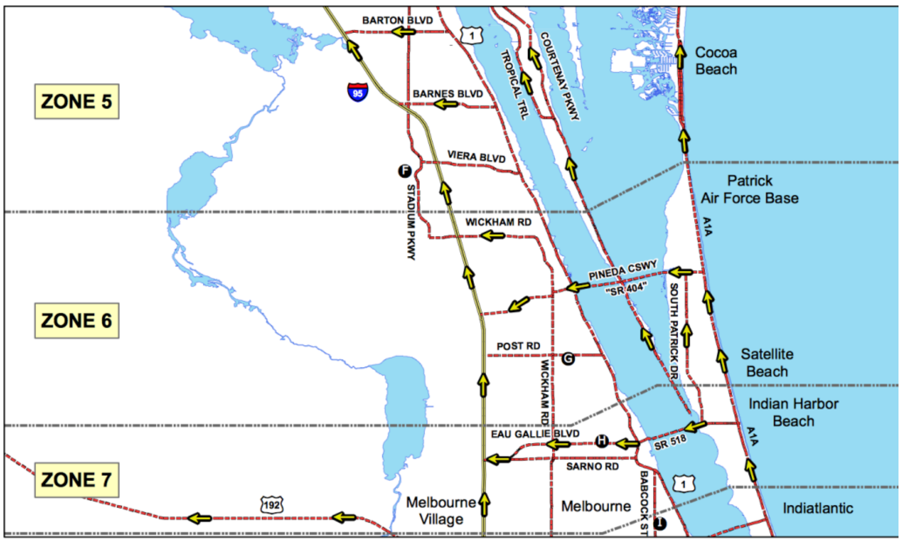
Assessing Criticality in Transportation Adaptation Planning



Hurricane evacuation routes (green arrows) in south of Cape Canaveral, Florida.
Map courtesy of Brevard County Emergency Management Office.

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INTRODUCTION

Before initiating a climate change vulnerability assessment, transportation agencies need to decide which assets they wish to evaluate. Identifying the relevant assets for a vulnerability study and determining which characteristics of these assets to examine can help agencies narrow the scope of the study, making it more manageable and affordable while allowing more in-depth assessment of the selected group of assets.

> **Pilot-Testing Approaches to Vulnerability Assessment**
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> FHWA is partnering with State Departments of Transportation, Metropolitan Planning Organizations, and Federal Land Management Agencies to pilot approaches to conducting vulnerability assessments for transportation infrastructure and analyzing options for adapting and improving resilience. These FHWA pilots, currently in various stages of implementation, have grappled with some of the key issues surrounding criticality. Some of these same issues have been explored in Mobile, Alabama, under the DOT-funded *Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: The Gulf Coast Study, Phase 2*. This memorandum provides examples of how the FHWA pilots and the Gulf Coast Study have approached the process of assessing criticality.

One way to narrow the range of assets to be evaluated is to conduct a **criticality assessment**, which involves identifying the most critical elements of the transportation system for analysis, using quantitative or qualitative criteria. A criticality assessment provides a structured way to focus on assets that are most important for the functioning of the transportation system.

This memorandum discusses common challenges associated with assessing criticality, options for defining criticality and identifying scope, and the process of applying criteria and ranking assets. It uses examples from the FHWA pilots and the Gulf Coast 2 study (see text box above) to illustrate a variety of approaches that have been used for assessing criticality. The Appendix lists criticality criteria developed under the Gulf Coast Study, Phase 2, along with brief explanations for why each criterion was chosen.

COMMON CHALLENGES IN ASSESSING CRITICALITY

The following challenges are common when attempting to identify critical assets:

- Definitions of criticality are vague and can be difficult to implement. Who decides what is critical? Definitions of "criticality" depend on the lens through which they are being evaluated (e.g., public health, emergency response, economic growth, mobility).
- Determining what constitutes "an asset" is not always straightforward. Organizations must decide whether (and how) to include critical services that

support transportation goals (e.g., Intelligent Transportation Systems, telecommunications, power) and the appropriate level of disaggregation. For example, should the asset be defined as the airport complex, the access road from the airport to another destination (e.g., the city center), a specific runway, or the pavement on the runway?

- It is difficult to define the boundaries and relationships of the system(s) in which the asset is embedded (e.g., a highway segment may have more economic importance to a multi-state region than to the county where it is located).
- It can be time-consuming and difficult to gather certain types of data on assets in a study area, particularly privately-owned assets (e.g., pipelines, port facilities, freight rail).
- Even when data are readily accessible from internal databases or elsewhere, it can be very difficult to integrate information on assets efficiently (e.g., spatial data may have incorrect or inconsistent reference information, making integration with other spatial data challenging).

OPTIONS FOR DEFINING CRITICALITY AND LIMITING STUDY SCOPE

This section discusses how the goals and audiences for a vulnerability study may shape criteria used to assess criticality, along with key considerations in defining criticality and the scope of a vulnerability assessment.

GOALS AND AUDIENCE FOR VULNERABILITY INFORMATION

Traditionally, assessments of criticality may connote notions of risk, but critical assets in the context of a climate change vulnerability assessment are intended to include those assets of "greatest importance," such as assets that are of economic importance, provide access to healthcare facilities, serve as emergency evacuation routes, provide social connectivity, have cultural significance, or support other core values.

The extent to which each of these elements is included in a criticality assessment should reflect the goals of the decision-makers who will ultimately use the results and recommendations of the vulnerability assessment. For this reason, it is necessary to clearly define the *purpose* and *intended audience* for the overall vulnerability assessment.

For example, the analysis may be intended to communicate the risks of climate change, justify specific projects, inform design decisions on projects in the pipeline, or a host of other outcomes. The intended use of vulnerability information and the intended audience should drive the design and approach of the criticality assessment.

Table 1 uses four hypothetical studies with different goals to show how factors such as target audience and purpose might shape the study scope and details of a criticality assessment.

Table 1: The Influence of Study Purposes, Audiences, and Outcomes on Criticality Criteria

Purpose of Study	Target Audience(s)	Intended Outcomes	Study Scope	Stakeholder Roles	Potential Criticality Criteria
Raise public awareness of climate risk to transportation assets	General public	Public support for adaptation projects	Limit study to a few high-profile assets across a diverse range of modes	Identify many stakeholders (including non-experts) and involve them throughout the process	Assets with highest use, assets providing access to key employment centers, health and safety
Begin implementing adaptation projects (particularly asset design)	High-level decision makers within transportation agency	Design planned bridge infrastructure for updated design storm characteristics	Limit study to assets that the agency owns and operates; include planned assets if possible	Include engineers, O&M, and other "boots on the ground" stakeholders in meetings to determine criticality	High-cost assets, assets with a long design life
Encourage increased coordination and communication among relevant agencies	Point people from each agency, agency partnerships	Work to share information, increase coordination around emergency events	Focus on assets at the intersection of involvement from multiple agencies	Include mid- and senior-level staff from different agencies in meetings to determine criticality	Assets that are multi-modal or at the intersection of multiple system types (communications, electricity, water); evacuation routes
Research potential risk management strategies	Academia, regional NGOs	Arrive at a consensus on best practices for risk assessment	Include a wide range of modes and assets in the assessment; determine criticality of many assets rather than focusing on a select few	Develop an approach that can be applied in other regions	Criteria that can be used in different regions across the United States; criteria that are cross-cutting and encompass a wide range of decision makers

There is no single right way to assess criticality as the first step in an overall vulnerability assessment. Key questions to consider in developing a criticality assessment include:

- Should your assessment include many assets or only a few? (Is the intent to go deeply into a few key assets or to focus broadly, but with less depth?)
- Should your assessment include a range of transportation modes, or only one mode?
- How should you define "critical?" Should the focus be on economic drivers, health and safety concerns, replacement cost, or other criteria?
- Who are your stakeholders? Might the criticality assessment be leveraged for other uses; might there be an existing criticality assessment that could be adapted for this purpose? When should you involve stakeholders in the process?

DEFINING CRITICALITY

Before an asset's degree of criticality can be determined, the term "criticality" itself must be clearly defined in the context of the vulnerability assessment. For many agencies, a critical asset is defined as an asset that is so important to the study area that its removal would result in significant losses.[1] However, this definition does not resolve three important questions: what is an asset, what is the study area, and who defines significant losses?

If we assume that our definition of "critical" should align with the profile of our target audience, we can make the definition of criticality more specific. For example, municipal and county decision makers are likely to care about high-profile, high-use assets across all modes, while senior management within a single agency may be more likely to prioritize assets that the agency owns or operates.

Prior work on identifying critical infrastructure has focused mainly on major transportation facilities that serve a national purpose—primarily interstate travel and trade. However, assessing what is critical to a local area requires that other criteria be taken into consideration, such as those related to community and economic viability. Recognizing interstate travel as the sole criterion for asset criticality might not capture the full measure of important transportation assets that support the economy of a particular area. It may be necessary to acknowledge the importance to the community of regional and local transportation connections (including major port facilities and railroad operations).

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[1] For example, see DHS (2007). Transportation Systems: Critical Infrastructure and Key Resources Sector-Specific Plan as input to the National Infrastructure Protection Plan. Department of Homeland Security. Arlington, VA. <http://www.dhs.gov/xlibrary/assets/nipp-ssp-transportation.pdf>

DEFINING CRITICALITY IN THE GULF COAST STUDY

Stakeholder input can be vital to defining criticality in a region, as was the case in the Gulf Coast Study. During the project vulnerability assessment process, various local and regional stakeholders were engaged to help define "critical" for the purpose of the study. The determination of criticality of transportation assets in Mobile was based on the following categories of criteria:

- Socioeconomic importance
- Use/operational importance
- Health and safety importance

The socioeconomic importance of an asset relates to how it contributes to the social viability of the community, as well as its role in supporting the local economy. Social viability involves measuring the importance of transportation assets to the community in terms of providing access to facilities that allow the community to function, while economic viability involves an asset's role in supporting commerce and providing access to major employment destinations. Many individual components, including households, schools, libraries, government centers, employment centers, retail establishments, places of worship, and other locations define a community as a whole. The role of transportation in providing connectivity between those destinations is well defined and enables community viability and livability. Connections to these facilities were factored into the Gulf Coast Study criticality analysis in recognition of their importance to community and economic functioning.

Operational importance was assessed by considering the use of each link in the transportation network, its capacity, and the importance of the operations that the asset supports to the Mobile County economy. Examples of use measures include average daily traffic along roadways, ridership for transit, annual gross tonnage for rail lines, and cargo volumes for ports.

Health and safety considerations include the asset's role in evacuation plans, disaster relief and recovery plans, the asset's role in moving hazardous materials, inclusion in the national defense system, and the extent to which an asset provides access to health care facilities.

Key Factors Defining Criticality in the Gulf Coast Phase 2 Study

Purpose of the study	Target audiences	Intended outcomes
Develop a vulnerability assessment methodology that fits Mobile, Alabama, and is replicable, transparent, and transferrable to other states and localities across the United States.	Mobile MPO Climate Change Working Group (primary) and U.S. DOT modal agencies/state and local transportation agencies (secondary).	*Senior MPO decision-makers*: Become better educated about potential impacts, improve emergency planning, rethink design assumptions in future infrastructure. *DOT and other transportation agencies*: Transferrable methods and tools that can be applied by transportation agencies across the United States at the state and local levels.

Because of the far-reaching goals of the study, the assessment of critical assets for Gulf Coast Phase 2 covered all modes (U.S. DOT, 2011). However, the assessment was also governed by the types of assets present in Mobile, Alabama: for example, transit in Mobile is currently a bus-only service, so only criteria relevant to those services were included. The emphasis on replicability and transferrable lessons drove the study team to focus the initial assessment on transparent, quantitative (wherever possible) criteria; these criteria were then equally weighted to reflect socioeconomic importance, operational/use, and health and safety concerns. Because Mobile is centrally located among multiple regional intermodal connections, accessibility to the ports and pipelines was also factored into criticality.

Assessing Infrastructure for Criticality in Mobile, Alabama (link)

DEFINING SCOPE

Defining the scope of a vulnerability assessment includes determining how many critical assets to identify and how to draw the spatial (e.g., county, state), temporal (e.g., existing, planned, existing and planned assets), modal (e.g., highways, ports, freight rail, transit), ownership (e.g., state-owned, county-owned, privately owned), and other parameters of the study. The scope of a vulnerability analysis should reflect the objectives and constraints of the target decision makers and key stakeholders. The sections below provide a discussion of several kinds of boundaries and the types of considerations that may go into decisions regarding them.

GEOGRAPHIC SCOPE

Geographic scope may be defined by the boundaries of an agency's jurisdiction, or may need to be defined through working with relevant partners to determine the area of consideration. For state and local transportation agencies, jurisdictional boundaries will be one of the most important determinants of scope. For metropolitan areas—such as Newark, New Jersey, where the area under the MPO's jurisdiction acts as an integral part of significant transportation-related activities in the Northeast corridor—the importance of a particular asset may need to be considered in two contexts: the importance of the asset to parties involved in the vulnerability assessment, and the importance of the asset in the context of broader regional or national systems that include the asset (in the case of Newark, for example, this could include interstate commerce on I-95).

TEMPORAL SCOPE (FUTURE ASSETS)

The study goals and audience may drive the temporal scope of the assets being assessed for criticality. For example, if the vulnerability assessment is oriented toward short-term changes and how to manage for them, the criticality assessment should focus on existing assets. Alternatively, if the goal of the assessment is to help an MPO consider climate change effects in its long-term planning efforts, it may be useful to include the assets in the long-range transportation plan in the "universe" of assets to be screened against criticality criteria and ultimately reviewed for vulnerability. If the audience for the study has a purview for assets with long design lives (and planned upgrades), or assets envisioned for the future, it is important to include these assets in the analysis.

MODAL SCOPE

The position of the decision maker and the perspectives of the stakeholders should determine the initial list of modes to include in the analysis. In many cases, the study may include only modes that the target decision maker or ultimate audience can control or influence. Highways, public transit, aviation, maritime, pipelines, bicycle and pedestrian facilities, and railroads are all examples of modes that could potentially be included in the analysis.

Example criticality criteria for different modes that were used in the Gulf Coast study are provided in the Appendix.

OWNERSHIP

The agency assessing criticality may want to limit the scope of assets considered in the criticality assessment based on ownership of the assets. Smaller, more focused analyses may limit the scope to assets owned and/or operated by the agency itself. For example, the Washington State DOT pilot focused its analysis on the State Highway System assets since the agency is responsible for the planning, design, construction, and maintenance of this system. That system includes assets such as roads, wetland mitigation sites, stormwater treatment facilities, rest areas, park and ride lots, transit facilities, maintenance facilities, air field assets, and the Washington State Ferry system.

APPLYING CRITERIA AND RANKING ASSETS

After articulating the project's scope, purpose, and intended audience, the next step is to assess the criticality of assets.

DEFINING ASSETS AND SYSTEMS

The criticality of an asset depends both on its physical characteristics (e.g., replacement value) and on its function in multiple systems (e.g., emergency evacuation route, key commercial route, level of activity, value of freight carried). One of the challenges that agencies face during the criticality assessment is defining assets and determining which auxiliary systems to include in the analysis. For example, an agency undertaking a study aimed at educating the general public or local decision makers might prefer to aggregate assets into recognizable groups, such as bridges, highways, and culverts. A study aimed at increasing agency cooperation will need a higher level of detail, with a particular focus on asset function across systems. Finally, a study with the objective of implementing adaptation strategies (e.g., asset management systems considering changes to design/retrofits) will require a level of detail high enough to inform quantitative assessments of vulnerability and risk and analyses of possible adaptation strategies specific to that asset.

Along with asset definitions, the study should define which supporting systems to include. Electricity transmission and distribution systems and intelligent transportation systems (ITS) are examples of auxiliary systems that might be considered "critical." The extent to which these systems are included in the criticality assessment depends on the purpose and intended audience of the study. If emergency management is a primary or secondary goal, the agency may want to include ITS systems. If power outages are a primary concern, the vulnerability assessment may need to address electricity assets.

THREE APPROACHES TO CRITICALITY ASSESSMENT

In practice, the FHWA pilot projects have generally used three approaches to narrow the universe of transportation assets based on their individual interpretation of criticality: the desk review approach, the stakeholder solicitation approach, and the hybrid approach. Each of these approaches is described in more detail below.

APPROACH 1: DESK REVIEW

One approach to formulating criticality criteria is to identify a broad range of criteria that capture use and access across a range of modes and systems. The desk review emphasizes objectivity, and uses quantitative information that is based on readily available data sources and requires little local knowledge to apply in asset ranking. In the desk review approach, modal experts or modelers use prioritization schemes already in place and rank assets based on data such as average daily traffic, functional classification, and expert judgment. This approach may or may not weight individual factors in an attempt to rank and classify the assets. This method may lend itself to studies intended to further research on appropriate decision support tools in this area, and/or studies for academic audiences. It may also be used as a first step in the process of identifying critical assets, as discussed below under Approach 3. Advantages of the desk review approach include its transparency and replicability. A potential disadvantage is that data may be lacking on important elements of criticality, many of which are qualitative and locally specific.

Examples:

VDOT/Hampton Roads Pilot Approach

The Virginia Department of Transportation (VDOT) led this pilot in partnership with the University of Virginia, the Hampton Roads Planning District Commission, and Hampton Roads Transportation Planning Organization. The pilot project team used multi-criteria decision analysis to evaluate transportation priorities in the region. To identify critical assets, VDOT compiled an initial selection of over 1,000 existing transportation assets from its asset management system. To narrow the scope, the project team screened for high-risk assets using criteria that included traffic volume, elevation relative to mean sea level, location on a maintenance priority route, and location on a hurricane evacuation route. The narrowed selection consisted of about 30 major assets, including two traffic management centers and three bridges.

New Jersey Pilot Approach

The North Jersey Transportation Planning Authority (NJTPA) led the interagency NJ Partnership to assess the vulnerability of transportation systems in New Jersey. Much of the state’s infrastructure is aging and concentrated near major rivers and the coast. The NJ Partnership wanted to understand how to make more strategic capital investments in light of the changing climate. To accomplish this goal, the project team conducted a climate vulnerability assessment on transportation assets in two geographic areas of focus. As a first step in this assessment, the team assigned assets into tiers of criticality based on the extent to which each asset connects critical destinations. The following factors determined criticality:

- Importance of the destinations, identified based on jobs and population density
- Magnitude of the connections, identified by traffic volume or ridership
- Emergency function of routes, identified by presence of coastal evacuation routes and other factors

Using a Geographic Information System (GIS)-based tool, the project team scored assets according to these criteria and then grouped them into three tiers of criticality: "low and medium," "high," and "extreme."

APPROACH 2: STAKEHOLDER ELICITATION

Determining asset criticality based on input from selected stakeholders and local experts is a second approach to assessing criticality. With a stakeholder elicitation approach, the project leaders will identify a group of stakeholders in the region with expert knowledge of specific interests (e.g., commercial activity, public safety, or road maintenance). The project leaders will then organize a workshop or series of workshops with these stakeholders to elicit feedback on which assets are critical.

Advantages of the stakeholder approach include getting buy-in from relevant stakeholders early in the vulnerability assessment process, encouraging collaboration and communication among stakeholders and actors likely to implement any adaptation strategies, accessing information that is not readily available in publicly available datasets, and quickly assessing criticality without a lengthy research process. However, the results of a stakeholder-driven process are highly subjective. The outcomes depend strongly on the quality of the workshop facilitation, the composition of workshop attendees, and the participation of key experts.

Examples:

The Oahu MPO Pilot Approach

The Oahu MPO pilot held a workshop that brought together climate scientists and local planning, engineering, and management professionals. Workshop participants identified and prioritized vulnerable transportation asset groups through an iterative discussion that relied heavily on local knowledge. A series of facilitated discussions helped participants evaluate the economic and social consequences of asset failure to due climate change. Based on the consensus from these discussions, the participants identified a small number of highly critical assets:

- Honolulu Harbor area
- Honolulu International Airport area
- Kalaeloa Airport, Kalaeloa Barbers Point Harbor, and Campbell Industrial Park
- Three bridges in Waikiki
- Rt-93, Farrington Highway

The project team then used GIS to map critical transportation infrastructure and associated access routes in each asset area.

WSDOT Approach

The objective of the Washington State Department of Transportation (WSDOT) pilot study was to develop a methodology for evaluating transportation assets vulnerable to climate change-related impacts and to prioritize those assets for proactive response actions. The pilot focused only on the assets it owns and operates, including airports, ferry terminals and operations, rail lines, state routes and interstate roadways, bridges, culverts, ramps, adjacent pedestrian and shared-use paths, roadsides and migration sites, and WSDOT-owned buildings. WSDOT involved O&M and engineering stakeholders in various facilitated workshops across the state in assessing criticality. The project team used a 1 to 10 rating scale to articulate the relative criticality for each asset. Workshop participants scored criticality based on the asset's character, its general function, and use (see Figure 1).

Figure 1: Rating Scale for Asset Criticality used by WSDOT

Very low to low	Moderate	Critical to Very Critical
1 2 3 4	5 6	7 8 9 10
Criticality of asset		
Notice that along with the qualitative terms there is an associated scale of 1 to 10, this is to serve as a facilitation tool for some people who may find it useful to think in terms of a numerical scale – although the scoring by each individual is of course subjective. The scale is a generic scale of criticality where "1" is very low (least critical) and "10" is very critical.		
		
Typically involves: non-NHS low AADT alternate routes available	Typically involves: some NHS non-NHS low to medium AADT serves as an alternative for other state routes	Typically involves: Interstate Lifeline some NHS sole access no alternate routes

APPROACH 3: HYBRID APPROACH

The hybrid approach includes aspects of both the desk review and the stakeholder elicitation approaches. Hybrid approaches often begin the process with a desk review, which identifies a long list of critical assets based on commonly available data such as average daily traffic or economic information for the region (e.g., data on imports/exports from a particular port). The project team will then use the results of the desk review to inform and structure feedback from stakeholders and local experts.

Examples:

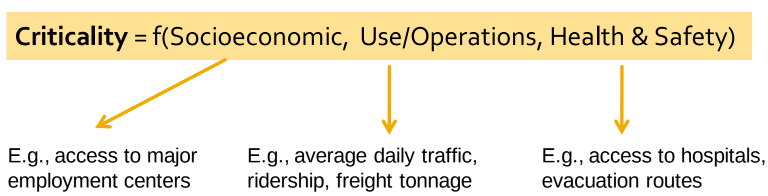
San Francisco/MTC Pilot Approach

San Francisco's Metropolitan Transportation Commission partnered with several other organizations on a pilot to assess climate vulnerability and risk in Alameda County, California. The project team focused on four categories of transportation infrastructure in Alameda: road network; transit network; storage, operations and maintenance, and control facilities; and bicycle and pedestrian networks.

The project team applied three filters to narrow down the asset inventory to a small set of representative assets. The first filter spatially selected for the assets located within the end-of-century sea level rise inundation area, discarding assets less likely to be exposed to sea level rise. The second filter analyzed the environmental, economic, and equity characteristics associated with each asset. In most cases, applying these two filters limited the list of representative assets to three or fewer within each of the four asset categories. The exception was the road network category; since there were hundreds of discrete arterial, collector, and local streets, the project team hosted a workshop to identify priority assets for evaluation. Participants in the workshop voted for priority transportation assets within Alameda County by affixing stickers to inundation maps.

Approach Used in the Gulf Coast Phase 2 Criticality Assessment

During the Gulf Coast Phase 2 project, criticality was defined as a function of socioeconomic considerations, use/operations, and health/safety priorities. Since the project looked across a number of modes, these overarching categories of criteria were chosen to maximize consistency across modes, although specific criteria in each category for the various modes were subsequently identified. The audience for this project includes transportation agencies across the country as well as decision makers in Mobile, Alabama; thus, objectivity, inclusivity, and transparency were key. This is why the Gulf Coast Phase 2 project used a hybrid approach with a strong desk review element augmented by periodic input from a local working group. The working group weighed in on the initial approach, the categories of criteria, and the mode-specific criteria. Transportation experts evaluated all available data and scored assets from 1 to 5 (low to high). Assets were then binned into high, medium, and low criticality categories based on the distribution of asset scores. The project team presented the results from this desk review at a stakeholder meeting and adjusted the list of critical assets based on stakeholder feedback. See the Appendix for the criteria used in the Gulf Coast Phase 2 project.



Assessing Infrastructure for Criticality in Mobile, Alabama (link)

CONCLUSIONS

There is no single right way to assess criticality as part of an overall vulnerability assessment; this exercise must be designed to suit the needs of the study and the ultimate users of the information to be provided on vulnerability. However, there are some common elements seen in the assessments discussed in this document. Based on these examples, successful criticality assessments generally:

- Identify assets that align with the priorities and values of the target audience.
- Create buy-in from important stakeholder groups (stakeholders who comprise or influence the target audience).

- Develop and organize relationships, contact information, data sources (spatial, financial, engineering), and other resources that will be useful during the subsequent vulnerability and risk analysis.
- Involve some sort of qualitative or quantitative ranking scheme based on identified criteria.

State DOTs, MPOs, and other transportation practitioners around the country have used a variety of criteria and methods to define criticality to meet the needs of their projects. The steps taken by these agencies can help inform future vulnerability assessments, and may assist other decision makers in taking the first step toward understanding how climate change impacts may affect transportation assets in their region.

RESOURCES

Climate Change & Extreme Weather Vulnerability Assessment Framework: http://www.fhwa.dot.gov/environment/climate_change/adaptation/resources_and_publications/vulnerability_assessment_framework/

FHWA Climate Change Resilience Pilots: http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/vulnerability_assessment_pilots/index.cfm

Gulf Coast Study: http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/index.cfm

Assessing Infrastructure for Criticality in Mobile, AL: http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/phase2_task1/index.cfm

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Appendix: Criticality Criteria Used in the Gulf Coast Study, Phase 2. For more information on the Gulf Coast Study, visit http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/gcs.cfm.

Socioeconomic

Criteria	***Description and Justification***	***Relevant Mode(s)***
Lack of redundancy	A measure of whether the network could be maintained or diverted from the loss of one link. Redundancy affects the functioning of the entire network: an asset that is critical is identified as having low redundancy.	Highways Ports Airports Pipelines
Provides community connection	Whether the asset provides links or access to facilities that the community relies on (schools, government buildings, etc.) or serves a variety of local industries throughout the area (through import/export, providing fuel to utilities, etc.).	Highways Rail Ports Airports Pipelines
Serves economic centers	Assets that provide access to important economic activity and employment centers may be critical for maintaining functioning of local and regional economies.	Highways Transit Rail Ports

Criteria	***Description and Justification***	***Relevant Mode(s)***
		Airports Pipelines
Multi-modal linkages	Whether an asset provides access to other modes of transportation. Multi-modal linkages help to maintain the functioning of the entire network.	Highways Rail Port Airport
Part of national and international commerce systems	Domestic and international commerce activities may rely on various assets for transporting materials. These assets may be critical for maintaining economic functioning.	Rail Ports Airports
Locally identified priority corridors	Local stakeholders can be surveyed to help identify any priority corridors based on their expert knowledge. These roads may provide vital linkages to important employment and cultural centers.	Highways
Ability to serve transit-dependent populations	Transit-dependent populations often include low-income, elderly, or physically disabled persons. These individuals would be unable to get to their jobs, medical appointments, grocery stores, or other important facilities without transit.	Transit
Ability to serve environmental justice populations	Environmental justice populations can include low-income and minority groups. Serving these populations helps to ensure that communities are treated equally and fairly with respect to access to transportation resources.	Transit

Criteria	***Description and Justification***	***Relevant Mode(s)***
Local supply pipeline	A measure of the end users that pipelines serve within the community (e.g., power generation, residential, industry). Pipelines that provide supply to various different users are more critical, as the community would be dependent on these energy supplies.	Pipelines
Important backup supply after major disruption	Pipeline supply that would be used after a major disaster while other links of the network are restored (for example, a gasoline pipeline to a distribution center).	Pipelines
Local sales pipeline	A local sales pipeline is one that is used by a utility selling to end users. End users rely on these pipelines for their energy supply. Critical pipelines have higher level of sales.	Pipelines

Operational

Criteria	*Description and Justification*	*Relevant Mode(s)*
Functional classification (Interstate, etc.)	Classification of a road according to the character of traffic service that it is intended to provide. There are three highway functional classifications: arterial, collector, and local roads. Arterials provide the highest level of service at the greatest speed for the longest uninterrupted distance, with some degree of access control. Collectors provide a less highly developed level of service at a lower speed for shorter distances by collecting traffic from local roads and connecting them with arterials. Local roads are those not defined as arterials or collectors; they primarily provide access to land with little or no through movement. High functional classes (such as interstates) are often more critical to the functioning of the road network.[2]	Highways
Usage (Average Daily Traffic)	Average Daily Traffic Volume, determined by a road's 2035 Annual Average Daily Traffic (AADT) volume.[3] Roads with higher ADT are more critical to functioning of road network because of high traffic.	Highways
Type / variety of services	Types and variety of vehicles and services provided, such as fixed-route, demand-response, and others. Transit services give a sense of the demographics of the population served that may be solely reliant on transit as a means of transportation, as well as activity centers to which riders are connected (such as medical facilities for appointments or employment centers). For example, the level of demand response service can be indicative of those within the agency's service area in need of assistance/evacuation support.	Transit
Fleet size	In conjunction with type/variety of service, fleet size could govern the limits of the population within the agency's service area that could be served during critical events.	Transit

[2] FHWA, 1997. Flexibility in Highway Design. Available: http://www.fhwa.dot.gov/environment/publications/flexibility/.
[3] From Mobile Area Transportation Study (MATS) regional travel demand model, used for the Mobile 2035 Long Range Transportation Plan Available: http://www.mobilempo.org/longrangeplan.html.

Criteria	***Description and Justification***	***Relevant Mode(s)***
Facilities	Location of facility could be critical for storing/deploying vehicles, as well as providing centralized support for first responders.	Transit
Main track classification	Defined by a state's rail plan. Classification as a main track indicates its function as a trunk rail facility. Disruptions to service along a main track impacts a railroad's ability to convey interstate and regional freight to distribution points. Using detour routes is a feasible option; however, there is limited redundancy in these alternate facilities.	Rail
Annual gross tonnage	Based on Association of American Railroads gross tonnage figures. Important railways often have high annual gross tonnage. These rails carry more freight and may be critical for delivering materials to communities.	Rail
Annual yard tonnage	Extrapolation of annual gross tonnage to develop a value for each facility. Facilities with higher tonnages are considered to be critical. The higher freight through these facilities may be critical for delivering materials to communities.	Rail
Current rail facility capacity utilization	Highly utilized facilities are generally more critical than other facilities. Capacity is a function of the number of trains per unit of time (i.e., per day or per week), the volume of rail cars comprising each train, and turnover rates of both the cars and the entire train. The degree to which rail facility capacity utilization is impacted can vary, but overall the efficiency and productivity of railroads if rail facilities have diminished capacity to turnover goods. Highly utilized facilities are impacted to a greater degree.	Rail
Operations	Types of material handled by rail and at yards (merchandise, intermodal, bulk, break bulk, etc.). Critical railroads handle more types of material. Communities may be dependent on materials handled by rail.	Rail

Criteria	*Description and Justification*	*Relevant Mode(s)*
Interchange utility	Ability to transfer rail cars within yards. Allows for interchange between carriers, which maintains the functioning of freight and transport of important materials to communities.	Rail
Local non-marine traffic	Whether non-port traffic takes place at rail facilities. Multi-utility yards support the functioning of entire system.	Rail
Use of and demand for facility	Unique facility requirements (infrastructure and equipment) are needed for handling varying cargo types (i.e., container, break bulk, dry bulk, liquid bulk, roll-on/roll-off, and passenger). Certain marine terminals or cargo types may be more critical than other types, depending on the magnitude of cargo volume being handled.	Ports
Port capacity	Throughput capacity at each individual terminal and collectively within each group of terminal types will influence the level of criticality. Marine terminals with existing excess capacity could accommodate cargo demand while other terminals are impacted.	Ports
Port cargo value	Marine terminals that handle cargo types for emergency response and trade resumption operations (i.e., fuel, heavy equipment handling, etc.) will be more critical than other types. Likewise, terminals that typically handle high value/time sensitive cargo that may also have unique requirements (e.g., refrigeration) will be more critical than other terminals.	Ports
Operations	Number of workers involved in port operations. Port operations are highly labor intensive and require a skilled labor force. If labor cannot access the port facilities/equipment, cargo will not be handled. Impact to labor's ability to access the port or the equipment they use will affect the ability to operate critical facilities.	Ports
Channel berth and depth	Similar to maximum vessel size, limitations on channel depth available will impact the level of criticality for port facilities. While a berth may be able to accommodate customers' vessels after	Ports

Criteria	***Description and Justification***	***Relevant Mode(s)***
	an event, the channel may restrict the size of vessel able to call at the marine terminals.	
Maximum vessel size	Not all vessels calling at a port are the same size; therefore, capacity for vessels of varying size by cargo type is an important criterion to consider when establishing criticality. If the backlands/storage area at a terminal is available, but the berth is not able to accommodate the vessels that call at that region/location, the carrier may go to another port and may not return.	Ports
Status	Derived from the National Plan of Integrated Airport Systems. Categories include:[4] • Commercial: Publicly owned airports that have at least 2,500 passenger boardings each calendar year and receive scheduled passenger service. • Military: Airports owned and operated by the US Department of Defense or public use commercial airports with military facilities (also called joint-use facilities). • Public Use: Airports that are either publicly owned or privately owned and open to everyone to use. • Private: Airports owned by individuals, corporations, or organizations that are specifically for the use of those individuals, companies, or organizations. They are not open to the public. In general, commercial airports could be considered more critical to transportation due to level of service they can sustain. However, communities with military, public, or private airports could also be considered critical if those are the only class airports serving their region.	Airports
FAR Part 139 certification	The level of service offered by the airport and the largest class of aircraft that uses the airport. Derived from the National Plan of Integrated Airport Systems. Categories include:[5]	Airports

[4] FAA Airport Categories, 2013. Available: http://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/categories/.
[5] FAA Part 139 Airport Certification, 2013. Available: http://www.faa.gov/airports/airport_safety/part139_cert/.

Criteria	*Description and Justification*	*Relevant Mode(s)*
	• Class I: Certificated to serve scheduled operations of large air carrier aircraft that can also serve unscheduled passenger operations of large air carrier aircraft and/or scheduled operations of small air carrier aircraft. • Class II: Certificated to serve scheduled operations of small air carrier aircraft and the unscheduled passenger operations of large air carrier aircraft. A Class II airport cannot serve scheduled large air carrier aircraft. • Class III: Certificated to serve scheduled operations of small air carrier aircraft. A Class III airport cannot serve scheduled or unscheduled large air carrier aircraft. • Class IV: Certificated to serve unscheduled passenger operations of large air carrier aircraft. A Class IV airport cannot serve scheduled large or small air carrier aircraft. In general, Class I and II airports would be considered more critical due to the breadth of operations they can facilitate. However, communities with Class III and IV airports could also be considered critical if those are the only class airports serving their region.	
Aircraft performance and dimensions	Measure of aircraft approach speed and aircraft design.[6] Derived from the National Plan of Integrated Airport Systems. In general, aircraft with higher speed and larger wingspans would be flying to Class I and II airports and thus would be considered more critical. However, slower and smaller aircraft that fly into regions with Class III and Class IV airports could be considered critical if those are the only class airports serving their region. Aircraft approach categories: • Category A: Speed less than 91 knots. • Category B: Speed 91 knots or greater but less than 121 knots. • Category C: Speed 121 knots or greater but less than 141 knots.	Airports

[6] FAA, 2012. Advisory Circular: Airport Design. AC 150/5300-13A Available: http://www.faa.gov/documentLibrary/media/Advisory_Circular/150_5300_13A.pdf.

Criteria	***Description and Justification***	***Relevant Mode(s)***
	• Category D: Speed 141 knots or greater but less than 166 knots. • Category E: Speed 166 knots or greater. This category includes, for the most part, those military, experimental, and some civil aircraft having extremely high speeds and critical performance characteristics. Aircraft design group: • Group I: tail height < 20 ft (< 6 m), wingspan < 49 ft (< 15 m) • Group II: tail height 20 - < 30 ft (6 m - < 9 m), wingspan 49 - < 79 ft (15 m - < 24 m) • Group III: tail height 30 - < 45 ft (9 m - < 13.5 m), wingspan 79 - < 118 ft (24 m - < 36 m) • Group IV: tail height 45- < 60 ft (13.5 m - < 18.5 m), wingspan 118 - < 171 ft (36 m - < 52 m) • Group V: tail height 60- < 66 ft (18.5 m - < 20 m), wingspan 171 - < 214 ft (52 m - < 65 m) • Group VI: tail height 66 - < 80 ft (20 m - < 24.5 m), wingspan 214 - < 262 ft (65 m - < 80 m)	
Instrumentation	Airplane approach instrumentation used at airports. Derived from the National Plan of Integrated Airport Systems, which establishes a hierarchy among airports. Instrumentation categories: • Precision: utilize both lateral (localizer) and vertical (glideslope) information • Non-precision: utilize lateral course information only • Visual: utilize visual information Precision approaches are present at many airports, regardless of class or category of the airport. In general, airports with precision approaches would be considered more critical than those without precision approaches.	Airports

Criteria	***Description and Justification***	***Relevant Mode(s)***
Category within the National Plan of Integrated Airport Systems	Derived from National Plan of Integrated Airport Systems. Categories include:[7] • Primary Airports: Public airports that have more than 10,000 passenger boardings each year. • Reliever: Designated by the FAA to relieve congestion at Commercial Service Airports and to provide improved general aviation access to the overall community. These may be publicly or privately owned. • General Aviation: All remaining airports, which includes privately owned, public use airports that enplane 2,500 or more passengers annually and receive scheduled airline service. Reliever airports provide congestion relief at primary airports and are typically located in large cities with a primary airport. Therefore, primary and general aviation airports would be considered more critical than reliever airports.	Airports
Category within Statewide Airport System Plan	Categories include international, national, regional, community, and local. In general, the higher level (international and national) airports would be considered more critical, but communities with regional, community and local airports could be considered critical if those are the only class category airports serving their region.	Airports
Passenger enplanements	The number of passengers boarding flights at an airport. Derived from the National Plan of Integrated Airport Systems, which establishes a hierarchy among airports. Critical airports may be frequently used facilities that have higher numbers of passenger enplanements.	Airports
Annual aircraft operations	The total number of takeoffs and landings at an airport over a year. Derived from the National Plan of Integrated Airport Systems, which establishes a hierarchy among airports. Critical	Airports

[7] FAA Airport Categories, 2013. Available: http://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/categories/.

Criteria	*Description and Justification*	*Relevant Mode(s)*
	airports may be frequently used facilities that have higher numbers of operations.	
Based aircraft	The number of operational aircraft based out of an airport in a given year. Derived from the National Plan of Integrated Airport Systems, which establishes a hierarchy among airports. Critical airports may be frequently used facilities that have higher numbers of based aircraft.	Airports
Economic impact	Annual economic impact of an airport's operations on the local community, taking into account wages and salaries paid by airport employers, and may include multiplier impacts that include the effects in the community when airport employees make purchases at local retail establishments. Airports may be critical for maintaining functioning of local and regional economies by providing job opportunities.	Airports
Range of pipeline sizes	Represents the capacity of the pipeline. Generally, larger pipelines serve more people and are therefore more critical than a smaller pipeline.	Pipelines
USDOT classification / pipeline contents under the Code of Federal Regulations	Assessment of the contents of the pipelines (e.g., natural gas, petroleum liquids). For example, natural gas could be considered a higher priority because of distribution via a local distribution utility, while consumers may have to travel in order to obtain liquid hydrocarbon fuels. Hospitals and residences more commonly use natural gas rather than petroleum liquid.	Pipelines
Operates local pumping and/or compression facilities	A measure of whether pipeline companies have local facilities, such as booster stations or pump stations. These facilities may be critical for the local or regional pipeline operation, which provides fuel to communities.	Pipelines
Operates local oil refinery	A measure of whether pipeline companies operate local oil refineries. Those companies with local refineries would be considered of higher value as they provide fuel to local communities.	Pipelines

Health and Safety

Criteria	*Description and Justification*	*Relevant Mode(s)*
Role in evacuation	Whether an asset is identified as an evacuation route, or provides a role during weather emergencies and evacuations. These assets may be critical during emergencies to allow for people to evacuate.	Highways Transit Rail Ports Airports
Component of the Disaster Relief and Recovery Plan	Designated roads that have to be cleared for emergency service (fire, police, and rescue) vehicles; rail, port, and airport facilities that are directly involved in Disaster Relief and Recovery Plans. These assets may be critical during disasters for emergency transportation and evacuation.	Highways Rail Ports Airports
Component of the National Defense System	Roads, rail, ports, and airports that have a role in the National Defense System. Serves a significant role in transporting materials, mobilizing personnel and equipment, facilitating recovery efforts during regional, state, or national emergencies. For rail, the class of rail facility is not the primary concern for criticality; rather, the primary concern is that a facility is functioning and able to facilitate critical transportation services. For ports, US Transportation Command (USTRANSCOM) and their Surface Deployment and	Highways Rail Ports Airports

Criteria	*Description and Justification*	*Relevant Mode(s)*
	Distribution Command (SDDC) manage the use of strategic ports for military deployments and sustainment operations. SDDC typically uses marine terminals with the ability load ro-ro and some container cargo. A significant vehicle staging area is required.	
Access to medical, health, and safety facilities	Whether an asset provides direct access or materials to hospitals and other health and safety facilities that are vital for health and human services. Pipelines may provide fuel to operate health and emergency facilities.	Highways Transit Rail Ports Airports Pipelines
Role in hazardous waste transport	Whether hazardous materials are transferred at rail or port facilities. These facilities may be critical for maintaining the movement of hazardous materials.	Rail Ports
Provides support to offshore facilities	Whether airports provide support to offshore facilities (such as oil platforms). These airports may be critical for the transportation of people and materials to offshore facilities.	Airports
Chemical facility anti-terrorism standards (CFATs) compliant	The Department of Homeland Security assesses pipelines based on their being a major system with high potential degree of damage from a terrorist attack. Those facilities thus identified are considered more critical.	Pipelines