DESIGN FOR HEALTH
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Health Impact Assessment

Threshold Analysis Workbook

Version 4.0

DESIGN FOR HEALTH is a collaboration between the University of Minnesota and Blue Cross and Blue Shield of Minnesota that serves to bridge the gap between the emerging research base on community design and healthy living with the every-day realities of local government planning.

UNIVERSITY OF MINNESOTA

Design for Health
www.designforhealth.net

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Health Impact Assessment Threshold Analysis Workbook
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Contents

Background: Design for Health HIA Threshold Analysis

This Design for Health (DFH) threshold workbook is part of a suite of health impact assessment (HIA) tools, including a preliminary checklist and an HIA rapid assessment. These HIA tools are unique because of their focus specifically on health issues related to urban and comprehensive planning. The three tools are designed to be used by those engaged with planning. They target issues where there is evidence that aspects of the built environment affect health and where planners have increased capacity to influence outcomes.

Different HIA approaches tend to be either very broad (considering a range of social issues potentially associated with health and well-being), or can be narrowly focused on only those issues with significant public-health data available. In contrast to these broad and narrow HIA approaches, these subject-specific Design for Health HIAs focus on the interests of urban planners and on areas where there is specific evidence of health effects. Urban planners already undertake a wide variety of environmental impact assessments, fiscal impact assessments, visioning processes, and sustainability and livability assessments. These HIA tools are meant to be a relatively easy way to supplement these activities and focus attention on human health.

A number of theoretical models are used in public health to examine the determinants or factors causing health or health problems. These factors typically involve biology, individual behavior, social and economic context, access to various services, and the environment. The HIA tools focus primarily on topics within the domain of the city or urban planning profession. It is important to note that there are a number of issues that are omitted from the HIA due to lack of clear evidence of a connection to health or lack of a role for planners in influencing particular health outcomes. Please refer to the *Caveats for HIA* appendix where we identify some of the issues that users of the HIA Threshold Analysis should be aware of when applying the tool for specific purposes.

How to Use the Design for Health HIA Threshold Analysis Workbook

The threshold analysis workbook can be used alone or in conjunction with the more participatory DFH rapid assessment described at http://www.designforhealth.net/techassistance/hiarapidassessment.html. The DFH preliminary checklist, however, precedes both of these HIA tools. Part one of the checklist determines whether the project or plan is significant enough to assess. Part two provides a tool to examine specific health topics. Instructions for finding the checklist are below.

This DFH threshold analysis workbook uses a point-based scoring system not unlike others used in planning and urban development, such as the LEED documents—LEED for Neighborhood Development (LEED-ND) rating system pilot version and LEED for New Construction (LEED-NC) rating systems. The threshold analysis is designed to be shorter and more straightforward to use than many of other tools that are available and focus specifically on human health rather than the natural environment.

Organization of the Workbook

The workbook focuses on a set of topics where there is evidence for links between human health and the built environment. Companion research summaries are published in the *DFH Key Questions* series available at http://www.designforhealth.net/techassistance/researchsummaries.html. While some research is mentioned in this workbook, the key questions sheets contain more detail. The *DFH Information Sheets* series explains how to translate the research into plans and ordinances and is available at http://www.designforhealth.net/techassistance/planningissues.html.

The complete list of health topics addressed in the Design for Health project, including the HIA threshold analysis, includes:

- Accessibility
- Air Quality
- Environment and Housing Quality
- Food
- Mental Health
- Physical Activity
- Safety
- Social Capital
- Water

The needs of specific populations, such as children, seniors, those with health problems, and those without cars, are integrated into each topic where relevant.

For more information including the justifications of thresholds and associations, please refer to the key questions research summary series online at http://www.designforhealth.net/techassistance/researchsummaries.html.

In this workbook, each health topic includes one or more thresholds or associations to be addressed in order for a comprehensive plan, development project, or policy to receive points. Plans or projects with more positive impacts on health, receive more points. For the purposes of this HIA, thresholds and associations are drawn from previous research examining the link between human health and the built environment are defined as follows:

- *Thresholds* are based on research evidence that provides numerical targets for healthy development. They are derived from a careful reading of existing literature, taking into account where several research studies agree on a particular phenomenon. There is great agreement, for example, that air quality within a few hundred meters of major roads can be a health problem, particularly for vulnerable groups, such as children. Please refer to the key questions sheets for each topical area.

- *Associations* are conditions that should be accounted for and, through a careful reading of existing research literature, have been shown to have positive or negative health effects. While there may be agreement on the nature and direction of the indicated associations, the particular phenomena may not lend itself well to the numerical precision suggested in the thresholds. For example, a number of studies have found that views of even small amounts of vegetation can improve mental health; the numerical precision of how much green space, however, remains unclear.

Workbooks such as this can take different approaches. They can be checklists of whether a feature is present or absent; a checklist format tends to be easier to defend but most often assigns equal weight to each question. Alternatively, an approach can assign weighted scores to more important topics or more value and reward plans that go beyond a minimum; however, many of the assigned points can seem arbitrary in how much they assign to different categories. In this application, the points attached to each threshold and association in the HIA analysis represents our best judgment of the relative importance of the health issue and the strength of the research on which the thresholds and associations are based. The point system on page five represents our best attempt to find a middle ground.

Step 1: Preliminary Assessment

As a first step, conduct part one of the DFH preliminary checklist. The checklist is available at: http://www.designforhealth.net/techassistance/hiaprimchecklist.html. The first part is used to determine

whether the development project, comprehensive plan or policy, based on its characteristics, is significant enough to assess. Measures of significance include:

- Geographical extent
- Reversibility
- Population size
- Cumulative impacts
- People affected
- Land-use importance
- Institutional capacity

In addition, part two of the DFH preliminary checklist identifies potential impacts on health topics, such as air quality and safety. Completing part two will help identify if a further HIA is needed, such as this threshold analysis. For consistency, all of the health topics in part two of the DFH preliminary checklist are also included in this workbook.

Step 2: Threshold Analysis Workbook

If it is determined that the project, plan or policy is significant enough to assess, the next step is to proceed to the HIA threshold analysis.

Components of the Threshold Analysis

The threshold analysis has several interrelated parts and is organized by the nine different health topics noted above. Some topics have only one issue evaluated as a threshold or association and others have two or three; the thresholds and associations are drawn from previous research which may or may *not* have one or more pieces of specific evidence related to connections between the built environment and health. The sections that follow provide information about each of the health topics and the manner in which they are addressed in the HIA. Then, for each threshold or association, the following information is provided in a table form:

Intent	A brief description of the significance of the health topic, including key research findings.
Rationale	A description of the relationship between the health topic and the built environment. **For more information including the justifications of thresholds and associations, please refer to the key questions research summary series online at http://www.designforhealth.net/techassistance/researchsummaries.html**
Requirements	Specifies the plan, policy, or project outcome to be achieved.
Definitions	Additional information about key terms and measures relative to requirements.
Submission	Possible evidence to be used to illustrate consistency with the requirements, often with multiple options provided.
Credits Available	The range of credits or points to be applied to a plan, policy, or project based on the extent to which it meets the requirements. The number of credits specified relates the strength of the research on which the thresholds and associations are based to the magnitude of the health benefit associated with the design of the physical environment. There are many factors at play in assigning points. In some situations, there may be exemplary circumstances that may not fully comport with the line of thinking put forth in the reasoning of different points, but are beneficial conditions for health in their own right. In these cases we assign bonus points.
Credits Awarded	

This format allows for detailed discussions of each health topic and the relevant thresholds and associations, as well as the pertinent information related to documenting progress in meeting them. The following score sheet summarizes the credits available in the HIA threshold analysis.

HIA Threshold Analysis Score sheet

Topic, Threshold or Association	Credits available				Total credits available	Credits Awarded
Topic: Accessibility					**18**	
Transit service (Threshold)	9	7	4	2	9	
Transit stops (Threshold)	9	6	3	1*	9	
Access to health care facility (Association)				2*		
Topic: Air Quality					**18**	
Distance from a freeway for residential uses and uses occupied by children (Threshold)	9	7	4	2*	9	
Polluting uses (Association)	6				6	
Air quality mitigation (Association)	3	1			3	
Topic: Environmental and Housing Quality					**7**	
Minimize exposure to lead (Association)	7				7	
Topic: Food					**12**	
Distance to a supermarket or fruit and vegetable shop (Threshold)	12	8	5	1*	12	
Topic: Mental Health					**7**	
Views of green (Association)	7				7	
Topic: Physical Activity					**12**	
Access to playing areas, parks and trails (Association)	6	3	1	1*	6	
Access to trail system (Association)	6	3	1		6	
Topic: Safety					**12**	
Lighting (Association)	4				4	
Complete streets, traffic calming, and safety features (Association)	8	4			8	
Topic: Social Capital					**2**	
Housing options (Association)	2				2	
Topic: Water Quality					**12**	
Groundwater and drinking water quality (Association)	5	1				
Surface water quality (Threshold)	7	3				
Total Credits--Potential and Awarded					**100**	

*bonus point

Topics

Topic: Accessibility

Being able to reach a variety of destinations (e.g., jobs, financial institutions, social contacts, health services, or grocery stores) is critical to many dimensions of a healthy community. Particularly for the elderly, the young, people with disabilities or the financially disadvantaged, transit is the mode of transportation that provides such access (where walking or cycling is too burdensome).

Providing for transit accessibility requires that: first, transit is available; second, the available transit service is of reasonably high quality (defined below); and third, transit is provided for different trip purposes. It also requires thinking about the design of these modes so that they are usable by as many people as possible, regardless of age, ability or circumstance, following the principles of universal design with accessible paths, inviting waiting facilities, and other similar features (NC State University 2004).

A useful place to start in promoting accessibility is to make opportunities available for transit service, in terms of service frequency and location. Density is a critical dimension, though certainly not the only dimension to consider. While specific density thresholds will not apply to every city, type of transit service, or destination people want to travel to, available research has honed in on minimum thresholds for intermediate bus transit with one-half mile between bus stops.

Available thresholds suggest at least 4 units per gross acre is an absolute minimum residential density for hourly transit service to be feasible. Hourly transit service is a minimal provision. Hourly service corresponds to the minimum level of service (LOS) "E" value for service frequency on a scale of A to F, where A is very frequent. It is also the minimum frequency used for determining hours of service and LOS (Pushkarev and Zupan, 1982). For this reason, 7 units per gross acre is a preferred alternative. What happens when the development or plan proposal applies to employment centered land uses, rather than residential? An alternative way to approach the issue of assessing suitable thresholds for transit is to consider the number of employees per acre. For example, research based in King County, Washington found substantive modal shifts from auto use to transit use and walking with densities between 20 and 50 employees per gross acre and even more so when densities exceeded 125 employees per gross acre (Frank and Pivo, 1994).

A second criteria is to ensure that areas around both work and residential environments contain transit stations within 1200 m (3,937 feet, or three-quarters of a mile) of all destinations. This threshold helps to attract as wide a trip-shed as possible. It is based on analysis of how far people are prepared to walk to transit, using data from thousands of transit boardings in the Twin Cities. It is at 750 meters (2,460 feet) that a considerable drop-off in the number of persons walking to transit (Iacono, Krizek and El Geneidy, 2007).

Transit service (Threshold)

Intent	Ensure adequate transit service.
Rationale	Transit service not only provides alternatives to auto-travel, but provides means of mobility for the elderly, young and/or financially disadvantaged.
Requirements	Residential components of the plan are built at an average of at least 4 (preferably 7) units per gross acre.
Definitions	Net acres are often referenced in zoning codes and consider only the developed area. Gross acres refers to the total land area, which may include streets, parks, water features, and other land not used directly for residential or employment-related development.
Submission	• Site plan with residential (or employment) density calculations. • Density calculations based on analysis completed at the block group level or smaller.
Credits Available	9 points: An average of more than 10 residential units / gross acre or more than 50 million sq. ft. commercial/office space in the study area. 7 points: 9 units / gross acre or 35-50 million sq. ft. commercial/office space in the study area. 4 points: 7 units / gross acre or 8-20 million sq. ft. commercial/office space in the study area. 2 points: 4 units / gross acre or 5-8 million sq. ft. self-contained commercial/office space in the study area.
Credits Awarded	

Transit stops (Threshold)

Intent	Ensure that residents can conveniently walk to transit service.
Rationale	On average, people are willing to walk up to 1200 m (three-quarters of a mile) to access a transit stop.
Requirements	All residential or employment areas are located within 1200 m distance of a transit stop with hourly service.
Definitions	A transit stop is a bus or train stop with service at least every hour during the daytime on weekdays and weekends. The "walking-transit-shed" area is an area within a 1200 m walk from each transit stop.
Submission	Site plan showing the location of transit stops, complete with 1200 m "walking-transit-shed" area highlighted for each stop, This is a street network buffer and can be easily produced using GIS—use the Service Area Analysis in the Network Analyst Extension in ArcGIS 9.2 and later.
Credits Available	9 points: Entire developed area is shaded within the "walking-transit-shed." 6 points: Fifty-percent of the developed area is shaded within the "walking-transit-shed." 3 points: If there are any transit stops within the study area that run with at least hourly service during the week from 9am-5pm. 1 bonus point: A rural transit program is provided in the community.
Credits Awarded	

Access to health care (association)

Intent	Provide access to health care facilities.*
Rationale	*Forthcoming in a supplemental Key Question Research Summary on facilities.*
Requirements	Health care facilities located within 20 miles (32 km) of all residences.
Definitions	Any health care facility and/or an establishment with a NAICS code beginning with 621 or 622.
Submission	Map showing the location of existing (or proposed) health care facilities and a 10 and 20 mile network buffer around each (easily done using the Service Area Analysis in the Network Analyst Extension in ArcGIS 9.2 and later versions).
Credits Available	2 bonus points: All residents are within a 10 mile distance of a hospital or other acute care facility 1 bonus point: All residents are within a 20 mile distance of a hospital or other acute care facility
Credits Awarded	

*For more information on access to health care facilities, please refer to the Caveats for HIA appendix.

Future work may provide credits for non-polluting vehicles.

Topic: Air Quality

Good air quality is key for promoting respiratory health. The main sources of air pollution are area sources (e.g. dry cleaners, lawn mowers), mobile sources (e.g. cars, trucks, off-road equipment), and stationary sources (e.g factories, power plants). The different sources produce various types of pollutants that can cause problems for respiratory, cardiovascular, and prenatal health, and cancer. Locating sensitive land uses, such as schools, day care centers, and playgrounds, close to polluting facilities or major roadways can raise health concerns for the populations that use them (Frumkin et al. 3004; Gehring et al. 2002; Grahame and Schlesinger 2007; Hitchins et al. 2002; Van Vliet et al. 1997; Garetano and Gochfeld 2000; Schreiber et al. 2002; Kobrossi et al.) Some pollutants tend to have a greater effect over an entire metropolitan area and others drop off fairly quickly away from the source (Hitchins et al. 2002). The air quality thresholds used in the HIA deal particularly with this latter category.

Another issue related to the air pollution impacts is the extent to which vegetated buffers are provided to mitigate some of the impacts of being located near polluting sources, such as roadways. While varied by plant species, pollutants, wind, and climatic factors, vegetation is capable of absorbing air pollutants (Kahn and Abbassi 2000). We measure this through tree canopy. Tree canopy can be measured from aerial photographs or satellite imagery. Tree canopy measurement is a fast moving field with new developments every year. For a discussion of methods see http://www.phytosphere.com/treeord/ordprt3c.htm.

Distance from a freeway for residential uses and uses occupied by children (Threshold)

Intent	Prevent respiratory diseases and premature births.
Rationale	Studies show decreasing particulates, respiratory diseases and premature births as distance from major roads increases. Residential areas, schools and playgrounds are key environments for sensitive populations.
Requirements	Residential areas, schools, day care facilities, playgrounds and sports fields should be more than 200 m (656 ft) from a major road.
Definitions	A major road is defined as having an average annual daily traffic (AADT) > 40,000, a freeway or a road with six or more lanes. Uses occupied by children include schools, day-care facilities, playgrounds, and sports fields. Canopy refers to the horizontal extension of a tree's branches in all directions from its trunk.
Submission	Comprehensive plan map or site plan that depicts relevant land uses: (a) all roads in the area with AADT > 40,000, (b) a 200 m (656 ft) buffer from each major road, and (c) a 500 m (1640 ft; 1/3 mile) buffer from each major road.
Credits Available	9 points: There are no residential uses, schools, playgrounds, sports fields, and day care facilities within 500 m of a major road and the buffer area has complete canopy. 7 points: Same as above but the buffer lacks tree canopy. 4 points: There are no residential uses, schools, day care facilities, playgrounds, and sports fields within 200 m of a major road. 2 bonus points: If there is 50% tree canopy in entire study area.
Credits Awarded	

Future work may expand this to airports and to other population groups such as seniors.

Polluting uses (Association)

Intent	Limit the amount of pollutants in the plan or project area.
Rationale	Certain businesses contribute disproportionately to air-quality problems.
Requirements	Non-residential uses need to be non-polluting or have adequate air pollution reduction technologies.
Definitions	Certain businesses that disproportionately contribute pollutants (e.g., certain dry cleaners, automotive paint shops, manufacturing plants).
Submission	List of non-residential uses and/or ordinance requiring pollution-reduction technologies.*
Credits Available	6 points: If any *one* of the following is satisfied: • There are no polluting non-residential uses, • Polluting sources are regulated locally as well as by state and federal governments with the specific intent of further reducing pollution.
Credits Awarded	

*For examples of local ordinances, please visit:
http://www.designforhealth.net/techassistance/aqordinances.html

Air quality mitigation (Association)

Intent	Mitigate existing pollutants.
Rationale	There is some evidence that well designed plantings can reduce air pollutants, specifically by helping remove particulates. The ability of plants to improve air quality, however, depends on plant species, pollutants, wind, climatic factors, etc., and the topic needs more research.
Requirements	Tree canopy should be provided.*
Definitions	A major road is defined as having an average annual daily traffic > 40,000, a freeway or a road with six or more lanes. Canopy refers to the horizontal extension of a tree's branches in all directions from its trunk, while canopy coverage is the combined density of canopy provided by multiple trees over a geographic area.
Submission	A detailed canopy analysis (using aerial photographs), a detailed planting plan, land cover information if it distinguishes between turf and tree cover, and/or tree preservation/replacement ordinance.
Credits Available	3 points: If any *one* of the following are satisfied: • 100% of major roads lined with street trees continuously on at least one side. • 75% of canopy coverage in plan area (for plan). • Onsite planting of trees to reach a projected 75% canopy coverage (for project). 1 point: If any *one* of the following are satisfied: • 50% of major roads lined with street trees continuously on at least one side. • 50% of canopy coverage in plan area (for plan). • Onsite planting of trees to reach a projected 50% canopy (for project) • Tree preservation or replacement ordinance is in place.
Credits Awarded	

* Definitions and credits may be modified in subsequent versions.

Topic: Environmental and Housing Quality

Where people live, the quality of their housing, the places where their children play, and other factors may expose them to pollutants and significant health risks, such as lung disease, lead poisoning, cancer, reproductive problems, birth defects, headaches, and more. These risks may be associated with nearby land uses, previous activities on a site, building materials, and housing quality (Lanphear and Roghmann 1997, Lanphear et al. 1998, Farfel et al. 2005, Miles 2005). While water and air are the primary conveyances for pollutants, exposure can also occur through contaminated soil and direct exposure to toxins and chemicals in the home or workplace environments (Paustenbach et al. 1997, Hood 2006, Renshaw et al. 2006).

Environmental mitigation (Association)

Intent	Minimize exposure to lead.
Rationale	There is evidence that exposure to dust and soil contaminated with lead can lead to health problems in humans, especially in children who are still growing.
Requirements	Sources of lead, as well as contaminated soil and dust, from previous uses, should be removed and cleaned to highest possible standard.
Definitions	na
Submission	Documentation illustrating that policies are in place that require that lead-bearing substances are not used in any exposed surface of a dwelling unit, child care facility, school, or recreational facility used by children.
Credits Available	7 points: Planning policies are in place that require that lead-bearing substances are not used in any exposed surface of a dwelling unit, child care facility, school, or recreational facility used by children
Credits Awarded	

* Definitions and credits may be modified in subsequent versions.

Topic: Food

Inadequate nutrition is associated with chronic diseases and conditions, such as cardiovascular disease, hypertension, stress, cancer, diabetes, low birth weight, obesity, and anemia. A significant contributor to dietary quality lies in access to healthy foods at a reasonable cost.

Planners often assume that access to supermarkets is the key issue linking food and planning. However, an additional concern centers around the quality of the food people have access to, particularly for those persons reliant on walking or transit. In terms of the built environment, a key question is whether people who live closer to stores and restaurants—particularly those with healthier options—eat better than those who live further away. Little research has looked directly at this issue, while there is evidence on two related issues: poor people have fewer nearby healthy food options or more nearby unhealthy ones, and poor people eat less healthy foods Cummins et al. 2005; Zenk et al. 2005; Moore and Diez Rioux 2006). It is not clear, however, that the reason poor people have less healthy diets is distance to food stores, as there are many explanations, including price and preferences (Drenowski 2004). Research shows stronger links between access to supermarkets and healthy eating than access to fast food and unhealthy eating (Morland et al. 2002; Burdette and Whitaker 2004; Laraia et al. (2004)).

While many people are interested in community gardening and farmers markets, they are limited in time of year and opening hours.

The threshold below focuses on access to healthy food, particularly for those without cars. Beyond the distance between a healthy food vendor and a residence, there are other factors to consider such as transportation options as highlighted in the section on accessibility.

Distance to a supermarket or fruit and vegetable shop (Threshold)

Intent	Provide access to fruits and vegetables.
Rationale	Studies show distances to supermarkets have the clearest effects on health. We also assume that fruit and vegetable stores would have similar benefits.
Requirements	Supermarkets or fruit and vegetable stores within 1600 m (1 mile) of all residential areas.
Definitions	A supermarket or fruit and vegetable store is a farmer's market or an establishment with a NAICS code of 445110 or 455230.*
Submission	Map showing the location of existing (or proposed) supermarket or fruit and vegetable stores, and a 1600 m network buffer around each (easily done using the Service Area Analysis in the Network Analyst Extension in ArcGIS 9.2 and later versions).
Credits Available	12 points: Entire developed area is covered by the buffer. 8 points: If 50% of the developed area is covered by the buffer. 5 points: If 25% of the developed area is covered by the buffer. 1 bonus point: There is a farmer's market (during summer months) within the buffer area. 1 bonus point: There are rural transit services (e.g. paratransit services) to and from a full-service grocery store
Credits Awarded	

* Definitions and credits may be modified in subsequent versions.

Topic: Mental Health

Recent data show that depression and other mental-health disorders will account for some of the world's largest health problems in upcoming decades (Maller et al. 2005). However, research reliably suggests that direct contact with vegetation or nature leads to improved mental health and psychological development (Ulrich et al. 1991; Kaplan and Kaplan 1989; Ulrich 1984; Maller et al. 2005). People do not have to actively use nature to benefit from it; rather, visual exposure is enough (Kaplan and Kaplan 1989; Ulrich 1984; Moore 1981; Parson et al. 1998). It is important to consider that different groups of people have differing views of what constitutes nature in the built environment, with variation by education level, age, ethnicity, profession, residential location, and other factors (Talbot and Kaplan 1984; Kuo et al. 1998; Gobster 2002; Talbot and Kaplan 1993; Forsyth and Musacchio 2005). The amount, size, quantity, and type of green space differ from study to study, making it difficult to develop thresholds associated with nature and the built environment.

For planners, the connection between nature and/or green space and mental health has implications when planning streets and parks.

Views of green (Association)

Intent	Provide views of green spaces, with canopy trees, from all buildings or dwellings. These may include parks, tree-lined streets, and tree-covered neighborhoods.
Rationale	Having access to views of green space serves to reduce stress and improve mental health.
Requirements	Provide views of green spaces, with canopy trees, from all buildings. These can be trees at the street level or, for those living in taller buildings, views to parklands or other green spaces
Definitions	Canopy is the top layer of a tree, including branches and foliage.
Submission	Provide tree inventory and/or plan for the municipality or the development and its context as well as accounts (sketches or other visual documentation) of views in multiple directions.*
Credits Available	7 points: If any one of the following are satisfied: • A majority of streets are lined with trees, • There are several pocket parks or larger around major employment and residential areas; or • There are views of green from the windows of most housing/work locations.
Credits Awarded	

* Definitions and credits may be modified in subsequent versions.

Topic: Physical Activity

Concerns about rising levels of obesity and cardiovascular disease have led to a considerable amount of attention to how the built environment can be designed to create more opportunities for physical activity (Mokdad et al. 2003). Physical activity is pursued in four purpose-related activity categories: work-related, household-related, recreational or leisure-time, and transportation-related. Some have hoped that by creating environments that increase travel walking and cycling, total physical activity will increase. However, research to date is mixed, particularly in terms of whether the environment rather than social and psychological factors affects total physical activity. What matters is creating opportunities for physical activity, rather than saying one environment is healthier than another.

The Design for Health project is primarily concerned with walking and/or cycling pursued outdoors for recreation or travel (as opposed to physical activity indoors in health clubs or on a treadmill or for job-related purposes). Providing access to playing areas, parks and trail systems allows greater opportunity for physical activity (Giles-Corti et al. 2005; Krizek and Johnson 2006; Krizek et al. 2007). This section, therefore, addresses residential proximity to playing areas, parks, open space, and trail systems.

Access to playing areas, parks, and trails (Association)

Intent	To make it easier for people to engage in a variety of activities, potentially increasing physical activity.
Rationale	Different people have different ways of being physically active and a variety of environments support such activities.
Requirements	Proportion of residential areas located less than 400 m (1/4 mile; 1312 ft) – 600 m (1968 ft) of a neighborhood park or open space.
Definitions	Neighborhood parks and open space areas should be publicly accessible and can facilitate active recreation (e.g. walking, cycling, organized games).
Submission	Map showing proximity to open spaces and parks that can accommodate active outdoor play with accompanying 400m and 600 m street network buffer[1] around the parks.[2]
Credits Available	6 points: All residences located within the 400 m buffer. 3 points: All residences located within the 600 m buffer. 1 point: 50 percent of residences within the 600m buffer. 1 bonus point: In rural communities, all residences are located within 400 (1/4 mile; 1312 ft) - 600m (1,968 ft) of an unbuilt open space (e.g. an open field).
Credits Awarded	

**** Definitions and credits may be modified in subsequent versions.***

[1] Detailed instructions for creating a network and street network buffer with Network Analyst in ArcGIS are provided in Appendix 3.

[2] A street network buffer indicates the area within a specific distance of a feature, such as an access point for a trail, measured along the street network. An airline buffer is a circle around a feature with a specific radius. It takes no account of the street network. However, the airline buffer tool may be better suited for this analysis in communities that do not have a detailed network file (i.e. one that includes walking paths to parks) or where there are many informal access points to parks not captured by the street network file. Because creating the airline buffer is a very simple GIS procedure communities may choose to run both analysis and then select the one that most accurately identifies the access areas.

Access to trail system (Association)

Intent	To make it easier for people to engage in a variety of activities potentially increasing physical activity.
Rationale	Different people have different ways of being physically active and a variety of environments support such activities.
Requirements	Off-street trail system within 600 m (1968 ft).*
Definitions	An off-street facility allows for bicycling and walking and is well suited for recreation and is more than 400 m (1312 feet; ¼ mile) long, for example.
Submission	Map showing proximity to off street trail system with accompanying 400 m and 600m network buffer[3], preferably measured from access points to the trail. [4]
Credits Available	6 points: All residences are located within the 400 m buffer. 3 points: All residences are located within the 600 m buffer. 1 point: 50 percent of residences are within the 600m buffer.
Credits Awarded	

* Definitions and credits may be modified in subsequent versions.

[3] Detailed instructions for creating a network and street network buffer in ArcGIS are provided in Appendix 3.

[4] A street network buffer indicates the area within a specific distance of a feature, such as an access point for a trail, measured along the street network. An airline buffer is a circle around a feature with a specific radius. It takes no account of the street network. However, the airline buffer tool may be better suited for this analysis in communities that do not have a detailed network file (i.e. one that includes walking paths to trails) because there may well be many informal access points to parks not captured by the street network file. Because creating the airline buffer is a very simple GIS procedure, communities may choose to run both analysis and then select the one that most accurately identifies the access areas.

Topic: Safety

Traditional approaches to public safety focus on fire protection, emergency medical services and law enforcement. In this analysis, safety highlights public-health aspects that directly relate to aspects of the built environment, specifically addressing safety by reducing transportation-related crashes (i.e., reducing crashes between vehicle and vehicle or bike/pedestrian and vehicle), crime and overall violence. Because of its wide range of issues addressed under the topic, safety can also be linked to health issues of physical activity, social capital and mental health. This section focuses on two issues: (1) increasing perceived and real safety; and (2) balancing the needs of multiple users and providing design features that elevate awareness of pedestrians and bicyclists.

In terms of increasing safety, research suggests that people often avoid areas with high levels of crime or even areas where they perceive or fear high levels of crime. Crime or perceived crime may be associated with a lack of street activity (i.e. "eyes on the street") and may affect people's likelihood of using the space. Research suggests that sensitively deployed street lighting can lead to reductions in crime and fear of crime, and increase pedestrian street use after dark (Painter 1996).

Secondly, relative to balancing the needs of multiple users, there are a variety of remedies available to address pedestrian and bicycle crashes. Traffic calming, for example, can mitigate the extent to which automobiles exceed the speed limit, thus, helping to reduce accidents. Marked crosswalks, for example, particularly those well designed and noticeable by drivers, significantly reduce pedestrian crashes (Zegeer et al. 2001).

Lighting (Association)

Intent	Increase perceived and actual safety.
Rationale	Adequate lighting can increase perceived safety.
Requirements	Ensure adequate lighting along all circulation corridors.
*Definitions**	Adequate lighting: allows pedestrians on sidewalks and paths to see other pedestrians at least 200 meters (1/8 mile; 656 ft) away.
Submission	Site plan showing how circulation corridors will be lit after sundown or a plan with a policy about adequate lighting.
Possible Credits	4 points: 80% of streets have adequate lighting.
Credits Awarded	

** Definitions and credits may be modified in subsequent versions. In particular adequate lighting will be defined.*

Traffic-calming and safety features (Association)

Intent	Balance the needs of multiple users and provide design features (cues) that elevate awareness of pedestrians and bicyclists.
Rationale	Areas that address complete streets and traffic-calming features have fewer crashes.
Requirements	Plan or project adequately accounts for safe circulation patterns for all modes.
Definitions	Traffic-calming features may include raised medians, painted crosswalks, curb extensions (e.g., bulb-outs, chicanes, neckdowns), pedestrian refuge islands, woonerfs, roundabouts, edge lines to narrow roadway for bike or parking lane. Complete streets ensure that the entire right of way is routinely designed and operated to enable safe access for all users.
Submission	A complete streets policy or site plan showing location of several traffic-calming features; traffic-calming policies in comprehensive plan and development regulations
Credits Available	8 points: • The community has as a "complete streets" policy AND incorporates several different traffic calming strategies throughout OR • 90% of the lane miles of streets in the community are posted at 30 mph or less and have sidewalks 4 points: • The community has as a "complete streets" policy OR incorporates several different traffic calming strategies throughout OR • 70% of the lane miles of streets in the community are posted at 30 mph or less and have sidewalks
Credits Awarded	

Topic: Social Capital

Social capital is often seen as an indicator of health. Those with strong personal and social relationships report better health (Poortinga 2006, 265). Studies have shown that social capital, measured in a number of different ways (e.g., increased levels of trust, political participation, neighborhood familiarity, participation in protests, election voting, etc.), is supported by various types of built environments. As such, different kinds of environments can facilitate social capital (Williamson 2004; Leyden 2003; Brisson and Usher 2005; Glaeser and Sacerdote 2000; Greiner et al. 2004). However, there is no clear consensus about the measurement of social capital or the environments that contribute to it.

Another factor often associated with social capital is housing tenure, though some studies find homeowners as having higher levels of social capital, others found persons living in larger apartments have higher levels (Glaser and Sacerdote 2000; Williamson 2004). These findings are likely associated with the use of different definitions of social capital, but emphasize that the issue of housing type and tenure is a complex one; therefore, this section addresses providing a mix of housing types and tenures affordable to households at the median income. While the literature provides support for mixing housing types, tenures, and costs, it provides little guidance related to how much of each type is needed.

Housing options (Association)

Intent	Provide housing types and tenures that support different socio-economic strata and also different activities.
Rationale	Different housing types and tenures seem to support different kinds of activities (political participation, spending an evening together, etc.).
Requirements	Provide housing options so people can have high quality, healthy, housing.*
Definitions	Housing types may include varying densities and cost. Housing tenure refers to renter vs. owner occupied.
Submission	Data on tract-level housing mix for plan or project.
Possible Credits	2 points: If any one of the following are satisfied: • A mix of housing tenures is provided at the neighborhood or census tract level so that there are at least 20 % ownership and 20 % rental units; • At least 50% of residential units are affordable to persons at or below the median household income
Credits Awarded	

* Definitions and credits may be modified in subsequent versions.

Topic: Water Quality

With regard to human health, water quality concerns focus on drinking water and water that people come into contact with during recreational and personal activities, such as swimming or fishing (particularly eating fish that have been caught). Drinking water and wastewater systems are typically regulated by federal and state laws. Planners, however, play an important role in protecting groundwater and surface water, since a variety of planning and design efforts influence water quality, including the use of septic systems, management and design of wastewater and stormwater services, disposal of toxic wastes and other pollutants, and amount of runoff caused by urban and agricultural uses. Relative to septic systems, high rates of failure, depending on the type of systems and the soil, geologic, and hydrologic conditions on a site (Randolph 2004, EPA 2005). For the most part, the current literature focuses more on the link between water quality and ecological concerns, rather than focusing on the link to human health

A key issue area that planners often consider is controlling the allowable amount of impervious surface to deal with nonpoint sources that affect water quality. Paved surfaces and buildings reduce natural filtration and exacerbate runoff, which carries wastes, fertilizers, sediments, and other pollutants directly or indirectly into surface and ground waters. While a primary focus is on the ecological effects of runoff, contaminants conveyed in runoff can lead to health problems for humans, such as gastrointestinal illness (diarrhea, vomiting, cramps), pneumonia, increased risks of cancers, and other health concerns (EPA 2006).

The issue of imperviousness and its relationship to water quality is complicated by the existence, or absence, of buffers along waterways (Schueler 1995). Like imperviousness, stream buffers have also been studied in an attempt to establish design standards. One study suggests a standard of 20 to 80 meters (66 to 262 feet) (Phillips 1989). The interrelationship between impervious surfaces and stream buffers makes using specific thresholds involving either one complicated. The amount of impervious surface that causes stream-quality degradation will vary widely, depending on the amount and quality of vegetated buffer, therefore, the chosen distance should be based on a series of related factors such as size of water body to be buffered, the purpose (e.g. flood protection, recreation), and surrounding land use (Phillips 1989, Haycock and Muscutt 1995).

Groundwater and drinking-water quality (Association)

Intent	Prevent groundwater contamination and ensure safe drinking water.
Rationale	Public water and sewer systems help ensure the protection of groundwater and drinking water quality, by providing consistent construction and management of infrastructure. Sources of groundwater contamination include proximity to poorly managed septic systems, leaking underground tanks, contamination from landfills, and other forms of polluted surface runoff (nitrogen fertilizers, mining, etc).
Requirements	Construct housing in areas that are served by public water and sewer systems.
Definitions	Public water and sewer systems are provided and maintained by public entities.
Submission	Water and sewer and/or stormwater management plan for the project area or community.
Credits Available	5 points: if developed in a site with existing water and sewer infrastructure or where this is planned to occur with development. 1 point: providing a management plan for septic/on-site wastewater systems if development is outside of the seven-county Twin Cities metropolitan area.
Credits Awarded	

Surface-water quality (Threshold)

Intent	To protect surface water used for drinking and recreation.
Rationale	Surface-water quality can have negative environmental impacts and may also affect the use of water bodies for fishing or swimming.
Requirements	Provide a vegetated buffer along water bodies.
Definitions	Any mown turf in the vegetated buffer should be subtracted from the measured dimension..
Submission	Site plan showing location of buffers; buffer policies in comprehensive plan and development regulations.
Credits Available	7 points: if 50 m (164 feet) or greater buffer is provided 3 points: if 20 m (66 feet) or greater buffer is provided
Credits Awarded	

Future versions might provide points for low-impact design features.

Appendices:

Appendix 1: Evidence Required

This appendix lists the information and data required in order to complete the Threshold HIA.

1. Topic: Accessibility

1.1. Transit service (Threshold)

- Site plan or future land use map with residential and employment density calculations.
  - Density calculations based on analysis completed at the block group level or smaller.
  - Gross density calculation for entire area.

1.2. Transit stops (Threshold)

- Site plan or future land use map showing the location of transit stops and has a 1200 m "walking-transit-shed" for each stop (this is a street network buffer and can be easily produced using GIS—use Service Area Analysis in the Network Analyst Extension in ArcGIS 9.2 and later).
  - Area calculation showing what percent of area is covered by the walking transit shed (unless the entire area is covered)

2. Topic: Air Quality

2.1. Distance from a freeway for residential uses and uses occupied by children (Threshold)

- Site plan or land use map that depicts relevant land uses (i.e. residential uses) and particular facilities that are existing or planned (i.e. schools, playgrounds, sports fields) in relationship to:
  - all major roads in the area with AADT > 40,000
  - A 200 m (656 ft) buffer from each major road
  - A 500 m (1640 ft; 1/3 mile) buffer from each major road.
  - Tree canopy analysis within 200m and 500m buffer

2.2. Polluting uses (Association)

- List of all existing or planned non-residential polluting uses (i.e. certain dry cleaners, automotive paint shops, manufacturing plants) *and/or*
- Local ordinance that require pollution-reduction technologies. *For examples of local ordinances, please visit: http://www.designforhealth.net/techassistance/aqordinances.html

2.3. Air quality mitigation (Association)

- A detailed canopy analysis (using aerial photographs), a detailed planting plan, land cover information if it distinguishes between turf and tree cover, and/or tree preservation/replacement ordinance.
  - Unless 100%, tree canopy area calculation

3. Topic: Environmental and Housing Quality

3.1. Minimize exposure to lead (Association)

- Documentation illustrating that policies are in place that require that lead-bearing substances are not used in any exposed surface of a dwelling unit, child care facility, school, or recreational facility used by children.

4. Topic: Food

4.1. Distance to a supermarket or fruit and vegetable shop (Threshold)

- Map showing the location of existing (or proposed) supermarket or fruit and vegetable stores, and a 1600 m network buffer around each (easily done using Service Area Analysis in the Network Analyst Extension in ArcGIS 9.2 and later versions).
  - Area calculation showing what percent of the area is covered by the buffer (unless the entire area is covered)

5. Topic: Mental Health

5.1. Views of Green (Association)

- Provide tree inventory and/or plan for the municipality or the development and its context as well as accounts (sketches or other visual documentation) of views in multiple directions.*

6. Topic: Physical Activity

6.1. Access to playing areas, parks and trails (Association)

- Map indicating planned or existing open spaces and parks that can accommodate active outdoor play with accompanying 400m and 600 m street network buffer around the parks. This is accomplished through the Service Area Analysis within the Network Analyst Extension.
  - Area calculation showing percent of municipality or development covered by the buffer (unless entire area is covered)

6.2. Access to trail system (Association)

- Map indicating planned or existing off street trail systems with accompanying 400m and 600 m street network buffer, preferably measured from access points to the trail using Service Area Analysis in Network Analyst in ArcGIS 9.2 or later.
  - Area calculation showing percent of municipality or development covered by the buffer (unless entire area is covered)

7. Topic: Safety

7.1. Lighting (Association)

- Site plan showing how circulation corridors will be lit after sundown or a plan with a policy about adequate lighting.

7.2. Traffic calming and safety features (Association)

- A complete streets policy or site plan showing location of several traffic-calming features; traffic-calming policies in comprehensive plan and development regulations
- Speed limits for all streets within community; map showing all streets with ≤ 30mph speed limits.

8. Topic: Social Capital

8.1. Housing options (Association)

- Data on tract-level housing mix for plan or project that shows: percent of owner units, percent of renter units; and percent of units affordable to persons at or below the median household income

9. Topic: Water Quality

9.1. Groundwater and drinking water quality (Association)

- Water and sewer plan for the project area or community overlaid onto the site plan or future land use map (to ensure that all planned development occurs in areas that are or will be served by sewer)

9.2. Surface water quality (Threshold)

- Map indicating all surface water bodies with accompanying 50m and 20 m buffer

Appendix 2: Caveats for HIA Threshold Analysis

The Design for Health HIA Threshold Analysis includes a wide range of measures intended to evaluate the health impacts of various characteristics of the built environment. However, it is important to note that there are a number of other measures that are omitted from the HIA, including those with:

- insufficient causal evidence to support a connection between health and the built environment at the local level
- a lack of information to assess impacts, and
- an absence of a role for planners in addressing measured outcomes.

The thresholds produced as part of the Design for Health HIA do not claim to have all the answers nor should they be viewed as bullet-proof measures. There are always bound to be outstanding, confounding, complex or unaccounted for issues that cloud matters. Below, we identify various issues that users of the HIA Threshold Analysis should be aware of when applying the tool for specific purposes. Our aim in this discussion is to provide the user with a brief discussion of the rich context from which the thresholds are drawn. Specific topics include:

- Crashes related to cycling and/or walking
- School location
- Certain forms of pollution
- Access to health care facilities
- Bicycle lanes
- Mixing of land uses

Some additional topics are under investigation for including in the thresholds but have not so far been included because of their very local or very global scale. These include:

- Global warming
- Noise

Crashes for cycling and/or walking.
Minimizing crashes by any mode is a primary concern for planners. However, the HIA Threshold Analysis lacks a specific measure to address this concern. There are number of issues that contributed to the decision. As good planning practice tells us, one of the most important factors to promote walking and cycling relates to the overall safety of the built environment. Counting the number of bicycle and pedestrian crashes for a particular area and aiming to minimize that number, at first glance, seems like a suitable strategy. The problem with this strategy, however, is that only examining the number of crashes tells an incomplete story. We need to understand the larger picture of overall levels of walking. A suburban intersection of two 6 lane roads may have no pedestrian crashes—but there also may be no pedestrians trying to cross this intersection. Conversely, the busiest pedestrian intersection in the world, reputedly Shibuya Station in Tokyo, likely has a high frequency of pedestrian crashes. But there are many tens of thousands of pedestrians crossing this intersection on a daily basis. Is the former safer than the latter? No. Any robust measure of pedestrian and/or cycling crashes needs to control for exposure—an overall measure of the pedestrian and/or cycling activity. Unfortunately, measures of walking or cycling exposure are extremely difficult to uncover for specific areas of a city. Not knowing levels of exposure tells an incomplete story. It is mainly for this reason that we avoided a relatively simple measure of bicycle and pedestrian crash intensity.

School location

A second item not addressed in the HIA Threshold Analysis is school location. There is much talk in communities worldwide about encouraging children to walk or cycle to school. In the U.S., for example, major transportation legislation has helped programs to spring up under the banner of Safe Routes to School. Such programs require satisfying at least four criteria to advance their success: (1) the presence of a "neighborhood" school, (2) school-age children in the "neighborhood," and of course, (3) safe routes between the two ("safe" usually meaning lower traffic speeds, highly visible street crossings, sidewalks, etc.), and (4) whether school-age children in the neighborhood attend the neighborhood school. While the first two items are relatively simple to measure, the third and fourth pose some challenges. Assessing the safety of routes can be very subjective and information such as pedestrian and bicycle crashes may not be available, as noted above. The fourth criteria may not be met in some communities where school choice policies have been adopted. Just like many families that often bypass the closest grocery store on account of tastes, quality, or preferences, children pass up their neighborhood school, bringing into question the merits of geographically based urban planning programs such as Safe Routes to School. Thus, it is partially remiss to only talk about school location without strong consideration given to the larger curricular or other factors influencing the location of what school children are attending.

Pollution—certain forms

While the HIA Threshold Analysis addresses health impacts from living near a major roadway, it does not address the health impacts of pollution from mobile sources more generally. The primary reason for this is that mobile source emissions—and their connection to air pollution, respiratory illness, and also global warming—represent an extremely complex phenomenon. Part of the complexity is related to the fact that different chemical processes play out at different stages of an automobile trip and also relate to the age of the car. There are generally considered to be four types of mobile source emissions: running (per mile), cold start, hot soak, and diurnal. Hydrocarbons are emitted from all these types of emissions, but carbon monoxide (or CO) is only emitted as part of running emissions and cold starts (requires combustion). Alternatively, carbon dioxide (CO_2) is mostly a result of cold starts—a factor for old and new cars but less of a concern for newer cars as they have cleaner running emissions. So, one can quickly see how different pollutants play out in a very complex manner that depend on the concern (and subsequently the chemical reaction being analyzed) as well as the age of the cars. Measuring the pollution impacts of mobile sources on a community or region-wide basis would pose a significant challenge to planners attempting to assess health impacts.

Access to health care facilities

Another item that one might expect to see in the HIA Threshold Analysis is access to health care. The issue of health care is one of the most talked about issues in the US and is certainly a prime concern of a healthy community. However, just because a health care facility exists in a community does not mean it is accessible. There are a number of barriers to access, including, but not limited to: (1) the availability and relationship to insurance (e.g., in network versus out of network), (2) the range of generalized versus specialized services that are provided, (3) personal preferences for a doctor, and (4) transit accessibility. While planners may be able to address the fourth item and assist in identifying sites for health care facilities, they have little control over the other three access issues noted above. For this reason, the thresholds deal with transit accessibility as a major source of points in the overall score for HIA Threshold Analysis. In addition, most health care needs are for care of minor and chronic diseases and ambulance trips are a small part of a healthy community. However, we do provide two bonus points for areas where all residents are within a 10 mile distance of a hospital or other acute care facility, and one point where they are within a 20 mile drive, although these distances will remain under consideration (Messina et al. 2006). It should be noted that these are rules of thumb given different conditions have different requirements for hospital access.

Bicycle lanes

While there is much discussion related to the health impacts of bicycling, the evidence related to the health effects of bicycling facilities was not sufficient to point to a threshold for the HIA. Apart from walking, cycling is arguably the most efficient and environmentally-friendly mode of transport available for shorter distance and urban trips. Providing bicycle infrastructure might appear to have positive impacts on health. However, understanding these impacts can be complex. Among the most important issues to consider is that there are different types of bicycle users—many of whom demand specific environments—ranging from youth and beginners to avid riders. The former demand separated facilities; the latter prefer on-street environments. With limited resources and space, planners often struggle in determining which should have precedence. They must consider the context, the type of user, the speed and nature of surrounding automobile traffic, and a whole host of other factors that do not lend themselves to simple thresholds.

Mixing of land uses

Providing a mix of land uses is an additional issue that is not specifically addressed in the HIA Threshold Analysis but is often characterized as good planning practice with potential health benefits. The challenge in developing a threshold related to mixed land uses is in operationalizing and quantifying the term. Many factors contribute to a "successful" mix of land uses, including size, quantity, bulk, scale, and types of uses. The availability of data and clear definitions about what constitutes a mix of land uses are key challenges to developing a measurable threshold. In addition, evidence related to the health impacts, including social capital and physical activity, vary significantly in their measurement of mixed use thus calling into question that a cause and effect relationship between mixed use and health. Further, how much mix is really needed? A subsistence farm is a single use but could be a healthy environment; a residential transit suburb with strong schools and faith communities may well be "healthier" than a neighborhood with mixed uses including those that pollute, sell large amounts of alcohol, or provide unhealthy foods.

Appendix 3: Building a Network and Street Distance Buffer in ArcGIS version 9.2 or later using Network Analyst

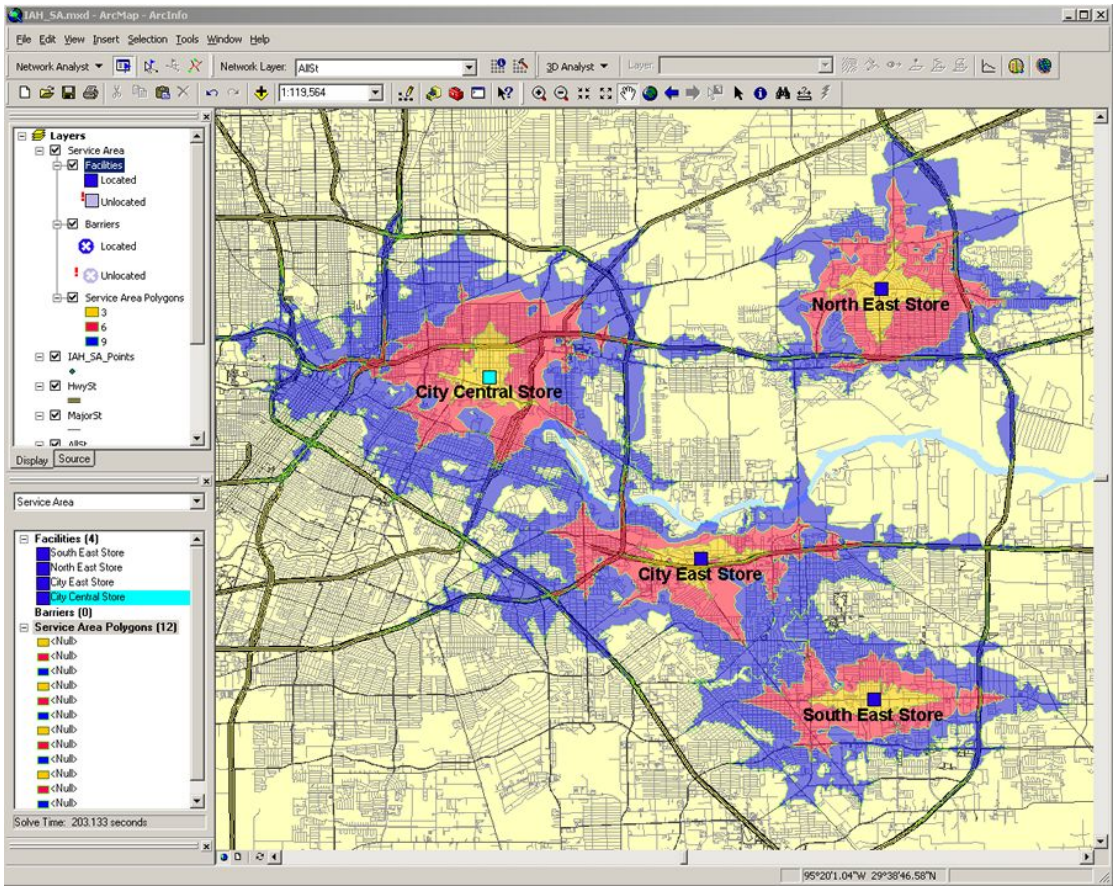
Note: These instructions are adapted from: Forsyth, Ann ed. 2007. ENVIRONMENT, FOOD, AND YOUTH: GIS PROTOCOLS VERSION 1.3, November 2007, University of Minnesota, TREC

Authors: David van Riper, Nishi Mishra, Ed D'Souza, and Ann Forsyth

1. Basic Concept

A network buffer includes the area within x distance along a street network from the starting point (a school or home in this case). In ArcGIS9, a new version of the extension Network Analyst fundamentally changed the way network buffers are created. Network Analyst is an optional extension depending on your level of license of the ArcGIS suite. Check with your system administrator to determine if you have the ArcView, ArcEditor, or ArcInfo license for the ArcGIS suite. The Network Analyst Extension can be purchased separately if it is not included in your level of license. ESRI also provides a free 60 day evaluation of the extension.

All street network buffers aim to measure the environment that can be reached by someone on foot along the street network. However, the way they calculate this can lead to quite different shapes and areas. Below is an illustration of the type of polygons you can expect to be created through the use of Network Analyst (ESRI 2008).



2. Basic Definition

A network buffer is an area within X-meters *street* distance of a point (or a polygon).

3. Detailed Definition

A network buffer is an area within X-meters street distance of a point (or a polygon) using the ArcGIS 9.2 Network Analyst Extension. Specifically, a network buffer is created using the Service Area Analysis. For this process, you will use both ArcMap and ArcCatalog.

4. Comments and Explanations

This is a little trickier to do in GIS than the straight-line buffer.

5. GIS Approach

Use Network Analyst extension for ArcGIS 9.2 or later to determine the new service area around the set of point features, in this case participants or schools. Line features such as roads or trails are used to create the network which is used to calculate all possible routes within a specified distance from the selected points.

GIS Steps

The following procedure was completed using an ArcInfo 9.2 license of ArcGIS.
Requirements:

1. **Road Layer** polyline (if no file exists for your organization, certain organizations may qualify for free road centerline data for Minnesota found at http://www.metrogis.org/data/datasets/street_centerlines/order_info/index.shtml or by contacting the Lawrence Group (http://www.lawrencegroup.com).
2. **Point Features** for buffer (i.e. park and trail access points, point location of supermarkets, etc.)
3. **Network Analyst Extension** for ArcGIS 9.2 or later

I. Create a New Network Dataset

1. Start **ArcCatalog**.

2. On the Main Menu click **Tools** and Click on **Extensions.**

a. Check **Network Analyst** Extension.

b. Click Close.

3. In the catalog tree, navigate to the feature dataset if you are creating a geodatabase based network dataset. If you are creating a shapefile based network dataset, navigate to the shapefile location in the catalog tree.

4. If you are creating a geodatabase based network dataset, right click on the polyline (street) feature dataset and point to **New** and then click **Network Dataset**. If you are creating a shapefile based network dataset right click on the polyline (street) shapefile and click **New Network Dataset**.

5. In the **New Network Dataset Wizard**

a. Type a name for the network dataset and Click **Next**.

b. Check the **Road feature classes** that will be used as network source in the network and Click **Next**.

c. Accept the **default connectivity** settings and Click **Next**.

d. Accept the **default** option **NO** to modify the connectivity with **elevation** field data or elevation field settings and Click **Next**.

e. Accept the **default YES** to model **Turn** in the Network and Click **Next**.

f. Click **Add**

i. Type **Length** in the Name field.
ii. Select **Cost** as **Usage Type**, if it is not already selected.
iii. Select **Meters** as the **Units**.
iv. Select **Double** as the **Data type**, if it is not already selected.
v. Click **OK**.
vi. Click **Next**.

g. Accept the default **Yes** to use the **default directions** settings to establish driving directions for the network dataset and Click **Next**.
h. Review the network dataset summary to check the options are correctly selected and Click **Finish**.

6. Click **Yes** to build the Network Dataset.

II. Create the Network or Street Distance Buffer

1. Start **ArcMap**
2. On the Main Menu click **Tools** and Click on **Extensions.**
   a. Check **Network Analyst** Extension.
   b. Click Close
3. Click the **Add Data** button  on the **Standard Toolbar**
   a. Navigate to the **Network Dataset** location, created earlier in Step I
   b. Click on the **Network Dataset** and click **Add** to add the Network Dataset to ArcMap.
   c. Click **Yes** to add all the feature classes, that participate in the network, to the map.
4. Click the **Add Data** button  on the **Standard Toolbar**
   a. Navigate to the **Point Layer** to be used for analysis, (i.e. your park access points layer)
   b. Click on the **Point Layer** and click **Add** to add it to ArcMap.
5. In the Table of Contents Right Click the **Point Layer** and click on **Open Attribute Table**
   a. In the **Attribute Table**
      i. Click **Options**
      ii. Click **Add Field**
      iii. Add the **Park ID** as **Text**
         - Type **Park_Id** in the **Name** field
         - Select **Text** (50) as **Type**
         - Accept **default** for **Length**
         - Click **OK**
      iv. Add the **SchoolPark_Id** as **Integer**
         - Type **Park_Id** in the **Name** field
         - Select **Short Integer** as **Type**
         - Accept **default** (0) for **Precision**
         - Click **OK**
      v. Enter the assigned Id for the park access points
6. On the main menu click **View**
   a. Click on **Toolbars**
   b. In the side menu click **Network Analyst** to add the Network Analyst toolbar to ArcMap
7. Click **Network Analyst Toolbar**
   a. Click **Network Analyst Window** button  to add the Network Analyst Window to the map
8. On the **Network Analyst Toolbar** Click **Network Analyst Dropdown Menu**
   a. Click **New Service Area**
   b. The **Table of contents** and the **Network Analyst** Window contains empty list of **Facilities**, **Barriers** and **Polygon** Categories (See Figure 1).

Figure 1

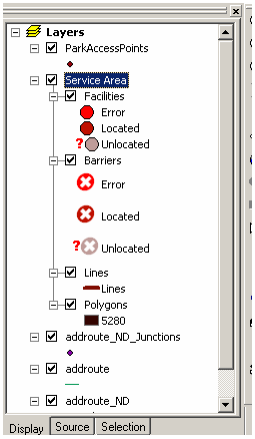
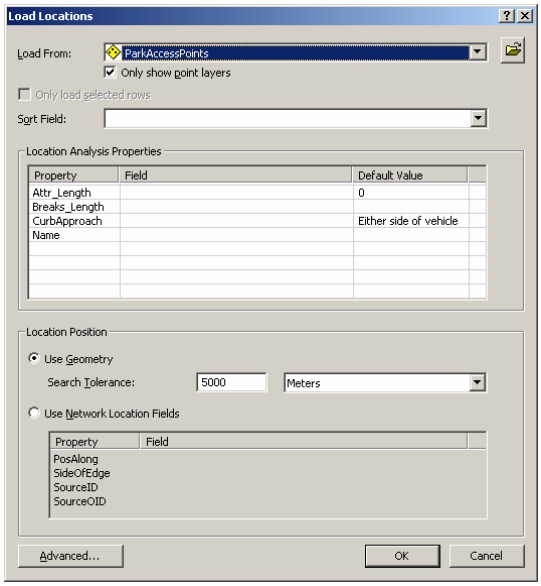


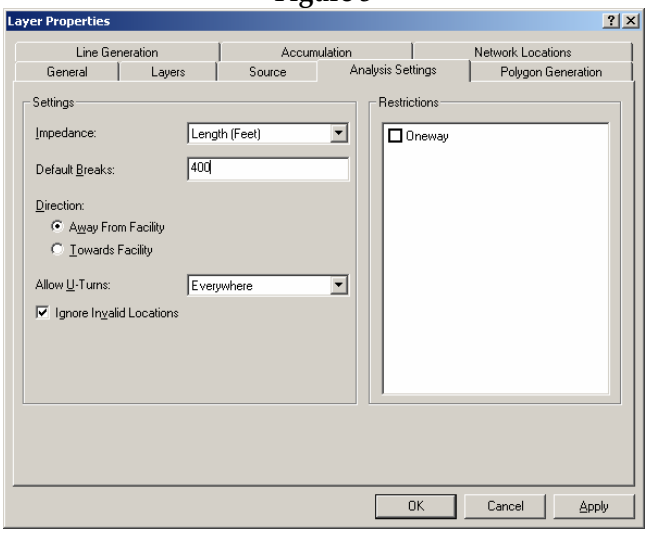
Figure 2



9. On the **Network Analyst Window** right Click **Facilities** and Click **Load Locations**
   a. In **Load Locations Window** (See Figure 2)
      i. Click **Browse** and Navigate to the **point feature layer**
      ii. Click on the **Point feature layer** and click **Add**
      iii. Choose the **Park Id** as the **Name** field. Accept the **default** for other **Location Analysis Properties**
      iv. Accept the **default Location Position**
      v. Click **OK**

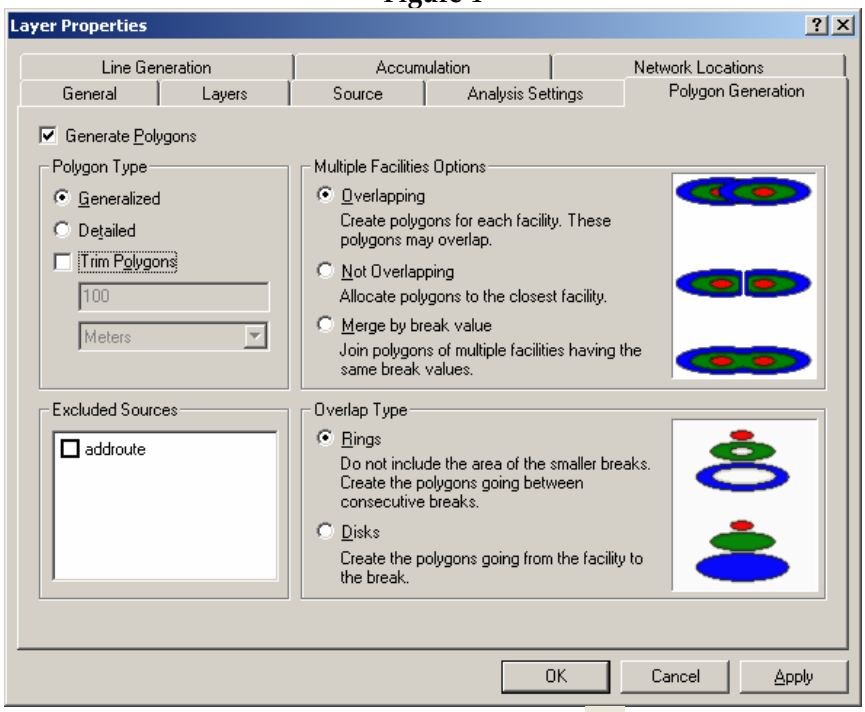
10. To set the properties to be used in the Analysis, In the Table of Contents Right Click the **Service Area Layer** and Click **Properties**
    a. Click on **Analysis Settings Tab** (See Figure 3)
       i. Choose **Length** (Meters) for **Impedance**.
       ii. Type the **Buffer Distance** for **Default Breaks**
       iii. Choose **Away From Facility** as **Direction**
       iv. Choose **Everywhere** for **Allow U-Turns**
       v. **Uncheck the box next to Oneway Restrictions.**

Figure 3



b. Click on **Polygon Generation Tab** (See Figure 4)
  i. Check **Generate Polygons**
  ii. Choose **Generalized** as the **Polygon Type**
  iii. Uncheck **Trim Polygons**
  iv. Choose **Overlapping** for **Multiple Facility Options**
  v. Choose **Rings** as the **Overlap Type**
c. Click **Ok**

Figure 4



11. On the Network Analyst Toolbar, Click **Solve** Button 
12. Joining attributes with Source Point Layer to carry over the data.
  a. Right Click the **Polygons Layer**
  b. Click **Joins and Relates** and then **Join**
    i. Choose **Facility Id** as the Field to base the join on
    ii. Choose the **Parks Layer** as the Table to Join to this layer
    iii. Choose the **Parks ID** as the field in the table to base the join on
  d. Right Click the **Polygons Layer**
  e. Click on **Data** and then **Export Data***
    i. Choose **this layer's source data** for the coordinate system
    ii. Specify the **Output location**

**Please note that the feature layers created with Network Analyst are only accessible with a valid license of Network Analyst. Please remember to export the feature layer, in this case, the Polygons layer, to either a feature class in a geodatabase or a shapefile as stated in Step 12 if you intent to distribute to others without Network Analyst.*

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