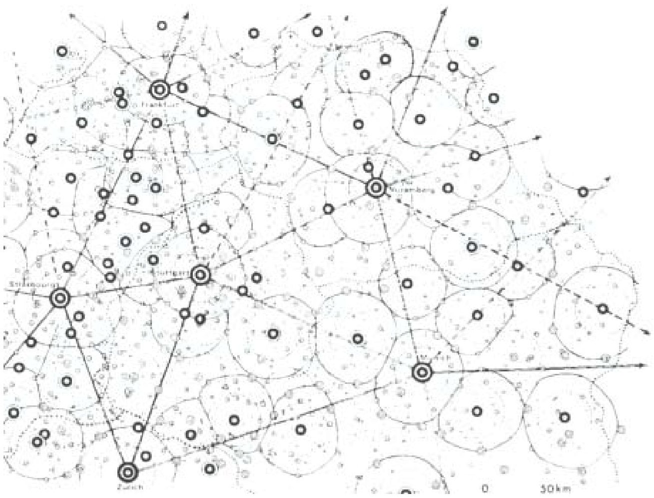


***Our topic is the connections among nodes in the network of human communities; that is, the means and ability people have in order to gain access to other people, goods, and services. The purpose of a multi-modal metropolitan transportation system, like other municipal functions, is to equitably maximize access of citizens to other people, goods, and services, while minimizing access costs, which include personal and collective costs, plus externalities. It is our premise that an efficient access network is a major solution to transportation challenges and the quality of our neighborhoods, towns, and cities.***

## Existing practice

The companion paper called "Implementation Barriers and Policies for Complete Networks" covers this topic. However, we would add the following:

Regional network plans are rarely coordinated with a regional land use scenario. Each jurisdiction (cities and/or counties) also develops network plans within their jurisdictional boundaries.

In most states, transit network planning on a regional scale is conducted by transit agencies and, often, Metropolitan Planning Organizations (MPOs). Transit corridors often cross local jurisdictional lines, and there can be multiple transit agencies responsible for service provision and planning, especially in large metropolitan regions. At times, transit lines will be contained entirely within a city or county boundaries. In this case, planning for the line and connections to the regional network may be spearheaded by the local jurisdiction, or potentially by developers in conjunction with the local jurisdiction.

often not well integrated and are often Transit agencies also maintain adopted capital and operations plans. These plans are typically short-term, covering 3 to 5 years, with some longer-term plans common as well. Because of funding considerations, long-range plans are often codified with regional funding streams, especially for major system expansion projects. It is usually the case that most funding is restricted to roadways and that is the priority of most states and regions.

## Guiding principles for desired practice

The Charter for the New Urbanism says:
"We advocate the restructuring of public policy and development practices to support the following principles: neighborhoods should be diverse in use and population; communities should be designed for the pedestrian and transit as well as the car; cities and towns should be shaped by physically defined and universally accessible public spaces and community institutions; urban places should be framed by architecture and landscape design that celebrate local history, climate, ecology, and building practice."

More recently, the Canons of Sustainable Architecture and Urbanism propose these principles guiding access and mobility:

*General*
7. Buildings, neighborhoods, towns and regions shall serve to maximize social interaction, economic and cultural activity, spiritual development, energy, creativity and time, leading to a high quality of life and sustainability.

*The Region*
3. The physical organization of the region shall promote transit, pedestrian, and bicycle systems to maximize access and mobility while reducing dependence on automobiles and trucks.
4. The spatial balance of jobs and housing is enabled at the regional scale by extensive transit systems. Development shall be primarily organized around transit lines and hubs.

*The Neighborhood, Town, and City*
1. The balance of jobs, shopping, schools, recreation, civic uses, institutions, housing, areas of food production, and natural places shall occur at the neighborhood scale, with these uses being within easy walking distances or easy access to transit.
8. Natural places of all kinds shall be within easy walking distance or accessible by transit.

*The Street, Block, and Network*
1. The design of streets and the entire right-of-way shall be directed at the positive shaping of the public realm in order to encourage shared pedestrian, bicycle and vehicular use.
2. The pattern of blocks and streets shall be compact and designed in a well-connected network for easy, safe and secure walkability. This will reduce overall vehicular usage by decreasing travel time and trip length. Design shall strive to minimize material and utility infrastructure.
*(Another principle extends the network to places inside buildings: "6. Building design, configuration, and sizes must reduce energy usage and promote easy internal vertical and horizontal walkability." There are others having to do with longevity, reuse, economic benefits, affordability, indigenous patterns, and more that should also be considered in this discussion. All the Canons should be involved.)*

These principles put top emphasis on walking and transit. The Networks and Modes group focused largely, but not exclusively, on transit, which accommodates pedestrians, bicyclists, and people in wheelchairs. *(The network for drivers has been the topic of intense discussion in the Context Sensitive Solutions initiative. The group urges a similar for transit service.)*

## Networks and corridors

In roadway planning, the concept of the corridor is a strong metaphor. Most metropolitan development has occurred in corridors which links development for many miles. There is some debate about whether the corridor metaphor makes sense for considering transit nodes or connections. The transit and roadway network at the corridor scale overlaps at key intersections and transit nodes. To move toward more sustainable use of those corridors, they should support mobility by a variety of modes.

Different corridors serve different functions, and these impact the localized and regional links in the transportation network. Corridor usage patterns are tied to the places and nodes along the corridor. Some corridors serve predominantly commute trips, with a heavy directional flow at peak hours, while others connect a multitude of destinations and have a more balanced flow of users.
The current practice does not support thinking across modes at the corridor level. Funding is usually compartmentalized by mode, and the type of interagency and interjurisdictional planning necessary to achieve multi-modal networks at the corridor level is not facilitated in practice. For transportation planners in a region to consider all modes of access and mobility in a place is completely outside the practice, and as a result the quality, and even existence, of each mode is often degraded.

A basic framework for understanding the corridor level network can be illustrated by the diagram at right (developed primarily to discuss transit corridors, this diagram can be applied to other modes as well).

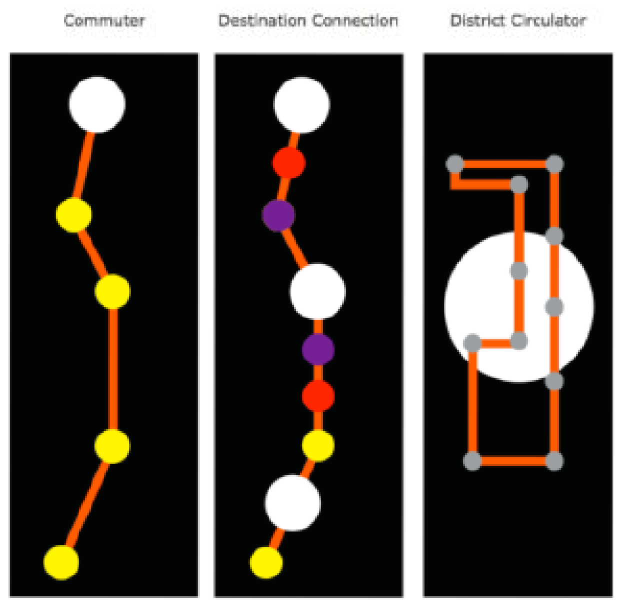


*Figure 7: Three corridor types*

This requires an understanding of the typical range of travel by each mode, and the subsequent spacing of links and nodes at appropriate distances. Once the typical trip distances are understood, the links in the corridor network need to be spaced at intervals that support activity by all modes. If typical walking trips are 1/4-mile not only does this require a network of walkable streets within 1/4-mile of any point, but it also requires connections to longer-distance transportation options within the same distance. Similarly, local transit needs to connect to higher capacity transit within a distance of approximately 4 miles, or it will not serve broader mobility needs. In any corridor, these links must be made along the corridor and as links in the regional network.

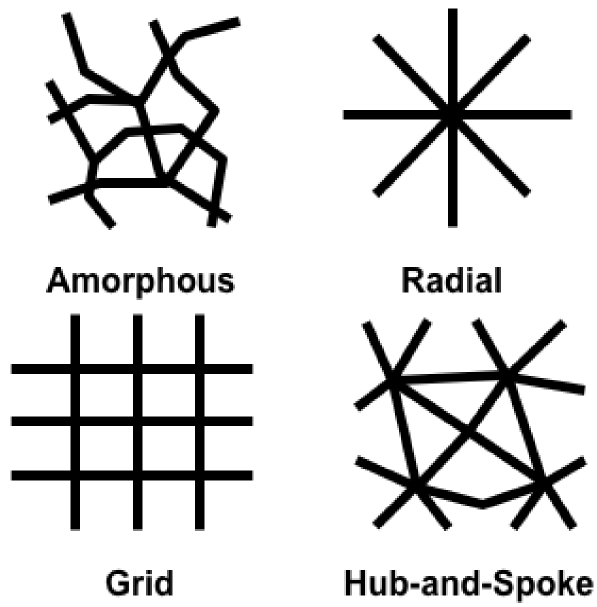
The bicycle and automobile links are more difficult to address through this framework, because they are not clearly part of the same hierarchy as pedestrians and transit trips. Every effort should be made, however, to link bicycle trips to the transit network through secure bicycle parking and bicycle capacity on transit vehicles, as well as park-and-ride opportunities at key nodes along a transit corridor. Parking, in particular, should be considered together with the network of places along a transit corridor, with consideration of both the placemaking and access needs of a particular transit node.

The type of corridor also determines the types of mobility patterns that need to be served. Commuter corridors, whether transit or roadway, tend to have high peak flows in a single direction. In transit networks, these corridors typically have higher auto access mode splits and the places around these corridors have less transit-based mobility for non-commute trips. Places along commuter corridors tend to move along the transect in a consistent progression of transect zones.

Destination connection corridors have less peak flow direction and volume because of the mix of uses in the corridor. In transit corridors, these justify higher levels of mid-day service and have a more balanced modal access profile. A single destination connection corridor may support a range of places, at different places along the transect.

Circulator corridors have almost no peak flow, because they are primarily providing constant access within the corridor. In the case of transit, these corridors have a primarily pedestrian access profile. These corridors tend to stay within a small range of the transect, connecting places that are close to each other in terms of transect zone.

### Network typologies for transit




Several network typologies may be utilized for transit. The traditional radial pattern has given way, in many instances, to grid and hub-and-spoke networks, which can more easily serve the geographically diverse locations involved in today's urban travel. Many transit systems now rely upon hybrid networks that contain elements of more than one network type. Ideally, each is used to advantage in handling the unique nature of the passenger flows to be accommodated. Indeed, urban travel patterns should be the ultimate determinant of transit network design.

Whenever transit service changes are being considered, their impacts on the network should be an important consideration. Do the changes reinforce or undermine the larger transit network? If the latter, is it time to reformulate the network itself? What travel patterns predominate—trips to a central point or those to many dispersed locations? Is frequent service economically sustainable, or is a timed-transfer-based system more realistic? The answers to these and similar questions can lead to service changes that are positive not only for those using the individual lines which are involved, but for riders throughout the larger transit system.

*Network typologies are explored in the paper " Transit Networks" by William Lieberman.*

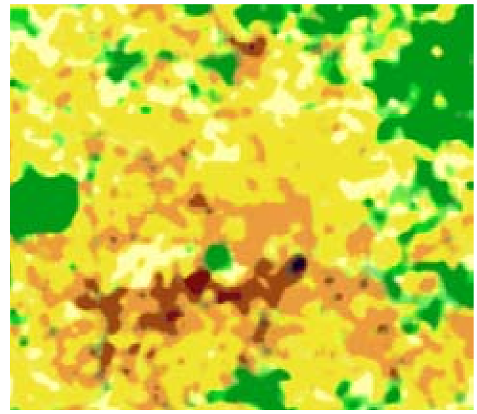
### Identifying new nodes for a transit network

The fundamental first question is how to identify nodes for new transit service.

Research[1] by Newman and Kenworthy suggests that the most powerful way to maximize utility, minimize cost, and reduce automobile dependency is to measure "activity intensity" across the region and its cities, towns, and neighborhoods. Activity intensity is the sum of residents and employees in an area. Those two uses of a place make up most of its activity intensity[2], and those are the best places to provide service.

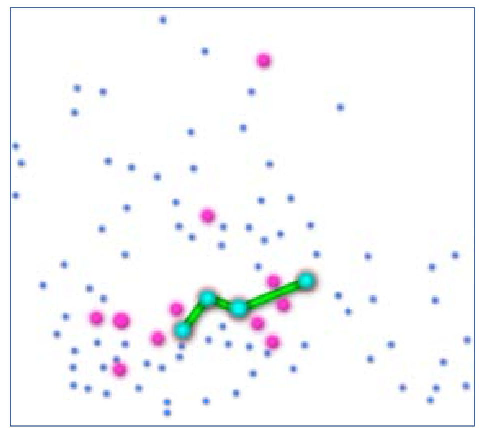
1. "Urban Design to Reduce Automobile Dependence," Peter Newman & Jeffrey Kenworthy. Published in Opolis: An International Journal of Suburban and Metropolitan Studies Vol 2, Issue 1 2006

The concept provides a set of metrics to guide choice of service capacity and frequency. How this might play out is demonstrated by applying the principles to the Houston region, in the series beginning above.



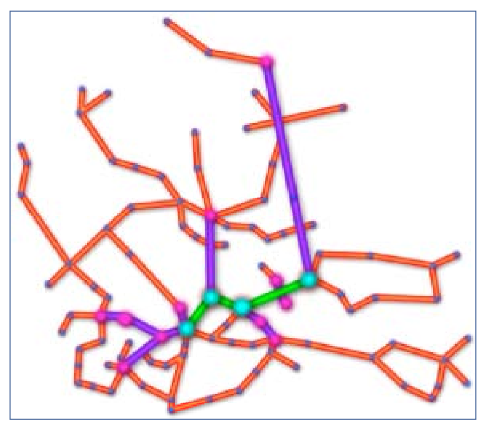
The top image shows activity intensity with black as the most intense areas, and green as the least intense (greenspace, rural). The area is about 30 miles across.

From a much larger image, it is easy to identify sets of centers beginning with the most intense and going down to lowest level of intensity that is still able to support some form of transit service. (about 14 jobs + pop people/acre).



The map at right shows three sets of centers and connects the biggest ones, as the highest priority for high-quality, high-capacity transit service.

The map at bottom right shows one quick way to build out that whole network, beginning with the delivery of the best possible service to the second tier of centers connected to the backbone.



Having that picture of a region in mind can guide investment, always moving to the next low-hanging fruit in terms of potential ridership with the least infrastructure.

There are many questions that arise, beginning with whether smaller centers along the route should have stations or not. Each stop increases trip time. Should we view the biggest centers as "cities" needing a nonstop inter-city line?

*This idea is explored further in the document "Activity Intensity and Transit Networks," by David Crossley. It is based on the work of Newman and Kenworthy in the document "Urban Design to reduce Automobile Dependence."*

## Generative capacity

Generative capacity for the region directly impacts mode, which supplies the network services to the places. A regional network must be able to supply the nodes at the center of the places as all are based on node/place access. All converges on the node, allowing each place maximum generative capacity and the ability to overlay multiple layers of network (i.e. modes) in a meaningful uncontradictory way: pedestrian, bikes, transit, cars, trucks, emergency services, information and education, jobs and money, people, goods, nature and natural resource access, other services.

2. A place's status as an attractor is the third consideration

Assuring districts remain workable for as many modes as possible, especially pedestrian, meaning pedestrian traffic cannot be cut off from accessing the node by bad traffic management like trucks and high speed cars, while ensuring that more cumbersome modes can also get there.

The districts/places focus must also be able to evolve in time without hindering these multiple mode accesses. Then, the networks of modes often coalign with the overlaying levels reinforcing the viability of each other.

From the paper "ITE Framework Model" by Andrew Gast-Bray.

### Types of transit service

Most discussions about regional mobility focus on commuters, particularly on the traditional peak hours at the end and beginning of the day. But about 83% of trips each day are not about commuting; essentially, they are about miscellaneous errands. Even at peak hours, huge percentages of the travelers are not commuting. To the extent nodes in the network can provide amenities without requiring non-pedestrian trips, demand for transportation might be reduced sufficiently to mitigate peak-hour demand.

We see essentially two kinds of transit service, what we call suburban and urban. While "urban" has a specific meaning in New Urbanism, and "sub-urban" means less than urban, these two terms are commonly used to describe geography, not characteristics or performance.

So suburban transit tends to mean longer trips, two of them per day, that serve home-to-work and back, and the passengers tend to arrive by car. Suburban service is often built in railroad rights of way and freeways in order to go fast and cover great distances. Urban transit tends to mean multiple, short trips per day, that serve home, work, study, play, and so forth. Passengers arrive on foot, so urban transit is usually built in streets (or under them) to provide service where people are.

### The Neighborhood Scale

At the neighborhood scale, the imperative in network planning is to provide broad access and safe circulation by a variety of modes. This requires a network with a range of route choices, but routes do not always need to overlap among modes. While some individual links may be designed to accommodate all modes of travel, others may be weighted more toward one or two (e.g. bike boulevards that prioritize bicycle mobility over all other forms).

The typical suburban street pattern fails in this regard, because it often only provides the network at one modal scale, that of the automobile, while failing to provide safe and convenient links for other modes.

Traditional city grids, with a network of similar streets on the other hand, provide the route choices necessary for successful multi-modal network planning, but often lack the street and route hierarchy that links back to corridor-level planning, and the desire for continuous, connected links. Attempts to create hierarchies within this type of street network have often led to design solutions that prioritize automobile mobility over other modes. A lack of on-street parking, and narrow sidewalks, for example, all recreate a network more favorable to automobile mobility, despite the same pattern as a multi-modal network.

Traditional city grids are not the only pattern that can support the multi-modal network. At the neighborhood scale, some disconnected grids with continuous links to other neighborhoods can serve a variety of modes. In non-grid configurations, however, the connector links need to serve more multi-modal functions on the same roadway than in more diffused networks in order to accommodate all modes of travel.

The existing practice measures success through metrics such as automobile Level Of Service (LOS), which prejudices against design solutions that support mobility and access by other modes of travel.

At this scale, modal network planning has the greatest overlap and interaction with land use planning and place-based thinking. Development intensity and configuration has a strong interaction with how the transportation network is planned and implemented. However, this interaction is not recognized in the current practice. This leads to plans that call for retail uses in places not well served by the multi-modal network, difficulty accessing transit stops and stations from development nodes, and myriad other disconnects.

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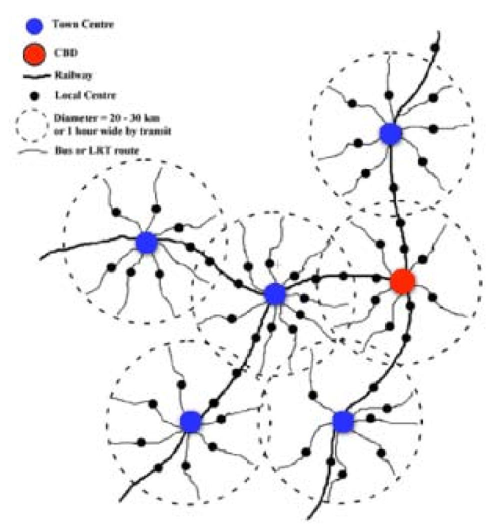
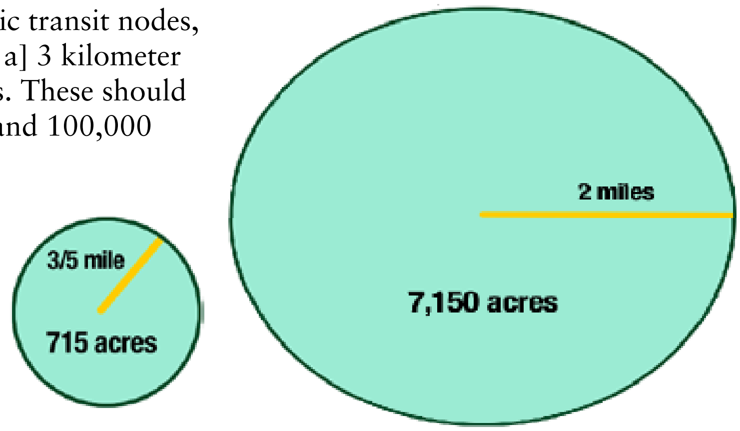
### Reconstructing an automobile city

In Newman and Kenworthy's research on reducing automobile dependency, they also propose "A Conceptual Plan for Reconstructing an Automobile City," shown at right. It treats suburban centers as satellites of several major activity centers (as opposed to only the original downtown core). It supposes a hierarchy of centers and proposes the growth of those centers, all linked in a network. They refer to each of the major nodes-with-satellites as "transit cities," each 20-30 kilometers in diameter. In such a group of centers, obviously there would be other ways to connect them, to build the regional transit network.




### Pedestrian & bicycle sheds

Newman and Kenworthy say "The redevelopment or new development of urban areas can facilitate the reduction of automobile dependence if Ped Sheds of 300 hectares [about 715 acres] [with a] 1 kilometer radius [about 3/5 of a mile] are used around Local Centers/public transit nodes, and 3,000 hectares [about 7,150 acres] [with a] 3 kilometer radius [about 1.9 miles] around Town Centers. These should have minimum development goals of 10,000 and 100,000 people+jobs, respectively.

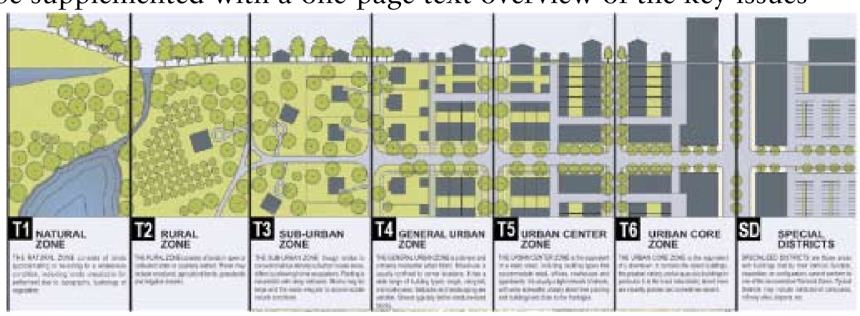



### The Transect

How can the Transect be used to guide design and decisions? In our early discussion, we explore this direction:

Produce three matrices, each developed along the Transect, that show:

- desired network spacing per mode (most likely a range, citing examples from model communities)
- various facility/transit types appropriate within each Tzone
- concise technical specifications for application of each facility type and integration to form a complete network. This will be supplemented with a one-page text overview of the key issues for each matrix, similar to the SmartCode Annotated pages.




We view this as a way to explain the neighborhood scale and a way to talk about parts of corridors as they move through transect zones. Node standards are also desired to be developed as the way to integrate modes within various place types.

Suburban commuter vs. urban transit - what works in each transect? Use the above matrix to focus on desired characteristic and outcomes?

Employ a full range from local buses to high speed rail – Mode should fit transect

### Right of way

If the nodes are identified, the question then is what right of way allows the network connections to be made? In looking at the major highway system in a region and comparing it to the activity intensity map, it is clear that the centers have largely evolved because of that highway system. So the obvious first place to look for transit right of way is in that existing infrastructure. This contrasts with the common practice of using the existing freight rail corridors for commuter transit. Many regions, certainly Houston, long ago ceased to have the most jobs and activity in the old rail hub, the central business district. Today, the polycentric nature of metropolitan areas requires looking for different approaches.

### Major discussion topics

- How does multi-modal network planning interface with place and land use planning? How do

we see transit as integral to regional growth and land use patterns?
- How do we balance funding for all modes of travel?
- In diffuse networks, how are the links aligned and connected?
- What are the goals of the multi-modal network, and how do all modes fit into this framework?
- How do we communicate the multi-modal network in simple graphic terms to others?

## Other considerations

*General*

Consider long-distance city to city connects

How do network requirements vary in different Transect Zones?

How to minimize negative impact of one mode on another

Need to focus primarily on non-commute trips (about 83% of daily trips) Need diagrams with the power of the Transect

*Transit*

What goals should we have for transit service? (reduce SOV commuting trips? Reduce SOV non-commuting trips? Provide more mobility choices?)

What transit service is appropriate at these levels:
- Region
- City
- Town
- Neighborhood
- Block

What spacing of stations is appropriate at what scale?

How do we improve transit service at existing, connected nodes?

How should transit serve drivers of cars?

How should transit serve bicyclists?

Using demand service to slowly increase technology and service (to begin to build demand)

*Cars & Trucks*

Need to focus on the non-highway car and truck network

Are there street types that lend themselves to multiple links in the modal networks (e.g. multi-way boulevards that can accommodate many modes)?

*Pedestrians*

Two major principles grow out of the guiding principles of the Charter and the Canons:
- There should be a safe pedestrian realm around the transit station area that is comfortable, convenient, enjoyable, interesting, and useful.
- The area should provide a variety of amenities and services throughout the pedestrian realm, including residential opportunities.

How do pedestrians access other modes in the network?

What are the minimum and ideal configurations for pedestrian ways?

What are the conflicts that must resolved for pedestrians?

Pedestrian (and bicyclists)
- Convenience of amenities
- Safety
- Comfort
- Spacing of facilities
- Node standards
- How does these vary in the Transect?

Should portions of station areas be car-free?

*Wheelchairs*

Needs discussion