24,331 acres of forest land for new residential development. The largest losses would occur in Mansfield, Taunton, and Lakeville. This would result in an overall increase of 595 acres of forest land lost as a result of this alternative.

Stoughton Alternative

The Stoughton Alternative is anticipated to result in the loss of 24,311 acres of forest land for new residential development. The largest losses would occur in Mansfield, Taunton, and Middleborough. This would result in an overall increase of 575 acres of forest land lost as a result of the growth induced by this alternative.

Rapid Bus Alternative

The Rapid Bus Alternative is anticipated to result in the least loss of forest land, with a projected loss of 24,117 acres of land for new residential development. The largest losses would similarly occur again in Mansfield, Taunton, and Middleborough. This alternative would result in an overall increase of 381 acres of forest land lost as a result of the growth induced by this alternative.

Scenario 2

Under Scenario 2, the implementation of smart growth measures is anticipated to shift new development from certain undeveloped areas (the PPAs) to targeted development areas, and to allow more dense residential development in these PDAs. Because the implementation of these measures cannot be assumed in all communities, the analysis evaluates two future scenarios – the "high" scenario, in which all of the smart growth measures are fully achieved by each community, and a "low" scenario with a lesser degree of successful smart growth implementation.

Attleboro Alternative

The Attleboro Alternative is anticipated to result in the loss of 16,611 to 18,747 acres of forest land for new residential development. The largest losses would occur in Taunton, Stoughton, and Middleborough. Implementing the Smart Growth measures would reduce the overall loss of forest land by 5,584 to 7,720 acres in comparison with Scenario 1.

Stoughton Alternative

The Stoughton Alternative is anticipated to result in the loss of 16,600 to 18,734 acres of farmland for new residential development. The largest losses would occur in Taunton, Middleborough and Stoughton. Implementing the Smart Growth measures would reduce the overall loss of forest land by 5,577 to 7,711 acres in comparison with Scenario 1.

Rapid Bus Alternative

The Rapid Bus Alternative is anticipated to result in the loss of 16,471 to 18,589 acres of forest land for new residential development. The largest losses would occur in Taunton, Middleborough, and Stoughton. Implementing the Smart Growth measures would reduce the overall loss of forest land by 5,528 to 7,646 acres in comparison with Scenario 1.

5.3.2.3 FARMLAND

Farmland is one specific type of land use that is of concern in the predominantly rural agricultural communities of the South Coast region, where it is economically important and forms a major element of the landscape. Farmland, unless protected by restrictions, is particularly vulnerable to development. This section evaluates the potential loss of farmland as a result of the No-Build Alternative and each of the South Coast Rail alternatives under Scenario 1 and Scenario 2. Table 5-10 provides a summary of the results of the analysis. A complete table is provided in Appendix 5.3-A.

Table 5-10 Farmland Impacts (Acres of Loss)

Alternative	Scenario 1	Scenario 2 (low)	Scenario 2 (high)
No-Build	11,447		
Attleboro	11,778	8,887	7,875
Stoughton	11,760	8,875	7,864
Rapid Bus	11,670	8,810	7,806

No-Build Alternative

The No-Build Alternative is anticipated to result in the loss of 11,447 acres of farmland for new residential development. The largest losses would occur in Rehoboth, Lakeville, and Middleborough.

Scenario 1

Under Scenario 1, the growth induced by each alternative was distributed by the RPAs and project consultants according to the process outlined in Section 5.2.1. The following sections identify the farmland use changes associated with each alternative (the total of the induced growth plus the No-Build Alternative).

Attleboro Alternative

The Attleboro Alternative is anticipated to result in the loss of 11,778 acres of farmland to new residential development. The largest losses would occur in Rehoboth, Lakeville, and Middleborough. This alternative would result in an overall increase of 331 acres of farmland lost in comparison to the No-Build Alternative.

Stoughton Alternative

The Stoughton Alternative is anticipated to result in the loss of 11,760 acres of farmland to new residential development. The largest losses would occur in Rehoboth, Lakeville, and Middleborough. This alternative would result in an overall increase of 313 acres of farmland lost in comparison to the No-Build Alternative.

Rapid Bus Alternative

The Rapid Bus Alternative is anticipated to result in the least loss of farmland, with a projected loss of 11,670 acres of land for new residential development. The largest losses would occur again in Rehoboth, Lakeville, and Middleborough. This alternative would result in an overall increase of 223 acres of farmland lost in comparison to the No-Build Alternative.

Scenario 2

Under Scenario 2, the implementation of smart growth measures is anticipated to shift new development from certain undeveloped areas (the PPAs) to targeted development areas, and to allow more dense residential development in these PDAs. Because the implementation of these measures cannot be assumed in all communities, the analysis evaluates two future scenarios – the "high" scenario, in which all of the smart growth measures are fully achieved by each community, and a "low" scenario with a lesser degree of successful smart growth implementation.

Attleboro Alternative

The Attleboro Alternative is anticipated to result in the loss of 7,875 to 8,887 acres of farmland for new residential development. The largest losses would occur in Rehoboth, Lakeville, and Middleborough. Implementing the Smart Growth measures would reduce the overall loss of farmland by 2,891 to 3,903 acres in comparison with Scenario 1.

Stoughton Alternative

The Stoughton Alternative is anticipated to result in the loss of 7,864 to 8,875 acres of farmland for new residential development. The largest losses would occur in Lakeville, Middleborough, and Rehoboth. Implementing the Smart Growth measures would reduce the overall loss of farmland by 2,885 to 3,896 acres in comparison with Scenario 1.

Rapid Bus Alternative

The Rapid Bus Alternative is anticipated to result in the loss of 7,806 to 8,810 acres of farmland for new residential development. The largest losses would occur in Rehoboth, Lakeville, and Middleborough. Implementing the Smart Growth measures would reduce the overall loss of farmland by 2,860 to 3,954 acres in comparison with Scenario 1.

5.3.2.4 WETLANDS

Although wetlands are stringently protected under local, state, and federal laws and regulations, these programs allow wetlands to be altered under certain circumstances, if proponents comply with relevant performance standards. Generally, small losses of wetlands are permissible if there are no practicable alternatives and compensatory mitigation is provided. This analysis assumes that there would be, on average, a small amount of direct wetland alteration for each new household. Indirect impacts to wetlands that result from development and could possibly degrade their functions and values were not estimated.

It should be noted that the U.S. Army Corps of Engineers and USEPA have a policy of "no net loss" of wetland functions and values. Accordingly, this analysis assumes that projected wetland losses would be permittable and unavoidable consequences of secondary developments resulting from the alternatives, and that compensatory mitigation would be required and implemented to offset those wetland losses.

The following analysis compares the No-Build Alternative with each of the Build alternatives under Scenario 1 and Scenario 2. Table 5-11 summarizes the results of this analysis, which are provided in a detailed table in Appendix 5.3-A.

Table 5-11 Wetland Impacts (Acres of Loss)

Alternative	Scenario 1	Scenario 2 (low)	Scenario 2 (high)
No-Build	13.11		
Attleboro	13.42	10.09	9.31
Stoughton	13.41	10.08	9.30
Rapid Bus	13.31	10.00	9.23

No-Build Alternative

The No-Build Alternative is anticipated to result in the loss of 13.02 acre of wetlands for new residential development. The largest losses would occur in Taunton, Mansfield, and Easton.

Scenario 1

Under Scenario 1, the growth induced by each alternative was distributed by the RPAs and project consultants according to the process outlined in Section 5.2.1. The following sections identify the wetland losses associated with each alternative (the total of the induced growth plus the No-Build Alternative).

Attleboro Alternative

The Attleboro Alternative is anticipated to result in the loss of 13.42 acres of wetland for new residential development. The largest losses would occur in Taunton, Mansfield, and Easton. This alternative would result in an overall increase of 0.3 acres of wetland lost as a result of growth induced by this alternative.

Stoughton Alternative

The Stoughton Alternative is anticipated to result in the loss of 13.41 acres of wetland for new residential development. The largest losses would occur again in Taunton, Mansfield, and Easton. This alternative would result in an overall increase of 0.2 acres of wetland lost as a result of growth induced by this alternative.

Rapid Bus Alternative

The Rapid Bus Alternative is anticipated to result in the least loss of wetland, with a projected loss of 13.31 acres of wetland for new residential development. The largest losses would occur in Taunton, Mansfield, and Easton. This alternative would result in an overall increase of 0.2 acres of wetland lost as a result of growth induced by this alternative.

Scenario 2

Under Scenario 2, the implementation of smart growth measures is anticipated to shift new development from certain undeveloped areas (the PPAs) to targeted development areas, and to allow more dense residential development in these PDAs. Because the implementation of these measures cannot be assumed in all communities, the analysis evaluates two future scenarios – the "high" scenario, in which all of the smart growth measures are fully achieved by each community, and a "low" scenario with a lesser degree of successful smart growth implementation.

Attleboro Alternative

The Attleboro Alternative is anticipated to result in the loss of 9.31 to 10.09 acres of wetland for new residential development. The largest losses would occur in Taunton, Easton, and Attleboro. Implementing the Smart Growth measures would reduce the overall loss of wetland by 3 to 4 acres in comparison with Scenario 1.

Stoughton Alternative

The Stoughton Alternative is anticipated to result in the loss of 9.30 to 10.08 acres of wetland for new residential development. The largest losses would occur in Taunton, Easton, and Attleboro. Implementing the Smart Growth measures would reduce the overall loss of wetland by 4.2 to 5 acres in comparison with Scenario 1.

Rapid Bus Alternative

The Rapid Bus Alternative is anticipated to result in the loss of 9.23 to 10.00 acres of wetland for new residential development. The largest losses would occur in Taunton, Easton, and Attleboro. Implementing the Smart Growth measures would reduce the overall loss of wetland by 3.3 to 4 acres in comparison with Scenario 1.

5.3.2.5 BIODIVERSITY

New development is anticipated to result in the loss of biological diversity within the South Coast region by reducing the abundance of plants and animals. Development may affect plants and animals in both terrestrial and aquatic habitats through the direct loss of habitat, by creating barriers to the movement of organisms, by reducing habitat quality, and by reducing the size of available habitats. The net results of these changes may be to reduce the size of populations, eliminate some populations, or potentially eliminate some species. These effects are directly correlated with the loss of natural undeveloped land, but also as a result of new infrastructure (roads, utilities) required for access to new developments. This analysis (Table 5-12) compares the No-Build Alternative with each of the Build alternatives under Scenario 1 and Scenario 2.

Table 5-12 Biodiversity Impacts (Acres with Decreased Value)

Alternative	Scenario 1	Scenario 2 (low)	Scenario 2 (high)
No-Build	134,984		
Attleboro	138,496	83,778	65,777
Stoughton	138,362	83,712	65,725
Rapid Bus	137,268	83,071	65,222

No-Build Alternative

The No-Build Alternative is anticipated to affect biodiversity according to a 3:1 ratio. For every 1 acre of undeveloped land that is converted for development, there will be an impact on the biodiversity of an additional 3 acres of land.[31] The greatest impacts on biodiversity would occur in communities where there is projected to be large amounts of new residential housing or where there are large average lots. The No-Build Alternative would reduce the biodiversity value of an estimated 134,984 acres of land within the Study Area.

[31] DeNormandie, J. (2009). *Losing Ground: Beyond the Footprint*. Lincoln, MA. Massachusetts Audubon Society.

Scenario 1

Under Scenario 1, the growth induced by each alternative was distributed by the RPAs and project consultants according to the process outlined in Section 5.2.1. The following sections identify the biodiversity losses associated with each alternative (the total of the induced growth plus the No-Build Alternative).

Attleboro Alternative

The Attleboro Alternative is anticipated to result in the loss of biodiversity value in approximately 138,496 acres of land, an increase of 3,512 acre-equivalents in comparison with the No-Build Alternative.

Stoughton Alternative

The Stoughton Alternative is anticipated to result in the loss of biodiversity value in approximately 138,362 acres of land, an increase of 3,378 acre-equivalents in comparison with the No-Build Alternative.

Rapid Bus Alternative

The Rapid Bus Alternative is anticipated to result in the loss of biodiversity value in approximately 137,268 acres of land, an increase of 2,285 acre-equivalents in comparison with the No-Build Alternative.

Scenario 2

Under Scenario 2, the implementation of smart growth measures is anticipated to shift new development from certain undeveloped areas (the PPAs) to targeted development areas, and to allow more dense residential development in these PDAs. Because the implementation of these measures cannot be assumed in all communities, the analysis evaluates two future scenarios – the "high" scenario, in which all of the smart growth measures are fully achieved by each community, and a "low" scenario with a lesser degree of successful smart growth implementation.

In the "high" scenario, it is expected that increasing housing density and reducing land consumption would benefit biodiversity. Under this scenario, for every 1 acre developed, there would be biodiversity impacts to 2.10 acres. For the "low" scenario, the impacts would be slightly greater, at a 2.37 acres of biodiversity impact per acre of land developed for housing.

Attleboro Alternative

The Attleboro Alternative, under Scenario 2, is anticipated to result in a decrease in biodiversity value in 65,777 to 83,778 acres of land. Implementing smart growth measures would reduce the biodiversity effects of growth by 54,718 to 72,719 acre-equivalents.

Stoughton Alternative

The Stoughton Alternative, under Scenario 2, is anticipated to result in a decrease in biodiversity value in 65,725 to 83,712 acres of land. Implementing smart growth measures would reduce the biodiversity effects of growth by 54,650 to 72,637 acre-equivalents.

Rapid Bus Alternative

The Rapid Bus Alternative, under Scenario 2, is anticipated to result in a decrease in biodiversity value in 65,222 to 83,071 acres of land. Implementing smart growth measures would reduce the biodiversity effects of growth by 54,197 to 72,047 acre-equivalents.

5.3.2.6 INFRASTRUCTURE

New development places increased demands on municipal infrastructure, particularly water and sewer services. This section evaluates the increase demand for water resulting from residential growth in the South Coast region. Water is a critical resource under existing conditions, as many of the South Coast communities depend on groundwater sources and impose water restrictions under most summer conditions due to limited supplies.

This section contrasts the future water demand of the No-Build alternative with the additive demand of Scenario 1 (Table 5-13). Scenario 2, by encouraging more compact development, is anticipated to reduce demand for irrigation water. There is not a high and low metric for the Scenario 2 analysis of water demand.

Table 5-13 Water Demand (Gallons per Household)

Alternative	Scenario 1	Scenario 2
No-Build	12,534,438	
Attleboro	12,828,725	10,968,500
Stoughton	12,819,463	10,961,452
Rapid Bus	12,713,875	10,876,782

No-Build Alternative

The No-Build Alternative is anticipated to continue current patterns of household water use. It is estimated that current trend of 65 gallons per person per day would hold, making the average household's water consumption approximately 162.5 gallons per day (2.5 persons per household). The largest impacts on water demand will be borne on the communities expected to grow the most in the coming twenty years. New residential housing and population growth in Taunton, Mansfield, and Easton will result in those communities having the highest increase in demand for water. Appendix 5.3-A breaks down the estimated demand by community.

Scenario 1

Under Scenario 1, the growth induced by each alternative was distributed by the RPAs and project consultants according to the process outlined in Section 5.2.1. The change in water demand associated with each alternative (the total of the induced growth plus the No-Build Alternative) are identified below. Growth under Scenario 1 is expected to consume as many land resources as under the No-Build Alternative. Water demand, under this scenario, is estimated at 162.5 gallons per household and would stay constant.

Attleboro Alternative

The Attleboro Alternative is anticipated to result in additional household water demand of 12,828,725 gallons, 294,287 gallons more than the No-Build alternative.

Stoughton Alternative

The Stoughton Alternative is anticipated to result in additional household water demand of 12,819,463 gallons, 285,025 gallons more than the No-Build alternative.

Rapid Bus Alternative

The Rapid Bus Alternative is anticipated to result in additional household water demand of 12,718,875 gallons, 184,438 gallons more than the No-Build alternative.

Scenario 2

Under Scenario 2, the implementation of smart growth measures is anticipated to shift new development from certain undeveloped areas (the PPAs) to targeted development areas, and to allow more dense residential development in these PDAs. In estimating the change in water demand, one standard metric was used to compare traditional development to smart growth developments.
Small lots, clustered single-family housing, or multifamily housing developments would have beneficial effects on water demand because there would be smaller lawns to water and fewer paved surfaces to keep clean. It is estimated that smart growth could reduce household water demand by 13 percent over conventional growth.

Attleboro Alternative

The Attleboro Alternative under the smart growth scenario is anticipated to result in household water demand savings of 1,860,225 gallons compared to Scenario 1.

Stoughton Alternative

The Stoughton Alternative under the smart growth scenario is anticipated to result in household water demand savings of 1,858,011 gallons compared to Scenario 1.

Rapid Bus Alternative

The Rapid Bus under the smart growth scenario is anticipated to result in household water demand savings of 1,837,093 gallons compared to Scenario 1.

5.3.2.7 GREENHOUSE GAS EMISSIONS

Future regional growth is anticipated to result in increased emissions of regulated air quality pollutants from mobile and stationary sources, as well as increased emissions of greenhouse gases (primarily CO_2). Because detailed traffic analysis cannot be conducted using the information available for these future scenarios, mobile source emissions cannot be calculated at this time. The analysis evaluates the stationary source emissions of greenhouse gases based on different emissions factors for dispersed

residential development contrasted with more compact, clustered development patterns anticipated under Scenario 2. It can be expected that people living in mixed use, transit-orientated neighborhoods will be able to make some of their trips on transit, by bicycle, or on foot. Table 5-14 summarizes the results of this analysis.

Table 5-14 Air Quality Impacts (CO_2 Emissions per Household) (tpy)

Alternative	Scenario 1	Scenario 2
No-Build	912,507	
Attleboro	933,931	933,931
Stoughton	933,257	933,257
Rapid Bus	925,934	925,934

Regional GHG emissions would increase and reduced sequestration capacities would be experienced as undeveloped forests are cleared to accommodate new household growth under the No-Build and Build scenarios. Various studies have attempted to quantify the role of forests in helping to sequester carbon from the atmosphere, but the analysis is complex and depends on multiple variables, many of which are poorly understood. The carbon sequestration capacity of individual tree species, the age of forests, the volume of trees cut down, and soil disturbance are a few examples of multiple factors that would affect carbon emissions in a certain area. Because it is very complex and not well understood, quantitative analysis of carbon sequestration was not undertaken for the South Coast Rail alternatives.

No-Build Alternative

The No-Build Alternative is anticipated to continue current patterns of residential housing construction. Using the eQUEST model on a typical 2,000 sf house, it estimated household greenhouse gas emissions to be approximately 11.83 tons per year. Table 5-14 summarizes the expected greenhouse gas emissions impact of the No-Build Alternative and induced growth from the selected alternatives. Greenhouse gas emissions were modeled with one alternative under Scenario 2 because the eQUEST model predicts the same GHG emissions per household regardless of the predicted 25 percent decrease in house size under Scenario 2, within the PPD areas.

The large growth in some communities expected in the South Coast region, in particular, Taunton, Mansfield, and Easton, would result in those communities having the greatest increase in greenhouse gas emissions. This alternative would reduce the ability of forests to sequester carbon from the atmosphere to reduce global warming potential and improve air quality.

Scenario 1

Attleboro Alternative

The Attleboro Alternative is anticipated to result in a 21,424 tpy increase in greenhouse gases over the No-Build alternative. As shown in Table 5-9, carbon sequestration would be reduced by the indirect loss of 24,331 acres of forest land under this alternative, including projected No-Build growth.

Stoughton Alternative

The Stoughton Alternative is anticipated to result in a 20,750 tpy increase in greenhouse gases over the No-Build alternative. As shown in Table 5-9, Carbon sequestration would be reduced by the indirect loss of 24,311 acres of forest land under this alternative, including projected No-Build growth.

Rapid Bus Alternative

The Rapid Bus Alternative is anticipated to result in a 12,427 tpy increase in greenhouse gases over the No-Build alternative. Carbon sequestration would be impacted by the estimated 24,117 acres of forest land consumption for new development under this alternative, including projected No-Build growth.

Scenario 2

Under Scenario 2, the implementation of smart growth measures is anticipated to shift new development from certain undeveloped areas (the PPAs) to targeted development areas, and to allow more dense residential development in these PDAs. To estimate the change in greenhouse gas emissions from residential development, the eQUEST model was given an input of a prospective 1,500 sf home, one that might be found in a small lot or multifamily housing developments. However, the model calculated the household greenhouse gas emissions to remain at 11.83 tons per year despite the reduction in size. The total greenhouse gas emissions are thus the same under each alternative.

The indirect impacts to carbon sequestration would be reduced under the smart growth alternatives. As shown in Table 5-9, the "low" and "high" scenarios would reduce the forest land cleared by 5,584 to 7,720 acres for the Attleboro Alternative, by 5,577 to 7,711 acres for the Stoughton Alternative, and by 5,528 to 7,646 acres for the Rapid Bus Alternative.

5.3.2.8 TRAFFIC

Future regional growth is anticipated to result in increased vehicle miles traveled. Because detailed traffic analysis cannot be conducted using the information available for these future scenarios, precise estimates of changes in vehicle miles traveled cannot be estimated at this time. However, the average changes in VMT for each scenario can be estimated using the factors presented in Table 5-4 for dispersed residential development contrasted with more compact, clustered development patterns anticipated under Scenario 2. VMT cannot be correlated with greenhouse gas emissions in this analysis because it does not account for speed, congestion, and other important factors. Table 5-15 summarizes the results of this analysis.

Table 5-15 Increased Vehicle Miles Traveled (per Day)

Alternative	Scenario 1	Scenario 2

No-Build	3,316,805	
Attleboro	3,394,678	2,017,195
Stoughton	3,392,227	2,015,899
Rapid Bus	3,365,610	2,000,328

No-Build Alternative

Under the No-Build Alternative, the South Coast region would experience substantial population growth and corresponding increases in VMT. Table 5-15 summarizes the expected VMT increase of the No-Build and induced growth from the selected alternatives.

Scenario 1

The results for Scenario 1 suggest that induced growth would increase the VMT within the Study Area. The household VMT included in this analysis (43 miles per day) are local trips (schools, shopping, and local jobs) rather than the long-distance commuting VMT that is evaluated in the regional assessment of the transportation effects of each alternative.

Attleboro Alternative

The Attleboro Alternative is anticipated to increase VMT by 77,873 per day over the No-Build alternative.

Stoughton Alternative

The Stoughton Alternative is anticipated to increase VMT by 75,422 per day over the No-Build alternative.

Rapid Bus Alternative

The Rapid Bus Alternative is anticipated to increase VMT by 48,805 per day over the No-Build alternative.

Scenario 2

Under Scenario 2, the implementation of smart growth measures is anticipated to shift new development from certain undeveloped areas (the PPAs) to targeted development areas, and to allow more dense residential and mixed-use development in the PDAs. This is anticipated to result in reductions in the vehicle miles traveled for each household, depending on the smart growth measures pursued.

Attleboro Alternative

If implemented with aggressive smart growth measures, the Attleboro Alternative could reduce VMT per day by 487,425 compared to the No-Build Alternative.

Stoughton Alternative

If implemented with aggressive smart growth measures, the Stoughton Alternative could reduce VMT per day by 490,451 compared to the No-Build Alternative.

Rapid Bus Alternative

If implemented with aggressive smart growth measures, the Rapid Bus Alternative could reduce VMT per day by 169,615 compared to the No-Build Alternative.

5.3.2.9 ECONOMIC EFFECTS

The economic analysis of the South Coast Rail alternatives reported in the *Corridor Plan* and Chapter 4.3 - *Socioeconomics* estimated the overall direct and indirect economic effects on the South Coast region as a result of implementing the alternatives, based on the TREDIS model. This section examines the projected growth in the region, distributed at the municipal level, with a qualitative assessment of the potential economic effects. Communities across the region can expect to benefit from additional tax revenues from growth, but they can expect some infrastructure costs for roads, water, and wastewater systems.

No-Build Alternative

The No-Build Alternative is anticipated to result increase households and jobs throughout the South Coast region, with a total of 74,371 new households (Table 5-5). The majority of communities would see an increase in households and therefore an increase in municipal property taxes. The study projects an additional 81,615 jobs within the Study Area, resulting in additional economic benefits from spending.

Scenario 1

Under Scenario 1, the growth induced by each alternative was distributed by the RPAs and project consultants according to the process outlined in Section 5.2.1. Wetland losses associated with each alternative (the total of the induced growth plus the No-Build Alternative) are identified below.

Attleboro Alternative

The Attleboro Alternative is anticipated to increase households to 76,428, an increase of 2,057 households from the No-Build Alternative. All municipalities within the Study Area would have an increased number of residences, which is anticipated to increase municipal property tax revenues. This alternative is anticipated to result in 75,030 jobs, an increase of 2,599 from the No-Build Alternative, with associated spending and multiplier economic effects.

Stoughton Alternative

The Stoughton Alternative is anticipated to increase households to 76,343, an increase of 1,972 households from the No-Build Alternative. All municipalities within the Study Area would have an increased number of residences, which is anticipated to increase municipal property tax revenues. This alternative is anticipated to result in 74,972 jobs, an increase of 2,533 from the No-Build Alternative, with associated spending and multiplier economic effects.

Rapid Bus Alternative

The Rapid Bus Alternative is anticipated to increase households to 75,681, an increase of 1,310 households from the No-Build Alternative. All municipalities within the Study Area would have an increased number of residences, which is anticipated to increase municipal property tax revenues. This alternative is anticipated to result in 74,117 jobs, an increase of 1,678 from the No-Build Alternative, with associated spending and multiplier economic effects.

Scenario 2

Under Scenario 2, the implementation of smart growth measures is anticipated to shift new development from certain undeveloped areas (the PPAs) to targeted development areas, and to allow more dense residential development in these PDAs. Because the implementation of these measures cannot be assumed in all communities, the analysis evaluates two future scenarios: the "high" scenario, in which all of the smart growth measures are fully achieved by each community, and a "low" scenario with a lesser degree of successful smart growth implementation. Scenario 2 does not change the total numbers of new households or jobs for each alternative, but distributes them differently among the Study Area communities based on implementing the Smart Growth measures.

Attleboro Alternative

The Attleboro Alternative is anticipated to reduce the projected number of households in 15 communities in many cases to levels below the projected number of households in the No-Build Alternative. These communities would therefore likely experience lower tax revenues in Scenario 2 than in the No-Build Alternative or Scenario 1. The Attleboro Alternative is anticipated to increase the projected number of households in 16 communities under Scenario 2 over the No-Build Alternative or Scenario 1, which could lead to additional tax revenues.

Stoughton Alternative

The Stoughton Alternative is anticipated to reduce the projected number of households in 16 communities in many cases to levels below the projected number of households in the No-Build Alternative. These communities would therefore be likely to experience lower tax revenues in Scenario 2 than in the No-Build Alternative or with Scenario 1. The Stoughton Alternative is anticipated to increase the projected number of households in 15 communities under Scenario 2 over the No-Build Alternative or Scenario 1, which could lead to an increase in tax revenues.

Rapid Bus Alternative

The Rapid Bus Alternative is anticipated to reduce the projected number of households in 15 communities in many cases to levels below the projected number of households in the No-Build Alternative. These communities would therefore be likely to experience lower tax revenues in Scenario 2 than in the No-Build Alternative or with Scenario 1. The Rapid Bus Alternative is anticipated to increase the projected number of households in 16 communities under Scenario 2 over the No-Build Alternative or Scenario 1, which could lead to additional tax revenues.

5.3.3 SUMMARY

Each of the three Build alternatives evaluated in this chapter is anticipated to induce additional growth within the South Coast region as a result of improved transit access. However, the induced growth from each is relatively small in comparison to the No-Build Alternative, which is projected to increase the number of households by 74,371 by 2030. The Attleboro Alternative is anticipated to add 2.8 percent to

this total, the largest induced growth of the three alternatives. The Stoughton Alternative would have the second largest growth, with a 2.7 percent increase. The Rapid Bus would have the lowest induced growth, at 1.8 percent of the baseline No-Build Alternative.

As described in the preceding sections, the No-Build Alternative and each of these build alternatives would result in the loss of land, including undeveloped forest land and farmland, loss of wetlands, and loss of biodiversity value. The amount of loss would be proportionate to the growth in households, with the Attleboro Alternative having a slightly greater amount of loss from induced growth than the Stoughton Alternative. The differences among the Build alternatives are negligible. Each of the Build alternatives would also slightly increase the effects of the No-Build baseline growth on water demand, greenhouse gas emissions, and vehicle miles traveled. The Build alternatives would also slightly increase municipal property tax revenues as a result of new home construction.

Implementing the smart growth measures described in Section 5.4 would not change the overall numbers of households or jobs within the Study Area, but would re-distribute them to create compact development zones and protect undeveloped land. The savings that would accrue from fully implementing smart growth measures (the Scenario 2 "high" metrics) would be substantial in many instances. For example, the smart growth scenario would result in saving as much as 3,900 acres of farmland for the Attleboro Alternative (33 percent of the farmland loss in Scenario 1), or 14,997 acres of land (32 percent of the total in Scenario 1). Although the differences among the build alternatives are negligible, the results clearly demonstrate the benefits of the smart growth measures that could be implemented as part of the South Coast Rail alternatives.

5.4 CUMULATIVE IMPACTS

This section describes the cumulative impacts of the South Coast Rail alternatives on the following resources:

- Air quality (ambient air quality and greenhouse gas emissions);
- Biodiversity;
- Economy (population and households, business activity and jobs, and tax revenue);
- Land use;
- Protected open space;
- Water quality; and
- Wetlands.

5.4.1 AIR QUALITY

This section discusses the cumulative impacts of the South Coast Rail alternatives to ambient air quality and greenhouse gas emissions. Hazardous air pollutant emissions from mobile sources are not expected to be a substantial aspect of the South Coast Rail alternatives, as described in Chapter 4.9 – *Air Quality* and in particular the section on *Air Toxics*.

Air quality in Massachusetts is regulated by the US Environmental Protection Agency (EPA) within various programs of the federal Clean Air Act and by the Massachusetts Department of Environmental Protection (DEP) under the Massachusetts Clean Air Act and the Global Warming Solutions Act. Certain projects must be evaluated for impacts to ambient air quality, greenhouse gas emissions, and hazardous air pollutant emissions. Controls to or offsets of these emissions are often required as part of facility operating permits. States are required to develop and implement plans to improve ambient air quality when thresholds are exceeded for certain pollutants.

5.4.1.1 AMBIENT AIR QUALITY

The existing ambient air quality in the South Coast region reflects past actions and regulatory controls. The current status and future trends in ambient air quality may be determined by reviewing monitoring data and regulatory programs. EPA regulates emissions of six "criteria pollutants" under the National Ambient Air Quality Standards (NAAQS) program.[32] The EPA has designated all three South Coast counties (Bristol, Norfolk, and Plymouth)[33] as in non-attainment status for ozone NAAQS but in attainment status for all other criteria pollutants.[34] The DEP has prepared a State Implementation Plan describing how the ozone NAAQS will be met by the end of the 2009 monitoring season.[35] The DEP's projections were made with a model that takes into consideration state and county growth factors.

Air quality monitoring shows a recent trend of decreasing volatile organic compounds (VOCs) and nitrogen oxides (NO_x) emissions (in the presence of sunlight and heat, VOCs and NO_x react to form ozone). New federal rules on emissions and fuel standards for non-road mobile sources (such as locomotives), as well as regulations on numerous other source products, will contribute to these anticipated reductions.

One recent project beneficially impacted ambient air quality. Electrifying the Northeast Corridor reduced diesel locomotive usage, resulting in lower emissions of air pollutants.

Several reasonably foreseeable future actions in the South Coast region will likely impact ambient air quality, but only minimally. Operating the proposed Weaver's Cove Energy LNG terminal and offshore berth would result in emissions of criteria pollutants at both locations, but not in sufficient concentrations to be considered a major source or regionally significant.[36] Constructing proposed industrial, business, or commercial parks in Fall River and Freetown, and at Great Woods in Mansfield would increase automobile traffic, resulting in more emissions of air pollutants than if these projects were not built. However, none of these projects would result in exceeding NAAQS. Even with these projects ambient air quality is expected improve over the current conditions due to increasing regulatory controls.[37] Although traffic would be increased, regulatory controls such as federal automobile emission standards and state vehicle inspection programs would reduce emissions.

The South Coast Rail alternatives themselves would not adversely impact ambient air quality. None of the alternatives would result in exceeding any of the NAAQS for the six criteria pollutants (Chapter 4.9 – *Air Quality*). There is less than one-tenth percent variation in emissions between the alternatives, including either electric- or diesel-powered train options of the rail alternatives.

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[32] EPA. 2009. *Six Common Air Pollutants*. EPA website: http://www.epa.gov/air/urbanair. Accessed on 25 September 2009.

[33] The entire state does not meet the ozone NAAQS.

[34] EPA. 2009. County Air Quality Report- Criteria Pollutants, Geographic Area: Massachusetts, Year: 2008. EPA website: http://iaspub.epa.gov/airsdata/adaqs.summary?geotype=st&geocode=MA&geoinfo=st%7EMA%7EMassachusetts&year=2008&fld=county&fld=stabbr&fld=regn&rpp=25. Accessed on 25 September 2009.

[35] DEP. 2008. *Final Massachusetts State Implementation Plan to Demonstrate Attainment of the National Ambient Air Quality Standard for Ozone*. Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs, Department of Environmental Protection: Boston.

[36] Weaver's Cove Energy. 2009. *Weaver's Cove Energy LNG Project, Offshore Berth Proposal, EEA # 13061. 2nd Draft Environmental Impact Report.* Prepared by Epsilon Associates, Inc.: Maynard, MA. See in particular Section 5.2.4.6, Federal Conformity Review Determination.

[37] US DOT. 2009. Route 24, Fall River and Freetown, Massachusetts, Access Improvements Project,; Environmental Assessment, Draft Individual Section 4(f) Evaluation, and Final Environmental Impact Report. US Department of Transportation, Federal Highway Administration and Commonwealth of Massachusetts, Massachusetts Highway Department: Cambridge and Boston, MA.

The cumulative impacts to air quality would be a combination of the historical activities, regulatory controls, and reasonably foreseeable future actions with the ambient air quality impacts that are anticipated from the South Coast Rail alternatives. Ambient air quality in 2030 would be improved over current conditions, even with the anticipated growth in the region, due to both the regulatory controls and the reduced rate of growth in traffic that would result from use of the transit system.

The project is expected to beneficially impact air quality indirectly. Compared to the No-Build Alternative, automobile traffic (in terms of vehicle miles traveled) would be reduced by up to nearly 78,000 vehicle miles traveled per day for the Build Alternatives in Scenario 1, with resultant reduction in emissions of regulated air pollutants (see Table 5-15).[38] The greatest reduction in vehicle miles traveled per day would be obtained by the Attleboro Electric Alternative (77,873) and the least by the Rapid Bus Alternative (48,805). There is less than a 0.2 percent difference in the modeled air emissions from each of the South Coast Rail alternatives.

Scenario 2 is anticipated to further reduce air pollutant emissions. Sprawl would be reduced, as compared to the Business as Usual scenario, because development would be concentrated in PDAs rather than broadly dispersed throughout the communities, resulting in less personal car use and therefore lower air pollution.[39] As shown in Table 5-15, up to nearly 500,000 fewer vehicle miles would be traveled per day in the Scenario 2. The Stoughton Alternative would result in 490,541 fewer miles traveled per day as compared to the No-Build Alternative, while the Rapid Bus Alternative would result in 169,615 fewer miles traveled per day.

Combined with the improving ambient air quality (decreasing air pollutant emissions) trend due to the regulatory controls described above, the cumulative impacts from all South Coast Rail alternatives would:

- Under Scenario 1, contribute to the trend of improving ambient air quality, or
- Under Scenario 2, further contribute to the trend of improving ambient air quality.

There would be no significant differences between the alternatives in the cumulative impacts to ambient air quality.

5.4.1.2 GREENHOUSE GASES

Greenhouse gas monitoring at the federal level has been conducted since 1990, and EPA recently initiated a program regulating greenhouse gases for large sources.[40] The most recent data available are from 2007 and, compared to 1990 data, indicate that total US emissions of greenhouse gases have increased by 17 percent over those 17 years (an average 1 percent per year increase).[41] Greenhouse gas emissions attributed to transportation sources principally from fossil fuel consumption increased 27 percent over the same time period (an average of 1.6 percent per year).

At the state level, greenhouse gas emissions in 1990 have been used as a baseline to establish projections to 2020.[42] Greenhouse gas reduction targets are to be developed for each decade from 2020

38 Ibid. See in particular Table 5-1, Summary of 2030 Mesoscale (Regional) Air Quality Analysis for South Coast Rail Project.

39 EOT. 2009. *Smart Energy/Smart Growth Toolkit: Transit-Oriented Development (TOD)*. Commonwealth of Massachusetts, Executive Office of Transportation and Public Works website: http://www.mass.gov/envir/smart_growth_toolkit/pages/mod-tod.html. Accessed 25 September 2009.

40 EPA. 2009. Final Mandatory Reporting of Greenhouse Gases Rule. EPA website: http://www.epa.gov/climatechange/emissions/ghgrulemaking.html. Accessed on 25 September 2009.

41 EPA. 2009. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007*. US Environmental Protection Agency: Washington, DC.

42 DEP. 2009. *Statewide Greenhouse Gas Emission Level: 1990 Baseline and 2020 Business As Usual Projection*. Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs, Department of Environmental Protection: Boston.

to 2050,[43] beginning with a target between 10 and 25 percent reduction (as compared to 1990 levels) and culminating in at least an 80 percent reduction by 2050.[44] The 1990 data indicate that greenhouse gas emissions attributable to transportation sources were 28.9 million metric tons of carbon dioxide equivalent ($MMTCO_{2e}$). Lacking current state-specific data of greenhouse gas emissions but assuming that the nation-wide increase in transportation greenhouse gas emissions are similarly increasing at the state level, approximately 36.7 $MMTCO_{2e}$ were emitted by the transportation sector in Massachusetts in 2007. It is not possible to predict what either the regulatory limit for nor what the actual rate of greenhouse gas emissions may be in 2030.

The EPA's recent rule requiring reporting greenhouse gas emissions applies to large greenhouse gas emission sources: facilities that emit more than 25,000 metric tons of carbon dioxide per year. Manufacturers of heavy-duty vehicles and engines such as locomotives will begin data collection in 2010 and light-duty vehicles and engines beginning with the 2011 model year. This reporting requirement will therefore begin within the timeframe of the proposed South Coast Rail construction (starting in 2012) and operation (starting in 2016).

Several reasonably foreseeable future actions could impact the global climate either adversely or beneficially:

- Operating the proposed Weaver's Cove Energy LNG offshore berth and terminal would contribute an estimated 321,000 tons per year of greenhouse gases (CO_{2e}).[45] Use of LNG instead of oil in power plants in New England could reduce greenhouse gas emissions by 3,250,000 tons per year CO_{2e}.[46] However, this reduction cannot be considered a reasonably foreseeable future action as no specific fuel source conversion projects in the South Coast region are currently undergoing the permitting process.
- Constructing the proposed industrial, business, or commercial parks in Fall River, Freetown, and Mansfield will likely contribute greenhouse gases to the atmosphere due to increased automobile traffic. For example, the Crossroads at 24 project in Fall River is required to conduct mesoscale air quality analyses for VOC and NO_x emissions for compliance with the DEP's Greenhouse Emissions Policy and Protocol. As with the ambient air quality, this project would result in greenhouse gas emissions but modeled air pollutant concentrations in the future (2030) are lower than current concentrations due to increasing regulatory controls.[47]

The South Coast Rail alternatives would result in direct and indirect emissions of greenhouse gases. Although all of the alternatives (including either electric- or diesel-powered train options, and with less than one-tenth percent variation in emissions between the alternatives) would result in direct greenhouse gas emissions, the modeled emissions are less than would occur under the No-Build Alternative (Chapter 4.9 – *Air Quality*). Automobile traffic (in terms of vehicle miles traveled) would be reduced, with resultant comparative reduction in greenhouse gas emissions (Chapter 4.9 – *Air Quality, Table 4.9-26: Summary of the 2030 Mesoscale (Regional) Air Quality Analysis for the South Coast Rail Alternatives)*.

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[43] MA DEP. 2009. *Air & Climate: Greenhouse Gases & Climate Change, What the State is Doing: Global Warming Solutions Act*. Website: http://www.mass.gov/dep/air/climate/index.htm#gwsa. Accessed 12 October 2009.

[44] DEP. 2009. *Statewide Greenhouse Gas Emission Level: 1990 Baseline and 2020 Business As Usual Projection*. Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs, Department of Environmental Protection: Boston.

[45] Weaver's Cove Energy. 2009. *Weaver's Cove Energy LNG Project, Offshore Berth Proposal, EEA # 13061. 2nd Draft Environmental Impact Report.* Prepared by Epsilon Associates, Inc.: Maynard, MA. See in particular Section 5.2.6.2, LNG Process Related Energy Use, Direct and Indirect Emissions.

[46] Ibid.

[47] US DOT. 2009. Route 24, Fall River and Freetown, Massachusetts, Access Improvements Project,; Environmental Assessment, Draft Individual Section 4(f) Evaluation, and Final Environmental Impact Report. US Department of Transportation, Federal Highway Administration and Commonwealth of Massachusetts, Massachusetts Highway Department: Cambridge and Boston, MA.

The South Coast Rail alternatives would result in greenhouse gas emissions from induced growth. As shown in Table 5-4, it is assumed that greenhouse gas emissions would average 11.83 tons per year CO_{2e} per household. Table 5-14 lists the CO_{2e} emissions for each alternative. Table 5-16 compares the calculated direct and indirect transportation-related, as well as residential growth, 2030 greenhouse gas emissions for each alternative from the Business as Usual scenario.

Table 5-16 Greenhouse Gas Emissions in 2030

Alternative	CO_{2e} Emissions (tpy)			Incremental Change from No-Build	Percent Change from No-Build
	Transportation Sources	Residential Sources	Total	(CO_{2e} tpy)	
No-Build	27,802,094	912,507	28,714,601	--	--
Attleboro Electric	27,739,761	933,931	28,673,692	-40,909	-0.14
Stoughton Electric	27,742,380	933,257	28,675,637	-38,964	-0.14
Rapid Bus	27,795,506	925,934	28,721,440	+6,839	+0.02

The data suggest a very minor change from the No-Build Alternative in greenhouse gas emissions that would directly or indirectly result from the South Coast Rail alternatives. Fewer miles would be traveled for all alternatives, offsetting the growth in the number of households for each alternative except the Rapid Bus Alternative.

The cumulative impacts evaluation combines the historical activities, regulatory controls, and reasonably foreseeable future actions with the greenhouse gas emissions that are anticipated from the South Coast Rail alternatives. As with ambient air quality, within Scenario 1 greenhouse gas emissions in 2030 would be improved over current conditions for all alternatives, even with the anticipated growth in the region, due to both the regulatory controls and the reduced rate of growth in traffic that would result from use of the transit system. It is not possible to predict the greenhouse gas emission level limits that may arise from the regulations mentioned above; it is only known that the limits will be some percentage lower than the 1990 emission levels. In any case, compared to the No-Build Alternative, automobile traffic (in terms of vehicle miles traveled) would be reduced, with resultant reduction in emissions of greenhouse gases, as presented in Chapter 4.9 – *Air Quality, Table 4.9-26: Summary of the 2030 Mesoscale (Regional) Air Quality Analysis for the South Coast Rail Alternatives*. The increase in households would, of course, increase associated greenhouse gas emissions over the No-Build Alternative. In either case, however, greenhouse gas emissions will be cumulatively reduced because of the regulatory requirements to reduce greenhouse gas emissions as compared to 1990 levels.

Scenario 2 is anticipated to reduce greenhouse gas emissions but the reductions may not be measurable at the regional level. As shown in Table 5-4, there would be no measurable difference in greenhouse gas emissions by household within Scenario 2. The location of the sources would differ (i.e., concentrated in PDAs instead of dispersed throughout the region) but the total emissions from stationary sources would not. Sprawl would be reduced, as compared to Scenario 1, because development would be concentrated close to station sites and in PDAs, presumably resulting in less personal car use and therefore lower greenhouse gas emissions.[48]

[48] EOT. 2009. *Smart Energy/Smart Growth Toolkit: Transit-Oriented Development (TOD)*. Commonwealth of Massachusetts, Executive Office of Transportation and Public Works website: http://www.mass.gov/envir/smart_growth_toolkit/pages/mod-tod.html. Accessed 25 September 2009.

As described in Section 5.3.2.7, forest clearing would likely reduce carbon sequestration, but cannot be quantified at this time. Changes in carbon sequestration would be proportional to the amount of land cleared for each alternative and scenario.

Combined with the improvements in greenhouse gas emissions required by regulatory standards described above, the cumulative impacts from the South Coast Rail alternatives would:

- Under Scenario 1, contribute additional greenhouse gas emissions but, depending upon the alternative selected, at minimally lower or higher rates than the No-Build Alternative, or
- Under Scenario 2, also contribute additional greenhouse gas emissions but, depending upon the alternative selected, at minimally lower or higher rates than the No-Build Alternative. The greenhouse gas emission source locations may vary, but the overall (regional) reduction as compared to the Business as Usual scenario may be immeasurable.

There would be no significant differences between the alternatives in the cumulative impacts to global climate change from greenhouse gas emissions.

5.4.1.3 AIR QUALITY SUMMARY

Table 5-17 summarizes the cumulative impacts to air quality (both ambient air quality and greenhouse gases) that would result from the South Coast Rail alternatives within the two scenarios.

The cumulative impacts of the South Coast Rail alternatives to ambient air quality would be decreased concentrations of criteria pollutants as a result of transit rather than personal automobile use, continuing a trend of improving air quality due to increasing regulatory controls. Improvements are expected for both scenarios, but greater improvements expected for Scenario 2. Similarly, the cumulative impacts to greenhouse gas levels would be decreased emissions for the rail alternatives (and a slight increase for the Rapid Bus Alternative), also due to new regulatory controls. There are no substantive differences between the scenarios in cumulative air quality impacts, and only minor differences between the alternatives. Scenario 2 would concentrate the indirect sources as compared to the more widely dispersed sources within Scenario 1, but the overall (regional) impacts to air quality would be similar between the two scenarios.

5.4.2 BIODIVERSITY

Biodiversity is not regulated by federal, state, or local agencies. However, evaluation of project impacts to biodiversity is typically a component of NEPA and MEPA analyses for federal and state agencies, respectively. This evaluation of the cumulative impacts to biodiversity is based, in part, on historical data from non-governmental sources rather than regulatory agency records.

Loss of biodiversity is linked to increases in land use: undeveloped land has higher biodiversity than developed land. Historical trends in land conversion, therefore, assist in understanding trends in loss of

Table 5-17 Comparison of Cumulative impacts to Air Quality in 2030

Historical Trends affecting Air Quality	Trends and Current or Future Actions affecting Air Quality	Alternative	Total Emissions	Incremental Change from No-Build	Percent Change from No-Build
Ambient Air Quality			***Criteria Pollutants***		
Improving ambient air quality due to increasing regulatory controls despite additional sources; current ozone NAAQS non-attainment	Continued improvement in air quality due to additional regulatory controls despite additional sources; anticipated attainment of ozone NAAQS	**SCENARIO 1**			
		No-Build	< NAAQS	--	--
		Attleboro	< NAAQS	Improvement	NA
		Stoughton	< NAAQS	Improvement	NA
		Rapid Bus	< NAAQS	Improvement	NA
		SCENARIO 2			
		No-Build	< NAAQS	--	--
		Attleboro	< NAAQS	Greater Improvement	NA
		Stoughton	< NAAQS	Greater Improvement	NA
		Rapid Bus	< NAAQS	Greater Improvement	NA
Greenhouse Gases			***CO_{2e} (tpy)***		
Increasing greenhouse gas emissions	Decreasing greenhouse gas emissions due to new state and federal controls despite additional sources	**SCENARIO 1**			
		No-Build	28,714,601	--	--
		Attleboro	28,673,692	-40,909	-0.14
		Stoughton	28,675,637	-38,964	-0.14
		Rapid Bus	28,721,440	+6,839	+0.02
		SCENARIO 2			
		No-Build	28,714,601	--	--
		Attleboro	28,673,692	-40,909	-0.14
		Stoughton	28,675,637	-38,964	-0.14
		Rapid Bus	28,721,440	+6,839	+0.02

biodiversity. As noted in the Corridor Plan,[49] a 1998 study conducted by regional planning agencies concluded that "more land had been developed in the South Coast region since 1960 than in the previous 340 years and that land development was occurring at 2.5 times the rate of population growth." At a more detailed level, the MassAudubon *Losing Ground* study series includes an analysis of land use changes throughout Massachusetts from 1971, 1985, 1999, and 2005 data. The 2009 report[50] notes that, statewide, 22 acres of natural land were developed per day during the period of 1999 to 2005, as compared to 40 acres per day between 1985 and 1999. Although land conversion is ongoing, the trend is of decreasing rates of conversion.

As described in Chapter 4.4 - *Land Use*, and according to the 2009 study,[51] natural (undeveloped) land in 2005 for the 31 communities totaled 347,263 acres. In the period from 1999 to 2005, 7,888 acres (2.2 percent of the 1999 total) in those 31 communities had been converted from natural land to developed land. It is assumed that the natural-to-developed land conversion rates calculated by MassAudubon are

[49] EOT. 2009. *South Coast Rail Economic Development and Land Use Corridor Plan.* Commonwealth of Massachusetts, Executive Office of Transportation and Public Works, and Executive Office of Housing and Economic Development. Prepared by Goody Clancy: Boston.

[50] MassAudubon. 2009. Losing Ground: Beyond the Footprint (Fourth Edition of the Losing Ground Series), Patterns of Development and Their Impact on the Nature of Massachusetts. Massachusetts Audubon Society: Lincoln, MA.

[51] MassAudubon. 2009. *Losing Ground: Beyond the Footprint* website: http://www.massaudubon.org/losingground/. Accessed 5 October 2009.

likely to continue for the foreseeable future. Based on this rate, for the 25-year period from 2005 to 2030 approximately 32,875 acres of natural land would be converted to developed land. This is lower than the amount of land conversion estimated with the No-Build Alternative (44,995 acres, see Table 5-8). Approximately 314,388 acres of natural land would remain in the South Coast region in 2030.

Several plots of land throughout the South Coast region have been set aside for conservation purposes, including preserving biodiversity (see Chapter 4.5 - *Open Space and ACEC*). As a single example, the Southeastern Massachusetts Bioreserve, a 13,600-acre area just east of Fall River, was established to protect, restore, and enhance the biological diversity and ecological integrity of a large ecosystem representative of the region.[52] The Bioreserve is comprised of portions of the Freetown/Fall River State Forest, the Acushnet Wildlife Management Area, watershed and conservation lands owned by the City of Fall River, and the former Acushnet Saw Mills property. The Bioreserve lands are owned by the Commonwealth of Massachusetts, the City of Fall River, and the Trustees of Reservations. There will be no economic development activities within the protected lands of the Bioreserve. Lands for the Southeastern Massachusetts Bioreserve are still being acquired.

At least one recent project has specifically converted undeveloped to developed land, affecting biodiversity in the South Coast region. The golf course adjacent to the Great Woods Conservation area in Mansfield converted 400 acres of forest to developed land (landscaped golf course and appurtenant facilities).[53] Somewhat more historically, constructing the numerous linear transportation facilities (surface streets, highways, and railroads) as well as utility corridors (aerial electric transmission lines and pipelines) from the late 1800s through the present time has fragmented the landscape, reducing biodiversity by segregating populations of low mobility species by creating physical or psychological barriers to movement. Highway construction projects, such as I-195 and I-495, continued until the late 1900s.

Several reasonably foreseeable future actions could adversely impact biodiversity:

- Constructing and operating the Weaver's Cover Energy LNG Terminal may impact winter flounder habitat, shellfish, and the benthic community.[54]
- Implementing the Taunton Comprehensive Wastewater Management Plan may impact diadromous fish populations within the Taunton River and Three Mile River.[55]
- Constructing the proposed Exit 8 ½ interchange on Highway 24 would require use of some 16.6 acres of the Freetown-Fall River State Forest for the interchange.[56] This project would impact wetlands at this location, but other land would be set aside (as part of the Southeastern Massachusetts Bioreserve) as mitigation.

[52] Bioreserve Partners. 2009. Facts about the Southeastern Massachusetts Bioreserve. Green Futures website: http://www.greenfutures.org/projects/green/biofacts.html. Accessed 29 October 2009.

[53] Chase, Harry B. Jr. 2009. Great Woods Today. Natural Resources Trust of Mansfield website: http://home.comcast.net/~nrtma/html/today.html. Accessed on 12 October 2009.

[54] Weaver's Cove Energy. 2009. *Weaver's Cove Energy LNG Project, Offshore Berth Proposal, EEA # 13061. 2nd Draft Environmental Impact Report.* Prepared by Epsilon Associates, Inc.: Maynard, MA. See Section 3.0 Wetlands, Marine Fisheries, and Water Quality.

[55] EEA. 2009. Certificate of the Secretary of Energy and Environmental Affairs on the Notice of Project Change, Comprehensive Wastewater Management Plan (Winthrop Street, Davenport Terrace, Williams Street Sewer Extension). Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs: Boston.

[56] US DOT. 2009. Route 24, Fall River and Freetown, Massachusetts, Access Improvements Project,; Environmental Assessment, Draft Individual Section 4(f) Evaluation, and Final Environmental Impact Report. US Department of Transportation, Federal Highway Administration and Commonwealth of Massachusetts, Massachusetts Highway Department: Cambridge and Boston, MA.

- Numerous ongoing or anticipated developments throughout the South Coast, as outlined in the Corridor Plan[57] will likely convert natural land to developed land. (Note, however, that many of these developments do not qualify as "reasonably foreseeable future actions" as defined above.)

As previously noted, no new highway projects are currently anticipated in the South Coast region; biodiversity would not be impacted by any of the planned transportation improvements.

A beneficial impact to biodiversity is expected to result from additional land acquisition for the Southeastern Massachusetts Bioreserve, as mentioned above.

The historical trends and current or future projects suggest that land development in the South Coast region is likely to continue for the foreseeable future. As expressed in the *Losing Ground* report series and reflected in the Corridor Plan, development generally propagates outward from the Boston metropolitan area, with a "sprawl frontier" of urban-character communities in the northern portion of the South Coast region and decreasing development density farther south into suburban and rural communities. Accordingly, there is a potential for greater conversion in the southernmost communities since the northernmost communities have already converted much of their land. Although the rate of conversion has slowed in recent years, the South Coast communities have not reached build-out. The South Coast region will likely experience continued loss of biodiversity correlated with land development in the foreseeable future irrespective of the South Coast Rail alternatives.

In addition to these identifiable, specific human activity trends and projects, global warming may have local effects on biodiversity. Recent studies predict the effects of climate change in New England that could dramatically change the distribution of plant communities and the distribution of some animal species. New England's average summer temperatures are anticipated to increase by 2 to 3^0 F by 2040, and by 6 to 14^0F by the end of the century, resulting in a summer climate similar to that of North Carolina.[58] Winters are also predicted to be warmer, by 8 to 12^0F, with fewer snow-covered days. These changes are expected to be accompanied by longer growing seasons, increasing by 4 to 6 weeks by 2099.

These changes are predicted to affect the distribution of plant species, with most tree species shifting their range north by at least 300 miles. The effects are highly uncertain, but Frumhoff et. al. predict that Southeastern Massachusetts would likely retain the same dominant forest type.[59] Changes in plant distributions are likely to occur more slowly than for animals, as a result of the longer generation times, and that changes in vegetation are likely to be complex and result from a combination of the effects of changing temperature, precipitation, snow cover, and other factors.[60]

Sea level, which has been rising since the end of the last glaciations, is predicted to accelerate. Even in the absence of climate change, sea levels will be 6 inches higher by 2099. There is a range of predictions for the added effects of climate change, from 17 inches to more than 4 feet (assuming that the Greenland ice cap does not melt catastrophically). Sea level rise could result in the loss of much of New England's coastal salt marshes if sediment accretion does not keep pace with sea level rise and if

[57] EOT. 2009. *South Coast Rail Economic Development and Land Use Corridor Plan.* Commonwealth of Massachusetts, Executive Office of Transportation and Public Works, and Executive Office of Housing and Economic Development. Prepared by Goody Clancy: Boston. See in particular Chapter 6: Elements of the Corridor Plan.

[58] Frumhoff, Peter C., James J. McCarthy, Jerry M. Melillo, Susanne C. Moser, Donald J. Wuebbles. 2007. *Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions.* Synthesis report of the Northeast Climate Impacts Assessment (NECIA), Cambridge MA: Union of Concerned Scientists. USC Publications

[59] Ibid.

[60] Bertin, Robert I. 2008. Plant phenology and distribution in relation to recent climate change. J. Torrey Bot. Soc. 135: 126-146.

topography and development at the current upland edges of salt marshes do not allow marshes to migrate landward.

Predictions for animal communities also suggest that some bird and mammal species could shift distributions northward as forest plant community composition and temperature extremes change. This is particularly the case for species whose present northern limit is linked to winter temperatures and snow cover. Warmer winters and less snow cover could allow these species to expand into New England. Other concerns with regard to wildlife habitat include changes in hydrography and increasing temperatures of stream waters, potentially affecting reproduction or survival of cold water fish, or changes in precipitation patterns that potentially alter the hydroperiod of vernal pools and affect reproductive success of obligate vernal pool amphibians. Vernal pools are particularly sensitive to changed in precipitation and evapotranspiration rates. Climate change predictions of more episodic precipitation and increased evapotranspiration rates suggest that vernal pools would dry earlier in the year and stay dry longer.[61]

With these exceptions, the plant and animal communities within the South Coast Rail study area are not anticipated to change substantially with projected climate change since these areas primarily support plant and animal communities with a more southern coastal plain distribution (the coastal plain extends from New Hampshire to Virginia), rather than the more vulnerable northern forest communities of northern New England. Salt marshes, cold-water fisheries, and vernal pools are the most vulnerable elements of the South Coast area.

Table 5-18 lists the habitat loss for each alternative without implementation of Smart Growth initiatives. The area of habitat losses in each case is minimal; the habitat types would persist regardless of the South Coast Rail alternatives.

Table 5-18 Habitat Loss in 2030

	Habitat Loss (acres)				
	Upland	Wetland	Vernal Pool (wetland)	Vernal Pool (supporting upland)[1]	Fragmentation
Attleboro	190.86	20.56	5.36	49.66	New fragmentation from Attleboro Bypass
Stoughton	182.27	11.86	1.77	55.04	Re-established fragmentation, Hockomock Swamp and Pine Swamp
Rapid Bus	316.98	21.48	2.26	19.26	None

1 "Supporting upland" habitat is the area surrounding a vernal pool, measured as the radius of 750 feet from the vernal pool.

In summary, each alternative has a distinguishing characteristic for at least one of the project-specific factors in regard to direct or indirect effects of loss of habitat, or increased fragmentation:

- The Attleboro Alternatives' alignment includes an entirely new segment, the Attleboro Bypass, which would substantively impact each habitat type and create new fragmentation.
- The Stoughton Alternatives would pass through the Hockomock Swamp and Pine Swamp on a currently out-of-service railroad bed, which would exacerbate existing fragmentation.
- The Rapid Bus Alternative would use existing highway alignments exclusively, but would have the greatest upland and wetland habitat loss because of required highway widening and interchange improvements.

[61] Brooks, Robert T. 2004. Weather-related effects on woodland vernal pool hydrology and hydroperiod. In *Wetlands.* (Vol. 24, No. 1, pp 104-114). The Society of Wetland Scientists.

Implementing the Smart Growth initiatives in Scenario 2 would control sprawl by focusing development in PPAs and limiting development in PDAs, diminishing the trend of natural land conversion to developed land and slowing the loss of biodiversity. As discussed in further detail in Chapter 4.2 - *Land Use*, the designated PDA and PPA areas would comprise 29,079 and 139,758 acres, respectively, in the 31 South Coast communities. Although the actual level of protection that the PPAs would receive is not known, at a minimum protecting the PPAs from development at some level would contribute to preserving biodiversity in those areas for all alternatives.

It is assumed that a 21 percent reduction in land consumption would result from implementing Smart Growth initiatives. For comparative purposes, the land conversion rates and habitat losses calculated for Scenario 1 may therefore be reduced by 21 percent for Scenario 2. This would have a commensurate benefit for biodiversity. As described in Section 5.3.2.5, new development within Scenario 1 would impact biodiversity at a 3:1 ratio: for every acre of undeveloped land that is converted to development, biodiversity on three additional acres would be impacted. Within Scenario 2, the conversion rate would be reduced to between 2.10:1 and 2.37:1. Table 5-12 lists the degraded habitat acreage for each alternative and scenario.

Using land conversion or habitat loss as an analog for biodiversity loss, Table 5-19 compares the combined historic trends in land conversion, recent or reasonably foreseeable future actions, and the range of land conversion that would result from each alternative within the two scenarios.

Table 5-19 Comparison of Cumulative impacts to Biodiversity in 2030

Historical Trends Affecting Biodiversity	Trends and Current or Future Actions affecting Biodiversity	Alternative	Land Conversion				Habitat Degradation (acres)[3]
			Natural Land Remaining in 2030 (acres)[1]	Direct and Indirect Habitat Loss (acres)[2]	Total Remaining Natural Land (acres)	Percent Change from No-Build	
40 acres per day land conversion; ecosystem fragmentation	22 acres per day land conversion; additional habitat degradation; climate change.	No-Build	302,268	--	302,268	--	134,984
		SCENARIO 1					
		Attleboro	301,007	-266.44	300,741	+0.51	138,496
		Stoughton	301,035	-250.94	300,784	+0.49	138,362
		Rapid Bus	301,481	-359.98	301,121	+0.38	137,268
		SCENARIO 2					
		Attleboro	311,914 to 316,095	-266.44	311,648 to 315,829	-3.10 to -4.49	65,777 to 83,778
		Stoughton	311,942 to 315,966	-250.94	311,691 to 315,715	-3.12 to -4.45	65,725 to 83,712
		Rapid Bus	312,212 to 316,205	-359.98	311,852 to 315,845	-3.17 to -4.49	65,222 to 83,071

1 Includes induced growth impacts. See Table 5-23, Cumulative impacts to Land Use in 2030.

2 The four habitat types distinguished in Table 5-18 have been summed only to illustrate the area of land conversion; they are not of equivalent biodiversity value.

3 See Table 5-12, Biodiversity Impacts (acres with decreased value).

Within Scenario 1, each alternative would result in approximately one-half percent or less additional conversion of undeveloped land as compared to the No-Build Alternative. Each alternative within Scenario 2 would result in up to nearly 4.5 percent less conversion of undeveloped land than the No-Build Alternative.

The recent trends in land conversion and concomitant biodiversity loss described above in combination with the impacts from all South Coast Rail alternatives would:

- Within Scenario 1, result in little additional land conversion and habitat loss as compared to the No-Build Alternative, with resultant minimal impacts to biodiversity. A slight increase in the area of degraded habitat would also be realized in this scenario; or
- Within Scenario 2, contribute less to land conversion and habitat loss than the No-Build Alternative, with lower resultant impacts to biodiversity. Substantively less area of habitat would be degraded in this scenario.

5.4.3 ECONOMY

The economy is not directly regulated by federal, state, or local agencies. However, evaluation of project impacts to economic conditions is typically a component of NEPA and MEPA analyses for federal and state agencies, respectively. Since governments are typically funded, in part, by taxes, tracking tax revenue streams often provides a good measure of the economy. Relevant parameters include population and households, jobs and business output, and tax collections.

Local, state, and federal agencies monitor (measure) various economic metrics. Changes in the population of and number of households in each community are good "leading indicator" metrics often used to predict economic changes. As described in the Corridor Plan, the "South Coast rail alternatives will improve accessibility and mobility in the South Coast region, and these improvements are expected to stimulate additional business sales, jobs, household income, and state and local taxes beyond that forecast in the absence of such improvements."[62] This evaluation of the cumulative impacts to the economy that would result from the South Coast Rail alternatives is based on projected impacts to households and population, economic activity and jobs, and tax revenues. These subjects are described individually in the following subsections, with a subsequent compilation for the cumulative impacts evaluation.

It should be noted that the data presented in this section are typically from the period of 2006 through 2008, the most current available for many metrics. This time period does not include the current (2009) economic downturn, and the economic and population projections therefore do not reflect these changed circumstances. It is not possible to determine the effect that the current economic downturn may have on the future economic conditions in the South Coast region with any precision. However, the economy is expected to have recovered by the planned start of the South Coast Rail construction (2012) and certainly by the start of operations (2016).

It should also be noted that implementing the Smart Growth initiatives in Scenario 2 is expected to change the location of economic impacts, but is not expected to change the overall (regional) impacts as compared to the Scenario 1.

5.4.3.1 HOUSEHOLD SIZE AND POPULATION

As presented in Table 5-5 of the indirect impact assessment, household growth in the South Coast region by 2030 is anticipated to total 74,371 under the No-Build Alternative. Assuming an average

[62] EOT. 2009. *South Coast Rail Economic Development and Land Use Corridor Plan.* Commonwealth of Massachusetts, Executive Office of Transportation and Public Works, and Executive Office of Housing and Economic Development. Prepared by Goody Clancy: Boston. See Chapter 5: Potential Economic Effects of South Coast Rail, and in particular Table 5-1: Economic Effects in 2030 of South Coast Rail (SCR) Rail Alternatives ($2007).

household size of 2.5 persons,[63] the population of the South Coast region would increase by approximately 185,928 persons by 2030. Based on a current regional population of approximately 740,000,[64] the South Coast region population would be approximately 908,000 in 2030 under the No-Build Alternative. The induced growth from each alternative would add more households and population:

- Attleboro Alternatives: 2,057 households and 5,143 persons;
- Stoughton Alternatives: 1,972 households and 4,930 persons; and
- Rapid Bus Alternative: 1,310 households and 3,275 persons.

In each case, the incremental increase in population provided by the South Coast Rail alternatives would be less than 0.5 percent of the South Coast regional population. Regional population is not expected to change from implementing Smart Growth initiatives, although population growth is likely to be concentrated in the PDAs rather than widely dispersed through the communities. The anticipated number of households in each community is provided in Table 5-5.

5.4.3.2 JOBS AND ECONOMIC ACTIVITY

Extensive economic data characterizing the current economy are provided in the Corridor Plan.[65] Bristol County includes some three-quarters of the population of and is almost entirely encompassed by the South Coast Rail project area (smaller portions of Plymouth and Norfolk counties are also within the project area). According to the Corridor Plan, the employment base in the state of Massachusetts grew by 53 percent in the 30-year time period from 1976 to 2006, while the Bristol County employment base grew by only 43 percent.[66] On average, the Bristol County job market increased by 1.4 percent per year over that 30-year period. Seventy percent job growth was seen in Norfolk County and 109 percent in Plymouth County. Dividing the 30-year period into 5-year increments, the highest rates of growth (statewide and in each county except Norfolk) were observed in the 1981 to 1986 period, followed by negative growth (job loss) in the 1986 to 1991 period.[67] With few periodic exceptions, Bristol County experienced the least job growth (and greatest job loss) of the three South Coast counties over the 30 years.

In the most recent period, total economic output in the South Coast Rail project area was over $50 billion in 2006, up 18 percent (3.6 percent per year) from the 2001 output of $43 billion.[68] Grouping the broad range of industry into four general types, agricultural output increased 42.7 percent (to $398 million), manufacturing 22.6 percent (to $12 billion), and services and trades 18.6 percent (to $34 billion), but other production (mining, construction, and utilities) lost 0.6 percent (to $4 billion).

Although economic output gained on average, the South Coast region lost jobs during this same 5-year time period: the 377,671 jobs in 2001 decreased to 374,832 in 2006.[69] The loss of 2,839 jobs equates to a 7.6 percent per year rate. The greatest number of job losses was realized in the manufacturing sector,

[63] Ibid. See in particular Chapter 5: Potential Economic Effects of South Coast Rail.
[64] Ibid.
[65] Ibid.
[66] Ibid. See in particular Appendix E: Baseline Report: Economic Development and Land Use Conditions in the South Coast Region Today, Chapter IV Economic Development Baseline.
[67] Ibid. See Appendix E: Baseline Report: Economic Development and Land Use Conditions in the South Coast Region Today, Chapter IV Economic Development Baseline, Figure 40: Employment Changes, 1976-2006.
[68] Ibid. See Appendix E: Baseline Report: Economic Development and Land Use Conditions in the South Coast Region Today, Chapter IV Economic Development Baseline, Table 25: Trends 2001-2006.
[69] Ibid. See Appendix E: Baseline Report: Economic Development and Land Use Conditions in the South Coast Region Today, Chapter IV Economic Development Baseline, Table 22: Employment Changes by Sector, 2001-2006.

down from 51,833 to 40,633. This represents a nearly 22 percent loss, but compares with state (23 percent) and national (21 percent) losses in the manufacturing sector in the same period. However, the Corridor Plan estimates that 380,000 jobs are currently present in the South Coast region.[70]

A number of the reasonably foreseeable future activities, as well as some more speculative projects, would add to economic activity and the job base in the South Coast region:

- The Weaver's Cover Energy LNG project in Fall River would add up to 350 jobs during construction and 30 to 35 permanent jobs during operation.[71]
- The proposed industrial, business, or commercial parks in Fall River and Freetown would increase business activity and add 11,000 jobs in these two communities[72] once the parks are occupied.
- Numerous other ongoing or anticipated developments throughout the South Coast, as outlined in the Corridor Plan,[73] are projected to increase business activity and add jobs in the region.

Many of these projects fall within the Southern Triangle portion of the South Coast Rail project area, and the effects would not differentiate between the cumulative impacts of the rail alternatives.

The historical and current data suggest that overall economic growth will continue in the South Coast region at a rate similar to the state as a whole, but growth (or loss) will vary substantively between individual industries and communities, and during different time periods as a result of overall economy or specific industry business cycles. In general, economic activity is greatest in the northernmost communities (those close to the Boston metropolitan) and communities already serviced by rail (such as the Northeast Corridor). Using the two geographic divisions described in the indirect effects analysis, the EDR Group predicts $52 billion in business activity in SCR-10 and $27 billion in SCR-21, for a total business output of $99 billion in 2030 under the No-Build Alternative.[74] As shown in Table 5-6, job growth in the South Coast region is expected to total 81,615 under the No-Build Alternative. The EDR Group predicts 374,832 jobs in SCR-10 and 215,745 jobs in SCR-21, for a total of 590,577 jobs in 2030 under the No-Build Alternative.

The South Coast Rail alternatives would impact the economy during both the construction phase and during the operational period. The construction phase is planned for 2012 to 2016. Based upon the preliminary estimates of construction costs, the Corridor Plan states that "expenditures for labor and materials would generate construction period benefits of about 7,000 to 8,000 jobs, $1.4 to $1.8 billion in business output, and about $315 to $360 million in household income."[75] The Corridor Plan does not assign these impacts to individual communities or distinguish between the separate alternatives. As described in Chapter 4.3 – *Socioeconomics*, the economic benefit derived from construction expenditures would be the greatest for the Attleboro Electric Alternative and the least for the Rapid Bus Alternative.

Economic benefits during operations would be longer term. By 2030, the South Coast Rail alternatives are expected to contribute between $268 and $295 million in net new business output annually within

[70] Ibid. See Chapter 5, Potential Economic Effects of the South Coast Rail.

[71] Weaver's Cove Energy. 2009. Community Benefits. Weaver's Cove Energy website: http://www.weaverscove.com/proposal-community.html. Accessed on 13 October 2009.

[72] Pateakos, Jay. 2009. Grants for Executive Park to be unveiled. Herald News (April 3, 2009) website: http://www.heraldnews.com/homepage/x180623384/Grants-for-Executive-Park-to-be-unveiled. Accessed 13 October 2009.

[73] EOT. 2009. South Coast Rail Economic Development and Land Use Corridor Plan. Commonwealth of Massachusetts, Executive Office of Transportation and Public Works, and Executive Office of Housing and Economic Development. Prepared by Goody Clancy: Boston. See in particular Appendix E: Baseline Report: Economic Development and Land Use Conditions in the South Coast Region Today, Chapter IV Economic Development Baseline.See in particular Chapter 6: Elements of the Corridor Plan.

[74] EDR Group. 2009. Basic Economic Variables. Data provided to Vanasse Hangen Brustlin, Inc. via e-mail on 16 October 2009. Economic Data Research Group: Boston.

[75] Ibid. Pg.9.

the South Coast region, with an additional $180 million to $192 million for the rest of the state.[76] The Rapid Bus Alternative would contribute some $187 million to the South Coast region and an additional $109 million to the rest of the state. Compared to the total business output in the South Coast in 2030 under the No-Build Alternative of approximately $99 billion, the South Coast Rail contribution would be approximately 0.20 to 0.30 percent of this total.

As described in Chapter 4.3 - *Socioeconomics*, some job losses are anticipated as a result of business displacements for construction of the South Coast Rail alternatives, specifically for the Fall River Depot Station (applicable to all alternatives) and the Mansfield Station (applicable only to the Attleboro Alternatives). Four businesses would be displaced in Fall River and two businesses in Mansfield. Specific numbers of jobs that would be lost are not known at this phase of the project. The affected businesses are small and the maximum number of job losses would likewise be small. It is possible that the displaced businesses would relocate and no jobs would be lost.

Regional job growth by 2030 attributable to the South Coast Rail alternatives under the Business as Usual scenario would be, as presented in Table 5-6:

- Attleboro Alternatives: 2,599 jobs;
- Stoughton Alternatives: 2,533 jobs; and
- Rapid Bus Alternative: 1,678 jobs.

An additional 1,200 to 1,260 jobs are estimated to result from the project but occur elsewhere in the state. As noted above, approximately 590,000 jobs would be expected by 2030 as the No-Build Alternative. In each case (and as noted in the Corridor Plan), the incremental increase in job growth permanently provided by the South Coast Rail alternatives under Scenario 1 would be approximately 0.4 percent of the South Coast regional job market.

As with the regional population discussed above, regional economic activity and the job market are not expected to change from implementing Smart Growth initiatives. Locally, commercial businesses may choose sites close to stations or, if Smart Growth policies are enacted in some communities but not others, may choose a community with implemented Smart Growth initiatives (in particular TOD) over another community without these measures. It is not possible to project such fine-scale changes within Scenario 2.

5.4.3.3 TAX REVENUE

The Corridor Plan graphically presents per-capita property tax receipts for selected South Coast communities in 2006.[77] These data indicate that tax receipts for communities that currently do not have train service (such as Fall River, New Bedford, and Taunton) are lower than for communities that currently do have train service (such as Attleboro, Foxborough, and Sharon). The effects of the current (2009) economic downturn on tax revenues at the municipal level are unknown at this time, nor is it possible to predict tax revenues at the municipal or state levels in 2030 with any precision.

[76] EOT. 2009. *South Coast Rail Economic Development and Land Use Corridor Plan.* Commonwealth of Massachusetts, Executive Office of Transportation and Public Works, and Executive Office of Housing and Economic Development. Prepared by Goody Clancy: Boston. Pg. 9.

[77] EOT. 2009. *South Coast Rail Economic Development and Land Use Corridor Plan.* Commonwealth of Massachusetts, Executive Office of Transportation and Public Works, and Executive Office of Housing and Economic Development. Prepared by Goody Clancy: Boston. See Appendix E: Baseline Report: Economic Development and Land Use Conditions in the South Coast Region Today, Chapter IV Economic Development Baseline, Figure 36: Per Capita Property Tax Receipts (All) 2006.

The South Coast Rail alternatives' potential direct impacts to the economy are outlined in Chapter 4.3 - *Socioeconomics*, which concludes that the direct property tax revenue losses for affected communities would be insignificant as compared to the total property tax receipts for each town. Property acquisitions (converting privately owned parcels to publicly owned, thereby eliminating the property tax generated) would be minimal, and few business or residential displacements would result from any of the alternatives.

Indirectly, property values are expected to increase near station sites due to increased access to transit but decrease along the rail alternative alignments due to increased noise levels from train operations. It is assumed that residential property values would increase by 5 to 25 percent for residences within one mile of new station sites and decrease by up to 20 percent within about 400 feet of the alignments or layover facilities. It is not possible to predict with any precision the property tax revenue changes that may result for each community.

The Corridor Plan indicates that, under Scenario 1, the rail alternatives would indirectly generate between $16 million and $18 million in net new state taxes and $8.5 million to $9.5 million in net new local business property taxes each year by 2030 as compared to the No-Build Alternative.[78] The expected changes for the rail alternatives are not attributed separately. The Rapid Bus Alternative would generate approximately 60 percent of these values. The estimated overall growth (forecast regional growth plus growth attracted to station sites and new induced growth) near rail stations would result in $62 million to $77 million in local property taxes.[79]

Implementing the Smart Growth initiatives in Scenario 2 is expected to change the location of economic impacts such as property tax revenue sources in each affected community, but is not expected to change the overall (regional) impacts as compared to Scenario 1.

5.4.3.4 SUMMARY

Combining the historic trends in the economy, recent or reasonably foreseeable future actions, and the varying effects on the economy that would result from each of the alternatives, the cumulative impacts of the South Coast Rail alternatives to the economy in 2030 for each alternative under the two scenarios are listed in Table 5-20.

All alternatives would measurably benefit the economy in the South Coast region, with actual benefits at the community level distributed according to the alternative's alignment. In all cases, the incremental addition of the project's economic benefit to the regional economy would be insubstantial; the cumulative effect of any of the alternatives would be a minimal change to any of the economic parameters. There is not a substantive cumulative difference between the rail alternatives. The Rapid Bus Alternative would have less of an economic impact than any of the rail alternatives. There would be no regional difference in the project's cumulative effect on the economy between the two scenarios. Economic benefits at the local level from Scenario 2 would be similar to those within the Scenario 1, but more concentrated within the communities. Economic growth would likely occur within the PDAs rather than the PPAs.

[78] EOT. 2009. *South Coast Rail Economic Development and Land Use Corridor Plan*. Commonwealth of Massachusetts, Executive Office of Transportation and Public Works, and Executive Office of Housing and Economic Development. Prepared by Goody Clancy: Boston. See Chapter 5, Potential Economic Effects of South Coast Rail.

[79] Ibid. See in Table 5-2, Estimated Growth Near SCR Commuter Rail Stations by 2030.

Local effects would vary considerably, especially in communities with stations. However, the cumulative impact even at the local level would be minimal. As a single example, household growth in Norton would be 110 for the Attleboro Alternative or 58 for the Stoughton Alternative. This is a considerable difference between the alternatives but minimal in either case compared to the 3,359 new households expected in Norton under the No-Build Alternative (see Table 5-5). Similarly, household growth in Easton would be 19 for the Attleboro Alternative or 111 for the Stoughton Alternative, compared to 5,541 for the No-Build Alternative.

From a regional perspective, the differences between the alternatives are minimal and do not differentiate between them. Only population and job numbers would vary measurably between the alternatives. As shown in Table 5-6, because ridership numbers vary somewhat between the rail alternatives, growth around the common stations in the Southern Triangle (Whale's Tooth, King's Station, Battleship Cove [except Rapid Bus], Fall River Depot, Freetown, and Taunton Depot) would vary somewhat. North of the Southern Triangle, more economic benefits would accrue to the communities with stations:

- Attleboro Alternative- Downtown Taunton, Barrowsville, and Mansfield;
- Stoughton Alternative- Taunton, Raynham Place, Easton Village, North Easton, Stoughton, and Canton Center; and
- Rapid Bus Alternative- Downtown Taunton and Galleria.

Ridership numbers for the Rapid Bus Alternative are substantively lower than the rail alternatives.[80] Combined with historical information about minimal induced growth from bus service, the contribution to the economy from the Rapid Bus Alternative would be lower (about 60 percent of the rail alternatives) at the local, regional, and state levels.

Table 5-20 Comparison of Cumulative impacts to the Economy in 2030

Historical Trend Affecting the Economy	Trends and Current or Future Actions Affecting the Economy	Alternative	Population	Jobs	Economic Activity	Tax Receipts	
						Municipal	State
Recent growth in economic activity but slower growth in job market; geographic differences north-to-south	Global economic downturn; planned commercial and industrial developments in Southern Triangle 380,000 current jobs with 1.4 % per year growth	No-Build	908,000	590,000	$99B	NA	NA
		SCENARIO 1					
		Attleboro	+ 5,143	+ 2,599	+$487M	+$8.5-9.5M	+$16-18M
		Stoughton	+ 4,930	+ 2,533	+$479M	+$8.5-9.5M	+$16-18M
		Rapid Bus	+ 3,275	+1,678	+$296M	+$5.1-5.7M	+$8.6-10.8M
		SCENARIO 2					
		Attleboro	+ 5,143	+ 2,599	+$487M	+$8.5-9.5M	+$16-18M
		Stoughton	+ 4,930	+ 2,533	+$479M	+$8.5-9.5M	+$16-18M
		Rapid Bus	+ 3,275	+1,678	+$296M	+$5.1-5.7M	+$8.6-10.8M

[80] EOT. 2009. *South Coast Rail Economic Development and Land Use Corridor Plan.* Commonwealth of Massachusetts, Executive Office of Transportation and Public Works, and Executive Office of Housing and Economic Development. Prepared by Goody Clancy: Boston. See Chapter 2, South Coast Rail Alternatives.

In summary, the economic trends described above in combination with the impacts from all South Coast Rail alternatives would:

- Within Scenario 1, beneficially contribute to economic growth in the South Coast region, with a wide range of local impacts, or
- Within Scenario 2, also beneficially contribute to economic growth in the South Coast region, with a wide range of local impacts concentrated in PDAs.

There would not be substantive differences between the alternatives in the cumulative impacts to the economy on a regional basis. Local effects may vary by alternative, especially for Scenario 2.

5.4.4 LAND USE

Land use in Massachusetts is directly regulated at the local level, typically through municipal zoning laws and ordinances. Although unique to each municipality, zoning laws commonly designate land usage (into categories such as residential, commercial, industrial, and open space) and development density (such as, for residential property, multi-family homes or single family homes, and lot size). Indirect regulation from federal and state agencies derives from policies established by land management agencies responsible for federal- or state-owned property, as well as certain programs such as the federal Wild and Scenic River program (which protects designated waterways) and the state Areas of Critical Environmental Concern program. Additionally, traditional environmental media-oriented laws can function as *de facto* land use regulatory programs: new facilities with air emissions or wastewater discharges, for example, may not be permitted in certain locations if the project design cannot meet air quality or water quality standards or requirements.

Managing land use, and in particular motivating a change in land use, may be accomplished by financial or other incentives. Tax increment financing and transfer of development rights programs, potential components of the Smart Growth plan, may be used by the state to motivate local land use change. To that end, the state has assisted each community in identifying Priority Development Areas (PDAs) and Priority Protection Areas (PPAs) that would focus development in certain areas and limit it in others. These programs are intended to limit sprawl, a potential negative indirect effect of the South Coast Rail alternatives.

This section evaluates the cumulative impacts of converting land from an undeveloped ("natural") state to developed land. Current land use within the South Coast region reflects the historical development of the area. Although much of the land is considered open space (forest, parks, farmland, or otherwise undeveloped land), no areas are completely undisturbed by human activity. Even indigenous people (native Americans) disturbed the natural environment prior to arrival of Europeans in the 1600s: forest fires were set to clear land and hunt for wildlife.[81] Development by European immigrants included establishing the villages that have grown into the communities currently present. Forests were cut for fuel and construction materials. Old growth forests (defined as having not been logged or disturbed for over 150 years) in the South Coast region are limited to 400 acres of the Acushnet Cedar Swamp, in which old-growth stands of Atlantic white cedar provide about 25 percent of the vegetative cover.[82] The industrial age concentrated development at particular locations with certain required resources (e.g., Fall River, where river flow powered mills) or for convenient transportation (e.g., New Bedford, with a

[81] Jorgensen, Niel. 1978. *A Sierra Club Naturalist's Guide to Southeastern New England*. Sierra Club Books: San Francisco.

[82] Davis, M.B. 2008. *Old Growth in the East* (revised survey).Available on-line at http://www.primalnature.org/ogeast/survey.html. Accessed 6 October 2009.

protected harbor for seafaring). Agricultural land use also changed the landscape, with forests cleared for crops.

As described in Chapter 4.14 - *Biodiversity*, a perspective of recent historical changes in land use is offered by the MassAudubon *Losing Ground* study series. The study was originally published in 1987, with new editions in 1999, 2003, and 2009. Each edition documents broad changes in land use over time. Although the study series provides a state-wide analysis, some aspects are community-specific or can be applied at the regional level.

The 1987 study[83] found that, statewide, open land developed for residential and commercial use between 1981 and 1986 totaled 103,000 acres (20,600 acres per year). The average growth in land development for that period was 2 percent per year.

The 1999 study[84] analyzed land development in Massachusetts from 1971 to 1996. The study found that the average annual rate of land conversion statewide had decreased from nearly 21,000 acres per year in the mid-1980s to just under 16,000 acres per year in the late 1990s. The 1999 study offered a summary of Massachusetts' developed land, as a percentage of the total area of the state, in selected years:

- 1972, 15.0 percent
- 1980, 18.3 percent
- 1985, 20.0 percent
- 1990, 21.2 percent
- 1996, 23.8 percent

Although the 1999 report does not provide community-specific data, the 31 South Coast Rail study area communities lie within areas characterized as under the greatest development pressure in the period from 1980 to 1996. The six northernmost communities in the South Coast region fell within a middle range of development, with 36 to 60 acres developed per square mile of each municipality for that period. The thirteen communities in the central/southern portion varied considerably in newly developed acreage, with Mansfield in the highest category of 102 to 169 acres developed per square mile of the municipality. The twelve communities along the coast generally fell within the lowest ranges of newly developed land, with only Fairhaven and Marion reaching the same middle range as the northern communities. These data suggest the greatest development pressures closest to the Boston metropolitan area, with decreasing development pressure (and some local variation) with increasing distance from Boston.

The 2003 study[85] focused on changes from forest and agricultural land use to residential and commercial development, and the hidden impacts of development. This statewide study evaluated data from the 14-year period of 1985 to 1999. MassAudubon calculated an average visible (in aerial photographs) conversion of 40 acres per day. Of the converted land, 88 percent went to new residential development.

According to the 2009 study,[86] natural (undeveloped) land in 2005 for the 31 communities totaled 347,263 acres (an average of 11,202 acres per community). In the period from 1999 to 2005, 7,888 acres (2.2 percent of the 1999 total) in those 31 communities had been converted from natural land to

[83] MassAudubon 1987. *Losing Ground: The Case for Land Conservation in Massachusetts*. Massachusetts Audubon Society: Lincoln, MA.

[84] MassAudubon 1999. *Losing Ground (Second Edition): An Analysis of Recent Rates and Patterns of Development and Their Effects on Open Space in Massachusetts*. Massachusetts Audubon Society: Lincoln, MA.

[85] MassAudubon 2003. *Losing Ground: At What Cost? (Third Edition of the Losing Ground Series), Changes in Land Use and Their Impact on Habitat, Biodiversity, and Ecosystem Services in Massachusetts*. Massachusetts Audubon Society: Lincoln, MA.

[86] MassAudubon. 2009. *Losing Ground: Beyond the Footprint* website: http://www.massaudubon.org/losingground/. Accessed 5 October 2009.

developed land. The average annual natural-to-developed land conversion rate in the South Coast region was 1,315 acres. The conversion rate varies by community, generally according to zoning densities. As described in the section on Metrics Used to Assess Impacts, land conversion ranges from 0.14 acres per household in Canton up to 1.23 acres per household in Lakeville.

Land uses can be grouped into four broad categories: residential, commercial, industrial, and open space. The Corridor Plan depicts current land uses for the entire South Coast region based on generalized community zoning;[87] Chapter 4.2: Land Use, Zoning and Public Policy provides maps indicating land uses and zoning along each alternative alignment. These figures also show that residential zoning dominates the South Coast region (at varying degrees of density), although much of the land is actually undeveloped (see Corridor Plan, Figure 4-5). Land currently undeveloped but zoned for residential use is more likely to be so developed than other land with different zoning classifications. Concentrated residential, commercial, and industrial use occurs at the larger towns in the region: New Bedford, Fall River, Taunton, Attleboro, Mansfield, Stoughton, and Canton.

Differences in development density are also reflected, to some degree, in a north-to-south direction. The Corridor Plan's characterization of community's urban, suburban, or semi-rural character (see Corridor Plan, Figure 4-1) reflects this geographic trend, combined with the concentrated development at selected coastal communities.

Current and foreseeable projects, as listed in the section on Trends and Reasonably Foreseeable Future Actions, are commonly located within or near the concentrated development of existing communities or along transportation corridors. Many of these projects consist of redevelopment of industrial property, such as the Weaver's Cove Energy LNG terminal use of the former Shell Oil facility and redevelopment of the Fall River Airport as the Fall River Commerce Park. These projects generally do not constitute land use changes from undeveloped to developed land as most of the areas were previously disturbed.

One future project with a specific land use change, the proposed Route 24 Access Improvement Project, would convert 16.6 acres of forest (undeveloped) land to transportation use for a new interchange.[88] Numerous additional projects, at varying degrees of planning or speculation, are listed in the Corridor Plan as candidates for PDAs under Scenario 2 (see Chapter 6, Elements of the Corridor Plan). Quantifiable (i.e., number of acres) land use conversions are not available for all future projects. As noted in Table 5-21 below, the total area encompassed by the PDAs in the 31 South Coast communities is 29,079 acres; it is not known what proportion of that area would be converted from undeveloped to developed land if each project was completed.

Based on the land use impacts presented in Table 5-8, approximately 44,995 acres of natural land would be converted to developed land under the No-Build Alternative, representing approximately 12.97 percent of the 347,263 acres of natural land present in the South Coast region in 2005. Approximately 302,268 acres of natural land would remain in the South Coast region in 2030.

As described in Chapter 4.2 – *Land Use*, direct impacts (conversion from any land use to transportation use) of the South Coast Rail alternatives would result from property acquisition to accommodate rail or

Table 5-21 PDAs and PPAs in the 31 South Coast Communities

[87] EOT. 2009. *South Coast Rail Economic Development and Land Use Corridor Plan.* Commonwealth of Massachusetts, Executive Office of Transportation and Public Works, and Executive Office of Housing and Economic Development. Prepared by Goody Clancy: Boston. See Figure 4-6: South Coast Zoning.

[88] US DOT. 2009. Route 24, Fall River and Freetown, Massachusetts, Access Improvements Project,; Environmental Assessment, Draft Individual Section 4(f) Evaluation, and Final Environmental Impact Report. US Department of Transportation, Federal Highway Administration and Commonwealth of Massachusetts, Massachusetts Highway Department: Cambridge and Boston, MA.

Community	Total Area (acres)	Priority Development Areas		Priority Protection Areas	
		Area (acres)	Percent	Area (acres)	Percent
Acushnet	12,064	44	0.36	591	4.90
Attleboro	17,815	2,024	11.36	26	0.15
Berkely	10,604	200	1.89	2,269	21.40
Bridgewater	18,179	1,460	8.03	3,323	18.28
Canton	12,487	1,256	10.06	3,683	29.49
Dartmouth	39,763	2,160	5.43	19,000	47.78
Dighton	14,268	30	0.21	1,631	11.43
Easton	18,709	1,195	6.39	7,499	40.08
Fairhaven	8,006	333	4.16	583	7.28
Fall River	24,756	1,912	7.72	533	2.15
Foxborough	13,342	1,120	8.39	2,235	16.75
Freetown	22,710	1,023	4.50	2,805	12.35
Lakeville	23,102	238	1.03	11,210	48.52
Mansfield	13,088	1,061	8.11	5,429	41.48
Marion	9,054	52	0.57	1,316	14.54
Mattapoisett	11,167	76	0.68	3,265	29.24
Middleborough	46,194	3,000	6.49	12,553	27.17
New Bedford	12,894	2,251	17.46	1,052	8.16
North Attleborough	12,418	899	7.24	1,632	13.14
Norton	18,724	333	1.78	10,234	54.66
Raynham	13,279	605	4.56	3,576	26.93
Rehoboth	30,371	215	0.71	3,226	10.62
Rochester	23,111	56	0.24	9,044	39.13
Seekonk	11,917	306	2.57	848	7.12
Sharon	15,626	153	0.98	2,780	17.79
Somerset	5,233	104	1.99	200	3.82
Stoughton	10,530	1,226	11.64	1,207	11.46
Swansea	14,834	490	3.30	2,047	13.80
Taunton	30,973	4,849	15.66	11,250	36.32
Wareham	23,951	242	1.01	6,904	28.83
Westport	33,068	166	0.50	7,807	23.61
TOTAL	*572,237*	*29,079*	*5.08*	*139,758*	*24.42*

Source: Corridor Plan, Figure 6-2 Corridor Map.

highway, station, and layover facilities. The indirect effects of the South Coast Rail alternatives would be related to the induced growth described in Section. Using the new household data from Table 5-2 and the land use impacts from Table 5-8, Table 5-22 shows the combined direct land use conversion and induced growth land use conversion that would result from each of the South Coast Rail alternatives in Scenario 1.[89]

Table 5-22 Land Conversion in 2030 (acres)

[89] As noted above, it is assumed that there would not be any significant differences in the number of new households induced by the electric- or diesel-powered train options, and the number of new households induced by the Whittenton Alternatives would be similar to those induced by the Stoughton Alternatives.

Alternative	Direct Conversion	Induced Growth	Total
Attleboro	90.59	1,170	1,261
Stoughton	106.80	1,126	1,233
Rapid Bus	25.70	761	787

The indirect effect (induced growth) of the South Coast Rail alternatives would be decreased by Scenario 2. As shown in Table 5-4, it was assumed that conversion rates within Scenario 2 would range between 0.39 and 0.44 acres per household, as compared to the 0.56 acres per household rate assumed for Scenario 1. The lower conversion rates for Scenario 2 are attributed to concentrated development in the PDAs and less development in the PPAs. Further, as described in the section on Assumptions for Future Growth, it was assumed that compact, mixed-use, or infill housing development is expected to account for 30 percent of induced growth and would reduce conversion to developed land by approximately 21 percent.[90]

Combining the historic trends in the land use conversions, recent or reasonably foreseeable future actions, and the varying land conversions that would result from each of the alternatives, the cumulative impacts of the South Coast Rail alternatives to the land use in 2030 for each alternative under the two scenarios are listed in Table 5-23.

Table 5-23 Comparison of Cumulative impacts to Land Use in 2030

			Land Conversion		
Historical Trends Affecting Land Use	Trends and Current or Future Actions Affecting Land Use	Alternative	Natural Land Remaining in 2030 (acres)	Incremental Change from No-Build (acres)	Percent Change from No-Build
Land conversion for agricultural, residential, commercial, and industrial development	Average land conversion rate of 1,315 acres per year	No-Build	302,268	--	--
		SCENARIO 1			
		Attleboro	301,007	-1,261	-0.42
		Stoughton	301,035	-1,233	-0.41
		Rapid Bus	301,481	-787	-0.26
		SCENARIO 2			
		Attleboro	311,914 to 316,095	+9,646 to +13,827	+3.19 to +4.57
		Stoughton	311,942 to 315,966	+9,674 to +13,698	+3.20 to +4.53
		Rapid Bus	312,212 to 316,205	+9,944 to +13,937	+3.29 to +4.61

For Scenario 1, compared to the approximately 302,268 acres of natural land that will remain in the South Coast region in 2030, the additional loss of less than 1,300 acres from induced growth for any of the South Coast Rail alternatives would represent no more than approximately 0.42 percent of the total

[90] Burchell, Robert W. and Mukherji, Sahan (2003). Conventional Development Versus Managed Growth: The Costs of Sprawl. *American Journal of Public Health*, 93 (9), 1537.

natural land area. For Scenario 2, between 9,646 and 13,937 acres less land would be lost to development than under the No-Build Alternative, a savings of up to nearly 5 percent. The South Coast Rail alternatives would not result in a substantial adverse cumulative impact to land within Scenario 1, and Scenario 2 would substantively slow the rate of land conversion.

An additional land use benefit of Scenario 2 would be brownfields redevelopment. The Taunton and Downtown Taunton Stations are both identified as brownfields sites; TOD of land surrounding these stations would convert abandoned, blighted land to productive use.

In summary, combined with the changing trends in land conversion rates described above, the cumulative impacts to land use from the South Coast Rail alternatives would:

- Within Scenario 1, minimally contribute to land use changes, or
- Within Scenario 2, reduce the land use changes by up to nearly 6 percent as compared to the No-Build Alternative.

There would be no substantive differences between the rail alternatives in the cumulative impacts to land use changes within the South Coast region; the Rapid Bus Alternative would have the lowest overall cumulative effect.

5.4.5 PROTECTED OPEN SPACE

Publicly owned protected open spaces are regulated by the agency responsible for the property (whether federal, state, or local). Privately owned protected open spaces are not directly regulated by a governmental agency unless a deed restriction (such as a conservation agreement) is attached to the property. At all levels, conversion of publicly or privately owned protected open space to other uses, including transportation corridors, is strongly regulated.

For example, at the state level, Article 97 of the Massachusetts Constitution protects all publicly owned lands used for conservation or recreation purposes. Before these properties can be sold, transferred, or converted to a different use, the following is required: action by the local Conservation Commission and Parks and Recreation Commission; a two-thirds vote by the municipal government; and a roll call two-thirds vote of the State House of Representatives and Senate.

This section evaluates the increasing protection of open space in the state as well as the South Coast region. Through a variety of legal vehicles (such as actual ownership or conservation restrictions), public and private entities have protected open space from development throughout the state. In the period from 1999 and 2005, 109,863 acres of open space were newly protected from development.[91] Data for 2006 and 2007 were not readily available, but in 2008 an additional 24,104 acres of land were protected by state action.[92] Based on these seven years of data, land has been increasingly protected from development at an average rate of 19,138 additional acres protected per year. According to the most current information available,[93] 1,359,717 acres are now protected[94] within the state, representing 26.27 percent of the total 5,175,192 acres.

[91] MassAudubon 2003. Losing Ground: At What Cost? (Third Edition of the Losing Ground Series), Changes in Land Use and Their Impact on Habitat, Biodiversity, and Ecosystem Services in Massachusetts. Massachusetts Audubon Society: Lincoln, MA.

[92] EEA. 2008. 2008 Land Protection Report. Executive Office of Energy and Environmental Affairs: Boston.

[93] MassGIS. 2009. Database on website: http://www.mass.gov/mgis/mapping.htm. Accessed on 7 October 2009. These data have not been field checked.

[94] "Protected" land includes land protected from development for conservation, recreation, water supply, agriculture, historical/cultural/scenic, and/or other purposes.

It is not possible to predict what effect the current economic downturn may have on state expenditures for land preservation in the future. In 2007, the current Commonwealth administration made a commitment to spend at least $50 million per year for land protection. Matched with funds from landowners, nonprofit organizations, municipalities, and federal sources, total fiscal year 2008 expenditures were $87.1 million.[95] It is reasonable to assume that, given the current economic condition, expenditures (and, hence, acreage acquired) in the near future will be less than in 2008 but likely to return to historical levels at some point. As a conservative measure, an average areal acquisition rate of approximately one-half the recent historical rate has been assumed for the projection to 2030. Based on this value (about 9,500 acres newly protected each year), an additional 199,500 acres would be protected in the 21-year period from 2009 to 2030. Accordingly, a total of approximately 1,559,217 acres would have protection from development in the state in 2030, representing 30.13 percent of the total area. Over 21 years, protected open space would increase by 14.7 percent under the No-Build Alternative.

Within the 31 South Coast communities, 54,818 of the total 572,237 acres are currently protected open space,[96] representing only 9.58 percent of the total area in the region. Data regarding the total area of recent protections to open space in the South Coast region were not readily available. Using the statewide acquisition assumptions, the current protected open space would expand by 0.7 percent per year (14.7 percent overall), or about 383.7 acres per year (8,058 acres total), resulting in approximately 62,876 acres of protected open space in the South Coast communities in 2030.

The South Coast Rail alternatives would directly affect (acquire) between 0.15 and 8.93 acres of protected open space.[97] The acquisition of this land would be a loss of protected open space. Additional loss of protected open space from indirect effects is not anticipated from the South Coast Rail alternatives in Scenario 1.

An increase in protected open space would result from full implementation of the Smart Growth initiatives in Scenario 2, more than offsetting the loss from direct acquisition. Over 70 PPAs (land or environmental resources that are not permanently protected but are worthy of increased levels of protection through planning, regulation, conservation, or acquisition) are listed in the Corridor Plan.[98] Table 5-21 lists the PPA areas for each community. Although the Smart Growth initiatives include several mechanisms to protect open space, it is not possible at this time to determine what proportion of the PPA area (139,758 acres) would be designated as protected open space. It is assumed simply that, by implementing the PPAs included as Smart Growth initiatives, more land would be protected by Scenario 2 than within Scenario 1.

Combining the historic trends in the increasing protection of open space and the varying effects on protected open space that would result from each of the alternatives, the cumulative impacts of the South Coast Rail alternatives to protected open spaces in 2030 for each alternative under the two scenarios are listed in Table 5-24.

Table 5-24 Comparison of Cumulative impacts to Protected Open Space in 2030

[95] EEA. 2008. 2008 Land Protection Report. Executive Office of Energy and Environmental Affairs: Boston.
[96] MassGIS. 2009. Database on website: http://www.mass.gov/mgis/mapping.htm. Accessed on 7 October 2009.
[97] Ibid. See Table 4-7.
[98] EOT. 2009. *South Coast Rail Economic Development and Land Use Corridor Plan.* Commonwealth of Massachusetts, Executive Office of Transportation and Public Works, and Executive Office of Housing and Economic Development. Prepared by Goody Clancy: Boston. See Figure 6-2, Corridor Map, and page 41.

Historical Trends Affecting Protected Open Space	Trends and Current or Future Actions Affecting Protected Open Space	Alternative	Protected Open Space		
			Protected Open Space in 2030 (acres)	Incremental Change from No-Build (acres)	Percent Change from No-Build
State commitment to protect open space through acquisition, spending $50M per year	Open space protected at a rate of 383.7 acres per year	No-Build	62,876	--	--
		SCENARIO 1			
		Attleboro	62,867	-8.93	-0.01
		Stoughton	62,874	-1.69	<-0.01
		Rapid Bus	62,872	-4.50	-0.01
		SCENARIO 2			
		Attleboro	>62,867	Unknown	Unknown
		Stoughton	>62,874	Unknown	Unknown
		Rapid Bus	>62,872	Unknown	Unknown

In summary, historical trends combined with the conservative estimate of increases in protected open space described above and the South Coast Rail alternatives impacts, the cumulative impacts to protected open space from the South Coast Rail alternatives would:

- Within Scenario 1, have a minimal adverse impact, or
- Within Scenario 2, have a beneficial impact of unknown magnitude that would be the same for all alternatives.

There would be no significant differences between the alternatives in the cumulative impacts to protected open spaces within the South Coast region.

5.4.6 THREATENED AND ENDANGERED SPECIES

Rare species are protected at the federal level by the US Fish & Wildlife Service, or the National Marine Fisheries Service, under the authority of the Endangered Species Act (ESA). At the state level, the Massachusetts Department of Fish and Wildlife (DFW) is responsible for administering the Natural Heritage and Endangered Species Program (NHESP) under the Massachusetts Endangered Species Act (MESA). Both the federal and state programs classify rare species according to their risk of extinction, prohibit "take" of species except as authorized by permit (and usually requiring mitigation), and implement plans to assist in the recovery of those species.

The historical development of the South Coast region described in the Biodiversity and Land Use sections has impacted native plants and animals to the extent that some species are now rare and have received legal protection in the form of the ESA and the MESA. Under the MESA definitions, an "Endangered" species is one that is in danger of extinction throughout all or a significant portion of its range within Massachusetts. A "Threatened" species is one that is likely to become endangered in Massachusetts in the foreseeable future. Species of Special Concern are those species that biological research has documented to have suffered a decline that could threaten the species if the decline continues unchecked, or those species that occur in such small numbers or with such a restricted distribution that they could easily become threatened within the Commonwealth. Similar definitions are used in the ESA at the national level.

Several of the state-listed rare species that are present in the South Coast region may be affected by the South Coast Rail alternatives, as described in Chapter 4.15 - *Threatened and Endangered Species*. No

federally listed species would be affected by the project. Table 5-25 lists the potentially impacted species and threats to each.

Table 5-25 State-Listed Species Potentially Impacted by the South Coast Rail Alternatives

Species	Listing Status	Threats
Marbled Salamander	Threatened	Loss, degradation and fragmentation of both aquatic breeding pool habitat required for reproduction and terrestrial habitat needed for foraging, overwintering, growth and development to development and urbanization.
Blue-Spotted Salamander	Species of Special Concern	Loss, degradation and fragmentation of both aquatic breeding pool habitat required for reproduction and terrestrial habitat needed for foraging, overwintering, growth and development to development and urbanization.
Wood Turtle	Species of Special Concern	Hay-mowing operations, development of wooded stream banks, roadway casualties, incidental collection of specimens for pets, unnaturally inflated rates of predation in suburban and urban areas, forestry and agricultural activities, and pollution of streams.
Blanding's Turtle	Threatened	Habitat loss, degradation, and fragmentation (i.e., roads) driven by commercial and residential expansion. Other threats include illegal collection, unnaturally inflated rates of predation in suburban and urban areas, agricultural and forestry practices, and natural succession (i.e., loss of nesting habitat).
Eastern Box Turtle	Species of Special Concern	Habitat destruction resulting from residential and industrial development; road mortality; collection by individuals for pets; mowing of fields and early successional habitat during the active season; unnaturally inflated rates of predation in suburban and urban areas; disturbance of nest sites by ATVs; and genetic degradation due to the release of non-native (pet store) turtles.
Mocha Emerald	Species of Special Concern	Stream damming or alteration; chemical pollution.
Hessel's Hairstreak	Species of Special Concern	Habitat loss; suppression of disturbance (fire, flooding), or excessive deer browsing, preventing regeneration of Atlantic white cedar; hydrologic alteration; invasion by exotic plants; introduced generalist parasitoids; insecticide spraying
Pale Green Pinion Moth	Species of Special Concern	Habitat loss; hydrologic alteration; invasion by exotic plants; introduced generalist parasitoids; insecticide spraying; light pollution.
Water-Willow Stem Borer Moth	Species of Special Concern	Habitat loss; hydrologic alteration; invasion by exotic plants; introduced generalist parasitoids; insecticide spraying; light pollution.
Ringed Boghaunter	Endangered	Artificial changes in water level and various forms of pollution (such as agricultural and road runoff), septic system failure, insecticide spraying.
Long's Bulrush	Threatened	Changes in the water quality and the natural fluctuating hydrologic regime of its habitat, invasion by exotic invasive plants, and exclusion of fire disturbance.

Source: NHESP Website: http://www.mass.gov/dfwele/dfw/nhesp/species_info/mesa_list/mesa_list.htm. Accessed 8 October 2009.

Historical and ongoing land development has converted natural land and altered wetlands and vernal pools, as described in Chapter 4.14 - *Biodiversity*, Chapter 4.2 - *Land Use* and Chapter 4.16 - *Wetlands*. Almost by definition, a species now protected by either the ESA or the MESA has been adversely impacted by such historical activities. The federal and state laws, enacted in 1973 and 1990, respectively, now prohibit "take" of individuals and/or adverse impacts their habitat except as permitted and usually with some mitigation requirement. Any major federal or state action (including providing funding or issuing a permit by an agency) requires analysis of impacts to listed species. Typically, projects adversely affecting listed species are not approved without a mitigation requirement. Project impacts to certain habitat types, such as wetlands and vernal pools, also typically require mitigation (for

example, the "no net loss" policy for wetlands). However, some of the threats to listed species are not subject to ESA or MESA regulations.

The New Bedford Airport Improvement Project is a recent example of an action in the South Coast region with potential impacts to protected species, one of which also may be affected by the South Coast Rail alternatives: the eastern box turtle (Chapter 4.15 - *Threatened and Endangered Species*). That project is required to obtain and comply with a Conservation and Management Permit to mitigate impacts to this species.

Similarly, future projects such as the Weaver's Cove Energy LNG terminal and offshore berth are required to consult with the National Marine Fisheries Service and the US Fish & Wildlife Service to develop a mitigation plan for potential impacts to federal- and state-listed marine species.[99] None of the species potentially affected by this project would be affected by the South Coast Rail alternatives.

As described in Chapter 4.15 - *Threatened and Endangered Species*, the South Coast Rail alternatives would also include mitigation of direct or indirect effects to listed species' habitat, resulting in a net benefit to those species. Indirect effects (from induced growth) would be regulated by the ESA or MESA, and relevant habitat protection laws for wetlands and vernal pools. Because of the overriding ESA and MESA regulations, there would be no difference in cumulative direct impacts to threatened or endangered species between the two scenarios even with full implementation of PPAs.

Several state-listed species could potentially experience cumulative adverse effects from the loss of habitat quality associated with land development (habitat fragmentation) or climate change, as discussed in Chapter 4.14. Eastern box turtles and vernal pool species (marbled and blue-spotted salamanders, Blanding's turtles) could continue to decline as a result of these indirect effects. As previously described, the indirect effects on habitat quality and connectedness would be greater for Scenario 1 for all alternatives, and would be reduced in Scenario 2 to levels below the No-Action Alternative.

In summary, federal and state laws and regulatory programs protect threatened or endangered species and certain habitat types. Regulatory protections prevent long-term adverse impacts to listed species. Because the MESA process requires net benefit measures for all projects, there would not be continued losses of listed species under the No-Build Alternative. Although historical activities likely led to identifying the species listed in Table 5-25 as threatened or endangered, recent, current, and reasonably foreseeable future actions, combined with the South Coast Rail alternatives, would:

- Within Scenario 1, have no direct adverse impact to threatened or endangered species, but with potential losses of habitat quality for some species, or
- Within Scenario 2, also have no adverse impact, with less habitat quality loss than in Scenario 1.

There would be no significant differences between the alternatives in the cumulative impacts to threatened or endangered species within the South Coast region.

5.4.7 WATER QUALITY

[99] Weaver's Cove Energy. 2009. *Weaver's Cove Energy LNG Project, Offshore Berth Proposal, EEA # 13061. 2nd Draft Environmental Impact Report.* Prepared by Epsilon Associates, Inc.: Maynard, MA. See Section 8.0 Mitigation and Draft Section 61 Findings.

Surface water quality is regulated at the federal level by the EPA under the Clean Water Act. Portions of the Clean Water Act fall within the authority of the US Army Corps of Engineers (Corps), and others have been delegated to the DEP. Relevant Clean Water Act programs include the National Pollutant Discharge Elimination System (regulating discharges of wastewater and storm water to certain surface water bodies), the Section 404 dredge and fill permit system (regulating discharges of dredged or fill material into certain surface water bodies), and the Total Maximum Daily Load program (regulating discharges of pollutants into certain water bodies with designated uses; this program has been delegated to DEP).

Surface water resources are protected at the state level under several laws and regulatory programs, including the Massachusetts Clean Waters Act. Other applicable rules, regulations, and guidance include the Massachusetts Wetlands Protection Act and Wetlands Protection Act Regulations, Massachusetts Public Waterfront Act and Waterways Regulations, the Surface Water Quality Standards, the proposed Stormwater Management Regulations, and the Massachusetts Stormwater Management Handbook.

As with other physical resources (such as ambient air and wetlands) discussed in this report, water quality in the South Coast region has been adversely impacted by historical activities but increasingly stringent federal and state regulatory controls over the past several decades have resulted in substantive improvements. Most of the surface water bodies and groundwater resources have been classified for specific uses and are protected for those uses. Point source and non-point source discharges to surface water bodies are regulated, and special protections are afforded to either outstanding resource waters (those with exceptional values) or impaired waters (those that do not meet standards for their designated use). Groundwater supply protection areas have been similarly established to protect aquifers that are used for public water supplies. Chapter 4.17: Water Resources provides a summary of the relevant regulatory programs and designations for each classified water resource in the South Coast Rail study area.

All potential sources of discharges to surface water bodies or groundwater resources must comply with the relevant regulatory requirements. Accordingly, none of the reasonably foreseeable future actions listed in the section on Trends and Reasonably Foreseeable Future Actions would result in a decrease of surface or ground water quality.

Similarly, the South Coast Rail alternatives in either Scenario 1 or Scenario 2 would not adversely impact water quality. The project would not require any process water discharges, and storm water discharges from the railroads, stations, or layover facilities would be managed in compliance with a Storm Water Pollution Prevention Plan (SWPPP) and with state stormwater standards. With the required mitigation and drainage features in place, the rail alternatives are not expected to contribute contaminants that would impair surface or ground water resources (Chapter 4.17 - *Water Resources*).The Rapid Bus Alternative is anticipated to add 163 acres of pavement but would not increase pollutant loading in stormwater runoff since traffic would decrease by 0.3 percent. This alternative would also be designed to comply with state stormwater standards.

Development could also indirectly affect water quality through nonpoint sources such as runoff from lawns (containing fertilizers, herbicides or pesticides). An increased number of septic systems in municipalities without sewer and wastewater treatment could also affect groundwater quality through the addition of nutrients, potentially increasing eutrophication in surface water bodies. As previously documented, there would be minor differences between the No-Build Alternative and the three Build Alternatives under Scenario 1. Each of these could result in indirect effects to surface or groundwater quality. Although not quantifiable at this phase of project design, it is likely that land development in

Scenario 2 would result in less pavement, due to cluster development, and less stormwater runoff than Scenario 1. Development in Scenario 2 is also anticipated to reduce lawn area, and would therefore have a slight reduction in potential indirect water quality effects.
Combining historical trends with the current regulatory environment and the South Coast Rail impacts to water quality, the cumulative impacts:

- Scenario 1 would have no impact to water quality, and
- Scenario 2 would also have no impact to water quality.

5.4.8 WETLANDS

Wetlands protection is closely related to the surface water quality laws and regulations mentioned above. Specifically, at the federal level, Section 404 of the Clean Water Act requires a Department of the Army permit for the discharge of dredged or fill material into waters of the United States, including adjacent wetlands. The Massachusetts Wetlands Protection Act and Wetlands Protection Act Regulations provide state protection. As mentioned above, a federal "no net loss" policy requires mitigation of wetland impacts. Only one community within the South Coast Rail study area, Westport, has registered wetlands within its boundary and has adopted restriction orders in compliance with the Coastal Wetlands Restriction Act or Inland Wetlands Restriction Act.

Wetlands in Massachusetts are currently protected at both the federal and state levels.[100] The regulatory programs implementing the federal Clean Water Act, as administered by the US Army Corps of Engineers, are conducted in compliance with the national policy of "no net loss" of wetlands.[101] At the state level, the regulatory programs implementing the Massachusetts Clean Waters Act and the Massachusetts Wetlands Protection Act, administered by the DEP, provide similar wetlands protection. The U.S. EPA notes that activities in upland areas outside of regulatory control may degrade wetlands quality, if not quantity.

The current wetlands in the South Coast region reflect the long history of land use change described in Section 5.4.4 above. Wetland areas in Massachusetts in the 1780s totaled approximately 818,000 acres, representing about 15.5 percent of the state's 5,284,480 acres of land.[102] By the 1980s, the total wetland area in Massachusetts was approximately 588,486 acres, representing 11.1 percent of the total area of the state and a 28-percent decrease over the 200-year period. In 1992, only 6 to 7 percent of Massachusetts was classified as wetlands.[103]

Wetlands loss rates, as both the numbers of acres lost per year and a percentage of total wetlands area, have varied substantively over time. The losses can be attributed to several different types of conversions, which have also changed over time. The loss of 229,514 acres of wetlands in 200 years averaged nearly 1,150 acres per year, a 0.14 percent annual loss rate. In 1978, the U.S. Soil Conservation Service[104] estimated Massachusetts' annual wetland loss rate at 0.4 percent, and attributed the losses primarily to urbanization.

[100] Only one community (Westport) in the South Coast region has adopted wetland restriction orders in compliance with state laws, but all of the communities could do so.

[101] White House Office on Environmental Policy. 1993. Protecting America's Wetlands: A Fair, Flexible, and Effective Approach. Washington, DC.

[102] Dahl, T.E. 1990. *Wetlands Losses in the United States 1780's to 1980's.* U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 13pp.

[103] Tiner, R.W., D.B. Foulis, C. Nichols, S. Schaller, D. Petersen, K. Andersen, and J. Swords. 1998. Wetland Status and Recent Trends for the Neponset Watershed, Massachusetts (1977-1991).

[104] U.S. Department of Agriculture, Soil Conservation Service [now Natural Resources Conservation Service]. Referenced in "Natural Communities (from the Silvio O. Conte National Fish and Wildlife Refuge Final Action Plan and Environmental Impact Statement, October, 1995, U.S. Fish and Wildlife Service, Hadley, MA)."

Historically, the state has lost between 58 and 64 percent of its wetlands from conversion to agriculture, road construction, and other building projects.[105]

Recently, the DEP has initiated a wetlands loss mapping project, reviewing recent historical and current aerial photographs to more precisely identify wetlands losses by comparing aerial photographs taken in 1990, 2001, and 2005. These losses, however, include both legal[106] (permitted) and illegal (unpermitted) wetland loss. Wetlands lost by a permitted activity may have been mitigated by the project proponent by creating new wetlands. The mapping program cannot distinguish newly created wetlands from naturally existing wetlands. The values provided in the following summary are, therefore, conservative by not fully accounting for mitigated impacts. Because both the federal and state governments have "no net loss" policies for wetlands, legally "lost" wetlands have been mitigated at a replacement ratio of at least 1:1.

For the Southeast Region of the DEP (which includes the 31 communities of the South Coast Rail study area), 545 acres of wetlands were lost from 1990 to 2001 (49 to 68 acres lost per year).[107] For the period from 2001 to 2005, 264 acres of wetlands were lost (66 acres per year) in the Southeast Region. The losses in the Southeast Region constituted 62 percent of the total wetland losses in the state.[108] Currently, there are approximately 126,464 acres of wetlands within the 31 communities comprising the South Coast Rail project area.[109] Conservatively assuming a consistent 66-acre-per-year loss rate,[110] 125,078 acres of wetlands would remain in 2030 (without considering mitigation under the state and federal no-net-loss requirements).

The wetlands loss mapping project allows for specific identification of conversion types, but data are not readily available at the regional level. Statewide, principal activities causing the wetlands loss varied; Table 5-26 lists wetland losses attributed to 11 conversion types in 2004 and 2006. These data show a relative consistency of the percentage of wetland impacts attributable to residential development, at 22.5 percent in 2004 and 19.3 percent in 2006, for an average of 20.9 percent. Using this average and the average annual conversion rate of 66 acres per year in the DEP's Southeast Region, approximately 13.8 acres of wetland loss per year can be attributed to residential development. Otherwise, these data suggest an ongoing trend of wetland loss within the South Coast Rail study area at varying rates over time and attributable to conversion for a variety of purposes.

It is not possible to definitively project-specific wetland losses that have or may occur from each of the recent or reasonably foreseeable activities listed in the section on Trends and Reasonably Foreseeable Future Actions. Some projects have received or applied for wetlands permits with the Corps and/or DEP, but there is not a clear indication of how recent historical wetland loss trends may change as a result of these and other projects. Lacking comprehensive project-specific data, it is reasonable to assume that the DEP's recent data, suggesting a loss rate of approximately 66 acres per year in the Southeastern Region, would continue for the foreseeable future. As noted above, historical trends projected into the future conservatively suggest that approximately 125,078 acres of wetlands would remain in the South Coast Rail study area in 2030 (again, without considering mitigation).

Table 5-26 Comparison of Statewide Wetland Conversion Types in 2004 and 2006

[105] Tiner, R.W. and W. Zinni. 1988. Recent wetland trends in southeastern Massachusetts. US Fish and Wildlife Service. Newton Corner, MA.

[106] According to the DEP, legal losses "include permitted losses likely to have been replicated under permitting criteria. MassDEP is currently unable to identify replicated wetlands."

[107] DEP. 2009. *Wetlands PPA Summary and Workplan*. Commonwealth of Massachusetts, Department of Environmental Protection: Boston. Available at DEP website: http://www.mass.gov/dep/water/priorities/09wet.pdf. Accessed on 4 October 2009.

[108] DEP. 2008. The Environmental Progress Report FY 2008- Wetlands. Commonwealth of Massachusetts, Department of Environmental Protection: Boston. Website: http://www.mass.gov/dep/water/priorities/wlfy08.htm. Accessed 4 October 2008.

[109] MassGIS database: http://www.mass.gov/mgis/massgis.htm. Accessed 5 October 2009.

[110] This value is conservative because it represents the average annual loss in the DEP's Southeast Region, which is larger than the 31-community South Coast Rail study area.

Wetlands Conversion Type	Percentage of Total Conversion 2004	2006
Agriculture	32.3	7.2
Commercial Development	18.7	12.5
Cranberry Bogs	(included in Agriculture)	9.6
Other	21.0	22.4
Gravel Operation	5.5	5.6
New Road	0.0	2.9
Dock or Pier	0.0	0.08
Residential Development	22.5	19.3
Transportation/Infrastructure	0.0	2.3
Clearing- unknown reason	0.0	16.4
Filling- unknown reason	0.0	1.6

Source: DEP. 2009. *Wetlands PPA Summary and Workplan*. Commonwealth of Massachusetts, Department of Environmental Protection: Boston.

Chapter 4.16 - *Wetlands* concludes that wetland impacts directly attributable to the South Coast Rail alternatives would range between 10 and 22 acres. Based upon regulatory requirements, these impacts would be mitigated at a 1:1, 2:1, or 3:1 ratio, depending upon the habitat type impacted. Accordingly, the direct wetlands impacts from the South Coast Rail alternatives would not result in a net loss.

As shown in Table 5-4, wetland losses from induced growth are estimated to be 7.35 square feet per new household; with the implementation of Smart Growth initiatives (resulting in denser development with multi-family homes), wetland losses would be as 5.81 square feet per household. Table 5-11 summarizes the anticipated wetland impacts from the two scenarios by growth induced by the South Coast Rail alternatives.

Table 5-27 lists the direct and indirect, as well as induced growth, wetland impacts attributable to the South Coast Rail alternatives for both scenarios, including mitigation (replacement) for wetland losses. It is assumed for this analysis that the indirect wetland losses would be of the highest value wetlands, requiring a 3:1 replacement ratio.

Table 5-27 Direct and Indirect Wetlands Impacts (acres)

	Direct and Indirect Effect[1]		Induced Growth Effect		
Alternative	**Loss**	**Mitigation**	**Loss**	**Mitigation**	**Total**
SCENARIO 1					
Attleboro	-20.56	+54.19	-13.42	+40.26	+60.47
Stoughton	-11.94	+33.00	-13.41	+40.23	+47.88
Rapid Bus	-21.48	+59.28	-13.31	+39.93	+64.42
SCENARIO 2					
Attleboro	-20.56	+54.19	-9.31 to -10.09	+27.93 to +30.27	+52.25 to +53.81
Stoughton	-11.94	+33.00	-9.30 to -10.08	+27.90 to +30.24	+39.66 to +41.22
Rapid Bus	-21.48	+59.28	-9.23 to -10.00	+27.69 to +30.00	+56.26 to +57.80

1 Source: Chapter 4.16. Table 4.16-57, Permanent Wetland Resource Impacts by Alternative.

Projecting historical trends into the future, as managed by current regulatory programs, combined with the South Coast Rail alternatives direct and indirect effects listed above, Table 5-28 compares the cumulative wetlands impacts (loss and mitigation) of the two scenarios to the No-Build Alternative.

Combining historical trends with the current regulatory environment (e.g., no-net-loss) and the South Coast Rail impacts to wetlands, the cumulative impacts:

- From Scenario 1 would be no net loss in wetland area, and
- From Scenario 2 would also be no net loss in wetland area.

There would be measureable, but insubstantial, differences between the alternatives.

5.4.9 SUMMARY OF CUMULATIVE IMPACTS

Table 5-29 summarizes the incremental changes to the evaluated resources from the South Coast Rail alternatives that, in combination with past activities or trends and other known current and future projects, would potentially result in a substantive cumulative effect. The comparison is provided for both scenarios for the three alternatives considered in this evaluation, in relationship to the status of these resources under the projected No-Build Alternative conditions in 2030. Because there is no substantive difference between the impacts from rail alternatives' electric- or diesel-powered trains, these options are not included in this summary comparison. Additionally, the impacts from the Whittenton Alternative are substantively equivalent to those from the Stoughton Alternative, and are therefore incorporated in the Stoughton Alternative summary.

Table 5-28 Comparison of Cumulative Impacts to Wetlands in 2030

			Wetlands		
Historical Trends Affecting Wetlands	**Trends and Current or Future Actions affecting Wetlands**	**Alternative**	**Wetlands in 2030 (acres)[1]**	**Incremental Change from No-Build (acres)**	**Percent Change from No-Build**
Historical wetland loss; recent Federal and State wetland regulations	No net loss policy; mitigation (replacement) ratios from 1:1 to 3:1	No-Build	125,078	--	--
		BUSINESS AS USUAL SCENARIO			
		Attleboro	125,138	+60.47	+0.05
		Stoughton	125,126	+47.88	+0.04
		Rapid Bus	125,142	+64.42	+0.05
		SMART GROWTH SCENARIO			
		Attleboro	125,130 to 125,132	+52.25 to +53.81	+0.04
		Stoughton	125,118 to 125,119	+39.66 to +41.22	+0.03
		Rapid Bus	125,134 to 125,136	+56.26 to +57.80	+0.04

1 Net, taking into account mitigation

Table 5-29 Summary of Incremental Changes from Alternatives

	Resource							
	Air Quality	**Biodiversity**	**Economy**	**Land Use**	**Protected Open Space**	**Threatened or Endangered Species**	**Water Quality**	**Wetlands (net change)**
NO-BUILD	Ambient Air Quality: Trend of improving air quality; projected to meet all NAAQS by 2010 Greenhouse Gas Emissions: Trend of increasing emissions, to be counteracted by new regulatory requirements. CO_{2e} emissions to be 80% of 1990 levels by 2050.	303,268 acres of natural land; 22 acres of land converted per day; 134,984 acres of decreased habitat quality; climate changes.	Population: 908,000 (363,200 households) Jobs: 590,000 Business Activity: $99B Tax Revenue: NA	Conversion of 1,315 acres per year; 302,268 acres of undeveloped land will remain in 2030.	Open space protected at average rate of 383.7 acres per year; 62,876 acres of protected open space will remain in 2030	Listed species protected by federal and state regulations. Indirect effects to habitat quality as a result of land conversion and climate change.	Trend of improving water quality. Indirect effects from new lawns and non-point sources.	No net loss policy; mitigation ratios of 1:1 to 3:1; 125,078 acres of wetlands will remain in 2030
ATTLEBORO	**Scenario 1** Ambient Air Quality: Improvement Greenhouse Gas Emissions: -40,909 CO_{2e}	Loss of 266.44 acres of habitat; 1,261 additional acres land conversion; 138,496 acres of decreased habitat quality.	Population: +5,143 (+2,057 households) Jobs: +2,599 Business Activity + $487M Tax Revenue + 26M	1,261 additional acres land conversion	Loss of 8.93 acres of protected open space	Impacts to threatened and endangered species would be mitigated. Indirect effects to habitat quality as a result of land conversion and climate change	No process water discharges, stormwater discharges controlled by SWPPP. Indirect effects from new lawns and non-point sources	Increase of 60.47 acres of wetlands, +0.05% (loss of 33.98 acres, before mitigation)
	Scenario 2 Ambient Air Quality: Greater Improvement Greenhouse Gas Emissions: : -40,909 CO_{2e}	Loss of 266.44 acres of habitat; 9,646 to 13,827 fewer acres land conversion; 65,777 to 83,778 acres of decreased habitat quality.	Population: +5,143 (+2,057 households) Jobs: +2,599 Business Activity + $487M Tax Revenue + 26M	9,646 to 13,827 fewer acres land conversion; no contribution to sprawl if PPAs and PDAs are enacted	Increase of protected open space due to PPAs, but number of acres is unknown.	Impacts to threatened and endangered species would be mitigated. Indirect effects to habitat quality reduced.	No process water discharges, stormwater discharges controlled by SWPPP. Indirect effects reduced.	Increase of 52.25 to 53.81 acres of wetlands, +0.04% (loss of 29.87 to 30.65 acres, before mitigation)
STOUGHTON	**Scenario 1** Ambient Air Quality: Improvement Greenhouse Gas Emissions: -38,964 CO_{2e}	Loss of 250.94 acres of habitat; 1,233 additional acres land conversion; 138,362 acres of decreased habitat quality.	Population: +4,930 (+1,972 households) Jobs: +2,533 Business Activity: +$479M Tax Revenue: +$26M	1,233 additional acres land conversion	Loss of 1.69 acres of protected open space	Impacts to threatened and endangered species would be mitigated. Indirect effects to habitat quality as a result of land conversion and climate change	No process water discharges, stormwater discharges controlled by SWPPP. Indirect effects from new lawns and non-point sources	Increase of 47.88 acres of wetlands, +0.04% (loss of 25.35 acres, before mitigation)

Table 5-29 (continued)

	Resource							
	Air Quality	Biodiversity	Economy	Land Use	Protected Open Space	Threatened or Endangered Species	Water Quality	Wetlands (net change)
STOUGHTON	**Scenario 2** Ambient Air Quality: Greater Improvement Greenhouse Gas Emissions: -38,964 CO_{2e}	Loss of 250.94 acres of habitat; 9,674 to 13,698 fewer acres land conversion; 65,725 to 83,712 acres of decreased habitat quality.	Population: +4,930 (+1,972 households) Jobs: +2,533 Business Activity: +$479M Tax Revenue: +$26M	9,674 to 13,698 fewer acres land conversion; no contribution to sprawl if PPAs and PDAs are enacted	Increase of protected open space due to PPAs	Impacts to threatened and endangered species would be mitigated. Indirect effects to habitat quality reduced.	No process water discharges, stormwater discharges controlled by SWPPP. Indirect effects reduced.	Increase of 39.66 to 41.22 acres of wetlands, +0.03% (loss of 21.24 to 22.02 acres, before mitigation)
RAPID BUS	**Scenario 1** Ambient Air Quality: Improvement Greenhouse Gas Emissions: + 6,839 CO_{2e}	Loss of 359.98 acres of habitat; 787 additional acres land conversion; 137,268 acres of decreased habitat quality.	Population: +3,275 (+1,310 households) Jobs: +1,678 Business Activity + $296M Tax Revenue + $15M	787 additional acres land conversion	Loss of 4.50 acres of protected open space	Impacts to threatened and endangered species would be mitigated. Indirect effects to habitat quality as a result of land conversion and climate change	No process water discharges, stormwater discharges controlled by SWPPP. Indirect effects from new lawns and non-point sources	Increase of 64.42 acres of wetlands, +0.05% (loss of 34.79 acres, before mitigation)
	Scenario 2 Ambient Air Quality: Greater Improvement Greenhouse Gas Emissions: + 6,839 CO_{2e}	Loss of 359.98 acres of habitat; 9,944 to 13,937 fewer acres land conversion; 65,222 to 83,071 acres of decreased habitat quality.	Population: +3,275 (+1,310 households) Jobs: +1,678 Business Activity + $296M Tax Revenue + $15M	9,944 to 13,937 fewer acres land conversion; no contribution to sprawl if PPAs and PDAs are enacted	Increase of protected open space due to PPAs	Impacts to threatened and endangered species would be mitigated. Indirect effects to habitat quality reduced.	No process water discharges, stormwater discharges controlled by SWPPP. Indirect effects reduced.	Increase of 56.26 to 57.80 acres of wetlands, +0.04% (loss of 30.71 to 31.28 acres, before mitigation)