ACHIEVING EXPERIENTIAL ACCESSIBILITY IN NATURE
ACCOMMODATING PERSONS WITH DISABILITIES IN TRAIL DESIGN

by

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A REPORT

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ABSTRACT

The absence of participation in physical activity is a public health concern for all people, but even more of a problem for the estimated 52 million Americans with disabilities (Rimmer 2005). Besides the physical health benefits derived from physical activity, when a trail leads through a natural setting, research shows that significant sensory and cognitive benefits can also be gained which leads to greater well-being (Maller et al. 2005; Hull and Michael 1995; Kaplan 1995; Irvine and Katherine 2002). Furthermore, when trails are planned and constructed in natural settings, most of the attention is directed at minimizing environmental impacts at the exclusion of maximizing the physical, sensory, and cognitive experience of users. This shortcoming is compounded when the user has disabilities. Besides typical disability concerns related to mobility, disabilities to be better accommodated in trail design also include vision and hearing impairments.

The focus of this research is investigating how trail planning and design in natural settings can better provide for the physical, sensory, and cognitive experience of users, particularly those users who have disabilities. Findings informed the development of Natural Trail Design Guidelines prepared for the City of Manhattan Parks and Recreation Department who is seeking to improve the City's existing natural trails. Sample designs for trail enhancements at Anneberg Park and the Konza Prairie near Manhattan, Kansas were proposed. Once implemented and assessed to be found successful, the Natural Trail Design Guidelines might be transferable to other locations.

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01 Introduction

BACKGROUND

There has been growing research that supports a significant link between interacting with a natural environment and improved levels of physical and mental health (Maller et al. 2005; Hull and Michael 1995; Kaplan 1995; Irvine and Katherine, 2002). A great way to make nature accessible for people, is through the availability of natural trails (NPS, 1996).

NATURAL TRAILS

Natural trails are trails that provide access to the natural landscape. (United States Department of Interior, National Park Service 1996). Natural trails come in many different forms. These forms include: courtyard trails, park trails, natural park trails, and regional trails.

- Courtyard Trails: Trail less than ½ miles long. They are typically located within an urban environment adjacent to a health facility and concentrate on the sensory experience of nature.
- Urban Park Trails: Trails ½ mile - 2 miles in length. They are located in parks that are surrounded by urban settings.
- Nature Park Trails: Trails with the length of ½ mile - 6 miles. They are surrounded by regional natural landscape.
- Regional trails: Trails over 2 miles long that travel through a variety of surrounding landscapes, including natural regional landscapes and urban areas.

Natural Trails have association with physical and mental health benefits due to the opportunity to interact with nature and the influence of physical experience. Walking is the most popular form of outdoor physical activity, closely followed by cycling, running, and hiking (Centers for Disease Control and Prevention 2012; United States Department of Labor 2008). Research has shown an increase in these physical activities correlate with availability of natural trails (NPS, 1996).

EXPERIENTIAL ACCESSIBILITY

Experiential accessibility is a result of universal design and the consideration of the three categories of experience. The categories of experience include: physical, sensory, and cognitive considerations (McManhan 2015). By addressing these considerations, experiential accessible designs address the needs of persons with disabilities, and in return, enhances the experience of the general user. This enhanced experience creates an interaction with nature that results in many benefits; including mental and physical well-being.

ISSUE

The issue is that many times natural trails are built to accommodate environmental needs, rather than addressing other concerns like accessibility. In turn, this rejects the needs of persons with disabilities. There are minimal trails that are built to be accessible and quite often reject the consideration of experiential accessibility (McMahan 2015). In addition, people with disabilities have lower physical activity levels than a person without disabilities. This leads to the underlying question driving this project: How can trail planning and design in natural settings better provide for the physical, sensory, and cognitive experience of users, particularly those users with a disability?

PURPOSE

The purpose of this study is to explore how trails can increase and better utilize the availability of natural settings to persons with a disability. In addition, to provide someone with a disability the fullest range of experience in the context of nature, the physical, sensory, and cognitive dimensions of human experience will be incorporated into trail design.

OUTCOME

The outcome of this study is the development of guidelines that apply experiential accessibility to two of the four different types of natural trails. The application of experiential accessibility will result in trails that incorporate cognitive, physical, and sensory aspects of trail experience that will benefit both general trail users and those with disabilities. This study will be applied to Manhattan, Kansas, but is applicable to other locations.

02
Literature Review

OVERVIEW

Topics addressed through the literature review provide understanding of the needs for experiential accessibility in natural trail design. These subjects include persons with disabilities, benefits of nature, experience, and natural trail design. **Figure 2.1** shows that the topics all work together and overlap each other to create experiential accessibility in nature. An understanding of experiential accessibility will contribute to the purpose of this project, to add beneficial considerations to existing natural trail guidelines. Few guidelines accommodate persons with disabilities; additionally, they often neglect sensory and cognitive considerations.

EXISTING TRAIL DESIGN GUIDELINES AND HANDBOOKS

There are many trail guidelines that already exist. Some address user experience while others address the need for accessibility. However, none of them address the necessity of user experience for those with a disability. Furthermore, accessibility in many existing guidelines use sectional and detail oriented approaches, often neglecting routing considerations. The following sources are examples of various trail guidelines that address user experience or accessibility.

ACCESSIBILITY GUIDEBOOK FOR OUTDOOR RECREATION AND TRAILS (Zeller et al. 2012)

The accessibility guidebook addresses the need for physical accessibility for persons with disabilities. It details the requirements for ADA considerations by addressing physical experience elements. These elements include: surface of trails, tread width, trail slope, resting intervals, passing spaces, tread obstacles, protruding objects, openings in trail surfaces, trail facilities, gates and trail barriers, trailheads, and trail signs. The guidelines address each of these elements with details that distinguish measurement requirements for persons with mobility disabilities

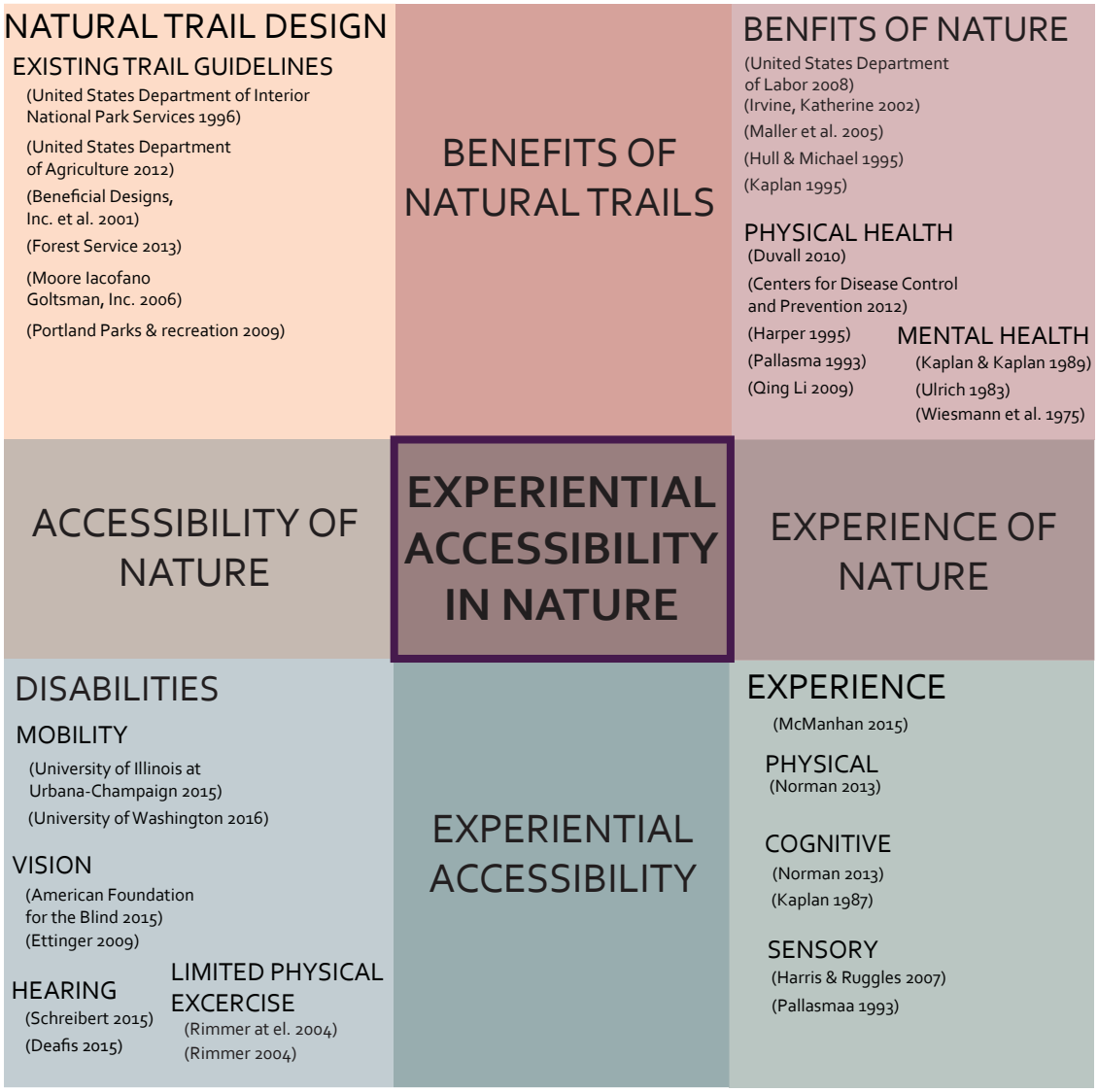

Figure 2.1: Literature Review Map

(Zeller et al. 2012). These guidelines present important information about physical accessibility requirements, however they neglect routing considerations and the importance of sensory and cognitive experience.

A HANDBOOK FOR TRAIL DESIGN, CONSTRUCTION, AND MAINTENANCE (United States Department of the Interior, National Park Service, 1996)

The handbook addresses elements focusing on environmental needs and considerations. It briefly states the need to consider user experience; however it does not directly relate guidelines to users. Instead the guidelines directly relate to environmental needs and the human-nature relationship, in addition to physical elements (NPS 1996).

DESIGNING SIDEWALKS AND TRAILS FOR ACCESS (Beneficial Designs, Inc. et al. 2001)

Guidelines found in The Designing Sidewalks and Trails for Access address the importance of physical comfort of universal design in both sidewalks and trails. The trails section addresses the relationship between environmental needs and the needs of users with disabilities. Although these guidelines address the importance of physical experience for persons with mobility, vision, and hearing impairment, they neglect the need for sensory and cognitive considerations. The guidelines also lack trail routing considerations (Beneficial Designs, Inc. et al. 2001).

UNITED STATES FOREST SERVICE TRAIL ACCESSIBILITY GUIDELINES (United States Forest Service, 2013)

The Forest Service Outdoor Recreation Accessibility Guidelines address the relationship between environmental needs and the physical experience needs of persons with disabilities. They address different exceptions to providing accessibility; however, they do not provide alternate opportunities to create a beneficial experience for those with disabilities (USFS 2013a).

PARK AND TRAIL ACCESSIBILITY DESIGN GUIDELINES (Moore Iacofano Goltsman, Inc. 2006)

The Park and Trail Accessibility Design Guidelines address accessibility for both parks and trails in terms of physical experience. The trails section of the guidelines specifically address different amenities along trails such as, benches, camping facilities, grills, overlooks, picnic tables, and many others. For each amenity, specific measurements are addressed with consideration of persons with mobility impairments. Although these guidelines provide useful information about the accessibility of amenities, they lack the consideration of trail routing and its effect on greater dimensions of experience and accessibility of the trail (Moore Iacofano Goltsman, Inc. 2006).

TRAIL DESIGN GUIDELINES FOR PORTLAND'S PARK SYSTEM (City of Portland Parks and Recreation, 2009)

The Trail Design Guidelines for Portland's Park System defines a design matrix of different types of trails found in Portland. For the different trails, the guidelines form a standard for the physical elements of experience including: width, running slope, cross slope, radius, sight distance, easement width, side slope, vertical clearance, and horizontal clearance (Portland Parks and Recreation 2009). One of the trail types addressed is an accessible trail with the consideration of all these physical elements for persons with mobility disabilities, neglecting other types of disabilities and sensory and cognitive considerations. Also, these guidelines do not address trail routing considerations.

After reviewing these guidelines, the additional need for including sensory and cognitive considerations in accessible trail design became apparent. Even if some persons with disabilities cannot physically access all segments of a trail, greater attention to trail routing can provide sensory and cognitive opportunities for experiential enrichment. Design considerations and strategies to accomplish this objective is explored through four topics: categories of disabilities, benefits of nature, dimensions of experience, and natural trail design.

PHYSICAL ACTIVITY LEVELS: PERSONS WITH DISABILITIES

The absence of participation in physical activity is a public health concern for all people, but even more so for the estimated 52 million Americans with disabilities (Rimmer 2005). It is a greater issue due to their greater risk for developing the types of serious health problems associated with a non-active lifestyle (Rimmer 2005). Research has shown that persons with disabilities are significantly less likely to engage in physically active lifestyles than people without a disability. According to the Healthy People 2010 Report, 56 % of adults with disabilities do not engage in any leisure-time physical activity, compared to 36% of adults without impairments. The results of this study show the importance of promoting moderate levels of physical activity among people with a disability. To do this, the barriers restricting physical activity for persons with a disability need to be better understood (Rimmer et al. 2004).

Studies show that many barriers prevent disabled persons from engaging in physical activities (Rimmer et al. 2004). As depicted in **Table 2.1**, barrier categories include: built and natural environment, cost, guidelines and regulations, information, emotional and psychological factors, knowledge and training, perceptions and attitudes, policies and procedures, and resource availability (Rimmer et al. 2004).

Outdoor environments are seen to have more barriers than indoor environments. This perception is due to the unpredictability of the outdoor environment, from weather and maintenance issues, to lack of amenities. **Table 2.2** shows categories of outdoor environmental barriers inhibiting physical exercise (Rimmer et al. 2004).

CATEGORY OF BARRIERS INHIBITING PHYSICAL ACTIVITY	
CATEGORY	DEFINITION
Natural Environment	Barriers relating directly to aspects of natural environment.
Cost/economic	Barriers relating to the cost of participating in recreation/fitness activities or costs associated with making facilities accessible.
Guidelines and codes	Issues related to the use and interpretation of laws and regulations concerning accessibility of information, particularly building codes and the ADA
Information	Access of information both within the facility and in facility brochures and advertisements
Emotional/psycological	Physical, emotional, or psychological barriers to participation in fitness and recreation activities among persons with disabilities
Perceptions and attitudes	Perceptions and attitudes of both professionals and non-disabled individuals toward accessibility and persons with disabilities
Policies and procedures	Barriers imposed by the implementation of facility or community-level rules or regulations
Resource availability	Needed resources that would allow persons with disabilities to participate in fitness and recreation activities, including transportation and adaptive equipment

Table 2.1: Categories of Barriers Inhibiting Physical Activity (Rimmer et al. 2004)

OUTDOOR ENVIRONMENT BARRIERS INHIBITING PHYSICAL EXERCISE	
CATEGORY	BARRIER
Natural Environment	Weather
	Path material
	Path damage
	Narrow path
	No curb cuts
	Steep slopes
Cost/economic	Few to no benches along trail
	No accessible bathrooms
	Lack of maintenance
Guidelines and codes	Prioritize Environmental Considerations
Information	Poor signage
	Lack of advertisement
Emotional/psycological	Fear of unknown
	Lack of informational signage
	Fear of failure
	Lack of support
	Availability of amenities
Perceptions & attitudes	Lack of support
	Idea of nature being not accessible
Policies & procedures	Availability of service dog use
Resource availability	Public transportation
	Adjacent parking

Table 2.2: Outdoor Environmental Barriers Inhibiting Physical Activity (Rimmer et al. 2004)

By understanding the reservations that many people with disabilities have towards physical activity, natural trails can be better designed to accommodate their needs, and encourage more participation. It is important to increase outdoor activity levels due to the mental and physical health benefits derived from being in a nature filled environment.

BENEFITS OF NATURE

Growing research, both quantitative and qualitative, has shown a link between interacting with a natural environment and improved levels of mental, and physical health (Maller et al. 2005; Hull and Michael 1995; Kaplan 1995; Irvine 2002; and Katherine 2002). To receive benefits, it has been found that the experience of the natural environment should involve physical, mental, and sensory interaction (McMahan 2014).

Nature has a significant role in the improvement of mental health. Research has shown connections between interacting with nature and improved levels of psychological and emotional health, and overall improvement in well-being (Maller et al. 2005; Hull and Michael 1995; Kaplan 1995; and Irvine and Warber 2002). Experiencing nature has a role in influencing both levels of stress and attentional functioning by creating a relaxing, however mysterious environment (Kaplan and Kaplan 1989). This element of mystery creates a quality in a landscape that requires a process of cognitive inference or prediction for users, resulting in psychological benefits (Kaplan and Kaplan 1989; and Wiesmann et al. 1975).

Exposure to nature also has physical health benefits. It has been proven to influence increased levels of physical exercise, in particular walking. Walking is the most popular form of outdoor exercise, spanning culture, participant age, and locality (Centers for Disease Control and Prevention 2012; United States Department of Labor 2008). The popularity of walking is closely followed by cycling, running, and hiking (United States Department of Labor 2008). The availability of these different forms of exercise in a natural environment has been shown to increase a person's likelihood to engage in physical activity (United States Department of Interior, National Park Service 1996).

To receive the mental and physical benefits of nature, an interaction must be present. This engagement with nature involves all of our senses which leads to an invigorating, mindful, and sensory experience (Pallasma 1993; and Duvall 2010). Due to this sensory experience, most humans have developed a high appreciation and need for interacting with nature. There has also been quantitative research showing the importance of our sensory intake of nature. One of these studies was conducted in Japan regarding forest bathing trips. The discovery led to an understanding of phytoncides, wood essential oils, and their effect on human health. The breathing in of phytoncides increases Natural Killer Cell activity (NK), resulting in cells that release anti-cancer proteins (Qing Li, 2009).

An experience with nature has shown to have a significant link with mental and physical health. To receive the health benefits associated with nature, a person must fully engage in the regional environment through physical, cognitive, and sensory elements. Natural trails have the potential to provide general users with this opportunity, in addition to persons with disabilities.

NATURAL TRAILS

Natural trails are trails that provide access to scenes of the regional landscape (United States Department of Interior, National Park Service 1996). However, to meet local user needs, natural trails come in many different forms. These forms include: courtyard trails, urban park trails, nature park trails, and regional trails. For these to be considered natural trails, they must provide users with an opportunity to interact with the regional landscape (United States Department of Interior, National Park Service 1996). Natural trails have association with physical and mental health benefits due to the opportunity to interact with nature and the influence of physical experience. Research has shown an increase in physical activity, which correlates with availability to natural trails (United States Department of Interior, National Park Service 1996).There are two main considerations of trail design: environment and user experience (United States Department of Interior, National Park Service 1996).

Design considerations of natural trails include environment impacts and user experience. Environmental impacts are considered during trail design and construction, and remain in constant awareness as maintenance is performed. The environment is a primary concern, driving the process of design and construction (United States Department of Interior, National Park Service 1996). To avoid negative environmental impacts the following considerations are addressed: awareness of cultural and natural resources, erosion prevention, and enhancement of biodiversity. These considerations are addressed by different strategies, and are summarized as design criteria listed in **Table 2.3**.

ENVIRONMENTAL CONSIDERATIONS	
CONSIDERATIONS	STRATEGIES
Awareness of cultural and natural resources	Use of native plants Materiality
Erosion Prevention	Avoid steep slopes Limit width of trails Materiality Avoid wetlands
Enhance Biodiversity	Avoid wetlands Protect threatened species Be senstive of habitat areas Avoid invasive species

Table 2.3: Environmental Considerations of Natural Trail Design

User experience is a secondary consideration in natural trail design after the primary consideration of environmental health. The user experience considers the needs and wants of a variety of user types enjoying the natural environment. These considerations include: stimulating the senses, encouraging learning, creating safety, re-creating the soul, exercising the body, and gaining satisfaction (United States Department of Interior, National Park Service 1996).

EXPERIENTIAL ACCESSIBILITY

Experiential accessibility is a result of universal design. It is the experiential conclusion of places that acknowledge the diversity of human ability. Universal design involves designing products and spaces to be used by the widest possible range of people (Hoyt 1993). The idea was adapted from accessible design with the belief that being just accessible is not enough. There is an overlay with consideration of the experiential quality of spaces. By designing for diversity of use, spaces will be more functional and user-friendly for everyone (Zimring 1987). Universal design addresses three categories of experience, resulting in places that are experientially accessible (McMahan 2015). The three categories included in **Figure 2.2**, create an ideal experience that addresses physical, sensory, and cognitive aspects of a place (McMahan 2015).

CATEGORIES OF EXPERIENCE

PHYSICAL

Physical experience involves the body's relationship with its surrounding environment (Norman 2011). There are two categories of physical experience; the ability to access, and the actual physical act of interacting. Providing access to places for human-nature interaction is an important design consideration. This category refers to the accessibility of a place. The act of interacting is also important since it involves the body's experience of the place and results in both physical and mental benefits (Norman 2011). This interaction is done through movement, by the process of entering, approaching, acting, and passing (Pallasmaa 1993).

To address the physical experience of trail design both ability to access and the act of interacting should be addressed. The ability to access is addressed through the feature of accessibility and the act of interacting is addressed through movement shown in **Table 2.4**.

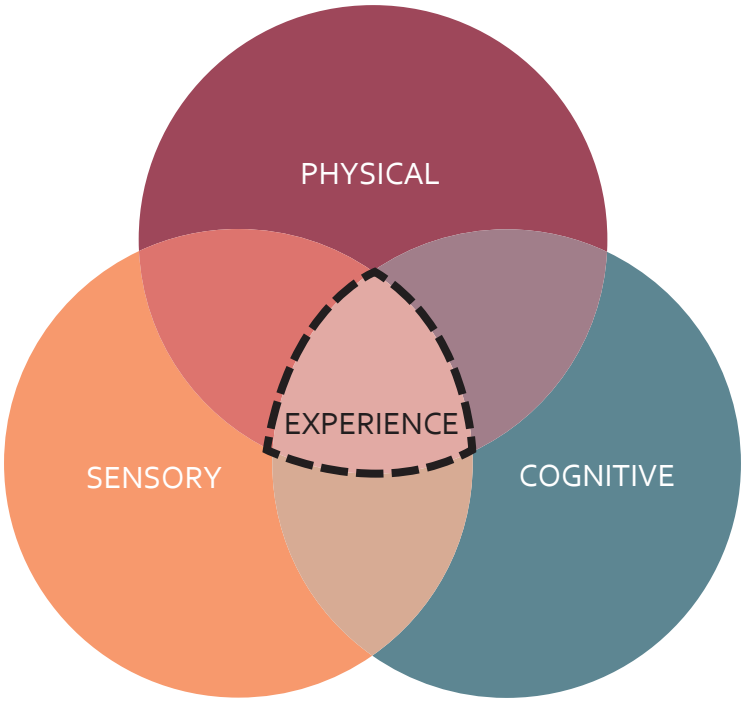

Figure 2.2: Three Categories of Experience

PHYSICAL EXPERIENCE
FEATURE
Ability (Norman 2011; ADA 2010)
Movement (Norman 2011; Pallasmaa 1993)

Table 2.4: Physical Experience Elements

SENSORY

Sensory perception is an important aspect of experience because it allows people to fully experience a place (Hilgard 1978). Vision is often seen as the most important sense, but in reality it is the combination of vision, hearing, touching, smelling, and tasting (Pallasmaa 1993; Harris and Ruggles 2007). Every touching experience we have is multi-sensory with not only the five senses, but also the sense of gravity, and muscle and bone (Pallasmaa 1993). The seven realms of sensory experience include vision, acoustic, scent, touch, muscle and bone (movement), body identification, and taste and all have a significant effect on a person's connection to the world:

- Vision is the least intimate of all the senses, it distances viewers from the surrounding world.
- Sound creates a sense of connection and solidarity (Pallasmaa 1993).
- Scent is often the most memorable of all the other senses (Pallasmaa 1993).
- Touch has a sense of nearness and intimacy; it has the ability to read texture, weight, density, and temperature (Pallasmaa 1993).
- Taste adds another dimension to design, as we experience objects our taste buds realize how those surfaces and textures would taste (Pallasmaa 1993).
- Muscle and bones (movement) refers to our movement through space, and the intake of our surroundings in relation to the body. This sense involves the understanding of our surroundings through movement, including approaching, entering, and acting (Pallasmaa 1993).
- Body identification relates to the empathic nature of humans in projecting ourselves into objects and scenes to understand the forces that are felt, and therefore feel them ourselves. (Pallasmaa 1993).

To address sensory perception, the features of sensory experience need to be considered. **Table 2.5** shows the features excluding body identification. Body identification is excluded because it addresses cognitive experience further than sensory experience. Muscles and bones is changed to movement, because movement describes the meaning, avoiding confusion and misunderstanding. Additionally, movement is included in the physical experience table because it addresses the physical interaction of the body.

SENSORY EXPERIENCE
FEATURE
Vision (Pallasmaa 1993; Hilgard 1978)
Sound (Pallasmaa 1993)
Scent (Pallasmaa 1993)
Touch (Pallasmaa 1993)
Taste (Pallasmaa 1993)
Movement (Pallasmaa 1993; Stea 1978)
Body Identification (cognitive experience)

Table 2.5: Sensory Experience Elements

COGNITIVE

Cognitive experience refers to human thought, both subconscious and conscious, that comes from the body and its interaction with the environment (Norman 2013). Most of human life falls under the subconscious. Humans interpret the world with intuition and understanding, by relating current experience with the past (Stea 1978). When a current experience doesn't directly relate to the past, there is a switch to conscious thinking. Conscious reactions refer to interactions that cause a sense of discovery through determining, pondering, and connecting. Both subconscious and conscious thought work together to form aspects of human life and experience (Norman 2013; Kaplan 1978).

Human life and experience are also affected by emotions. Emotions and cognition cannot be separated. Cognition attempts to make sense of the world while emotions link value to that understanding. Humans find great emotional discomfort when confusion arises. A positive emotional state provides opportunity for the brain to notice changes in the environment, to be distracted by events, and to piece together events and knowledge (Norman 2013). As a result, to address cognitive experience, one must consider both voluntary and involuntary attention.

Voluntary cognitive attention refers to attention that requires effort. A city is a great example of voluntary attention due to the overwhelming stimuli. It takes effort to concentrate and understand the surrounding environment. Voluntary attention can result in stress and a sense of confusion. In opposition, involuntary attention requires no effort, it provides opportunities to relax and intake objects that strike fascination (Norman 2013). Nature provides opportunities for involuntary attention due to the absence of distractions, resulting in a sense of discovery, wonder, and fascination (Kaplan 1989). When involuntary cognitive attention occurs, humans process the information perceived at different levels.

Processing happens at three different levels. To determine a person's emotional and cognitive state, designers must design for all three levels to address the cognitive needs of users. The three levels are visceral, behavioral, and reflective. "Visceral" refers to the basic productive mechanisms of the human affective system, coupled with motor system. This processing is fast, completely subconscious, and sensitive to the current state of things. Designers use aesthetic sensibilities to drive these responses. "Behavioral" is a process that is a performance of a well-learned action. Every action during this level is associated with an expectation through feedback. Feedback is the way to understand results of behavioral processing and plays an important role in our emotional lives. "Reflective" is the longest level of processing. It consists of understanding, reasoning, and conscious decision-making. It often occurs after action has happened (Norman 2013). It is the afterthought of the result of an action; it is the memory of the experience.

Designers can address the three levels of processing under the desirable voluntary category. This can be accomplished with the consideration of a sense of fascination, through five different elements: involvement, challenges, safety, body identification, and mystery (Kaplan 1978; Norman 2011; Pallasmaa 1993; and Stea 1978). Involvement is the availability of exploration for understanding (Kaplan 1978; Norman 2011). Challenges propose a sense of accomplishment after completion and give action a reason, making the opportunity to gain useful information available (Norman 2011). Mystery provides a sense of discovery (Norman 2013). Body identification is the act of projecting oneself into objects and scenes

to understand the forces that are felt. (Pallasmaa 1993; Norman 2011). Lastly, feeling of safety provides the opportunity for the cognitive intake of the other elements (Kalplan 1978). The cognitive experience can be addressed with consideration of these five elements seen in **Table 2.6.** They provide a voluntary emotional cognitive response.

COGNITIVE EXPERIENCE
FEATURE
Involvement (Kaplan 1978; Norman 2011)
Challenge (Norman 2011)
Mystery (Kalplan 1978)
Feeling of Safety (Kalplan 1978)
Body Identification (Pallasmaa 1993; Stea 1978)

Table 2.6: Elements of Cognitive Experience

The three categories of experience; physical, sensory, and cognitive, work together to create a fulfilling and beneficial experience. These categories also fall into the user experience considerations of trail design depicted in **Table 2.7**. This shows that trail design is more than just the physical aspect of experience, instead it is more diverse. Trail design should meet all of people's needs through the consideration of physical experience, sensory experience, and cognitive experience.

TRAIL EXPERIENCE			
USER EXPERIENCE	PHYSICAL	SENSORY	COGNITIVE
Stimulation of the Senses		●	
Place of learning			●
Feeling of safety			●
Re-creation of the soul			●
Exercise of the body	●		
Satisfaction	●	●	●

Table 2.7: Categories of User Experience

ACCESSIBILITY

To achieve experiential accessibility, the three categories of experience need to be accessible to all people. There needs to be a layer of accessibility applied to each category of experience, as seen in **Figure 2.3**. It is important for designers to acknowledge the diversity of human ability, and design for the widest range of people possible. A general understanding of feelings and differences in experience, greatly improves the ability for designers to accommodate for strengths and challenges for those with a disability. A complete understanding is impossible; however, being as empathic as possible can greatly improve consideration. With this understanding designing experience can accent strengths and limit challenges, providing an experience desirable for all.

An additional consideration is the emotional effect that is felt with the development of a disability, through the transition from being able to do everything to being limited. The opportunity for a slow progression is sometimes necessary for confidence building. There are a wide range of impairments and how the particular impairment impacts a person's function. Age, amount of experience using assistive devices, and current functioning will also impact the ability and perception of ability of an individual. The three disabilities that will be addressed are mobility, vision, and hearing disabilities.

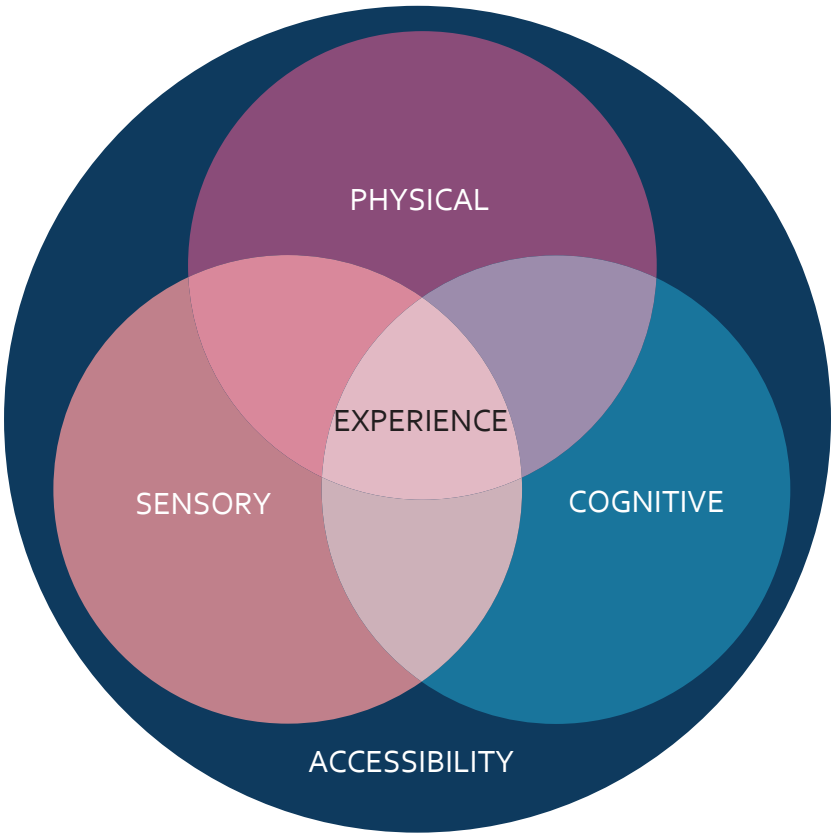

Figure 2.3: Layers of Accessibility

MOBILITY

Mobility impairments have a wide range of severity, starting with limitations of stamina to paralysis. Some impairments are caused by conditions at birth while others result from physical injury or illness (University of Illinois at Urbana-Champaign 2015). There is also a variety in the duration of impairment, ranging from temporary to permanent. It is important to understand that mobility impairments can impact people in many different ways, minimizing the negative impacts and maximizing positives can enhance their everyday experience (University of Illinois at Urbana-Champaign 2015).

PHYSICAL

People with mobility impairments have challenges involving the physical experience of a place. There are many different devices that may be used by people who have a mobility disability including: canes, walkers, crutches, wheelchairs, and motorized wheelchairs, depending on the severity of their condition. Sometimes places have limited access for persons with this disability. Limiting factors include small spaces difficult to maneuver, physical barriers such as stairs, surface materials difficult to cross, and length beyond endurance levels (University of Washington 2016).

SENSORY

The sensory experience for people with mobility disabilities varies. Depending on the severity of their condition, there may not be the opportunity to touch, causing a greater dependence on other senses to understand textures of objects. People with mobility disabilities also have an opportunity to better intake the world. Depending on their condition, movement may be slower, presenting the chance to further enjoy surroundings. In the situation that a wheelchair is used, the world is seen at a different view, closer to the ground. This also creates opportunities that could potentially enhance interactions with the environment (University of Illinois at Urbana-Champaign 2015).

COGNITIVE

Mobility impairments range in severity, and cognitive experience will also vary significantly. Familiarity of a place reduces stress because wayfinding and rest areas are more likely to be remembered (University of Illinois at Urbana-Champaign 2015).

The wide variety of conditions for people with mobility impairments creates a challenge in addressing all of the strengths and challenges encountered. An understanding of the variety of conditions can help inform design decisions that enhance strengths and minimize challenges. These strengths reveal great opportunities to enhance the experience of places for everyone. These trail design considerations are represented in **Table 2.8**.

MOBILITY IMPAIRMENTS		
CATEGORY	USER EXPERIENCE	CONSIDERATIONS
PHYSICAL	Exercise of the body	Access with mobility devices
		Physical barriers
		Trail elements
		Slope considerations
	Satisfaction	Places of rest
		Variety in terrain
		Path alignment
SENSORY	Stimulation of the senses	Proximity of path to vegetation
		Visual interest at sitting height
		Touchable amenities
	Satisfaction	Multisensory experience
		Variety in surrounding landscape
		Variety in degrees of enclosure
COGNITIVE	Place of learning	Educational opportunities
		Interactive opportunities
	Feeling of safety	Places of rest
		Availability of restrooms
		Variety in sun exposure
		Buffer from traffic
		Buffer from distractions
		Lighting
		Signage at seated height
		Wayfinding
	Re-creation of the soul	Buffer from distractions
		View sheds
		Edge conditions
		Variety in degrees of enclosure
	Satisfaction	Sense of purpose
		Point of interest
		Educational opportunities

Table 2.8: Mobility Impairments (Synthesis by Author)

VISION IMPAIRMENTS

Vision disabilities include people with blindness and low vision. With this disability there are challenges relating to orientation and mobility. Skills are developed to accommodate these challenges that result in differences in the experiential categories of a place; physical, sensory, and cognitive. People with blindness or low vision face challenges, but also have strengths that give them the opportunity to perceive the world in a beautiful way that is difficult to understand and comprehend (AFB 2015).

PHYSICAL

People with blindness or vision loss often use a cane or other devices to move safely through indoor and outdoor environments. Some of the different devices include canes, walkers, guide dogs, and human guides (AFB 2015). These devices are considered an extension of the body and help people with vision impairment better physically interact with their surrounding environment (AFB 2015).

SENSORY

Development of the senses is a skill that maximizes understanding of the surrounding environment to detect desired places and avoid potentially dangerous situations such as vehicular traffic or obstructions. Development of the senses also improves quality of life by the opportunity to enjoy and understand surroundings. The general public often believes that people with blindness or low vision have super senses, which is not true. People with impaired vision do not have as many visual distractions, so they have the opportunity to perceive the world through other senses (Ettinger 2009). Their worlds are rich with tastes, textures, sounds, and scents (Quietwater 2005). "There is more to life than the picture." (Newman 2005).

COGNITIVE

For additional independence, people with blindness or low vision have developed wayfinding skills (American Foundation for the Blind 2015). These skills include the use of directions and landmarks to find destinations. It also entails the use of public transportation and the avoidance of dangerous situations such as high traffic intersections. The act of wayfinding for someone that has blindness or low vision, makes a cognitive experience of a place vary greatly with familiarity.

An understanding of the challenges faced by people with visual impairment can help inform design as shown in **Table 2.9**. However, it is also important for designers to understand the strengths of someone with blindness or low vision. These strengths express great opportunities to enhance the experience of places, not only for people that have visual impairment, but for everyone.

HEARING IMPAIRMENTS

"Deaf people can do anything hearing people can, except hear." (Schreibert 2015). Everyday experience for people with deafness or hearing loss is not much different from people that possess hearing. The difference exists in the sensory and cognitive aspects of experience, and not in the physical.

SENSORY

People who have hearing impairments have an alternate sensory experience than people who hear. Hearing impairment sharpens other senses to compensate for information intake, which presents both benefits and challenges. The major benefit it that enhancement of other senses broadens the experiential spectrum. Challenges exist when vision or other senses may also be impaired which might contribute to feelings of diminished safety (Schreibert 2015).

VISION IMPAIRMENTS		
CATEGORY	USER EXPERIENCE	CONSIDERATIONS
PHYSICAL	Exercise of the body	High contrast of trail edge
		Physical barriers
		Physical exercise amenties
	Satisfaction	Places of rest
		Variety in terrain
		Path alignment
SENSORY	Stimulation of the senses	Proximity of path to vegetation
		Braille signage
		Touchable path edge
		Variety in degrees of enclosure
		Sun and shade considerations
		Variety in surrounding landscape
		Touchable amenities
	Satisfaction	Multisensory experience
		Variety in surrounding landscape
		Variety in degrees of enclosure
COGNITIVE	Place of learning	Educational opportunities
		Interactive opportunities
	Feeling of safety	Touchable amenities
		Buffer from traffic
		Buffer from distractions
		Lighting
		Variety in sun exposure
		Braille signage indicating trail use
		Availability of restrooms
		Wayfinding
	Re-creation of the soul	Buffer from distractions
		Edge conditions
		Variety in degrees of enclosure
	Satisfaction	Sense of purpose
		Point of interest
		Educational opportunities

Table 2.9: Vision Impairments (Synthesis by Author)

COGNITIVE

Cognitive experience for people with low hearing or deafness can be significantly different. The availability of other senses to intake and relay information is important for cognitive benefits. Feeling of safety is also affected by the inability to hear, potentially causing situational stress and discomfort. Accommodating these cognitive challenges can be done by addressing the need for the use of other senses.

Design can accommodate hearing impairment challenges by concentrating on the availability of the other senses. **Table 2.10** presents considerations for persons with hearing disabilities in trail design.

HEARING IMPAIRMENTS		
CATEGORY	USER EXPERIENCE	CONSIDERATIONS
SENSORY	Stimulation of the senses	Multisensory
		Variety in texture
		Color variations
	Satisfaction	Variety in surrounding landscape
		Path alignment
		View sheds
COGNITIVE	Place of learning	Educational opportunities
		Interactive opportunities
	Feeling of safety	Restrooms
		Variety in degrees of enclosure
		Lighting
		Indication of trail users
	Re-creation of the soul	Buffer from distractions
		Edge conditions
		Variety in degrees of enclosure
	Satisfaction	Sense of purpose
		Point of interest
		Educational opportunities

Table 2.10: Accommodating Hearing Impairments in Trail Design (Synthesis by Author)

CONCLUSION

The literature review presents the importance of providing all people with the opportunity to interact with nature. This interaction is important because human-nature relationships benefit both physical and mental health. Unfortunately, people with disabilities often have lower physical activity levels due to perceptions of unavailability to physical exercise and the outdoor environment; often the perception of unavailability is true. Natural trails have the potential to provide this interaction for persons with disabilities, but natural trails accommodate environment needs first. Many times this results in the inability to provide accessibility to the entire trail, although, it does remain possible to provide the most beneficial experience for people with disabilities. The literature review concludes with an understanding that providing an opportunity to access the three categories of experience results in a physically and mentally beneficial experience. This presents the importance and opportunity to provide natural trail guidelines that contain sensory and cognitive considerations, in addition to routing considerations.

03 Methodology

OVERVIEW

Methods used to answer the research question and sub-questions are accomplished through four phases: 1) Framework Development informed by the literature review, 2) Framework Review Using Precedents and User Profiles, 3) Development of Natural Trail Guidelines, and 4) Application of Design Guidelines to two natural trails in Manhattan, Kansas. **Figure 3.1** summarizes these phases, and each phase will be described in more detail in the following sections.

FRAMEWORK DEVELOPMENT

The literature review concludes with an understanding that providing opportunities for physical, sensory, and cognitive interaction in trail design results in physical and mental health benefits. Additionally, persons with disabilities tend to participate in lower amounts of physical activities due to barriers associated with both physical exercise and the outdoor environment. This issue presents the importance and opportunity to provide natural trail guidelines that contain sensory and cognitive considerations, in addition to routing considerations that eliminate the barriers and utilizes opportunities. In order to create guidelines a framework is developed. The framework is developed through an understanding of these topics; categories of experience, persons with disabilities and the barriers associated with lack of exercise, and existing trail design strategies.

• Additional information regarding framework development is presented in Chapter 4.

FRAMEWORK REVIEW USING USER PROFILES AND PRECEDENTS

User profiles and precedents are used to review the framework by verifying that the needs of users are addressed, in addition to the inclusion of previous successful design strategies. The user profile establishes what users need, while a precedent review summarizes what works.

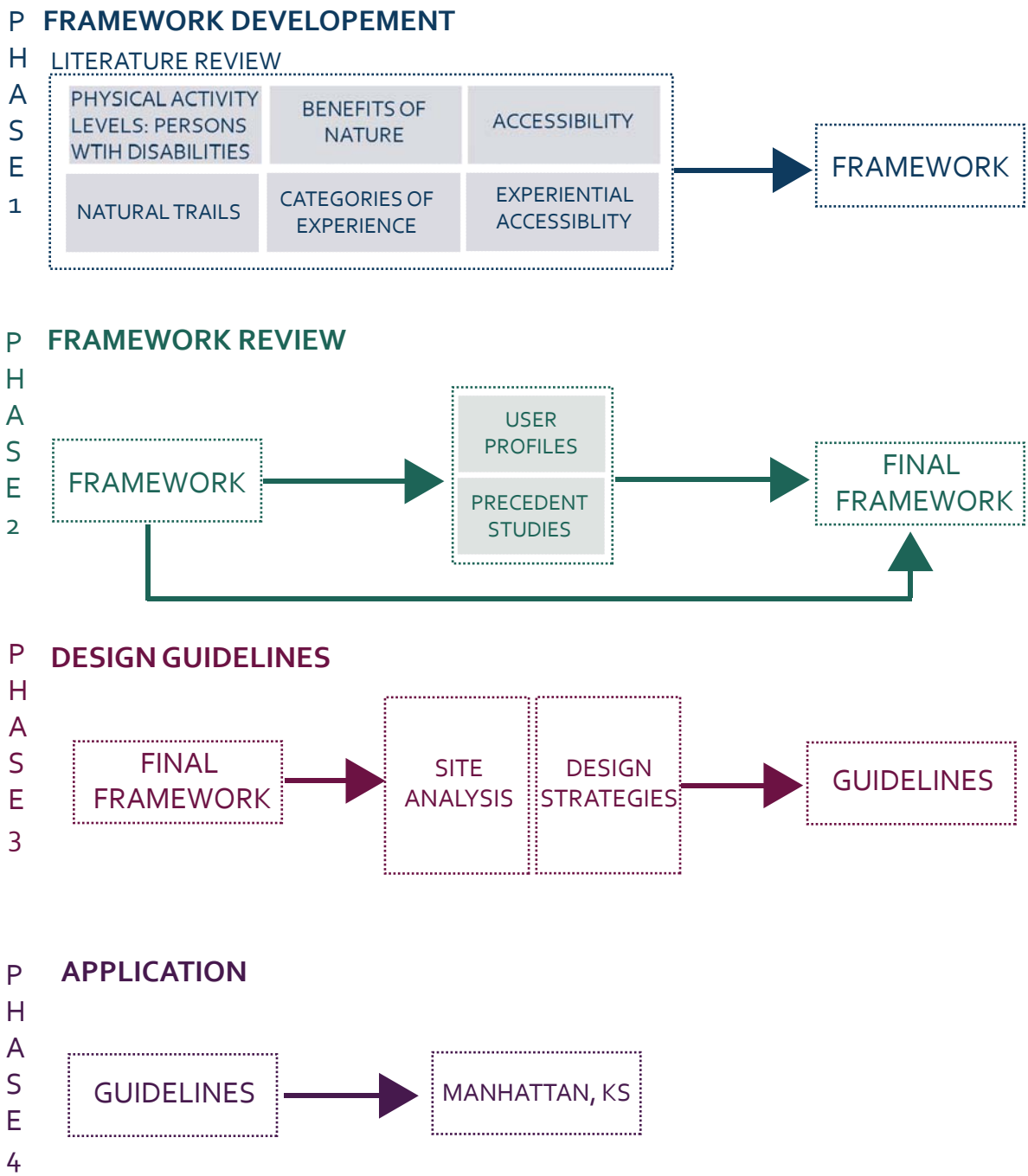

Figure 3.1: Methodology Summary

USER PROFILES

User profiles determine the range of trail considerations that need to be incorporated to serve the full spectrum of potential trail users. There are four different user types addressed in this study: general users, vision impaired users, mobility impaired users, and hearing impaired users. General users are the largest group and provides overall cost justification for trail construction. Sensitive design can concurrently incorporate features that accommodate people with disabilities with little additional cost while broadening the dimensions of experience for all. Accommodation may be as simple as trail routing, or introducing elements to increase multi-sensory appeal. A framework has been developed to define and organize these multi-sensory elements which will later be incorporated into trail design guidelines for "all" users.

PRECEDENT STUDIES

Precedent studies are used to review the framework by verifying the inclusion of previous design strategies that were successful in addressing the three categories of experience. They were selected by first considering the needs for persons with disabilities, then reviewing sensory and cognitive considerations. Through the identification process, four different trail types are discovered and defined. The trail types include: Courtyard Trail, Urban Park Trail, Natural Park Trail, and Regional Trail. They were defined through an understanding of the different user needs, and availability to a connection with nature.

Twelve precedents are identified, consisting of three trails from each of the four trail types. After the identification process, each precedent is evaluated using the three categories of experience: physical, sensory, and cognitive. After all precedents are studied, the framework is reviewed by use of the precedents. The review results in the verification that the framework includes existing natural trail strategies.

NATURAL TRAIL TYPES

COURTYARD TRAIL

Courtyard trails exist in small urban spaces and are often located adjacent to hospitals or retirement homes. They accommodate people with lower mobility abilities by addressing the inability to travel long distances. They accomplish this by having a short trail (typically 100-500 feet) and multiple places to rest along the trail. They often are built to have a healing quality by creating sensory elements that evoke multiple senses.

URBAN PARK TRAIL

Urban park trails are located in an urban park. These trails are of a medium distance (typically ¼-2 miles), often with a hard trail surface and wide tread. Because of this, they accommodate a wide range of abilities. Due to being urban there is often parking, and public transit available. Often they are full of lawn areas and recreational opportunities. Although these spaces are able to accommodate a large range of people, there is typically a lack in opportunity to have the unique experience of nature.

NATURE PARK TRAIL

Nature park trails are medium in length (typically 1-2 miles) and exist in a regional natural setting. Often, nature park trails are rough in terrain because they prioritize environmental needs before user needs. Due to the prioritizing of environment needs, Nature Park trails often lack accommodation for those with disabilities.

REGIONAL TRAIL

Regional trails travel long distances (typically 2-10 miles). Often, the surface changes throughout the trail. Regional trails accommodate many user groups due to the variety of terrain and availability of trail heads. Areas of rest are often available.

• Additional information regarding framework review is presented in Chapter 5.

DEVELOPMENT OF NATURAL TRAIL GUIDELINES

The guidelines are inspired by existing handbooks and guidelines. There are two sections; site analysis and design strategies. The site analysis portion will distinguish the purpose and methods of the spatial analysis, involving both field work and Geographic Information Systems (GIS) methods. The design strategies section will introduce strategies to implement in trail design that will provide experiential accessibility for users and focus on routing considerations.

• Additional information regarding the Natural Trail Guidelines can be found in Chapter 6.

APPLICATION OF DESIGN GUIDELINES

As a test application of the trail design guidelines, Anneberg Park on the west side of Manhattan, Kansas is used. Anneberg Park provides a variety of amenities including soccer fields, baseball fields, playgrounds, pond area, picnic area, and a trail surrounding the park. Surrounding land uses include single and multi-family development to the north and west, a golf course to the east, and Wildcat Creek and steep hills to the south. The existing trail perimeter trail, passes alongside playfields, and passes through portions of woodland in a natural setting. Anneberg Park was selected due to its location and amenities. In addition, the trail design guidelines will be applied to the Konza Prairie Preserve which represents a Regional Trail. The focus will be on trail routing to avoid steep slopes and providing better connections to cultural features.

• Additional information regarding the guidelines application can be seen in Chapter 7.

04 Framework Development

OVERVIEW

The development of the framework is influenced by the literature review, which concluded existing trail guidelines are oriented toward mobility only and do not incorporate sensory or cognitive dimensions which would appeal to a broader spectrum of users—particularly those with disabilities. Disabled persons typically have low rates of physical activity participation. Actively engaging in physical exercise, especially in a natural setting, offers physical and mental health benefits. The framework is designed to address the shortcomings of existing trail guidelines, while also addressing general needs of trail design. The framework's basic organization is in three levels: category of experience, feature, and element. The framework is further expanded beyond the basic organization with an addition of three subjects: examples/types, site analysis inventory/methods, and design considerations/strategies. The three subjects address each element of the basic framework.

BASIC FRAMEWORK

CATEGORY OF EXPERIENCE

The category of experience divides the framework into three different tables which include physical experience, sensory experience, and cognitive experience. These three categories came from an understanding of the full dimensions of experience as noted by researchers. Each experience table has two columns; "Features" and "Elements", as seen in **Table 4.1**. Features are taken from the literature review to determine subjects that have an effect on the certain category of experience. Each feature has multiple elements that contribute to experience.

CATEGORY OF EXPERIENCE	
FEATURE	ELEMENT
Literature review	Synthesis of literature review

Table 4.1: Organization of Framework

FEATURE

Features are defined through research regarding the different categories of experience. For each of the categories, multiple sources are used to define the features. The features are the basis for the production and organization of the framework, defining the topics to be addressed in order to accomplish the experiential qualities of the specific category of experience.

ELEMENT

The elements are determined through the synthesis of the literature review from multiple sources of information and understanding. The first source of information came from the reference used to define the feature, due to sources defining both the features and elements in multiple cases. An additional source of information came from the existing trail design guidelines study. Although there were many shortcomings in the cognitive and sensory categories of experience, significant physical experience elements were defined. Additionally, the study of accessibility and different disabilities added elements that improve the sensory and cognitive experience of nature trails for persons with disabilities. Although many sources had mentioned all of these various elements, they were organized and connected to the features through synthesis.

The framework development results in three tables, **Tables 4.3-4.5**, that distinguish the elements that natural trail design guidelines should address to accent opportunities and overcome limitations in natural trail design. The application of the framework to natural trail design results in trails that fulfilled all categories of experience with considerations of persons with disabilities. Not only does the framework define considerations for persons with disabilities, but the improvement of experience for the general user.

PHYSICAL FRAMEWORK

The framework for physical experience focuses on the physical ability and strain that one would experience when using a natural trail. This framework has a greater focus on persons with disabilities and the considerations that has a direct effect on the ability of someone to access the trail.

FEATURES

The features in the physical experience framework include ability and movement. The features are defined through the use of three different sources, seen in **Table 4.2**. The information gained from the sources regard the study of physical experience.

ELEMENTS

The elements of physical experience are defined through a synthesis of the literature review through multiple sources. The topics addressed in the synthesis of physical experience include existing trail guidelines, physical experience, and accessibility. Through study and understanding of these topics, elements were defined for each of the two features, ability and movement, seen in **Figure 4.1**. Elements addressing ability include trail, access points, and amenities. One element, path alignment, is defined for movement. The topics relationship with resulting elements can be seen in **Figure 4.1**. **Table 4.3** is the final basic framework for physical experience.

PHYSICAL EXPERIENCE
FEATURE
Ability (Norman 2011; ADA 2010)
Movement (Norman 2011; Pallasmaa 1993)

Table 4.2: Physical Experience Features

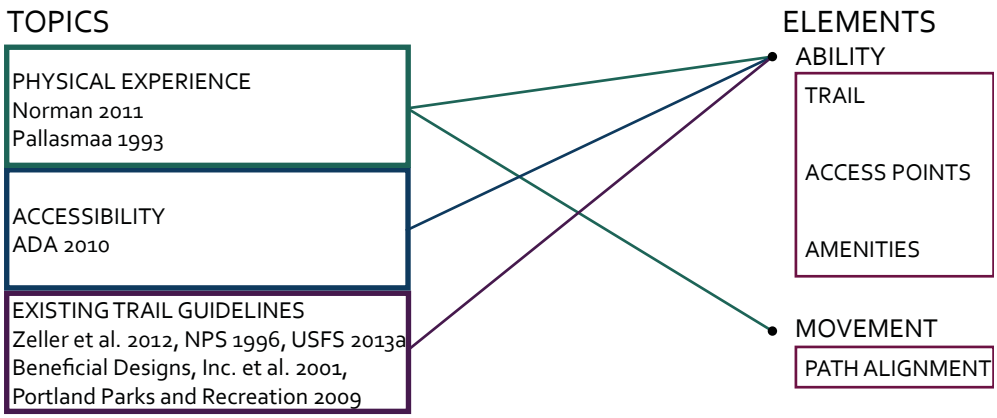

Figure 4.1: Physical Experience Topics and Elements (Synthesis by Author)

PHYSICAL EXPERIENCE	
FEATURE	ELEMENTS
Ability	Trail
	Access points
	Amenities
Movement	Path alignment

Table 4.3: Physical Experience Features and Elements (Synthesis by Author)

SENSORY FRAMEWORK

FEATURES

The features of the sensory experience framework, **Table 4.4**, include the five senses with the addition of movement, a sense related to the body's movement through space. Bodily identification is excluded from the sensory framework. It better identifies with cognitive elements, therefore it is included in the cognitive experience framework.

SENSORY EXPERIENCE
FEATURE
Vision (Pallasmaa 1993; Hilgard 1978)
Sound (Pallasmaa 1993)
Scent (Pallasmaa 1993)
Touch (Pallasmaa 1993)
Taste (Pallasmaa 1993)
Movement (Pallasmaa 1993; Stea 1978)
Body Identification (cognitive experience)

Table 4.4: Sensory Experience Features

ELEMENTS

The elements of sensory experience are defined through a synthesis of the literature review. The synthesis involves multiple topics including sensory experience, existing trail design guidelines, and barriers associated with lower physical activities levels of persons with disabilities. The connection of topics and elements are shown in **Figure 4.2**. Through the study of these topics, elements were determined for each of the features, creating the final basic framework, seen in **Table 4.5**.

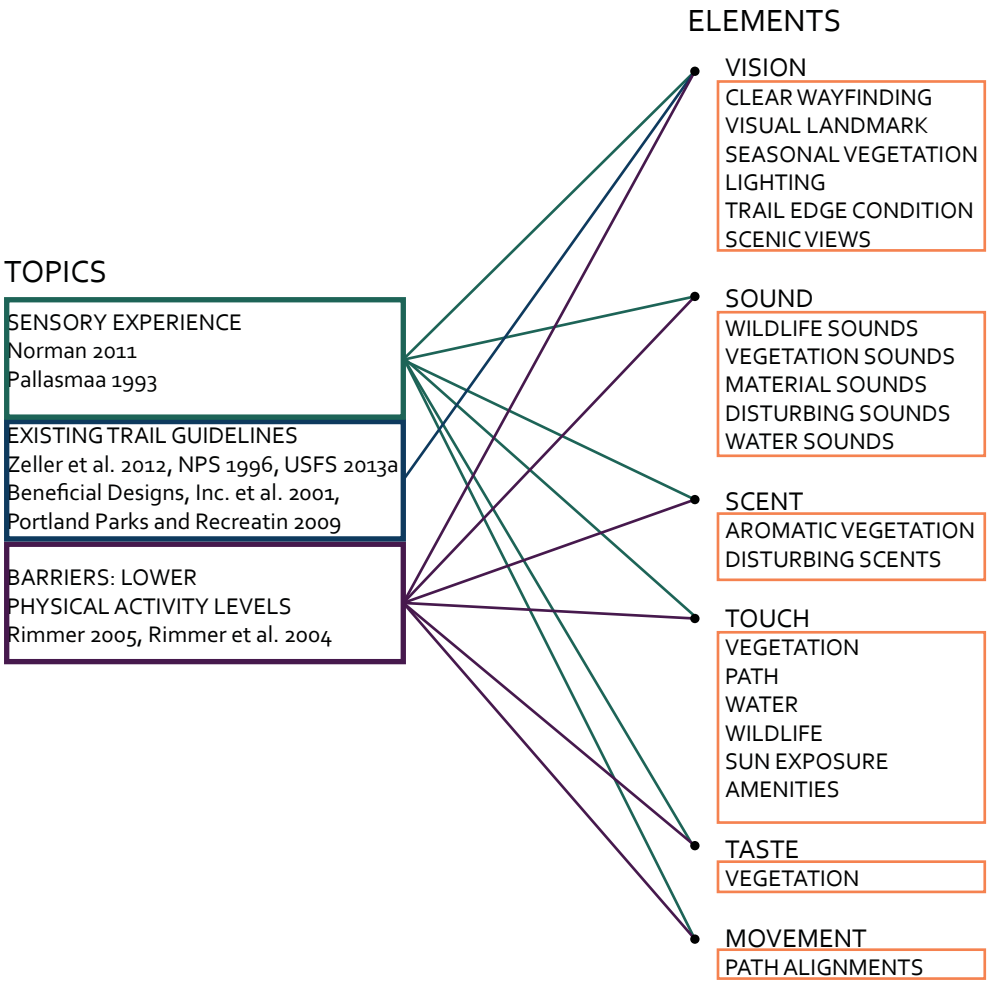

Figure 4.2: Sensory Experience Topics and Elements (Synthesis by Author)

SENSORY EXPERIENCE	
FEATURE	ELEMENTS
Vision	Clear wayfinding
	Visual landmark
	Seasonal vegetation
	Lighting
	Trail edge condition
	Scenic views
Sound	Wildlife sounds
	Vegetation sounds
	Material sounds
	Disturbing sounds
	Water sounds
Scent	Aromatic vegetation
	Disturbing scents
Touch	Vegetation
	Path
	Water
	Wildlife
	Sun exposure
	Amenities
Taste	Vegetation
Movement	Path alignment

Table 4.5: Sensory Experience Features and Elements (Synthesis by Author)

COGNITIVE FRAMEWORK

FEATURES

The features of cognitive experience are defined through synthesis of the literature review. The determination of the features was done through understanding of features that have an effect on experience relating to cognitive functions. The sources used to determine these features are seen in **Table 4.6**.

COGNITIVE EXPERIENCE
FEATURE
Involvement (Kaplan 1978; Norman 2011)
Challenge (Norman 2011)
Mystery (Kalplan 1978)
Feeling of Safety (Kalplan 1978)
Body Identification (Pallasmaa 1993; Stea 1978)

Table 4.6: Cognitive Experience Features

ELEMENTS

The elements of cognitive experience are determined through understanding of different subjects, including cognitive experience and existing trail guidelines, seen in **Figure 4.3**. The elements are defined for each of the features previously addressed. The outcome is the basic cognitive framework, seen in **Table 4.7**.

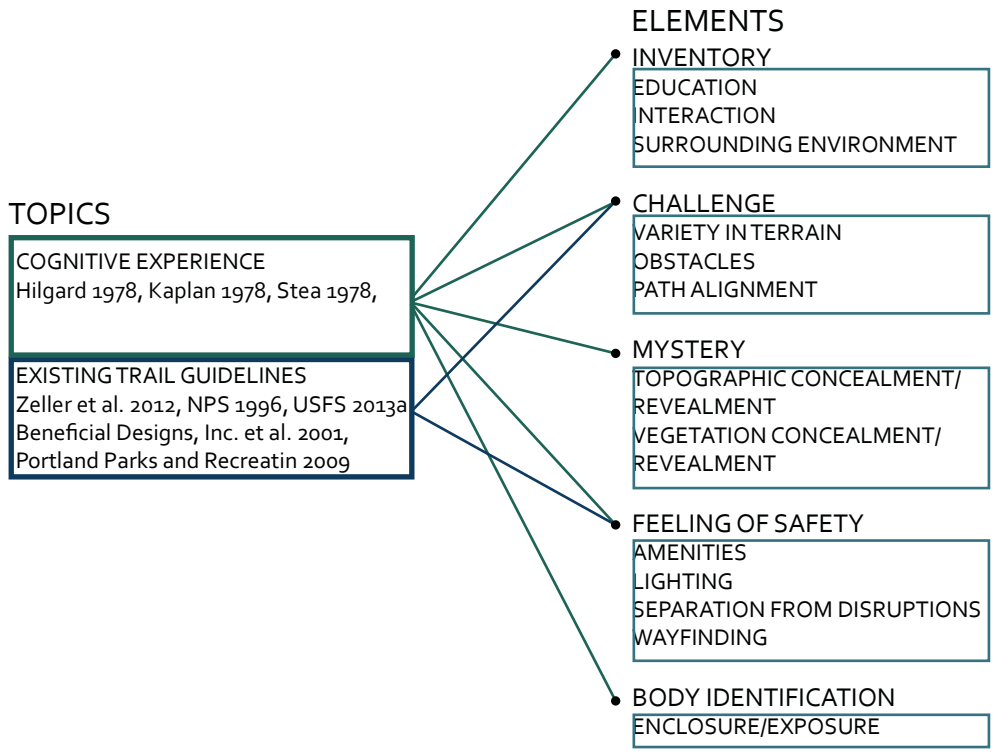

Figure 4.3: Cognitive Experience Topics and Elements (Synthesis by Author)

FRAMEWORK: COGNITIVE EXPERIENCE	
FEATURE	ELEMENTS
Involvement	Education
	Interaction
	Surrounding environment
Challenge	Variety in terrain
	Obstacles
	Path alignment
Mystery	Concealment/ revealment by topography
	Concealment/ revealment by vegetation
Feeling of Safety	Amenities
	Lighting
	Separation from disruptions
	Wayfinding
Body Identification	Enclosure/ exposure

Table 4.7: Cognitive Experience Features and Elements (Synthesis by Author)

FRAMEWORK EXTENSION

The framework extension is completed with consideration of the application of the framework. The extension includes examples and types, site analysis and inventory analysis, and design guidelines and strategies. The three sections are determined for each element, previously defined. The extension of the framework can be seen in **Tables 4.8-4.10**.

EXAMPLES/TYPES

The examples and types are opportunities present in trail design to accomplish features of experience. They are defined through synthesis of the literature review and personal experience of a variety of natural trails, and precedent studies. The examples and types transition the framework to become specifically focused on trail design and trail surroundings, resulting in the ability to create guidelines addressing both site analysis and design strategies.

SITE ANALYSIS INVENTORY/METHODS

The site analysis inventory methods are defined through consideration of examples and types. They direct the ability to define, through different methods of site analysis, existing conditions and opportunities trails and their surroundings present in addressing the three categories of experience.

• Additional information regarding site analysis inventory and methods can be found in Chapter 6.

DESIGN CONSIDERATIONS/STRATEGIES

Design considerations and strategies are created through consideration of precedent studies, personal experience, and design background. The guidelines directly relate to features of experience, accomplishing the goal of making the most fulfilling experience accessible to those with disabilities.

• Additional information regarding design considerations and strategies can be found in Chapter 6.

FRAMEWORK: PHYSICAL EXPERIENCE		
FEATURE	ELEMENTS	EXAMPLES/TYPES
Ability	Trail	Width, length, slope, obstacles, surface material
	Access points	Proximity to public transit and parking
	Amenities	Places to rest, restrooms, water
Movement	Path alignment	Vertical, horizontal

SITE ANALYSIS	DESIGN CONSIDERATIONS/STRATEGIES
Identify trail elements; width, length, slope, surface material; map obstacles	Indroduce ADA requirements for width, length, slope, and surface materials of trail; remove obstacles
Identify distance between trail access points, public transit and parking	Introduce additonal access points, public transit stops, and parking
Identify locations of ideal places of rest, restrooms, water; map existing amenities	Create additional places of rest; introduce viewpoints and benches
Perform slope studies	Route trail with a variety of slopes and alignments

Table 4.8: Physical Experience Extended Framework (Synthesis by Author)

FRAMEWORK: SENSORY EXPERIENCE		
FEATURE	ELEMENTS	EXAMPLES/TYPES
Vision	Clear wayfinding	Directional signage, trail material, points of interest
	Visual landmark	Specimen tree, topographic knoll, rock outcrop, water feature, wildlife
	Seasonal vegetation	Colors, seasonal growth/forms, falling leaves
	Lighting	Shadow patterns, sun set/rise conditions, exposure to sun
	Trail edge condition	Topography, vegetation
	Scenic views	Distant views, near views, panoramic views
Sound	Wildlife sounds	Direct wildlife sounds, movement sounds
	Vegetation sounds	Vegetation movement sounds in wind
	Material sounds	Trail surface material, interactive sounds, reflected sounds
	Disturbing sounds	Traffic sounds, machinery sounds, construction sounds
	Water sounds	Reflected sounds, water movement sounds

SITE ANALYSIS INVENTORY/METHODS	DESIGN CONSIDERATIONS/STRATEGIES
Map areas of directional confusion/splits in path, locate signage	Introduce directional signage; introduce wayfinding through the use of trail surface material; remove directional confusion
Map visual points of interest, map frequent wildlife sightings	Route trail near visual landmark, create or amplify visual landmark
Identify specific tree species or groupings	Route trail through different tree species; introduce tree groupings having seasonal interest
Shadow studies, identify seasonal sun location, slope aspect studies	Route trail to provide access to sunset/sunrise vantage points, and a variety of sunny and shady spaces
Slope studies, identify adjacent vegetation heights	Route trail through a variety of vegetation and slope degrees; introduce regional species groupings
Slope studies, map view sheds, map scenic interests	Create frames for views; amplify scenic views; mask/remove unattractive views
Identify wildlife sightings/hearings/ evidence of wildlife	Route trail near frequent wildlife sighting areas; introduce vegetation and features that attract wildlife
Identify seasonal wind patterns; identify vegetation with auditory qualities, conduct slope aspect studies	Route trail adjacent to vegetation noted ofr seasonal auditory qualities, introduce vegetation with auditory qualities
Map typical sounds along trail routes	Introduce different trail surface materials, introduce interactive sounds
Map trail segments or specific locations of persistent, disturbing sounds	Route trail away from high auditory disturbances; mask auditory disturbances
Map stream, seepage, waterfall, and, riffle locations	Route trail adjacent to water features; amplify water movements/drips; create new water features

FRAMEWORK: SENSORY EXPERIENCE (Continued)		
FEATURE	ELEMENTS	EXAMPLES/TYPES
Scent	Aromatic vegetation	Vegetation with aromatic qualities
	Disturbing scents	Urban scents, industrial scents
Touch	Vegetation	Textural vegetation
	Path	Regional materials, variety of materials
	Water	Water located near path
	Wildlife	Tracks, direct contact
	Sun exposure	Sunny areas, shaded areas, semi-shaded areas
	Amenities	Benches, signage, educational opportunities
Taste	Vegetation	Edible vegetation/fuits, community gardens, etc.
Movement	Path alignment	Approach, enter, interact, slope

Table 4.9: Sensory Experience Extended Framework (Synthesis by Author)

SITE ANALYSIS INVENTORY/METHODS	DESIGN CONSIDERATIONS/STRATEGIES
Identify seasonal wind patterns, identify aromatic plant species	Considering prevailing wind directions, route trail near aromatic species; introduce aromatic species
Map areas of scent disturbances	Considering prevailing wind directions, route trail away from disturbing scents; eliminate disturbing scents
Identify distance of vegetation from path edge, map species groupings	Route trail near vegetation with tactile qualities and avoid spiny species; introduce tactile vegetation adjacent to trail edge; remove untouchable vegetation adjacent to trail edge
Identify and map different trail surface materials	Introduce a variety of trail surface materials
Map location of water features	Route trail adjacent to water features; create interactive water features
Map wildlife indicators	Route trail near wildlife sightings; introduce vegetation and features that attract wildlife
Map location of tree canopies; map slope aspect; identify seasonal sun directions	Route trail through a variety of sun exposure conditions
Map location of amenities, identify materials of amenities	Introduce regional materials in amenities; create touchable amenities
Identify edible vegetation and fruits	Route trail near edible vegetation; introduce edible vegetation; create edible gardens
Map location of tree canopies and landmarks; identify slope percentage and path shape; identify transitions	Route trail with a variety of vertical and horizontal alignments; create trail entrances

FRAMEWORK: COGNITIVE EXPERIENCE		
FEATURE	ELEMENTS	EXAMPLES/TYPES
Involvement	Education	Water, vegetation, wildlife
	Interaction	Vegetation, regional materials, wildlife
	Surrounding environment	Plains, dense woods, water, topography,
Challenge	Variety in terrain	Slope length, slope %, stairs/ stepping stone
	Obstacles	Rocks, vegetation, stairs, stepping stones
	Path alignment	Winding, straight, jagged
Mystery	Concealment/ revealment by topography	Concealment by topographic ridges and trail bends
	Concealment/ revealment by vegetation	Dense woods, open plains extending to horizon, etc.
Feeling of Safety	Amenities	Restrooms, places of rest, benches
	Lighting	Sun/shade exposure, night lighting
	Separation from disruptions	Traffic, urban sounds
	Wayfinding	Signage, maps
Body Identification	Enclosure/ exposure	Distant/near views, viewsheds, overhead structures, topography, vegetation, etc.

Table 4.10: Cognitive Experience Extended Framework (Synthesis by Author)

SITE ANALYSIS INVENTORY/METHODS	DESIGN CONSIDERATIONS/STRATEGIES
Map water systems and vegetation groupings	Route trail near visible natural systems; introduce explanatory signage; introduce vegetation that attracts wildlife; amplify natural systems
Identify touchable vegetation; map frequent wildlife sightings and vegetation groupings	Route trail through vegetation with tactile qualities; introduce vegetation along trail edge; introduce vegetation that attracts wildlife; introduce regional materials for amenities
Map plant groupings, slopes, soils, and hydrology	Route trail through a variety of environments and near water
Slope studies	Route trail with a variety of vertical trail gradients and surrounding slopes
Map location of objects intruding onto path	Route trail through rock outcrops; amplify difficulty (with consideration of ability); include loops/route options for least challenge
Topographic inventory	Route trail with a variety of vertical and horizontal alignment options
Viewshed analysis; topographic and 3D trail mapping	Align trail (vertical, horizontal) to strategically conceal/ reveal interesting features
Identify vegetation type/groupings along trail which provide concealment or revealment locations	Route trail to take advantage of concealment/ revealment opportunites created by vegetation; plant vegetation for this purpose
Identify trail length and ideal places to rest	Create places of rest; introduce benches and restrooms
Identify seasonal sun locations, identify sun set/rise time relative to trail use; identify person/animal concealment locations	Route trail relative light/dark conditions; provide supplemental lighting if needed; provide emergency communications if appropriate
Map areas of disturbances	Route trail to avoid disturbances, create buffer from disturbances
Map areas of directional confusion	Introduce directional signage and maps for locational understanding
Map tree canopies, species groupings, topography, viewshed analysis, and transition areas	Route trail through a variety of vegetation types, topography, eco-transitions

05 Framework Review

OVERVIEW

User profiles and precedents studies are used to review the framework. The review determines if the framework addresses all the necessary considerations. User profiles verify the considerations for persons with disabilities, while precedent studies include the consideration for strategies of successful trail designs.

USER PROFILES

OVERVIEW

Designers seek to address all people, but everyone is unique. The user profiles show general considerations for persons with mobility, vision, and hearing impairments. Their needs and wants will vary significantly, but with a general understanding, accommodations of their needs will be improved. With this understanding, trails will better accommodate those with a disability, and in addition to providing a fulfilling experience for general users.

USER TYPES

There are four different user types addressed in this study. The four user types consist of: the general user, vision impaired users, mobility impaired users, and hearing impaired users. The four user types are selected to expand users that have access to use, experience, and benefit from being in a natural setting. Each of the user profiles were defined from synthesis of the literature review, regarding barriers associated with lack of physical exercise for those with a disability, and understanding of the disability itself.

MOBILITY IMPAIRMENTS (MI)

A person with mobility impairments is one of the user types addressed in this study. Mobility impairments have a wide range of severity, starting with limitations of stamina to paralysis. Some impairments are caused by conditions at birth while others are a result of physical injury or illness. There are also variety in the length of conditions, some are permanent while other a temporal (University of Illinois at Urbana-Champaign, 2015). It is important to understand that mobility impairments can impact people in many different ways, minimizing the negative impacts and maximizing positives can enhance their everyday experience. **Tables 5.4-5.6** show the elements that apply to the experience of a persons with mobility disabilities addressing the three categories of experience. Additional considerations, seen in **Table 5.1**, are synthesized through understanding of outdoor environment barriers and mobility disabilities. The additional considerations are specific to mobility disabilities and draw attention to specific elements that need additional design deliberations to make use, experience, and benefits of natural trails available to persons with mobility impairments.

MOBILITY IMPAIRMENT CONSIDERATIONS			
CATEGORY	FEATURE	ELEMENTS	ADDITIONAL CONSIDERATIONS
PHYSICAL	Ability	Trail	Access with mobility devices: 4' min. width; hard surfaced or with compacted earth/fine rock chips; no obstacles
		Access points	Parking with HC provision and close to trail
		Amenities	Places of rest, accessible restrooms
	Movement	Path alignment	Gentle slopes (0-4%, 8% max); shorter trail segment options; no sharp turns

MOBILITY IMPAIRMENT CONSIDERATIONS (Continued)			
CATEGORY	FEATURE	ELEMENTS	ADDITIONAL CONSIDERATIONS
SENSORY	Vision	Clear wayfinding	Signage at seated height
		Visual landmark	Visual landmarks at seated height
		Seasonal vegetation	
		Lighting	
		Trail edge condition	
		Scenic views	Scenic views at seated height
	Sound	Wildlife sounds	
		Vegetation sounds	
		Material sounds	
		Disturbing sounds	
		Water sounds	
	Scent	Aromatic vegetation	
		Disturbing scents	
	Touch	Vegetation	
		Path	
		Water	
		Wildlife	
		Sun exposure	
		Amenities	
	Taste	Vegetation	
	Movement	Path alignment	
COGNITIVE	Involvement	Education	Educational elements at seated height
		Interaction	Interactive elements at seated height
		Surrounding env.	
	Challenge	Variety in terrain	
		Obstacles	Lack of obstacles
		Path alignment	
	Mystery	Topographic concealment/ revealment	
		Veg.concealment/ revealment	
	Feeling of Safety	Amenities	Accessible restrooms
		Lighting	
		Separation from disruptions	
		Wayfinding	Signage at seated height
	Body Identification	Enclosure/ exposure	

Table 5.1: Mobility Impairment Additional Considerations (Synthesis by Author)

VISION IMPAIRMENTS (VI)

Another user type is a person with vision impairments. Vision disabilities include people with blindness and low vision. With vision impairments, there are challenges relating to orientation and mobility. Skills are developed to accommodate these challenges that result in differences in the experiential categories of a place; physical, sensory, and cognitive. People with blindness or low vision not only face challenges, but have strengths that give them the opportunity to experience the world in a beautiful way that is difficult to understand and comprehend. **Tables 5.4-5.6** show the elements that apply to the experience of a persons with vision impairments and an opportunity to accent the unique way they intake the world. **Table 5.2** shows additional considerations, synthesized through a general understanding of persons with vision impairments and barriers associated with the outdoor environment. The additional considerations are specific to vision impairments and draw attention to specific elements that need attention to make use, experience, and benefits of natural trails available to persons with vision impairments (American Foundation for the Blind 2015).

VISION IMPAIRMENT CONSIDERATIONS			
CATEGORY	FEATURE	ELEMENTS	ADDITIONAL CONSIDERATIONS
PHYSICAL	Ability	Trail	Provide visual/textural contrast between trail surface and
		Access points	
		Amenities	Include braille on signage; provision of audio tour equipment if appropriate
	Movement	Path alignment	
SENSORY	Vision	Clear wayfinding	
		Visual landmark	
		Seasonal vegetation	
		Lighting	
		Trail edge condition	
		Scenic views	

VISION IMPAIRMENT CONSIDERATIONS (Continued)			
CATEGORY	FEATURE	ELEMENTS	ADDITIONAL CONSIDERATIONS
SENSORY	Sound	Wildlife sounds	Route trail/provide stopping points to listen for wildlife sounds--especially birds; provide attractants
		Vegetation sounds	Route trail/introduce plantings which generate seasonal sounds
		Material sounds	Provide a variety of trail surfaces with different sounds
		Disturbing sounds	
		Water sounds	Route trail/construct features to produce/accentuate water sounds
	Scent	Aromatic vegetation	Route trail/introduce aromatic plants
		Disturbing scents	
	Touch	Vegetation	Route trail/introduce vegetation with tactile qualities; create tactile "stations"
		Path	Constrast materials along trail edge
		Water	Provide opportunites to touch water
		Wildlife	Where appropriate and under supervision, provide opportunities to touch animals
		Sun exposure	Route trail to provide a variety of sun/shade conditions which can be felt
		Amenities	Wayfinding with braille
	Taste	Vegetation	If appropriate, provide vegetation tasting opportunities (fruits, etc.)
	Movement	Path alignment	

VISION IMPAIRMENT CONSIDERATIONS (Continued)			
CATEGORY	FEATURE	ELEMENTS	ADDITIONAL CONSIDERATIONS
COGNITIVE	Involvement	Education	Touchable inclusions
		Interaction	Touchable inclusions
		Surrounding	
	Challenge	Variety in terrain	
		Obstacles	Touchable warnings
		Path alignment	
	Mystery	Topographic concealment/reveal	
		Vegetation concealment/reveal	
	Feeling of Safety	Amenities	
		Lighting	
		Separation from disruptions	
		Wayfinding	Signage with braille, touchable strategies
	Body Identification	Enclosure/exposure	

Table 5.2: Vision Impairment Additional Considerations (Synthesis by Author)

HEARING IMPAIRMENTS (HI)

Everyday experience for people with deafness or hearing loss is not much different from people who possess hearing. The differences exist in the sensory and cognitive aspects of experience, and not in the physical. **Tables 5.4-5.6** show the elements, addressing the three categories of experience that apply to the experience of a person with hearing disabilities. Additional considerations, seen in **Table 5.3,** are synthesized through understanding of outdoor environment barriers and hearing disabilities. These considerations address the needs of persons with hearing impairments to use, experience, and benefit from natural trails if fully available.

HEARING IMPAIRMENT CONSIDERATIONS			
CATEGORY	FEATURE	ELEMENTS	ADDITIONAL CONSIDERATIONS
PHYSICAL	Ability	Trail	
		Access points	
		Amenities	Signage for other trail users to provide wide clearance when passing from behind
	Movement	Path alignment	
SENSORY	Vision	Clear wayfinding	
		Visual landmark	
		Seasonal vegetation	
		Lighting	High visibility
		Trail edge condition	
		Scenic views	
	Sound	Wildlife sounds	
		Vegetation sounds	
		Material sounds	
		Disturbance sounds	
		Water sounds	

HEARING IMPAIRMENT CONSIDERATIONS (Continued)			
CATEGORY	FEATURE	ELEMENTS	ADDITIONAL CONSIDERATIONS
SENSORY	Scent	Aromatic vegetation	
		Disturbance scents	
	Touch	Vegetation	
		Path	
		Water	
		Wildlife	
		Sun exposure	
		Amenities	
	Taste	Vegetation	
	Movement	Path alignment	
COGNITIVE	Involvement	Education	
		Interaction	
		Surrounding	
	Challenge	Variety in terrain	
		Obstacles	
		Path alignment	
	Mystery	Topographic concealment/reveal	
		Vegetation concealment/reveal	
	Feeling of Safety	Amenities	
		Lighting	Where appropriate, provide extra lighting in dark areas or areas with no sound warning
		Separation from disruptions	
		Wayfinding	
	Body Identification	Enclosure/exposure	

Table 5.3: Hearing Impairments Additional Considerations (Synthesis by Author)

GENERAL USER (GEN)

The general user considers the average person without a disability. The general user is included in this study to represent that the application of the natural trail design guidelines will help a large percentage of the population. This study does not only improve trail design for persons with disabilities, but also the general public, increasing the impact and benefits derived with application. **Tables 5.4-5.6** show the elements; addressing the three categories of experience, that applies to the general public. The tables show that sensory and cognitive experiential elements have a significant impact on the general user.

PHYSICAL EXPERIENCE FOR ALL USERS					
FEATURE	ELEMENTS	MI	VI	HI	GEN
Ability	Trail	●	●		
	Access points	●			
	Amenities	●			
Movement	Path alignment	●	●	●	●

Users: MI = Mobility Impairments; VI = Visual Impairments;
HI = Hearing Impairments; GEN = General

Table 5.4: Physical Experience User Impacts

SENSORY EXPERIENCE FOR ALL USERS					
FEATURE	ELEMENTS	MI	VI	HI	GEN
Vision	Clear wayfinding	●		●	●
	Visual landmark	●		●	●
	Seasonal vegetation	●		●	●
	Lighting	●		●	●
	Trail edge condition	●		●	●
	Scenic views	●		●	●
Sound	Wildlife sounds	●	●		●
	Vegetation sounds	●	●		●
	Material sounds	●	●		●
	Disturbing sounds	●	●		●
	Water sounds	●	●		●
Scent	Aromatic vegetation	●	●	●	●
	Disturbing scents	●	●	●	●
Touch	Vegetation	●	●	●	●
	Path	●	●	●	●
	Water	●	●	●	●
	Wildlife	●	●	●	●
	Sun exposure	●	●	●	●
	Amenities	●	●	●	●
Taste	Vegetation	●	●	●	●
Movement	Path alignment		●	●	●

Users: MI = Mobility Impairments; VI = Visual Impairments;
HI = Hearing Impairments; GEN = General

Table 5.5: Sensory Experience User Impacts

COGNITIVE EXPERIENCE FOR ALL USERS					
FEATURE	ELEMENTS	MI	VI	HI	GEN
Involvement	Education	●	●	●	●
	Interaction	●	●	●	●
	Surrounding environment	●	●	●	●
Challenge	Variety in terrain	●	●	●	●
	Obstacles	●	●		
	Path alignment	●	●	●	●
Mystery	Topographic concealment/revealment	●	●	●	●
	Vegetation concealment/revealment	●	●	●	●
Feeling of Safety	Amenities	●	●	●	●
	Lighting	●		●	●
	Separation from disruptions	●	●	●	●
	Wayfinding	●	●	●	●
Body Identification	Enclosure/ exposure	●	●	●	●

Users: MI = Mobility Impairments; VI = Visual Impairments;
HI = Hearing Impairments; GEN = General

Table 5.6: Cognitive Experience User Impacts

TRAIL TYPES

For trails to address a wide range of ability for each of the user groups, four types of trail are defined, seen in **Table 5.7**. It is important for designers to acknowledge the diversity of human ability, with an understanding that the range of ability can be significant, even within a user type. To accommodate this range, the guidelines apply to four different types of trails. All four are addressed to accommodate the widest range of abilities. When all four of these trails are available to the community, a significant amount of the population can experience nature with mental and physical benefits. **Figure 5.1** shows that with application of the guidelines the user types addressed by the each type of trail is expanded.

NATURAL TRAILS					
SYMBOL	NAME	LENGTH	TERRAIN	LANDSCAPE	DIFFICULTY
	Courtyard trail	Less than 1/2 mile	Level	Sensory Gardens	Easy
	Urban park trail	1/2-2 miles	Moderate	Park	Easy/moderate
	Nature park trail	1/2-6 mile	Variety	Natural	Moderate/ Difficult
	Regional trail	More than 2 miles	Variety	Variety	All

Table 5.7: Natural Trail Types

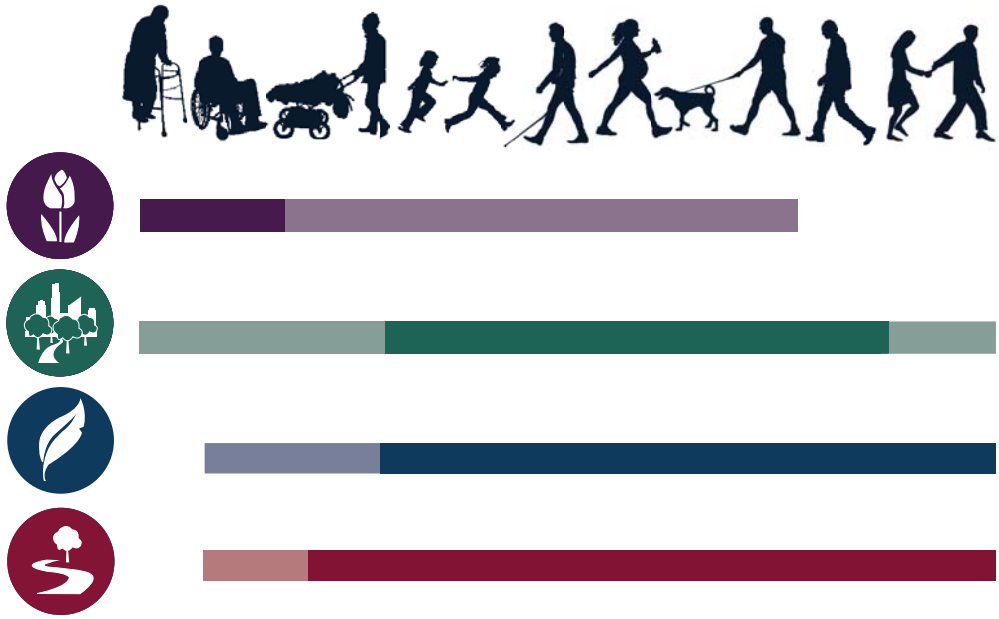

Figure 5.1: Expansion of Trail Use

CONCLUSION

With the application of these Natural Trail Guidelines, the experience of trails will be enhanced by the application of physical, sensory, and cognitive experiential elements. This will enhance the experience not only for persons with disabilities, but for the general user as well. Furthermore, the user groups of the trails will also be expanded by applying strategies that address the needs of persons with mobility, vision, and hearing impairments. The result is trails that enhance and expand the experience of nature to a larger percentage of the population.

PRECEDENT STUDIES

Precedent studies are completed to review the framework. They are used to verify the inclusion of successful trail designs. Additionally, precedents are used to inspire the production of the design strategies section of the framework.

Three precedents from each natural trail type are identified. The identification is completed by first identifying trail design that significantly considers accessibility. The process of identifying appropriate precedents was conducted by a variety of methods. One method reviewed lectures given at the 2016 American Society of Landscape Architects (ASLA) Conference held in Chicago. In addition to the lectures, further precedents were identified through website suggestions from the lecturers themselves. Another method was personal experience of visiting the trails. After trails with accessibility considerations were identified, the elimination process considered reflections on the three categories of experience. The trails with significant design strategies towards the categories of experience were selected for this study, three for each trail type.

A quick study is done to identify the location, designers, and strategies of each of trail to determine the main focus and intent. This study is further expanded by applying the framework to the precedents.

COURTYARD TRAILS

NORTHEAST GEORGIA MEDICAL CENTER'S THERAPEUTIC GARDEN

Location: Gainesville, Georgia
Designers: Stephan Sanchez at HGOR and The Fockele Garden Co.

PHYSICAL EXPERIENCE

To accommodate persons with disabilities, pathways were designed to have a subtle slope and wide tread. The paths are made of concrete to prevent the existence of obstacles. The courtyard is adjacent to the medical center, providing access to restrooms. Benches are strategically placed throughout the garden to provide places of rest while enjoying the scenery.

SENSORY EXPERIENCE

Plantings have a variety of color, texture, and seasonal interest to provide a unique sensory experience. A high retaining wall surrounds the garden to create a buffer from urban distractions, creating an opportunity for users to focus on the subtle sensory qualities of nature. Throughout the courtyard, there is a variety of enclosure, shaped by retaining walls, various heights of vegetation, and changes in topography.

COGNITIVE EXPERIENCE

The pathways are oval in shape and create a sense of mystery and discovery as patients travel throughout the courtyard. There is also a slight change in topography to create a minor challenge and sense of accomplishment. Sculptures are placed strategically throughout the garden to create a sense of interest and discovery. A retaining wall surrounding the courtyard creates separation from distractions and traffic, creating a feeling of safety throughout the space.

STRATEGIES

- Plantings provide a variety of color, texture, and seasonal interest
- An oval walkway creates sense of discovery and physical accessibility
- Sculptures placed strategically throughout to create interest and discovery
- Walls create enclosure and buffer from urban distractions

(Schnall 2014)

THE CROWN SKY GARDEN
Location: Children's Hospital of Chicago, Illinois

PHYSICAL EXPERIENCE
Pathways and features influence physical activity. Curving light walls are placed throughout the garden and change colors as children walk along the pathways. Path width and slope meet requirements for children in wheelchairs to have access to all spaces within the garden. Garden spaces allow for programmatic flexibility to create opportunities for physical movement and exercise.

SENSORY EXPERIENCE
There are many features throughout the garden which create a unique and healing sensory experience for children. There is a light wall with variations in color. The light wall responds to touch; forming images of water, from calm tidal movements to intense colorful bubbles. The sound of water fills the space due to a wall of hand stacked glass marbles with running water. Recycled wood logs are used for seating and playful elements, giving children an opportunity to touch nature. Bamboo and design elements present a variety in texture throughout the space. There is also a scenic view of downtown Chicago, presenting a contrast in visual interest.

COGNITIVE EXPERIENCE
The light wall throughout the garden varies in height, resulting in variations of enclosure throughout the space. The wall is also meandering, creating a sense of discovery as children travel around the curves. There are a variety of spaces, intimate and social, to give children opportunities to choose the most comfortable experience. Access to natural light and bamboo give children an interaction with nature that encourages healing.

STRATEGIES
- Interactive light wall encourages interaction with user
- Garden provides multiple places of discovery and innovative engagement
- Regional vegetation and materials are used for tactile engagement
- Sounds of water enhance auditory experience
- Reclaimed wood sculptures are used for interactive purposes
- Garden provides a variety of intimate and social spaces

(Mikyoung Kim Design 2013)

THE HEWIT FOUNDATION HEALING GARDEN

Location: Littleton Adventist Hospital, Littleton, Colorado

PHYSICAL EXPERIENCE

Stone benches are placed throughout the garden to create areas of rest along a gradually sloping pathway. The pathways are concrete and wide enough to accommodate users in wheelchairs. A raking garden is available for children and adults for physical exercise, and is accessible to all people. The courtyard is adjacent to a parking lot and hospital, making it easily accessible.

SENSORY EXPERIENCE

A tiered waterfall sends the sound of water throughout the space. There are interactive elements that encourage the community to interact with nature. These elements consist of a raking garden, vegetation along walkways, and a waterfall. There is also a whisper garden that encourages children to whisper about their feelings, experiences, hopes and fear. There is a wall that reverberates sounds to send the children's voices from one end of the wall to the other. A rock element creates a scenic view for patients. Vegetation varies in height throughout the space to create a variety in enclosure and shade opportunities.

COGNITIVE EXPERIENCE

A variety of program spaces allows for users to enjoy intimacy or social interaction. Vegetation and walls are used to buffer surrounding disturbances. Meandering pathways create a sense of wonder and discovery throughout the space. There is also a rock feature that creates interest and wonder as one views it from different directions. Interactive elements throughout the garden create a purpose and value to the cognitive experience of the garden.

STRATEGIES

- Using a waterfall as an interactive element and to identify space through sound
- Meandering path through a series of small gardens
- Variety in enclosure through vegetation and artful interactive walls
- Interactive art pieces
- Landart as a scenic focal point

(Cote 2011)

URBAN PARK TRAILS

NEARLY LAGOON

Location: Santa Cruz, California

PHYSICAL EXPERIENCE

Pathways are under one mile in length, four feet and above in width and have a gentle grade. The terrain is firm, made of hardened earth and boardwalks. Parking is adjacent to the trail head, with restrooms conveniently available. There are resting areas throughout the trail consisting of picnic tables and benches.

SENSORY EXPERIENCE

The boardwalk passes over a marsh full of turtles and cattails. The flapping of dragonfly wings and rustling willows fills the air along the trail, creating an enticing soundscape. After passing the marsh, visitors travel through a native meadow adjacent to touchable native plants having various colors and textures.

COGNITIVE EXPERIENCE

Interpretive signs along the path tell about creatures that inhabit the marsh and lagoon, flora, and native people. There is an overlook point which serves as a final destination and provides a sense of accomplishment. Landscape and enclosure variation reveal a sense of discovery and interest while traveling along the path.

STRATEGIES

- Pathways of gentle grade have a firm and wide surface
- Provision of interpretive panels
- Floating boardwalk avoids a steep grade and protects sensitive environmental features
- Attraction of dragonflies to create soundscape
- Accessible restrooms, parking, and picnic tables
- Touchable vegetation adjacent to pathways
- Destination point
- Path meandering through different landscapes

(Andersen 2008)

BREAKENRIDGE PARK
Location: San Antonio, Texas

PHYSICAL EXPERIENCE
Parking is adjacent to trails throughout park. Signage indicates trails that are physically available to persons with disabilities through artful ways. Accessible paths are wide with a gentle slope. Path material consists of both concrete and stable gravel paths through nature areas.

SENSORY EXPERIENCE
A variety of scenic places are available throughout the park, and paths lead through forested areas, meadows, and recreational areas. Different degrees of enclosure are available along the meandering paths, due to differing heights of vegetation. Some paths run along a river with fast moving water, resulting in a water filled soundscape.

COGNITIVE EXPERIENCE
Artful signage is located throughout the park. Signage indicates availability of restrooms, rest areas and accessibility, and increases the feeling of safety. Informational signage is also available informing wildlife conservation in the area. Some paths are meandering, resulting in a feeling of discovery as users travel through the park. Directional signage is also frequently located throughout the park to avoid disorientation.

STRATEGIES
- Gentle grade with firm surfaces
- Signage indicates accessibility
- Artful wayfinding
- Maps to avoid disorientation
- Various trail sizes
- Interaction with water
- Availability of restrooms

(Brackenridge Park Conservancy 2010)

FLETCHER PARK GREENWAY
Location: Fletcher, North Carolina

PHYSICAL EXPERIENCE
Parking is adjacent to the trail head. The paths meander with a gentle grade. The trail has a wide tread, and firm surface, consisting of both concrete and gravel. Restrooms are available near the parking area. There are also signs and a map indicating trail location and length.

SENSORY EXPERIENCE
The path runs along a creek and crosses it periodically, filling the air with the sound of water running along rocks. The trail then travels along meadows with soft grasses, and forest areas with tall shade trees. The variation in surrounding landscapes provides a variety of enclosures throughout the trail. Wildlife is preserved, creating the opportunity to hear birds chirping, squirrels rustling through the trees, and more.

COGNITIVE EXPERIENCE
The path meanders through a variety of surrounding landscapes creating variation in enclosure and sense of discovery. Signage is placed along the trail to educate the community about watersheds and the health benefits of physical activity.

STRATEGIES
- Gentle trail grade with wide and firm surface
- Accessible parking and restrooms
- Meandering path through various landscapes
- Variety in degree of enclosure
- Close proximity to creek
- Educational signage

(CMLC 2015)

NATURE PARK TRAILS

MARTIN NATURE PARK

Location: Oklahoma City, Oklahoma

PHYSICAL EXPERIENCE

Trails avoid steep slopes by meandering. A boardwalk was built to avoid damage to the environment while keeping the slope at a rate that is attainable for people that have a disability. Paths are wide with a stable earth surface. View stations throughout the park have signage that is available for those with vision impairments or in a wheelchair. Trail length is 1.2 miles, with multiple stopping points throughout.

SENSORY EXPERIENCE

A boardwalk runs over a pond, giving users the experience of being on the water and hearing the sound of frogs and turtles playing in the water. Multiple landscape characters are also available along the trail, producing a variety of enclosure and scenic value. Many sightings of wild animals are reported consisting of deer, coyote, squirrels, raccoons, and more. The existence of wildlife adds interest in vision and sound.

COGNITIVE EXPERIENCE

Informational signage is provided throughout the park, highlighting educational points about ecosystems and the wildlife of the surrounding area. The signage includes braille, resulting in more people being able to understand the surrounding landscape. There are also points of interest throughout the park, presenting users with a goal and sense of accomplishment. Paths meander through a variety of surroundings, presenting different degrees of enclosure, interest, and sense of discovery. Navigational signage exists through the park, in addition to a smartphone application that can be used for independent navigation.

STRATEGIES

- Wildlife viewing stations
- Serpentine boardwalk
- Trail signs that provide descriptive navigation information for all users
- Smartphone applications that provides independent navigation
- Points of interest to create purpose

(Wilderness Matters 2015)

ATTLEBORO SPRINGS WILDLIFE SANCTUARY
Location: La Salette, Massachusetts

PHYSICAL EXPERIENCE
The trail is a half mile loop that is wide and level. There is a variety of trail surface material consisting of crushed stone, bridges, boardwalks and an observation deck. There is a guide rope on the left side of the trail for people with vision impairments to be able to guide themselves. An audio tour is also available.

SENSORY EXPERIENCE
Trail surfaces consist of crushed stone, bridges, and boardwalks, which create a variety of underfoot textures. The trail wanders through different landscapes including wetlands, a pond, pine forest, oak forest, and meadow. These various surroundings support different wildlife that create sounds and sights that are unique identifiers of each species. Much of the trail is in close proximity to water, which creates sounds and attracts wildlife for potential sighting. Trail routing also considered the location of trees and observational areas to strategically provide variation in sun and shade patterns.

COGNITIVE EXPERIENCE
Throughout this trail loop there are variations in surroundings and trail surface. These variations create interest and a sense of discovery with each new terrain type. There is also an observation deck located at the far end of the loop, which serves as a destination goal. Educational signage, with an optional audio tour, provides information about the different ecosystems and surrounding wildlife.

STRATEGIES
- Guide rope with beads to indicate point of interest or benches
- Sun vs shade considerations
- Bird watching and hearing areas
- Wetland conservation for diversity of wildlife
- Pond for frogs and turtles to jump and splash
- Close proximity to water
- Audio tour

(Mass Audubon 2015)

WELLFLEET BAY WILDLIFE SANCTUARY

Location: Wellfleet Bay, Massachusetts

PHYSICAL EXPERIENCE

A nature center adjacent to the trail provides availability of restrooms and information for trail users. The trail is wide with a concrete surface and low grade change. There is signage throughout the trail for wayfinding purposes.

SENSORY EXPERIENCE

Vegetation is a focus of this wildlife sanctuary. Vegetation was chosen in areas to attract wildlife such as butterfly and hummingbirds. The trail also runs by areas such as wetlands, salt marsh, a spring, and woodland. All of these different ecosystems have a variety of vegetation and wildlife. This variation allows for different sensory experiences due to wildlife, vegetation textures, and water. Docks are available for trail users to get in closer proximity to the water.

COGNITIVE EXPERIENCE

An overlook exist at the end of the trail, and serves a destination attraction. While traveling the trail many different landscapes are experienced, adding interest and discovery to the journey. There is also signage throughout the pathway to educate users of the different ecosystems that they are experiencing.

STRATEGIES

- Butterfly and hummingbird garden
- Wetland preservation for diversity of wildlife
- Vegetation to accommodate bird watching and hearing area
- Overlooks off of boardwalk for scenic views
- Variety in enclosure due to variety in vegetation
- Scenic destination at end of trail to provide purpose

(Mass Audubon 2015)

REGIONAL TRAILS

ALAMEDA CREEK TRAIL

Location: Alameda Creek, California

PHYSICAL EXPERIENCE

The grade of the trail is typically gentle with a wide and hard surface. The length is over four miles but has multiple adjacent parking areas along the way. There are also rest areas throughout the trail, but no restrooms. Picnic tables are also accessible for those in wheelchairs.

SENSORY EXPERIENCE

The trail runs along a series of long ponds that contract during the dry season. A little farther on the trail, locust, pine, and other trees provide ample shade and a variety of sensory experience.. Enclosure also varies due to changes in vegetation height which ranges from grasses to tall trees.

COGNITIVE EXPERIENCE

The variety in surrounding terrain creates a sense of wonder and discovery. There are gentle grade changes that could be challenging for those in wheelchairs, but also create an opportunity for a sense of accomplishment. There are many stopping points to enjoy distant scenic views.

STRATEGIES

- Gentle grade with wide, hard surfaced path
- Variety in shade and sunlight patterns
- Variety in surrounding vegetation
- Ponds located throughout to provide sensory interest
- Points of distant views

(Lewkowicz 2007)

DORAN REGIONAL PARK TRAIL

Location: Doran, California

PHYSICAL EXPERIENCE

The trail is short but connects to a larger regional trail with an entrance adjacent to a parking lot. The trail width is four feet and wider with level terrain and hard surface materials. The accessible amenities include restrooms, picnic tables, beach wheelchairs, and parking.

SENSORY EXPERIENCE

There is a variety of vegetation adjacent to the path, resulting in a variety of textures and colors throughout the walk. Vegetation also attracts wildlife, such as birds. There are many observation opportunities for birdwatching. The boardwalk also crosses over a creek which adds audio interest when traveling across and along it.

COGNITIVE EXPERIENCE

Sculptures are placed to create interest and wonder. Art, in the form of sculptures, is used as wayfinding tools throughout the trail. The path meanders through the wetlands creating interest with various views of the surrounding landscapes.

STRATEGIES

- Birdwatching areas
- Meandering path with distant views
- Variety in texture and height of vegetation
- Vegetation adjacent to path
- Level terrain with firm surface
- Artful wayfinding
- Accessible parking, restroom, and picnic tables

(Lewkowicz 2010)

GOLDEN GATE PROMENADE

Location: San Francisco, California

PHYSICAL EXPERIENCE

The length of the trail is over four miles but has multiple parking lots along the trail. The path is over four feet and a level grade. The surface material consists of boardwalks and paved surfaces. Accessible amenities include a visitor center, beach wheelchair, parking, restrooms, and picnic tables. There are rest areas with benches having interesting views throughout the path. There are distinctive edges to the path, either railings or stoppers.

SENSORY EXPERIENCE

The path meanders through a variety of landscapes consisting of beaches, grassy fields, and urban settings bringing a variety of sounds and visual interest. The trail brings you close to the ocean on a boardwalk, giving an opportunity to hear the waves and pelicans. There are many scenic views framed by elements such as the San Francisco skyline.

COGNITIVE EXPERIENCE

The trail meanders through a variety of settings, creating interest and discovery. Various scenic views create a sense of wonder throughout the experience. Frequent restrooms along the way avoid a sense of worry. Installed lighting is also frequent along the path providing safety.

STRATEGIES

- Level grade with hard terrain
- Variety in surface materials
- Wildlife interaction points
- Beach areas for wheelchairs
- Boardwalks to bring wheelchairs to water
- Variety in landscape urban to natural
- Availability of beach wheelchair
- Accessible parking, restroom, and picnic tables

(Ecklund 2012)

Table 5.8 summarizes the findings of the precedent review which will be carried forward when developing strategies for the design guidelines.

CONCLUSION

The framework development considered both the definition of user profiles and a review of trail precedents. User profiles verify that the framework addresses the needs of persons with mobility, vision, and hearing impairments, in addition to improving the experience of the general user. The review of precedents identified some successful design strategies that accomplish both accessibility and broadened sense of experience.

PRECEDENT STUDIES REVIEW														
			COURTYARD			URBAN PARK			NATURE PARK			REGIONAL		
PHSYICAL	FEATURE	ELEMENTS	1	2	3	4	5	6	7	8	9	10	11	12
	Ability	Trail	●	●	●	●	●	●	●	●	●	●	●	●
		Access points	●		●	●	●	●	●	●	●	●	●	●
		Amenities	●	●	●	●	●		●	●	●	●	●	●
	Movement	Path alignment		●				●	●		●	●		●
SENSORY	Vision	Clear wayfinding		●					●					
		Visual landmark		●					●	●				
		Seasonal vegetation	●		●	●	●	●	●	●	●	●	●	●
		Lighting		●										
		Trail edge condition		●	●	●	●	●	●	●	●			●
		Scenic views		●		●			●	●	●	●	●	●
	Sound	Wildlife sounds				●	●	●	●	●	●		●	●
		Vegetation sounds	●	●	●	●	●		●	●	●	●	●	
		Material sounds		●						●			●	
		Disturbing sounds	●											
		Water sounds		●	●		●	●	●	●	●		●	●
	Scent	Aromatic vegetation	●			●	●			●	●		●	
		Disturbing scents												
	Touch	Vegetation	●	●	●			●	●	●	●	●		
		Path				●			●	●			●	
		Water			●		●	●	●	●	●		●	●
		Wildlife				●			●	●	●		●	
		Sun exposure	●	●	●		●		●	●	●			
		Amenities	●	●		●	●		●	●	●			
	Taste	Vegetation			●									
	Movement	Path alignment					●		●	●		●		●
COGNITIVE	Involvement	Education		●		●		●	●	●	●			
		Interaction		●	●	●			●	●				
		Surrounding environment					●		●	●	●		●	
	Challenge	Variety in terrain							●	●	●	●	●	
		Obstacles		●										
		Path alignment	●	●	●	●	●		●	●	●	●	●	
	Mystery	Concealment/ revealment by topography	●	●										
		Concealment/ revealment by vegetation	●				●			●	●	●	●	
	Feeling of Safety	Amenities		●	●		●	●	●					●
		Lighting		●										●
		Separation from disruptions	●					●						
		Wayfinding					●		●	●	●			
	Body Identification	Enclosure/ exposure		●		●	●	●	●	●	●		●	●

1.Northeast Georgia Medical Center's Therapeutic Garden. 2. The Crown Sky Garden.

3.The Hewit Foundation Healing Garden. 4. Nearly Lagoon. 5.Brackenridge Park. 6. Fletcher Park Greenway.

7. Martin Nature Park. 8.Attleboro Springs Wildlife Sanctuary. 9. Wellfleet Bay Wildlife Sanctuary.

10. Alameda Creek Trail. 11. Doran Regional Park Trail. 12. Golden Gate Promenade.

Table 5.8: Precedent Study Framework

06
Design Guidelines

SPATIAL ANALYSIS

OVERVIEW

The spatial analysis determines what categories of experience are sufficiently provided by existing trail systems. It will also be used to determine potential opportunities for enhanced experience. In addition to experiential qualities, accessibility is determined. The spatial analysis will consider the existing and proposed locations for site elements which support the physical, sensory, and cognitive dimensions of user experience.

METHODS

For this study, and in future application of the trail design guidelines, a hybrid of spatial analysis methods is used to establish baseline conditions and opportunities. These methods include field work, remote sensing, and archive research, depending on the depth of study required and the tools available. Each of the three methods will be briefly described.

FIELDWORK

For most trails of short to moderate length, fieldwork is the most direct method to quickly assess current site conditions and features from the ground perspective of users. The level of physical detail and sensory/cognitive connections are unsurpassed. Most important, in-field judgments can be made to prioritize or exclude site elements for further consideration. In addition, potential opportunities to introduce sensory or cognitive elements can more easily be identified. Fieldwork can be used to originate findings or confirm ("ground truth") conclusions drawn from remote sensing or literary sources.

REMOTE SENSING

If remote sensing tools and expertise are available, this method is suitable for large area analysis, or when numeric analysis is needed such as slope determination or aspect mapping. Remote sensing may take the forms of aerial photography, LiDAR, or multi-spectral scanning. Data compositing, analysis, ad mapping is typically done through Geographic Information Systems (GIS). Simple aerial photography review can be accomplished through free programs like Google Earth (Google 2016), whereas more sophisticated analysis/mapping can be done through GIS programs such as ArcGIS (ESRI 2016). Remote sensing/GIS is particularly useful when trying to route trails through sensitive habitat or when many routing alternatives are being considered. Remote sensing/GIS is best suited for mapping the physical aspects of human experience.

ARCHIVE RESEARCH

Archive research involves collecting site information from archival records which may provide background on the historical or cultural aspects of a place which may not be apparent from a site visit or remote sensing. Sources may include historic photography, written journals, newspaper accounts, family records, survey records, or a multitude of other records. Scale might range from small properties to an entire regional setting. This method is best suited for the cognitive aspects of user experience which imbues meaning and affinity.

SITE ANALYSIS

BASE MAP PREPARATION

The first step of designing a trail to accommodate all three aspects of user experience is typically the creation of a base map to document the spatial context of the trail and its surroundings. Typical base data needed includes: roads/streets, sidewalks, buildings, parks, trails, trail access points, water features, vegetation groupings, bus stops, parking, and topographic mapping. If the base map is being produced through GIS, then a digital elevation model (DEM) and other electronic data are also required. This data may be available through national sources like the United States Geological Survey National Map (http://viewer.nationalmap.gov/viewer), or preferably more detailed data can be obtained through regional, state, city, or other local sources. Much of the digital data is conveniently available online.

PHYSICAL EXPERIENCE MAPPING

The physical experience aspects of trail routing and design are the most easily determined and seek to accommodate general users, advanced users (better physical condition), and users with disabilities. The first analysis should be slope determination which greatly influences trail routing. A variety of trail slopes should be provided to appeal to all user types, but alternative routes can also be included to accommodate users with disabilities where possible. Slope mapping is very easy and rapid to accomplish through GIS analysis, but field work can also be used to collect and more generally map the steepness of trail segments. Once a trail has been routed and/or mapped, additional trail attributes can be coded such as trail width and surface type for different trail segments. For existing trails, some cities have these trail attributes already mapped in GIS, or it may be necessary to originate and compile the data for a new or proposed trail. **Table 6.1** lists the appropriate range of trail slopes, widths, and paving materials suitable for various user types. **Table 6.2** outlines the processing workflow for a more thorough GIS-based analysis. GIS analysis or field work can also be used to map visibility for overlooks, or map significant site features that may be of interest, or areas to avoid.

ACCESSIBILITY REQUIREMENTS	
Width	4' with passing areas of 10'
Surface	Varies (Stable)
Running Slope	0-5% (8% for max of 50')
Length	1/2 mile

Table 6.1: Physical Experience Quantities

PHYSICAL EXPERIENCE SITE ANALYSIS				
FEATURE	ELEMENTS	SITE ANALYSIS INVENTORY/METHODS	FIELD WORK	REMOTE SENSING
Ability	Trail	Identify trail elements; width, length, slope, surface material, map obstacles	Width	Slope
			Length	
			Surface material	
			Obstacles	
	Access points	Identify distance between trail access points and public transit and parking		Distance between access and public transit stops
				Distance between access and parking
	Amenities	Map places of rest, restrooms, water; identify disance between amenities	Places of rest	Distance between amenities
			Restrooms	
			Water fountains	
Movement	Path alignment	Slope studies, path shape	Path shape	Slope studies

Table 6.2: Physical Experience Data (Synthesis by Author)

SENSORY EXPERIENCE MAPPING

As previously described, field work is the best way to identify and map site features which may appeal to trail users' senses. In addition to physical slope, trails can be routed to specific site locations or features which stimulate the visual, auditory, olfactory, tactile, and taste senses. If site features supporting a more multi-sensory experience do not currently exist, they can be introduced to appeal to all trail users, especially those who have disabilities. **Table 6.3** depicts site features which provide opportunities for a more multi-sensory experience, and the methods to obtain the information.

SENSORY EXPERIENCE SITE ANALYSIS		
FEATURE	ELEMENTS	SITE ANALYSIS INVENTORY/METHODS
Vision	Clear wayfinding	Directional signage, trail material, points of interest
	Visual landmark	Specimen tree, topographic knoll, rock outcrop, water feature, wildlife
	Seasonal vegetation	Colors, seasonal growth/forms, falling leaves
	Lighting	Shadow patterns, sun set/rise conditions, exposure to sun
	Trail edge condition	Topography, vegetation
	Scenic views	Distant views, near views, panoramic views

FIELD WORK	REMOTE SENSING	REGIONAL RESEARCH
Directional confusion/splits in path		
Signage		
Visual interest		
Tree species groupings		
Shadow studies	Slope aspect	Seasonal sun location
Vegetation heights	Slope studies	
View sheds	Slope studies	
Scenic interest	View sheds	

SENSORY EXPERIENCE SITE ANALYSIS (Continued)		
FEATURE	ELEMENTS	SITE ANALYSIS INVENTORY/METHODS
Sound	Wildlife sounds	Direct wildlife sounds, movement sounds
	Vegetation sounds	Vegetation movement sounds in wind
	Material sounds	Trail surface material, interactive sounds, reflected sounds
	Disturbing sounds	Traffic sounds, machinery sounds, construction sounds
	Water sounds	Reflected sounds, water movement sounds
Scent	Aromatic vegetation	Vegetation with aromatic qualities
	Disturbing scents	Urban scents, industrial scents
Touch	Vegetation	Textural vegetation
	Path	Regional materials, variety of materials
	Water	Water located near path
	Wildlife	Tracks, direct contact
	Sun exposure	Sunny areas, shaded areas, semi-shaded areas
	Amenities	Benches, signage, educational opportunities
Taste	Vegetation	Edible vegetation/fruits, community gardens, etc.
Movement	Path alignment	Approach, enter, interact, slope

Table 6.3: Sensory Experience Data (Synthesis by Author)

FIELD WORK	REMOTE SENSING	REGIONAL RESEARCH
Wildlife sightings		
Wildlife sounds		
Evidence of wildlife		
Audio vegetation	Slope aspect	Wind patterns
Sounds created through interaction		
Auditory disturbances		
Streams/Creeks		
Seepage		
Waterfalls		
Riffles		
Aromatic plants		
Scents of distubances		
Species groupings		
Trail surface material changes		
Water		
Wildlife indicators		
Tree canopies	Slope aspect	Seasonal sun location
Amenities		
Amenities materials		
Edible vegetation		
Tree canopies	Slope studies	
Landmarks		
Path shape		

COGNITIVE MAPPING

The cognitive aspects of human experience are more intangible and may be more difficult to map, but field work and archival research can be used identify site areas which may induce feelings of historical or cultural significance. More simply, there may be specific site areas or features which current or past trail users report as being particularly enjoyable and memorable. Trail stops, general trail routing, and alignment revealing surprise, mystery, or awe can all be used to accentuate the cognitive aspects of human experience. Archival research may reveal specific locations which can be commemorated through educational signage or remnants. In some instances, the goal may be to generally convey the general history of a place, but not identify specific locations to protect historical or archaeological artifacts. **Table 6.4** lists several ideas which can be used to enhance the cognitive experience.

COGNITIVE EXPERIENCE SITE ANALYSIS		
FEATURE	ELEMENTS	SITE ANALYSIS INVENTORY/METHODS
Involvement	Education	Map water systems and vegetation groupings
	Interaction	Identify touchable vegetation; map frequent wildlife sightings and vegetation groupings
	Surrounding environment	Map plant groupings, slopes, soils, and hydrology
Challenge	Variety in terrain	Slope studies
	Obstacles	Map location of objects intruding onto path
	Path alignment	Topographic inventory

FIELD WORK	REMOTE SENSING	REGIONAL RESEARCH
Water systems		Cultural research
Vegetation groupings		
Touchable vegetation		Cultural research
Wildlife Sightings		
Vegetation groupings		
Vegetation groupings	Slope studies	Cultural/ Historical research
Water systems		
	Slope studies	
Objects intruding on path		
	Topographic inventory	

COGNITIVE EXPERIENCE SITE ANALYSIS (Continued)		
FEATURE	ELEMENTS	SITE ANALYSIS INVENTORY/METHODS
Mystery	Concealment/ revealment by topography	Viewshed analysis; topographic and 3D trail mapping
	Concealment/ revealment by vegetation	Identify vegetation type/groupings along trail which provide concealment or revealment locations
Feeling of Safety	Amenities	Identify trail length and ideal places to rest
	Lighting	Identify seasonal sun locations, identify sun set/rise time relative to trail use; identify person/animal concealment locations
	Separation from disruptions	Map areas of disturbances
	Wayfinding	Map areas of directional confusion
Body Identification	Enclosure/ exposure	Map tree canopies, species groupings, topography, viewshed analysis, and transition areas

Table 6.4: Cognitive Experience Data (Synthesis by Author)

FIELD WORK	REMOTE SENSING	REGIONAL RESEARCH
Viewshed analysis	Viewshed analysis	
	Topographic inventory	
Vegetation groupings		
Places of rest	Trail length	
Light studies	Slope aspect	Seasonal sun location
		Sun set/rise time
Disturbances	Streets	
Directional confusion		
Tree canopies	Topographic inventory	
Vegetation groupings	Viewshed analysis	
Viewshed analysis		

CONCLUSION

The site analysis concludes with an understanding of the existing experiential qualities of the trail and opportunities to enhance the experience. The resulting map shows locations of existing experiential qualities and opportunities addressing the three categories of experience. Additionally, an understanding of elements neglected within the categories of experience will be discovered. As a result, the site analysis has a significant role in the implementation of design strategies by distinguishing opportunities to utilize and neglected elements to address.

DESIGN STRATEGIES

Design strategies include considerations for the three categories of experience. There are five different types of strategies. The five different types include; trail routing considerations, introduction of new qualities, creation of new design components, amplification of existing conditions, and masking or removal of unwanted conditions. The design strategies are produced to provide a fulfilling experience for persons with disabilities. There is an understanding that an entire trail, often, can't be fully accessible to persons with disabilities, resulting in routing considerations. The design strategies are also created to enhance the experiential quantities for the general user, so that the benefits from implementation profit a wide range of people.

The application of the designs strategies, responds to the existing conditions from the site analysis. In situations that certain existing conditions have opportunities to enhance user experience, routing and amplification are considered. If existing conditions are limiting, masking and removal are strategies that are considered. In a case that experiential qualities are absent, creation and introduction are applied. **Figure 6.1** shows the design strategies that should be applied in response to existing conditions.

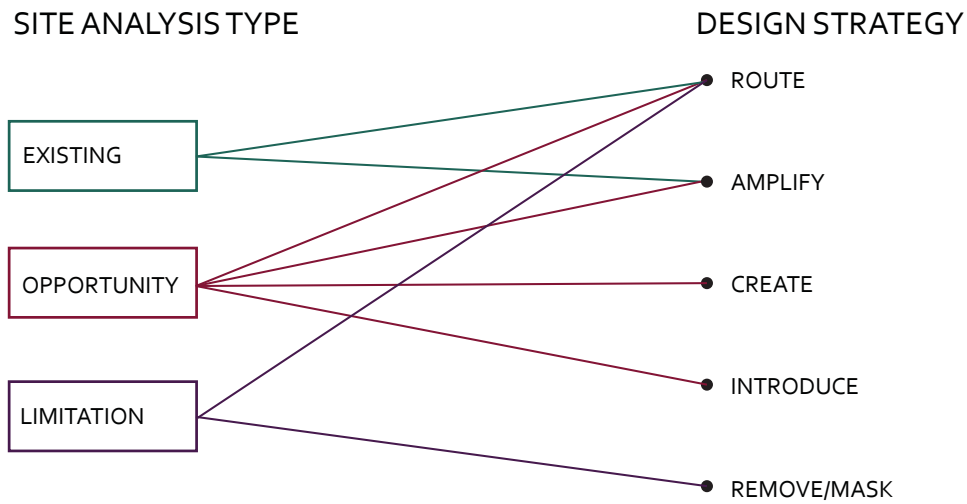

Figure 6.1 : Connection of Design Strategies to Site Analysis (By Author)

PHYSICAL EXPERIENCE GUIDELINES

ROUTE

Route trail with a variety of slopes and alignments (**Figure 6.2**)

• Variety in slope with consideration of slope percentage for accessibility

Figure 6.2: Trail Slope Variety to Address Physical Accessibility

Route trail along topography to avoid high slope percentages (**Figure 6.3**)

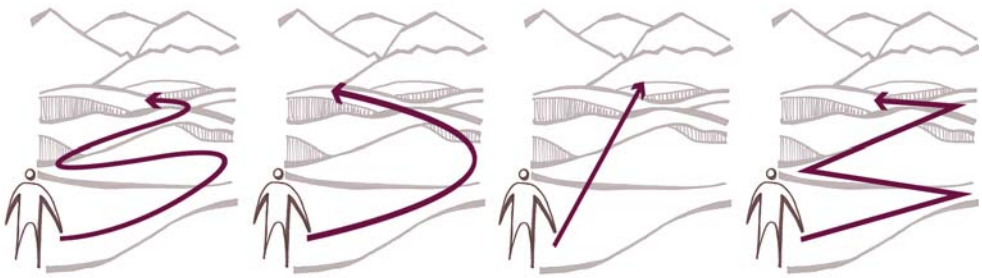

Figure 6.3: Trail Alignments to Address Physical Accessibility

INTRODUCE

Introduce additional access points, public transit stops, and parking.

• Public transit stops and parking should be within 1/8 of a mile from access points. This can be accommodated by either the addition of access points near parking and stops, or by the addition of parking and stops near access points.

Introduce viewpoints and benches

Introduce ADA requirements for trail width, length, slope, and surface materials, **Table 6.5**.

ACCESSIBILITY REQUIREMENTS	
Width	4' with passing areas of 10'
Surface	Varies (Stable)
Running Slope	0-5% (8% for max of 50')
Length	1/2 mile

Table 6.5: Accessibility Requirements

CREATE
Create additional places of rest
• Places of rest should be every ¼ mile along the trail. Places of rest include an amenity that provides seating and visual interest.

REMOVE
Remove obstacles
• Continuing maintenance may be necessary.

SENSORY EXPERIENCE

VISION

ROUTE
Route trail near visual landmark

Route trail through different tree species

Route trail to provide access to sunset/sunrise vantage points
• Route trail to accent seasonal location of sunrise/set, seen in **Figure 6.4**.

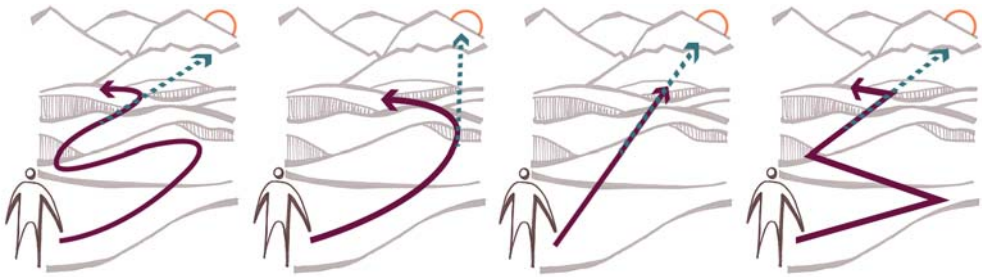

Figure 6.4: Trail Alignment to Accent Sun Location

Route trail through a variety of vegetation and slope degrees (**Figure 6.5**)
• Vegetation and topography to provide trail users with layers of visual interest.

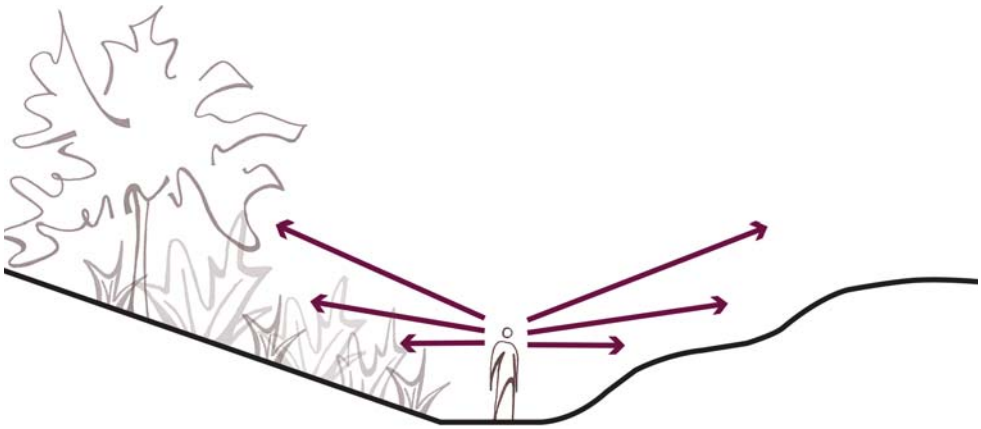

Figure 6.5: Vegetation/Topography Visual Layers

Route trail through a variety of sunny and shady spaces

AMPLIFY
Amplify scenic views
• Use of regional materials to draw attention to scenic views through placement and alignment.

INTRODUCE

Introduce directional signage

• Place a map of trail with locational indication at the beginning of trail, forks, and every ½ mile.

Introduce wayfinding through the use of trail surface material

• Use change of material to distinguish section of trail related to signage or distance.

Introduced tree groupings with seasonal interest

• Identify trees with seasonal interest native to region through regional research.

CREATE

Create visual landmark

• Landart can be created to function as a visual landmark.

Create frames for views

• Views can be framed by art or by vegetation. **Figure 6.6** shows examples of different ways views can be framed.

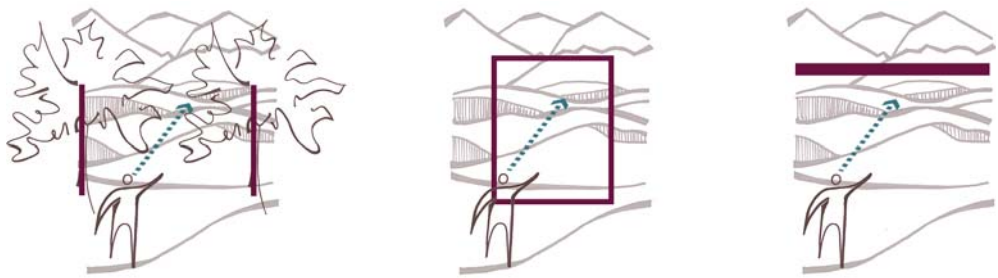

Figure 6.6: Framed Views

MASK/REMOVE
Remove directional confusion
• Place signage at forks in trail.

Mask/remove unattractive views
• Use topography or vegetation to mask disruptive views.

SOUND

ROUTE
Route trail near frequent wildlife sightings areas

Route trail adjacent to vegetation noted for seasonal auditory qualities

Route trail away from streets and high auditory disturbances

Route trail adjacent to water features

AMPLIFY
Amplify water movements/drips
• Use regional materials to accent the sounds of water. Strategies to accomplish this include placement of rocks in flowing water or under drips.

INTRODUCE
Introduce vegetation and features that attract wildlife
• Use regional native vegetation to attract wildlife.

Introduce vegetation with auditory qualities
• Use regional native auditory vegetation.

Introduce different trail surface materials
• Consider trail surfaces that stable to be accessible to persons with disabilities.

Introduce interactive sounds
• Use surface materials that creates sounds
• Amenities with sounds created through interaction.

CREATE
Create new water features
• Utilize existing drainage to create water features.

MASK/REMOVE
Mask auditory disturbances
• Use topography or vegetation to buffer trail from auditory disturbances.

SCENT

ROUTE
Route trail near aromatic species

Route trail away from high scent disturbances

INTRODUCE
Introduce aromatic species
• Use aromatic vegetation native to region.

REMOVE/MASK
Mask/remove bad smells
• Use topography to mask bad smells.

TOUCH

ROUTE
Route trail near vegetation with tactile qualities and avoid spiny species

Route trail adjacent to water features

Route trail near frequent wildlife sighting areas

Route trail through a variety of sun exposure conditions
• Considerations of shade created by topography and vegetation, seen in **Figure 6.7**.

Figure 6.7: Sun/Shade Conditions

INTRODUCE
Introduce a variety of trail surface materials

Introduce regional materials in amenities
• Material consideration for benches, signage, overhead structures, and railings.

Introduce vegetation and features that attract wildlife
• Use regional native vegetation to attract wildlife.

Introduce tactile vegetation adjacent to trail edge**, Figure 6.8.**

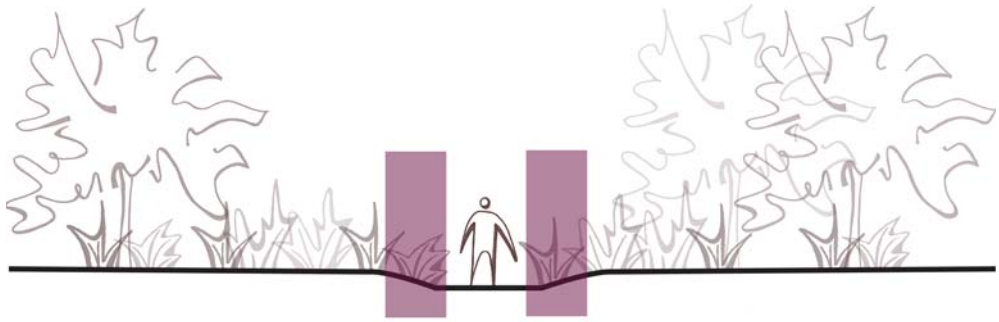

Figure 6.8: Vegetation Adjacent to Path

CREATE
Create interactive water features

Create touchable amenities
• Examples include signage with braille or relief of views.

MASK/REMOVE
Remove untouchable vegetation adjacent to trail edge
• Avoid vegetation with thorns or poison.

TASTE

ROUTE
Route trail near edible vegetation

INTRODUCE
Introduce edible vegetation
• Use vegetation native to region.

CREATE
Create edible gardens

MOVEMENT

ROUTE
Route trail with variety of vertical and horizontal alignments, **Figure 6.9** and **Figure 6.10**

Figure 6.9: Vertical Variety

Figure 6.10: Horizontal Variety

CREATE
Create trail entrances
• Transitions from exposure to enclosure, seen in **Figure 6.11**

Figure 6.11: Entrances

COGNITIVE EXPERIENCE

INVOLVEMENT

ROUTE
Route trail near visible natural systems

Route trail through vegetation with tactile qualities

Route trail through a variety of environments

Route trail near water

INTRODUCE
Introduce explanatory signage

Introduce vegetation that attracts wildlife
• Use regional native vegetation to attract wildlife.

Introduce vegetation along trail edge**, Figure 6.12**

Figure 6.12: Trail Edge Vegetation

Introduce regional material for amenities

AMPLIFY
Amplify natural systems

CHALLENGE

AMPLIFY
Amplify difficulty (with consideration of ability)

INTRODUCE
Introduce loop/route options for least challenge
• Variety in trail lengths to provide availability to different abilities.

ROUTE

Route trail with a variety of running slope and surrounding slope (vertical, horizontal) seen in **Figure 6.13**

Figure 6.13: Challenge Trail Alignment

MYSTERY

ROUTE

Route trail with alignment to strategically concealment/revealment interesting features.

•Route trail to take advantage of concealment/revealment of opportunities created by vegetation and topographic elements, **Figure 6.14**

Figure 6.14: Trail Routing for Mystery

Route trail through species groupings

INTRODUCE
Introduced vegetation to create concealment/revealment opportunities

AMPLIFY
Amplify view of horizon
• User of visual layers to accent horizon

FEELING OF SAFETY

ROUTE
Route trail through sun/shade conditions

Route trail to avoid disturbances

INTRODUCE
Introduce benches
• Use of regional materials

Introduce restrooms
• Accessible

Introduce lighting
• Use of non-intrusive lighting.

Introduce directional signage and maps for locational understanding

CREATE
Create places of rest with benches and restrooms

Create buffer from disturbances
• Use of topography or vegetation to place between trail and disturbances.

BODY IDENTIFICATION

ROUTE
Route trail through a variety of vegetation types

Route trail with enclosure from topography

CREATE
Create transitional spaces.
• Utilize exposure to enclosure situations by placement of specimen trees, ornamental vegetation, or framing art piece, seen in **Figure 6. 15**.

Figure 6.15: Transitional Spaces

CONCLUSION

The site analysis and design strategies work together to improve existing trail systems. The improvement involves making the most fulfilling experience of the trail system accessibility to those with disabilities, furthermore, improving the experience for the general user. In addition to being applicable to existing trails, the design strategies can be a consideration for new trail designs. The site analysis distinguishes limitations and opportunities, while the design strategies define the approaches to utilize opportunities and mask limitations. In result, the application of guidelines will provide a fulfilling experience for persons with disabilities and general users.

07 Application

OVERVIEW

To test how the Natural Trail Design Guidelines might be specifically applied to a local site, the trail in Frank Anneberg Park, located in Manhattan, Kansas was chosen as an example of an Urban Park Trail. After consulting with the City of Manhattan Parks and Recreation Department, this existing trail was chosen because of its popularity and location. Another consideration is that the trail is relatively flat and is already largely accessible by persons with disabilities, although no usage statistics are currently tracked.

In addition to Anneberg Park, the guidelines are applied to the Konza Prairie Trail. The Konza Prairie hiking trail is located southeast of Manhattan, Kansas and is an example of an Nature Park Trail. The location of both Anneberg Park and The Konza Prairie Trail is shown in **Figure 7.1**.

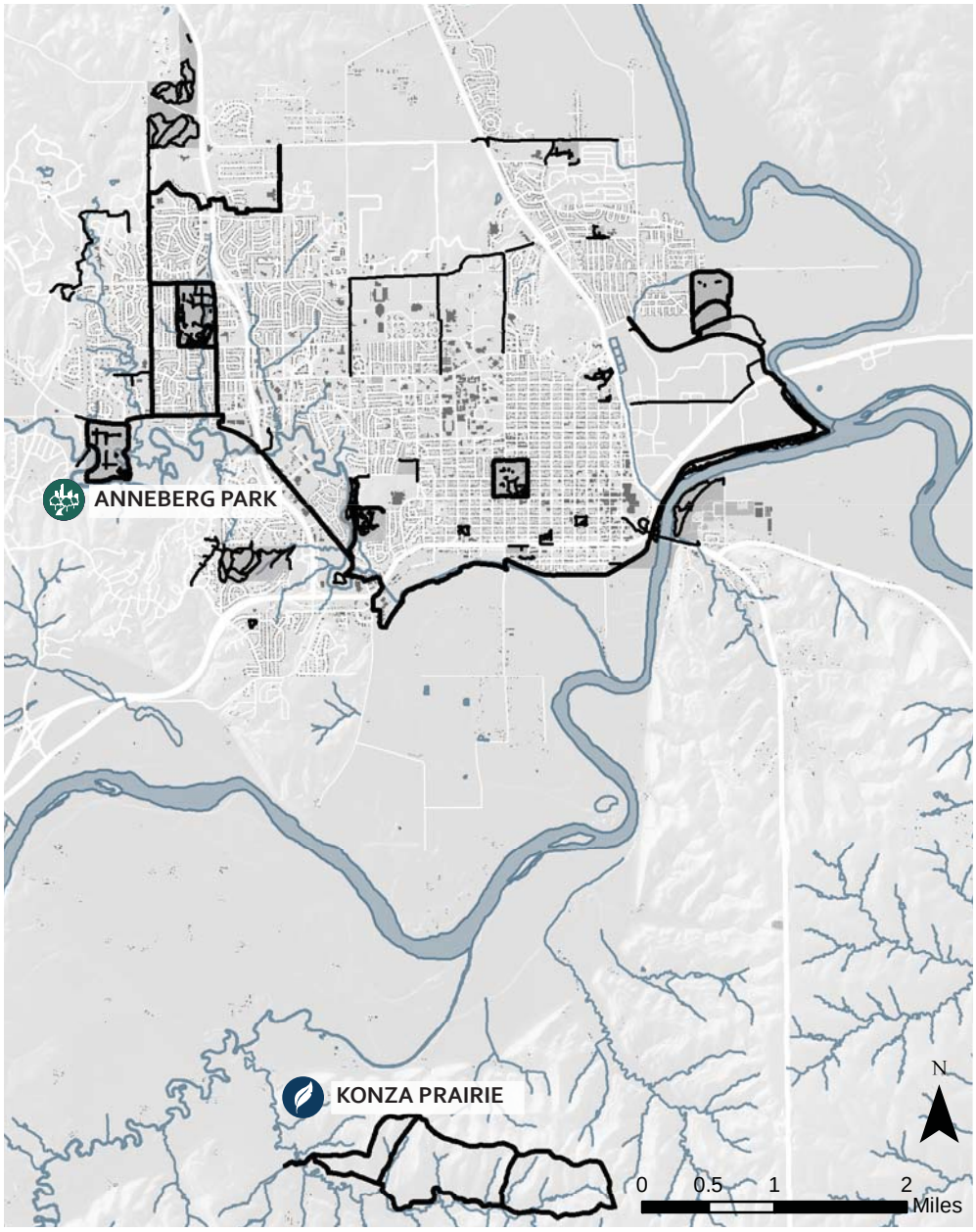

Figure 7.1: Trail Locations in Manhattan, Kansas

ANNEBERG PARK

Frank Anneberg Park (hereafter "Anneberg Park") is located on the west side of Manhattan, adjacent to Anderson Avenue. The park is circumscribed by a trail that is approximately 1.5 miles long. Terrain is relatively flat and the trail is surfaced with earth, gravel, and concrete. The trail passes alongside soccer fields, baseball fields, playgrounds, pond area, and passes through several peripheral wooded areas. In the larger context, the park and trail are surrounded by single- and multi-family residences to the north and west, a small golf course to the east, and Wildcat Creek and a backdrop of steep hills to the south. The trail receives use by park visitors and many surrounding residents.

SITE ANALYSIS

Site analysis for Anneberg Park started with field work. The result of the field work is a map, **Figure 7.2**, which includes notes. The notes are sensory and cognitive experiential elements that were identified by walking along the park trail to determine existing sensory elements and noting opportunities for additive elements. The information from the field work was then entered into ArcGIS as shown in **Figure 7.3** and **Tables 7.1-7.2**.

Figure 7.2: Anneberg Park Fieldwork Notes

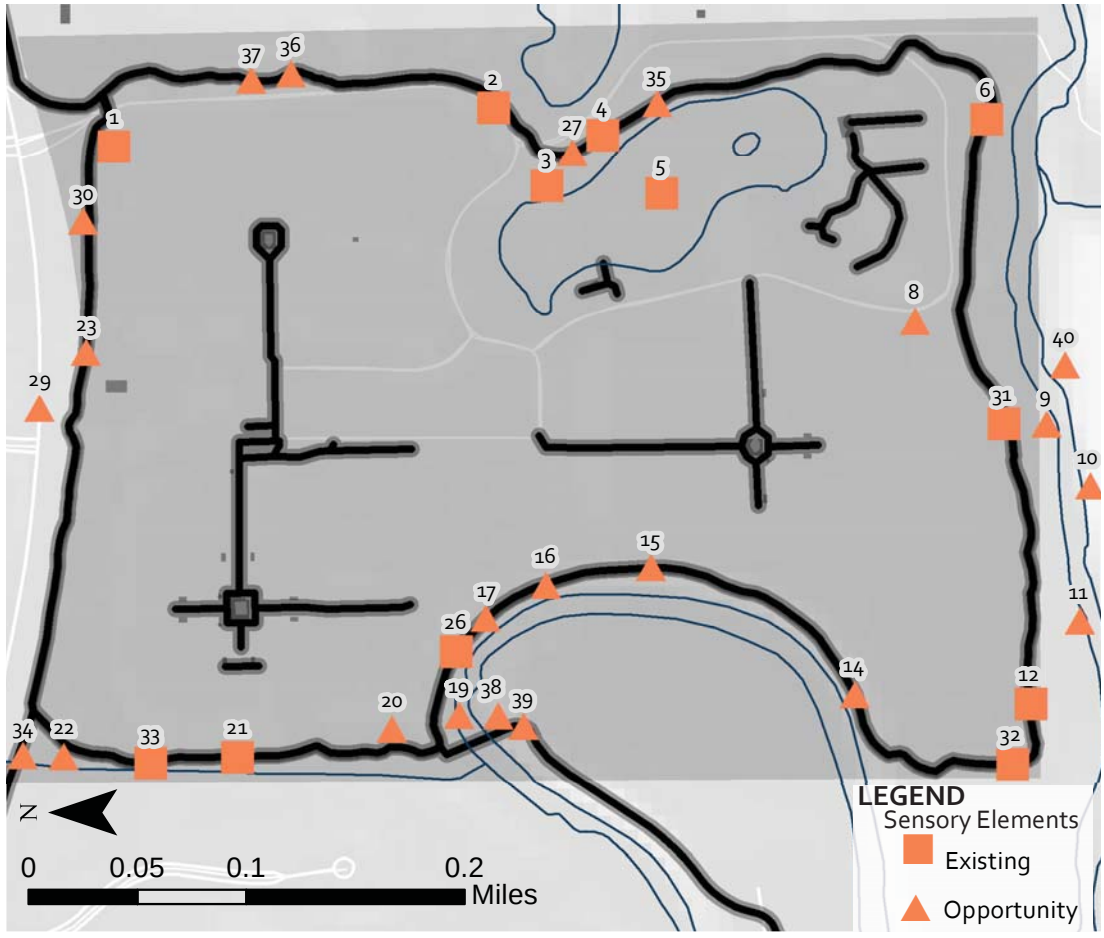

Figure 7.3: Sensory elements of Anneberg Park Mapped in ArcGIS

Figure 7.4: Visual Interest in Anneberg Park

Figure 7.5: Movement through "Enclosed" Woods

SENSORY EXPERIENCE					
ID	SHAPE	Type	Feature	Element	Name
1	Point	Existing	Touch	Path	Surface Material Change
2	Point	Existing	Vision/Sound	Wildlife	Bird Nest
3	Point	Existing	Vision/Sound	Wildlife	Geese
4	Point	Existing	Vision	Scenic view	View of near water and distant flint hills
5	Point	Existing	Vision/Sound/Touch	Water	Pond
6	Point	Existing	Sound/Vision	Wildlife	Birds
8	Point	Opportunity	Vision/Sound/Touch	Water	Drainage channel
9	Point	Opportunity	Vision	Visual landmark	Specimen Sycamore tree
10	Point	Opportunity	Vision	Visual landmark	Specimen Sycamore tree
11	Point	Opportunity	Vision	Visual landmark	Specimen Sycamore tree
12	Point	Existing	Sound	Wildlife sounds	Birds
14	Point	Opportunity	Vision	Scenic views	Distant view of flint hills
15	Point	Opportunity	Vision	Scenic views	View of Flint Hills: Distant
16	Point	Opportunity	Vision/Sound/Touch	Water	Creek
17	Point	Opportunity	Vision	Visual Landmark	Slight view of water
19	Point	Opportunity	Vision	Visual interest	View of water, bridge and distant flint hills
20	Point	Opportunity	Vision/Sound/Touch	Water	Drainage channel
21	Point	Existing	Touch	Sun exposure	Overhanging tree
22	Point	Opportunity	Vision/Sound/Touch	Water	Drainage channel
23	Point	Opportunity	Vision	Scenic views	Views of Flint Hills
26	Point	Existing	Movement	Path alignment	Slight incline
27	Point	Opportunity	Vision	Scenic view	View of near water and distant flint hills
29	Point	Opportunity	Sound	Disturbance Sound	Traffic
30	Point	Opportunity	Vision/Sound/Touch	Vegetation	Seasonal Vegetation
31	Point	Existing	Touch	Shade/Sun exposure	Shade/Sun through light tree overhead
32	Point	Existing	Sound	Vegetation sounds	Leaves
33	Point	Existing	Sound	Vegetation sounds	Leaves
34	Point	Opportunity	Vision/Sound/Touch	Water	Drainage Channel
35	Point	Opportunity	Vision/Sound/Touch	Water	Water interaction
36	Point	Opportunity	Vision	Water	View of creek
37	Point	Opportunity	Movement	Exposure/Enclosure	Topography
38	Point	Opportunity	Vision/Sound	Water	View of water
39	Point	Opportunity	Vision	Scenic View	View of Flint Hills
40	Point	Opportunity	Vision	Trail Edge	Topographic Layers

Table 7.1: Sensory Experience Points in Anneberg Park Tabulated in ArcGIS

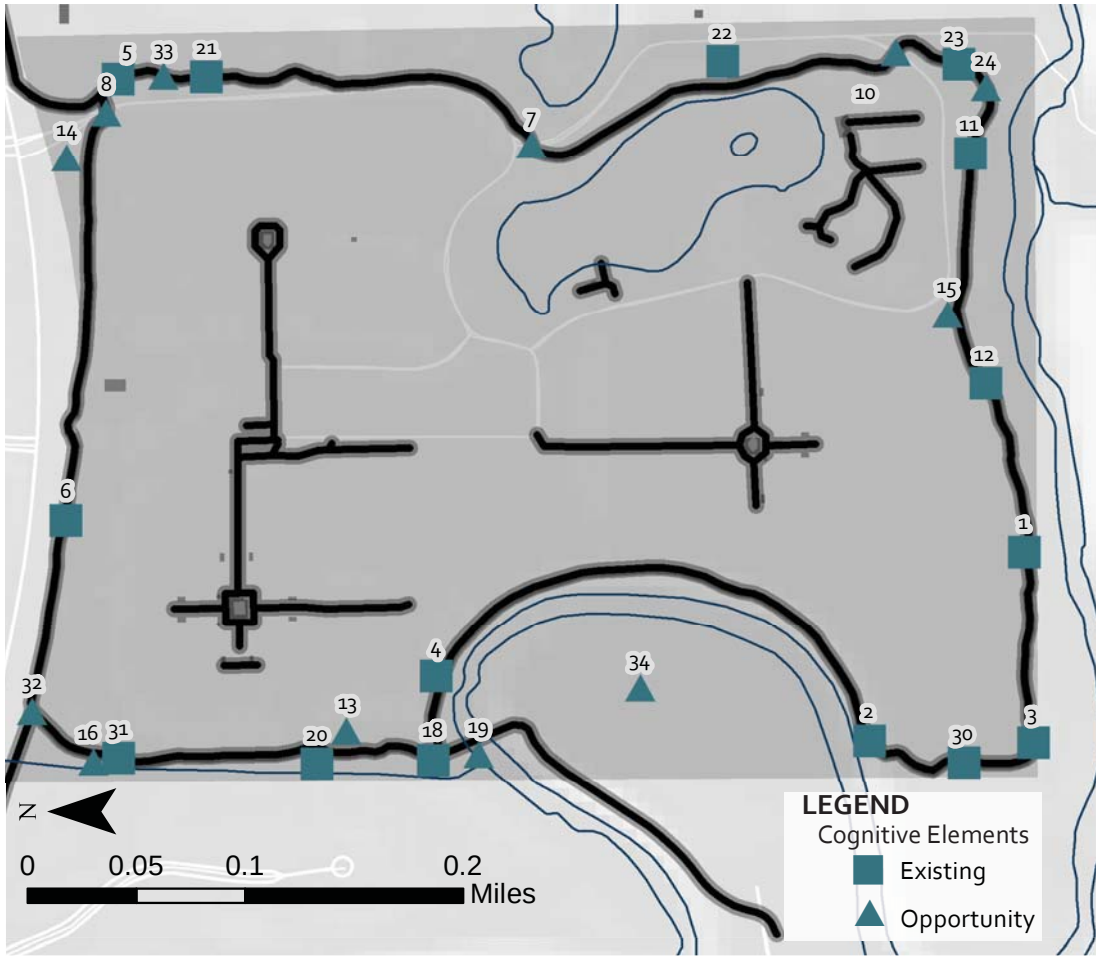

Figure 7.6: Cognitive Elements of Anneberg Park Mapped in ArcGIS

Figure 7.7: Anneberg's Visual Goal Point

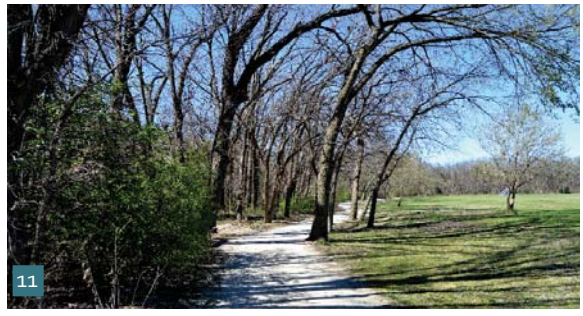

Figure 7.8: Exposure and Enclosure

COGNITIVE EXPERIENCE					
ID	SHAPE	Type	Feature	Element	Name
1	Point	Existing	Body identification	Enclosure/exposure	Tree gateway
2	Point	Existing	Body identification	Enclosure/exposure	Transition to open area
3	Point	Existing	Mystery	Vegetation concealment	Curve and vegetation
4	Point	Existing	Challenge	Enclosure/exposure	Topographic
5	Point	Existing	Mystery	Vegetation concealment	Exposure to enclosure
6	Point	Existing	Body identification	Enclosure/exposure	Tree gateway
7	Point	Opportunity	Feeling of safety	Separation from disruptions	Road crossing
8	Point	Opportunity	Feeling of safety	Separation from disruptions	Road crossing
10	Point	Opportunity	Feeling of safety	Separation from disruptions	Road crossing
11	Point	Existing	Body identification	Enclosure/exposure	Transition exposed to enclosed
12	Point	Existing	Body identification	Enclosure/exposure	Open
13	Point	Opportunity	Involvement	Water	Drainage channel
14	Point	Opportunity	Involvement	Water	Drainage channel
15	Point	Opportunity	Involvement	Water	Drainage channel
16	Point	Opportunity	Involvement	Water	Drainage channel
18	Point	Existing	Body identification	Enclosure/exposure	Topographic exposure
19	Point	Opportunity	Involvement	Interaction	Visual goal point
20	Point	Existing	Body identification	Enclosure/exposure	Topographic concealment
21	Point	Existing	Mystery	Vegetation Concealment	Vegetation Reveal
22	Point	Existing	Feeling of Safety	Separation from disruptions	Separation from road with topography
23	Point	Existing	Body identification	Exposure	Open area
24	Point	Opportunity	Mystery	Vegetation concealment	Potential transition
30	Point	Existing	Body identification	Enclosure	Overhead Vegetation
31	Point	Existing	Body identification	Enclosure	Overhead Vegetation
32	Point	Opportunity	Mystery	Vegetation concealment	Potential transition
33	Point	Opportunity	Mystery	Vegetation concealment	Potential transition
34	Point	Opportunity	All	All	Open field

Table7.2: Cognitive Experience points in Anneberg Park Tabulated in ArcGIS

Table 7.3-7.4 shows the existing elements and opportunities in Anneberg Park that contribute to a heightened sensory and cognitive experience. The tables also document elements neglected in the existing park trail design and highlight possible remedies. The highlighted numbers in **Table 7.3-7.4** show the opportunities that were developed into designs aimed at improving the overall Anneberg Park trail experience.

COGNITIVE EXPERIENCE: ANNEBERG			
FEATURE	ELEMENTS	EXISTING	OPPORTUNITY
Involvement	Education		
	Interaction		**19**
	Surrounding environment		13, **14**, 15, **16**
Challenge	Variety in terrain		**34**
	Obstacles		
	Path alignment	**4**	**34**
Mystery	Topographic concealment/ revealment		
	Vegetation concealment/ revealment	**3**, **5**, **21**,	**24**, **32**, **33**
Feeling of Safety	Amenities		
	Lighting		
	Separation from disruptions	**22**	**7**, **8**, **10**
	Wayfinding		
Body Identification	Enclosure/exposure	1, **2**, **6**, 11, 12, 18, **20**, **23**, **30**, **31**	

Table 7.3: Cognitive Opportunities and Existing Elements of Anneberg Park

SENSORY EXPERIENCE: ANNEBERG			
FEATURE	ELEMENTS	EXISTING	OPPORTUNITY
Vision	Clear wayfinding		
	Visual landmark	2, 3, 6	8, 9, 10, 11, 16, 17, 20, 22, 34, 35, 38
	Seasonal vegetation		30
	Lighting		
	Trail edge condition		40
	Scenic views	4	14, 15, 19, 23, 27, 36
Sound	Wildlife sounds	2, 3, 6, 12	
	Vegetation sounds	32, 33	30
	Material sounds		
	Disturbing sounds		29
	Water sounds	5	8, 16, 20, 22, 34, 35, 38
Scent	Aromatic vegetation		
	Disturbing scents		
Touch	Vegetation		30
	Path	1	
	Water		8, 16, 20, 22, 34, 35
	Wildlife		
	Sun exposure	21, 31	
	Amenities		
Taste	Vegetation		
Movement	Path alignment	26	37

Table 7.4: Sensory Opportunities and Existing Elements of Anneberg Park

As depicted in Figure 1.9, locations for potential trail enhancements were mapped. Focus areas of priority (dashed circle areas) were defined according to the following criteria: 1) need for accessibility; 2) cluster of sensory and cognitive elements; 3) widest variety of elements addressed int he framework; and 4) areas of highest visibility, such as entrances. After determination of focus areas, additional analysis was undertaken. The additional analysis includes all the categories of user experience and addresses both the trail and its surrounding environment. The trail analysis includes trail surface material, slope, and width. Slope percentage and orientation aspect were studies for the surrounding environment.

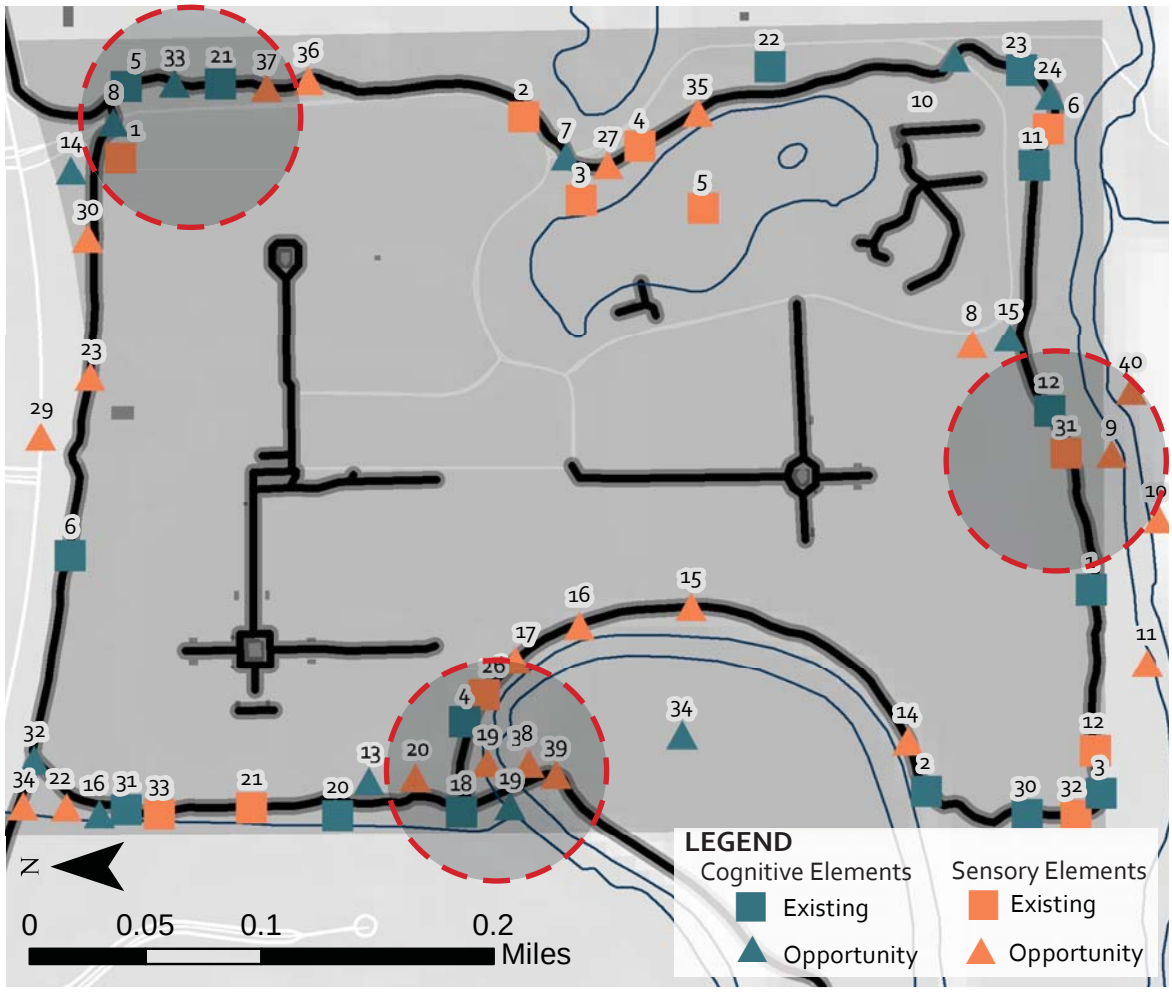

Figure 7.9: Areas of Focus for Anneberg Park

The trail surface inventory, shown in **Figure 7.10** determined that Anneberg Park Trail is mostly unpaved and is covered by a thin layer of limestone chips. This presents the issue of potentially being too soft to accommodate wheelchairs during rainy conditions when the underlying earth is soft or muddy, **Figure 7.11.**

Figure 7.10: Limestone Gravel Path

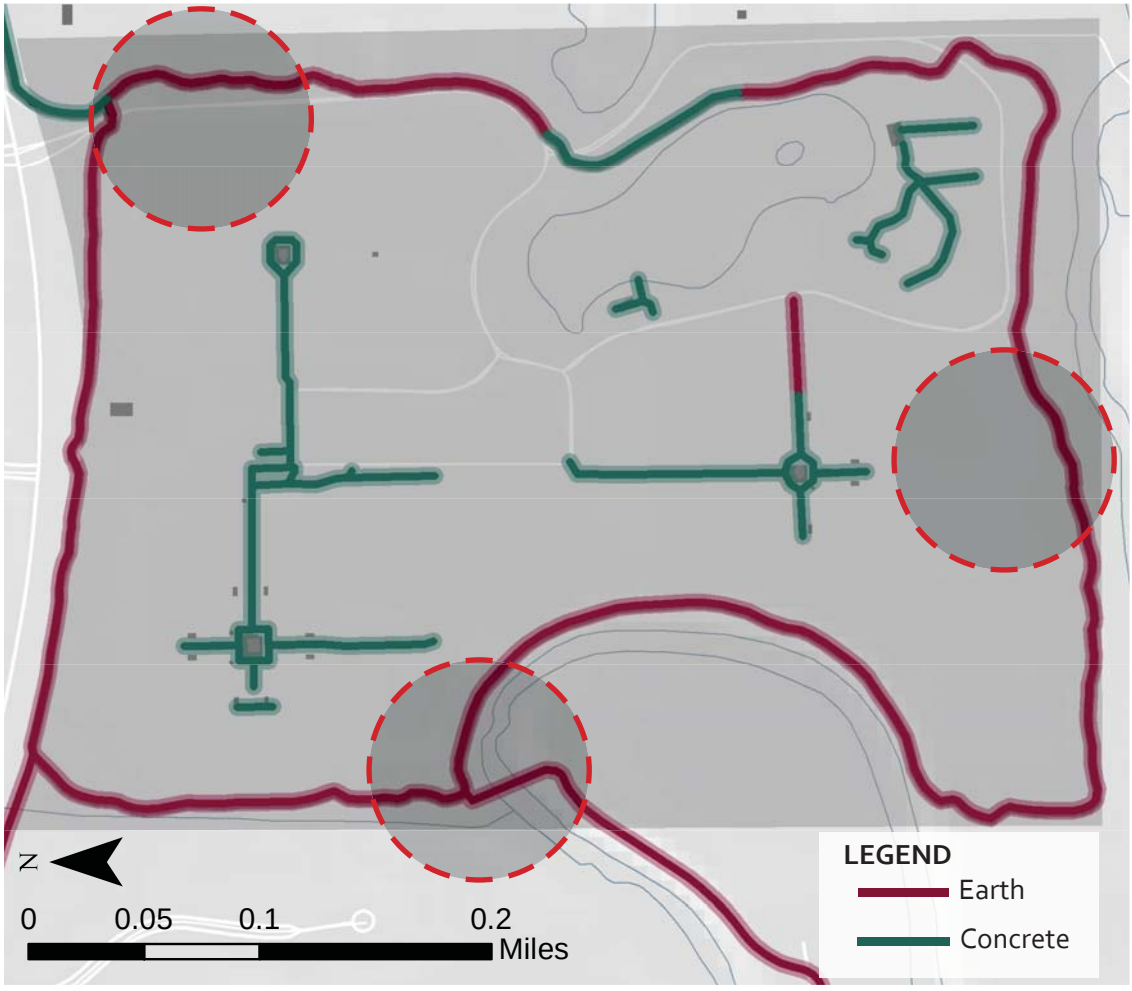

Figure 7.11: Trail Surface Inventory

Results of the trail width inventory, **Figure 7.13,** shows that the Anneberg Park Trail is typically over six feet wide and is accessible to persons with disabilities. Trail width can be seen in **Figure 7.12**.

Figure 7. 12: Anneberg Trail Width

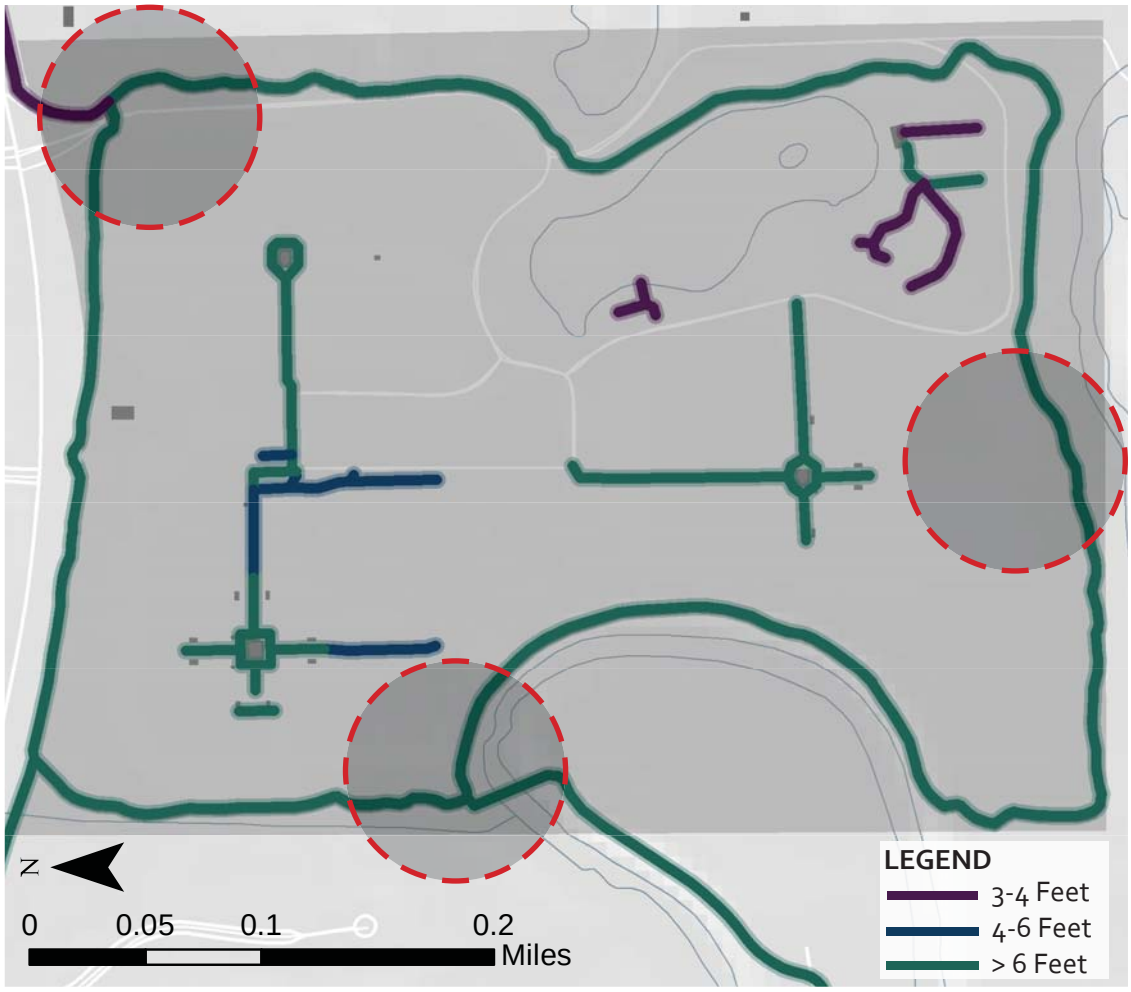

Figure 7.13: Trail Width Inventory

Trail slope is shown in **Figure 7.15**. The slope map shows that Anneberg trail is relatively flat, mostly under (3%), resulting in accessibility to persons with disabilities. Through fieldwork, it was determined that the area of highest slope percentage occurs along the banks of Wildcat Creek, but is addressed through the use of a bridge, **Figure 7.14**.

Figure 7. 14: Bridge over Wildcat Creek

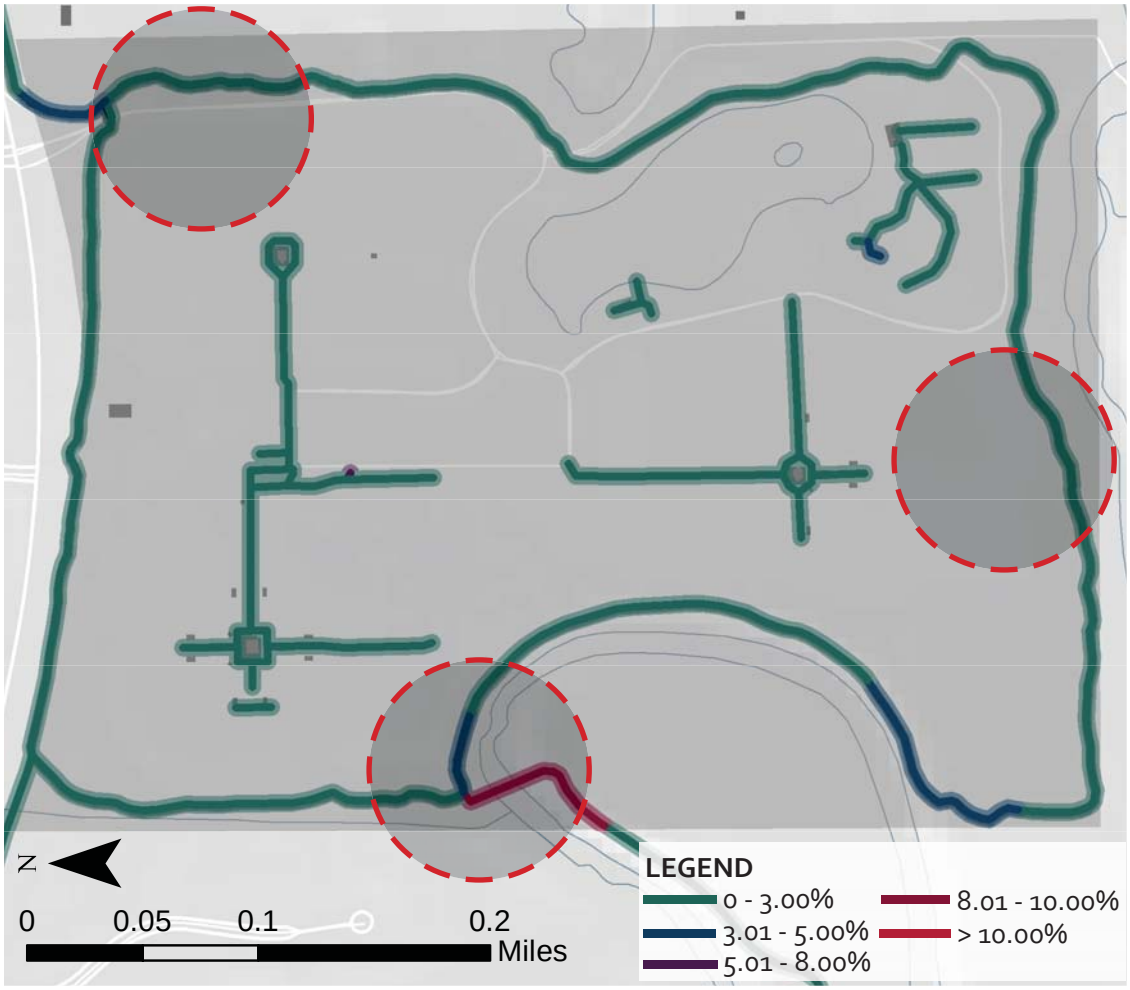

Figure 7.15: Trail Slope Analysis

The slope percentage map, **Figure 7.17,** represents the surrounding environments slope percentage. The map shows that the trail alignment runs along several steep slope locations. Through field work, **Figure 7.16,** it is determined that steep slopes are formed from Wildcat Creek and topography beyond.

Figure 7.16: Wildcat Creek Topography

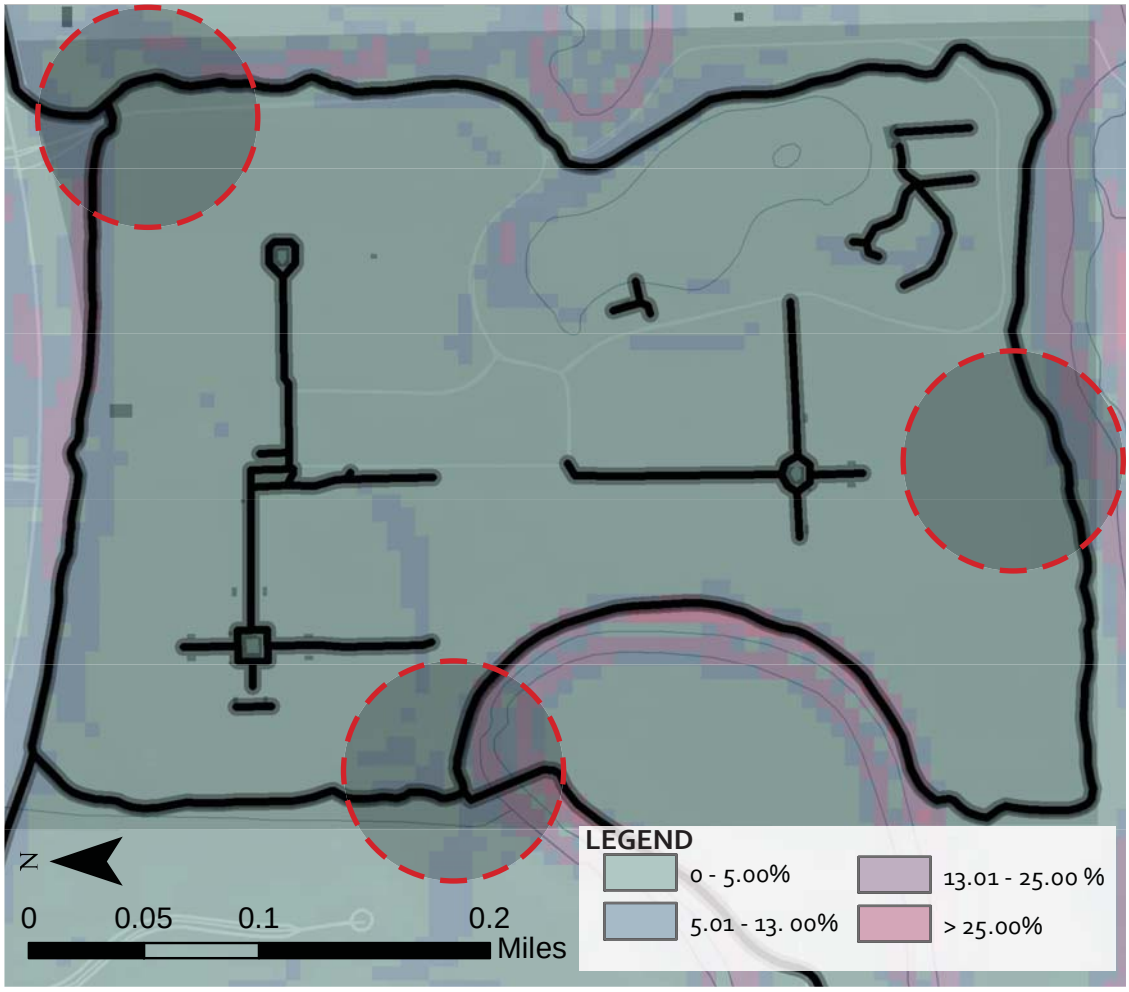

Figure 7.17: Slope Percentage of Surrounding Context

Slope aspect, **Figure 7.19,** shows the direction that surrounding slopes face. **Figure 7.18,** represents the South side of Anneberg Park and the slope that faces north towards the trail, across Wildcat Creek.

Figure 7.18: Topography across Wildcat Creek

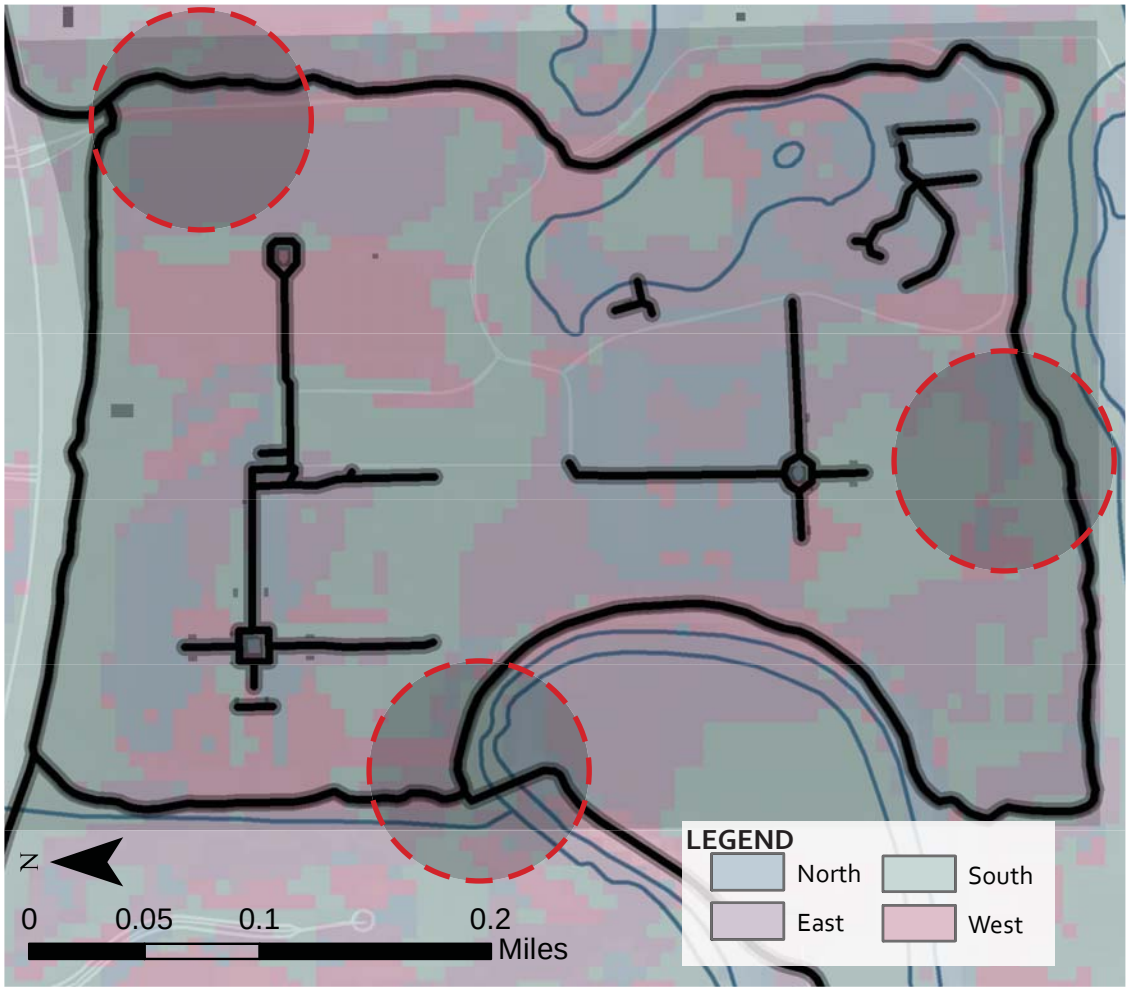

Figure 7.19: Slope Aspect

Four potential trail design modifications are proposed later in this chapter that incorporate design strategies from the Natural Trail Design Guidelines. Locations for these design modifications were based on the proceeding site inventory and are shown in **Figures 7.20-7.21**.

Figure 7.20: Opportunities for Design

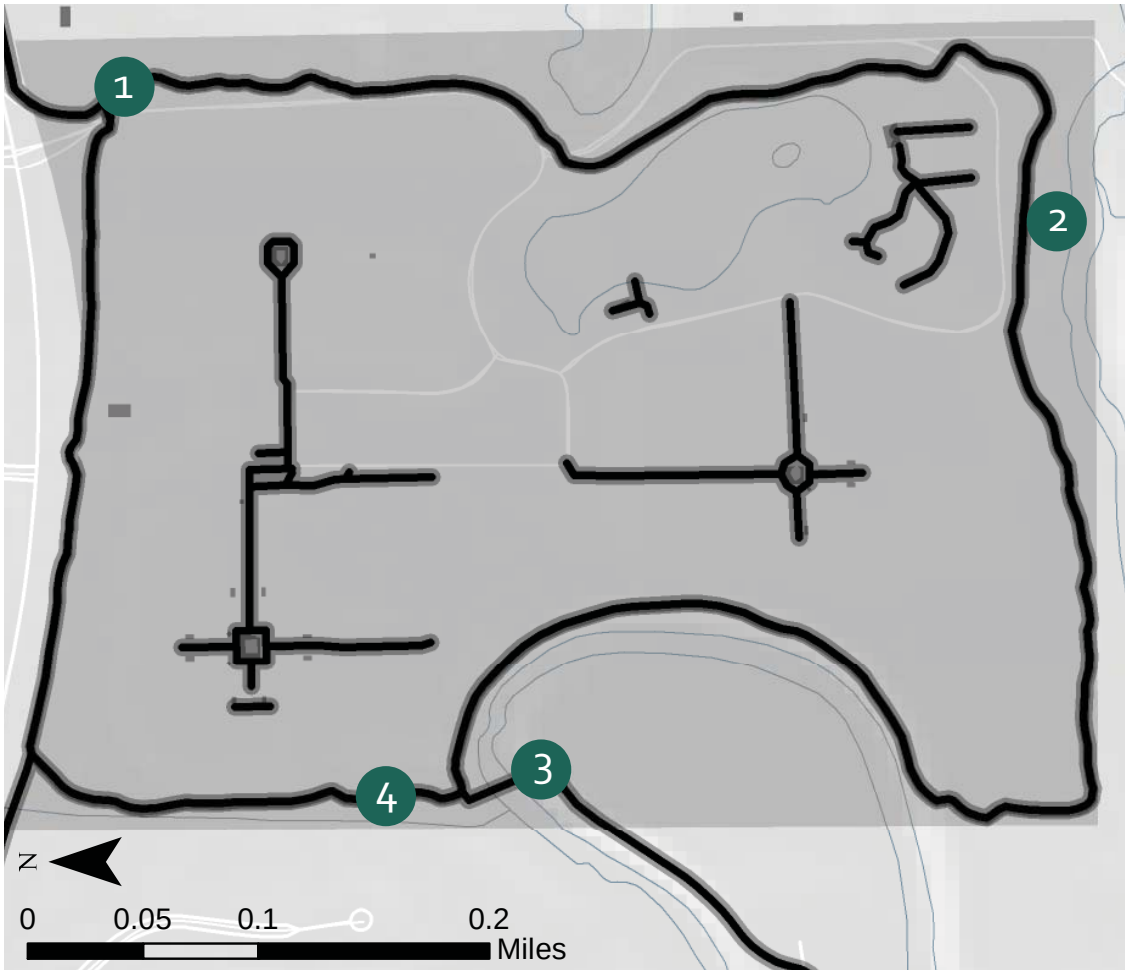

Figure 7.21: Design Locations

DESIGN 1: WOODLAND ENTRANCE

The entrance TO Anneberg Park Trail will be enhanced by the addition of multiple sensory and cognitive elements to the existing nature trail segment (**Tables 7.5-7.6**). The implementation of vegetation adjacent to the entrance path creates opportunities for users to touch vegetative materials and smell the aromatic qualities of native species. Additionally, wildlife is attracted to the vegetation, furthering the experience of transition onto the nature trail. Signage with education and directional understanding creates a sense of content. With the simple addition of signage and native vegetation, the entrance to the Anneberg Park Nature Trail can be significantly improved for persons with disabilities and the general user (**Figure 7.22**).

DESIGN STRATEGIES

- Introduce vegetation adjacent to trail edge
- Introduce vegetation and features that attract wildlife
- Introduce different trail surface materials
- Introduce aromatic species
- Introduce regional materials in amenities
- Create entrances
- Introduce educational signage
- Introduce directional signage and maps for locational understanding

Figure 7.22: Woodland Entrance

SENSORY EXPERIENCE		
FEATURE	ELEMENTS	1
Vision	Clear wayfinding	●
	Visual landmark	
	Seasonal vegetation	
	Lighting	
	Trail edge condition	
	Scenic views	
Sound	Wildlife sounds	●
	Vegetation sounds	
	Material sounds	●
	Disturbance sounds	
	Water sounds	
Scent	Aromatic vegetation	●
	Disturbance scents	
Touch	Vegetation	●
	Path	●
	Water	
	Wildlife	
	Sun exposure	
	Amenities	
Taste	Vegetation	
Movement	Path alignment	

Table 7.5: Anneberg Park Entrance Sensory Experience

COGNITIVE EXPERIENCE		
FEATURE	ELEMENTS	1
Involvement	Education	●
	Interaction	
	Surrounding environment	
Challenge	Variety in terrain	
	Obstacles	
	Path alignment	
Mystery	Topographic concealment/ revealment	
	Vegetation concealment/ revealment	●
Feeling of Safety	Amenities	
	Lighting	
	Separation from disruptions	
	Wayfinding	●
Body Identification	Enclosure/exposure	●

Table 7.6: Anneberg Park Entrance Cognitive Experience

DESIGN 2: SOUTH SIDE CREEK

The South Side Creek is a design that utilizes the close adjacency of Wildcat Creek to the Anneberg Park Perimeter Trail. The design suggests additional trail routing to create a closer encounter to water for trail users. Additionally, trail routing provides opportunities through alignment considerations to create a sense of discovery for trail users. Existing large sycamore trees add visual interest during all seasons. Educational opportunities are also encouraged through the addition of signage and proximity to natural systems. Amenities, such as limestone benches, are proposed to provide areas of rest and touchable regional materials. Through the implementation of South Side Creek design, sensory and cognitive experiences will be enhanced, as seen in **Table 7.7** and **Table 7.8**. With the use of guidelines associated with routing considerations, existing opportunities can be utilized and enhanced for trail users with disabilities and the general user (**Figure 7.23**).

DESIGN STRATEGIES

- Route trail with purposeful alignment (vertical, horizontal)
- Route trail adjacent to water features
- Route trail near visual landmark
- Route trail near visible natural systems
- Introduce educational signage
- Introduce regional material for amenities

Figure 7.23: South Side Creek

SENSORY EXPERIENCE		
FEATURE	ELEMENTS	2
Vision	Clear wayfinding	●
	Visual landmark	●
	Seasonal vegetation	●
	Lighting	
	Trail edge condition	
	Scenic views	●
Sound	Wildlife sounds	●
	Vegetation sounds	●
	Material sounds	
	Disturbance sounds	
	Water sounds	
Scent	Aromatic vegetation	●
	Disturbance scents	
Touch	Vegetation	
	Path	●
	Water	●
	Wildlife	
	Sun exposure	●
	Amenities	●
Taste	Vegetation	
Movement	Path alignment	●

Table 7.7: Anneberg River South Sensory Experience

COGNITIVE EXPERIENCE		
FEATURE	ELEMENTS	2
Involvement	Education	●
	Interaction	●
	Surrounding environment	●
Challenge	Variety in terrain	●
	Obstacles	
	Path alignment	
Mystery	Topographic concealment/ revealment	
	Vegetation concealment/ revealment	●
Feeling of Safety	Amenities	●
	Lighting	
	Separation from disruptions	●
	Wayfinding	●
Body Identification	Enclosure/exposure	●

Table 7.8: Anneberg River South Cognitive Experience

DESIGN 03: ANNEBERG MEADOW

Anneberg Meadow provides a destination point along the existing trail and takes advantage of distant views of the Flint Hills. The design amplifies the view by providing limestone benches that create directional focus. In addition, Anneberg Meadow utilizes the opportunity of an open field by planting native vegetation that attracts wildlife and has aromatic qualities. An additional trail through the meadow would allow trail users to further interact with a natural setting and provide additional opportunities to have a sensory experience, **Table 7.9**. The cognitive experience is also improved through the considerations of trail routing and amenities provided, **Table 7.10**. **Figure 7.24,** shows the inclusion of stone benches and native vegetation, the experiential will enhance qualities of Anneberg Park.

DESIGN STRATEGIES

- Create frames for views
- Introduce vegetation adjacent to trail edge.
- Introduce vegetation and features that attract wildlife
- Introduce aromatic species
- Introduce benches
- Introduce regional materials in amenities
- Amplify scenic views

Figure 7.24: Flint Hill Viewpoint

SENSORY EXPERIENCE		
FEATURE	ELEMENTS	3
Vision	Clear wayfinding	●
	Visual landmark	●
	Seasonal vegetation	●
	Lighting	
	Trail edge condition	
	Scenic views	●
Sound	Wildlife sounds	●
	Vegetation sounds	
	Material sounds	
	Disturbance sounds	
	Water sounds	
Scent	Aromatic vegetation	●
	Disturbance scents	
Touch	Vegetation	●
	Path	
	Water	
	Wildlife	
	Sun exposure	●
	Amenities	●
Taste	Vegetation	
Movement	Path alignment	●

Table 7.9: Anneberg Meadow View Sensory Experience

COGNITIVE EXPERIENCE		
FEATURE	ELEMENTS	3
Involvement	Education	
	Interaction	●
	Surrounding environment	
Challenge	Variety in terrain	
	Obstacles	
	Path alignment	●
Mystery	Topographic concealment/ revealment	●
	Vegetation concealment/ revealment	
Feeling of Safety	Amenities	●
	Lighting	
	Separation from disruptions	●
	Wayfinding	
Body Identification	Enclosure/exposure	●

Table 7.10: Anneberg Meadow View Cognitive Experience

DESIGN 4: INTERACTIVE DRAINAGE

The interactive drainage design utilizes the opportunity presented by a existing drainage channel in Anneberg Park, **Figure 7.25**. The design suggests the addition of native vegetation that attracts wildlife and has aromatic qualities placed adjacent to the trail. The drainage channel is enhanced by the addition of limestone pebbles and large boulders that will amplify the sound of water, in addition to creating an opportunity for interaction. The sensory experience is enhanced by the addition of these elements, seen in **Table 7. 11**. The cognitive experience is also improved, **Table 7.12**.

DESIGN STRATEGIES

- Amplify water movements/drips
- Create new water features
- Introduce vegetation along trail edge
- Introduce vegetation and features that attract wildlife
- Introduce aromatic species
- Route trail adjacent to water
- Create interactive water features

Figure 7.25: Interactive Drainage

SENSORY EXPERIENCE		
FEATURE	ELEMENTS	4
Vision	Clear wayfinding	
	Visual landmark	●
	Seasonal vegetation	
	Lighting	
	Trail edge condition	
	Scenic views	
Sound	Wildlife sounds	●
	Vegetation sounds	●
	Material sounds	
	Disturbance sounds	
	Water sounds	●
Scent	Aromatic vegetation	●
	Disturbance scents	
Touch	Vegetation	
	Path	
	Water	●
	Wildlife	●
	Sun exposure	
	Amenities	
Taste	Vegetation	
Movement	Path alignment	●

Table 7.11: Anneberg Drainage Sensory Experience

COGNITIVE EXPERIENCE		
FEATURE	ELEMENTS	4
Involvement	Education	●
	Interaction	●
	Surrounding environment	●
Challenge	Variety in terrain	
	Obstacles	
	Path alignment	
Mystery	Topographic concealment/ revealment	
	Vegetation concealment/ revealment	
Feeling of Safety	Amenities	
	Lighting	
	Separation from disruptions	
	Wayfinding	●
Body Identification	Enclosure/exposure	●

Table 7.12: Anneberg Drainage Cognitive Experience

CONCLUSION

Through the implementation of the framework, four designs are proposed to improve the range of experience by multiple users of the Anneberg Park Trail. **Table 7.13** shows the cognitive elements addressed through the four designs. The designs address sensory elements shown in **Table 7.14**. As a result, implementation of the designs for Anneberg Park Trail will enhance sensory and cognitive experience, improving the trail for persons with disabilities, in addition to general users (**Figure 7.25**).

COGNITIVE EXPERIENCE: ANNEBERG							
FEATURE	ELEMENTS	EXISTING	OPPORTUNITY	1	2	3	4
Involvement	Education			●	●		●
	Interaction		19			●	●
	Surrounding environment		13, 14, 15, 16				●
Challenge	Variety in terrain		34				
	Obstacles						
	Path alignment	4	34			●	
Mystery	Topographic concealment/ revealment					●	
	Vegetation concealment/ revealment	3, 5, 21,	24, 32, 33	●	●		
Feeling of Safety	Amenities					●	
	Lighting						
	Separation from disruptions	22	7, 8, 10			●	
	Wayfinding			●	●		●
Body Identification	Enclosure/exposure	1, 2, 6, 11, 12, 18, 20, 23, 30, 31		●	●	●	●

Table 7.13: Anneberg Cognitive Experience

SENSORY EXPERIENCE: ANNEBERG							
FEATURE	ELEMENTS	EXISTING	OPPORTUNITY	1	2	3	4
Vision	Clear wayfinding			●	●	●	
	Visual landmark	2, 3, 6	8, 9, 10, 11, 16, 17, 20, 22, 34, 35, 38		●	●	●
	Seasonal vegetation		30		●	●	
	Lighting						
	Trail edge condition		40				
	Scenic views	4	14, 15, 19, 23, 27, 36		●	●	
Sound	Wildlife sounds	2, 3, 6, 12		●	●	●	●
	Vegetation sounds	32, 33	30		●		●
	Material sounds			●			
	Disturbing sounds		29				
	Water sounds	5	8, 16, 20, 22, 34, 35, 38				●
Scent	Aromatic vegetation			●	●	●	●
	Disturbing scents						
Touch	Vegetation		30	●		●	
	Path	1		●	●		
	Water		8, 16, 20, 22, 34, 35		●		●
	Wildlife						●
	Sun exposure	21, 31			●	●	
	Amenities				●	●	
Taste	Vegetation						
Movement	Path alignment	26	37		●	●	●

Table 7.14: Anneberg Sensory Experience

Figure 7.26: Before and after

KONZA PRAIRIE PRESERVE

The Konza Prairie is located South of Manhattan, Kansas. The reserve consists of three trail loops; The Nature Trail (2.5 miles), Kings Creek Loop (4.4 miles), and Godwin Hill Loop (6.0 miles). Terrain varies and the trail surface mainly consists of crushed limestone and earth. The trail travels through the Konza Prairie consisting of terrain and views of the native Kansas landscape. The trail receives use by local and out of town visitors.

SITE ANALYSIS

Site analysis for the Konza Prairie started with field work. The result of the field work is a map, **Figure 7.27**, which includes notes. The notes relate to physical, sensory and cognitive experiential elements that were identified by walking along the trail to determine existing elements and limitations, and noting opportunities for additive elements. The information from the field work was then entered into ArcGIS as shown in **Figure 7.28-7.30** and **Tables 7.15-7.18**.

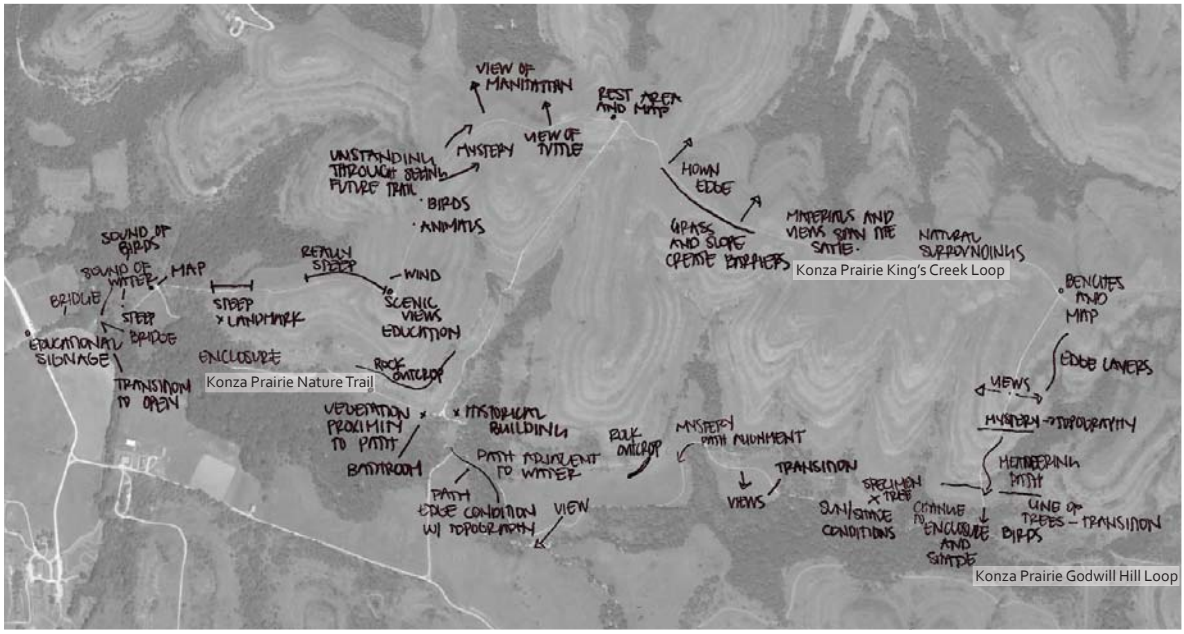

Figure 7. 27: Field Notes of Konza Prairie

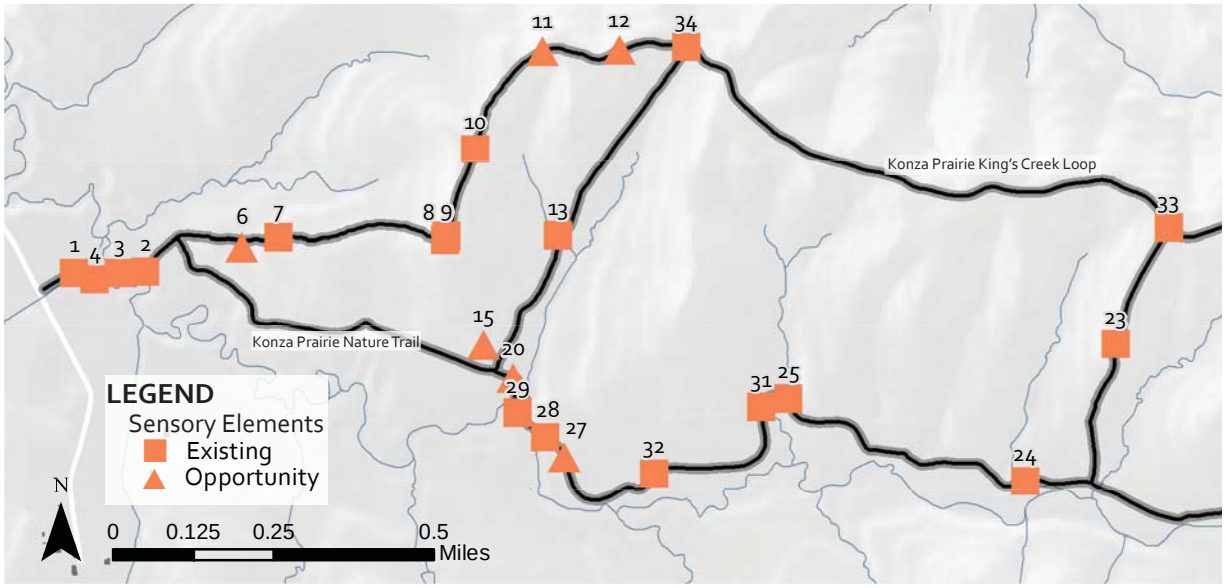

Figure 7. 28: Sensory Elements of Konza Prairie

SENSORY EXPERIENCE					
ID	SHAPE	Type	Feature	Element	Name
1	Point	Existing	Vision/Sound/Touch	Water	Creek
2	Point	Existing	Vision/Sound/Touch	Water	Creek
3	Point	Existing	Touch	Path	Surface material change
4	Point	Exisitng	Touch	Path	Surface material change
6	Point	Opportunity	Vision	Visual landmark	Speciman tree
7	Point	Existing	Vision	Scenic views	Distant views
8	Point	Existing	Vision	Scenic views	Distant views
9	Point	Existing	Touch	Amenities	Limestone seating
10	Point	Existing	Sound	Wildlife	Birds
11	Point	Opportunity	Vision	Scenic view	Distant view of Manhattan
12	Point	Opportunity	Vision	Scenic view	Distant view of Tuttle Creek Resevoir
13	Point	Existing	Vision/Sound/Touch	Water	Creek
15	Point	Opportunity	Vision	Visual landmark	Rock outcrop
20	Point	Opportunity	Vision/Sound/Touch	Water	Creek
23	Point	Existing	Vision	Scenic views	Distant views
24	Point	Existing	Vision/Sound/Touch	Water	Creek
25	Point	Existing	Vision/Sound/Touch	Water	Creek
27	Point	Opportunity	Vision/Sound/Touch	Water	Water feature potential
28	Point	Existing	Vision/Sound/Touch	Water	Creek
29	Point	Existing	Vision/Sound/Touch	Water	Creek
31	Point	Existing	Vision	Scenic views	Distant and near views
32	Point	Existing	Vision	Scenic views	Distant views
33	Point	Existing	Touch	Amenities	Limestone seating
34	Point	Existing	Touch	Amenities	Limestone seating

Table 7. 15: Sensory Elements of Konza Prairie in ArcGIS

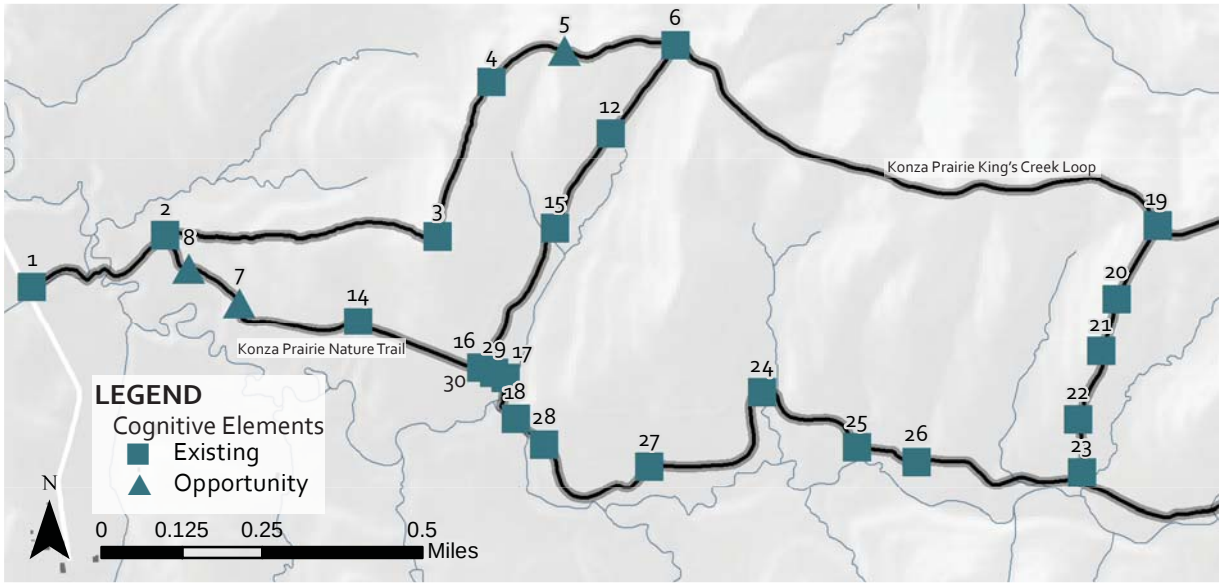

Figure 7. 29: Cognitive Elements of Konza Prairie

COGNITIVE EXPERIENCE					
ID	SHAPE	Type	Feature	Element	Name
1	Point	Existing	Involvement	Education	Educational signage
2	Point	Existing	Feeling of safety	Wayfinding	Map
3	Point	Existing	Involvement	Education	Educational signage
4	Point	Existing	Mystery	Topographic concealment	Path alignment to accent topographic concealment downslope
5	Point	Opportunity	Body identification	Enclosure/exposure	Constrast of developed/regional
6	Point	Existing	Feeling of safety	Wayfinding	Map
7	Point	Opportunity	Body identification	Vegetation concealment	Transistion from exposure to enclosure
8	Point	Opportunity	Body identification	Vegetation revealment	Transistion from enclosure ot exposure
12	Point	Existing	Feeling of safety	Wayfinding	Distant vision of path ahead
14	Point	Existing	Mystery	Vegetation concealment	Path aligned around vegetation
15	Point	Existing	Mystery	Vegetation concealment/ revealment	Path alignment to accent vegetation concealment/revealment
16	Point	Existing	Feeling of safety	Wayfinding	Map
17	Point	Existing	Mystery	Vegetation concealment/ revealment	Path alignment to accent vegetation concealment/revealment
18	Point	Existing	Involvement	Education	Educational signage
19	Point	Existing	Feeling of safety	Wayfinding	Map
20	Point	Existing	Mystery	Topographic concealment	Down slope concealing path ahead
21	Point	Existing	Mystery	Topographic concealment/ revealment	Path alignment to accent topographic concealment/reavealment
22	Point	Existing	Body identification	Enclosure/exposure	Tree gateway
23	Point	Existing	Body identification	Enclosure/exposure	Transition from exposure to enclosure
24	Point	Existing	Mystery	Vegetation concealment/revealmen t	Path alignment to accent vegetation concealment/revealment
25	Point	Existing	Mystery	Vegetation concealment	Path alignment to accent vegetation concealment/revealment
26	Point	Existing	Mystery	Vegetation concealment	Path alignment to accent vegetation concealment/revealment
27	Point	Existing	Mystery	Vegetation concealment	Path alignment to accent vegetation concealment/revealment
28	Point	Existing	Body identification	Enclosure/exposure	Transition from exposure to enclosure
29	Point	Existing	Feeling of safety	Amenities	Restrooms/bench
30	Point	Opportunity	Involvement	Interaction	Historic Building

Table 7. 16: Cognitive Elements of Konza Prairie in ArcGIS

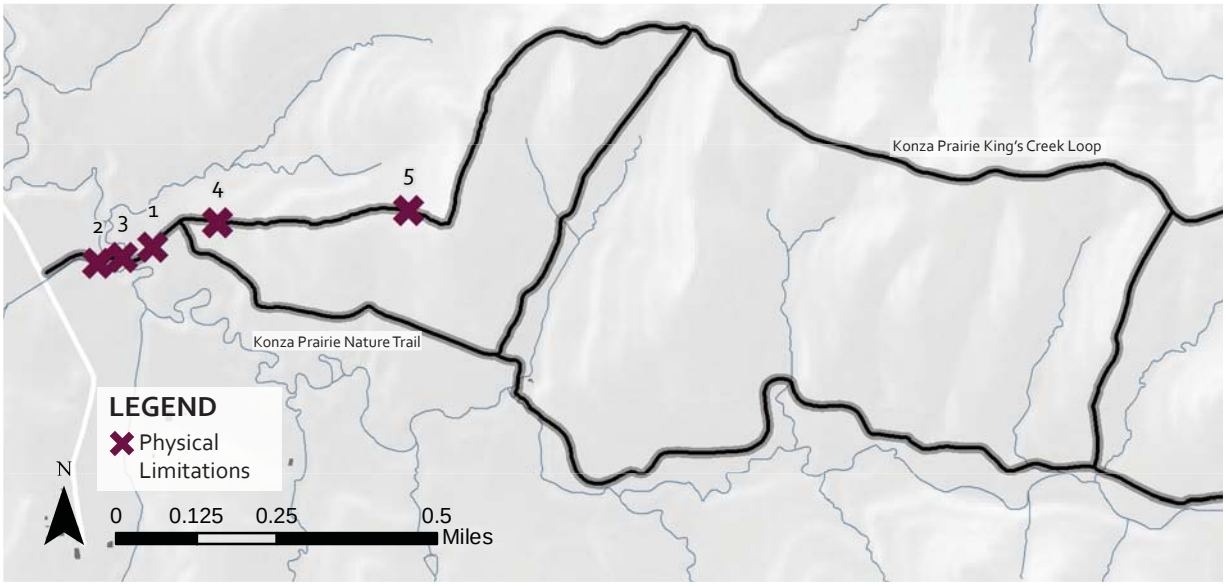

Figure 7. 30: Physical Elements of Konza Prairie

PHYSICAL EXPERIENCE					
ID	SHAPE	Type	Feature	Element	Name
1	Point	Limitation	Accessibility	Obstacle/Slope	Steep slope with limestone stairs
2	Point	Limitation	Accessibility	Obstacle/Trail width	Bridge
3	Point	Limitation	Accessibility	Obstacle/Trail width	Bridge
4	Point	Limitation	Accessibility	Slope	Steep Slope
5	Point	Limitation	Accessibility	Obstacle/Slope	Steep slope with limestone stairs

Table 7. 17: Physical Elements of Konza Prairie in ArcGIS

Table 7.19 shows the physical experience limitations that prevent the Konza Prairie from being used by those with a disability. **Tables 7.18-7.20** show the existing elements and opportunities in the Konza Prairie that contribute to the sensory and cognitive experience. The tables show that many sensory and cognitive elements exist along the trail, but may not be accessible due to physical experience limitations. The highlighted numbers in **Tables 7.18-7.20** show limitations addressed and existing elements heightened to enhance the experience of the Konza Prairie for those with disabilities and the general user.

COGNITIVE EXPERIENCE: KONZA			
FEATURE	ELEMENTS	EXISTING	OPPORTUNITY
Involvement	Education	**1**, 3, **18**	
	Interaction		**30**
	Surrounding environment		
Challenge	Variety in terrain		
	Obstacles		
	Path alignment		
Mystery	Topographic concealment/ revealment	4, 20, 21	
	Vegetation concealment/ revealment	14, 15, 17, 24, 25, 26, **27**	
Feeling of Safety	Amenities	**29**	
	Lighting		
	Separation from disruptions		
	Wayfinding	**2**, 6, 12, **16**, 19	
Body Identification	Enclosure/exposure	7, **8**, 22, 23, **28**	5

Table 7.18: Cognitive Opportunities and Existing Elements of the Konza Prairie

PHYSICAL EXPERIENCE: KONZA		
FEATURE	ELEMENTS	LIMITATION
Ability	Trail	**1**, **2**, **3**, **4**, 5
	Access points	
	Amenities	
Movement	Path alignment	

Table 7.19: Physical Limitations of the Konza Prairie

SENSORY EXPERIENCE: KONZA			
FEATURE	ELEMENTS	EXISTING	OPPORTUNITY
Vision	Clear wayfinding		
	Visual landmark	**1**, **2**, 13, 20, 24, 25, 28, **29**	6, **15**, 27
	Seasonal vegetation		
	Lighting		
	Trail edge condition		
	Scenic views	7, 8, 23, 31, 32	11, 12
Sound	Wildlife sounds	10	
	Vegetation sounds		
	Material sounds		
	Disturbing sounds		
	Water sounds	1, 2, 13, 20, 24, 25, **28**, **29**	**27**
Scent	Aromatic vegetation		
	Disturbing scents		
Touch	Vegetation		
	Path	**3**, **4**	
	Water	1, 2, 13, **20**, 24, 25, **28**, **29**	27
	Wildlife		
	Sun exposure		
	Amenities	9, 33, 34	
Taste	Vegetation		
Movement	Path alignment		

Table 7.20: Sensory Opportunities and Existing Elements of the Konza Prairie

Two areas of focus are proposed on the Konza Prairie. They are determined using the criteria previously described. The first area of focus (a) is due to the consideration of accessibility through barriers associated with physical experience. The second focus area (b) is defined because of the amount of sensory and cognitive elements clustered together. After determining the location for potential opportunities (**Figure 7.31**), additional analysis in ArcGIS was undertaken. The additional analysis includes all the categories of user experience and addresses both the trail and its surrounding environment. Study of the trail includes slope percentages, and for the surrounding environment, slope percentage and orientation aspect.

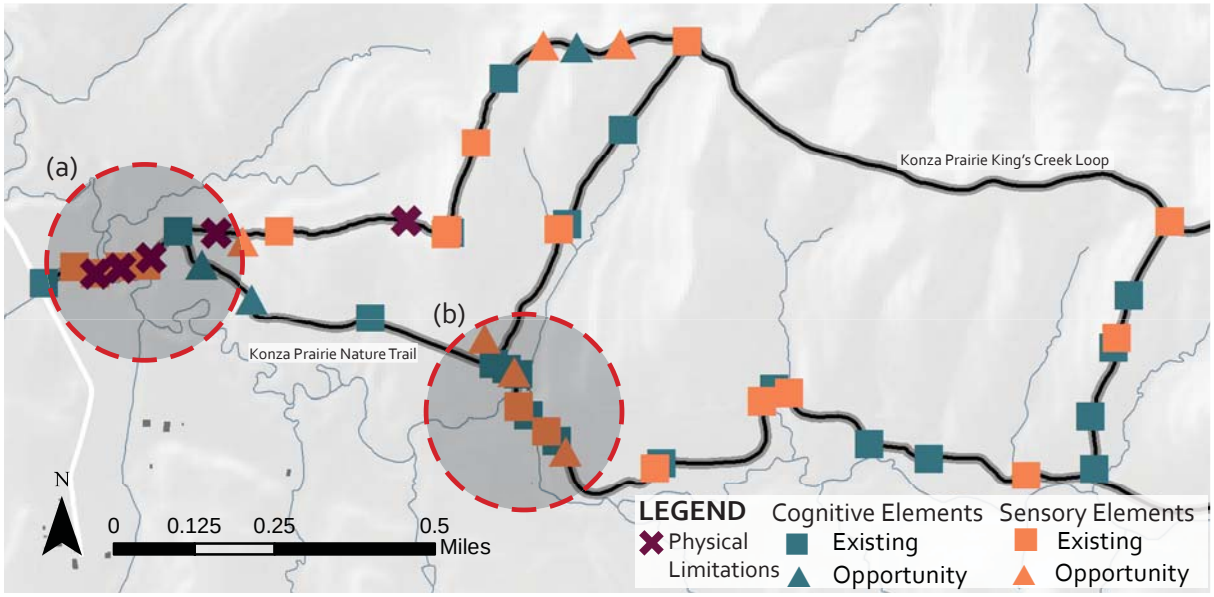

Figure 7.31: Areas of Focus for the Konza Prairie

The trail slope percentage map, **Figure 7.32,** shows that the trail has a wide variety of average slope percentages. A significant amount of the trail isn't accessible due to steep slopes.

Slope aspect, **Figure 7.33,** shows the direction that surrounding slopes face

The slope percentage map, **Figure 7.34,** represents the surrounding environments slope percentage. The surrounding slope has a significant effect on the rerouting of an accessible trail, **Figure 7.35**.

Three designs are developed that incorporate design strategies from the Natural Trail Design Guidelines. After determining the location for potential opportunities off of the new trail route(**Figure 7.35**), design are developed to enhance the experience for trail users with disabilities and the general user.

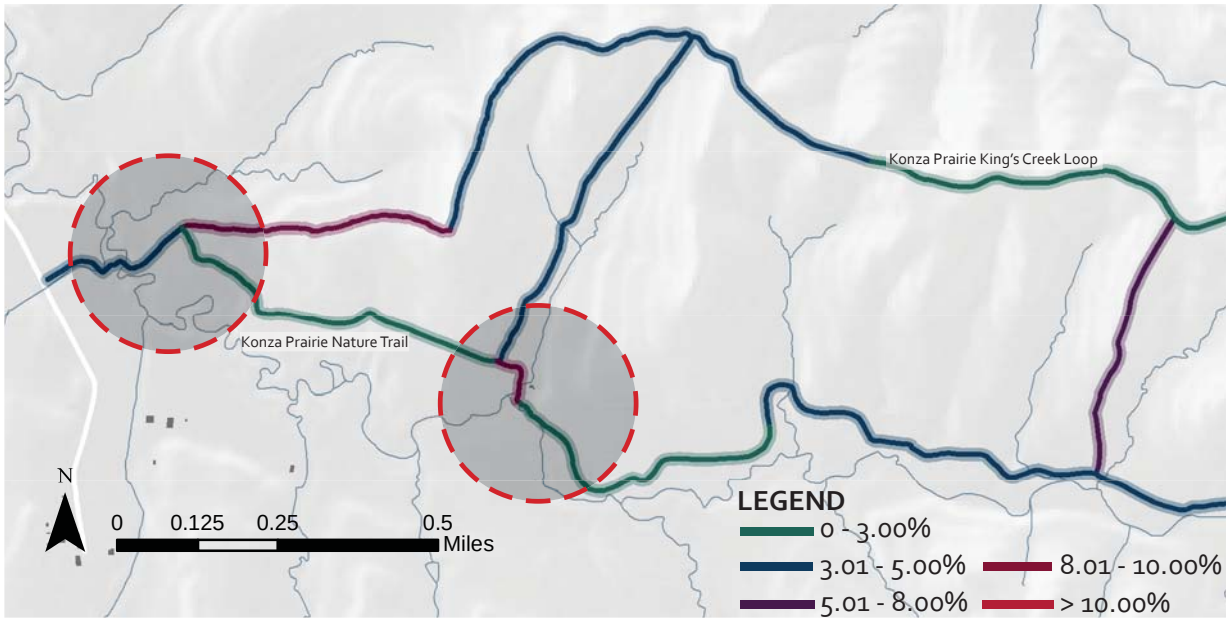

Figure 7.32: Trail Slope Percentage of the Konza Prairie

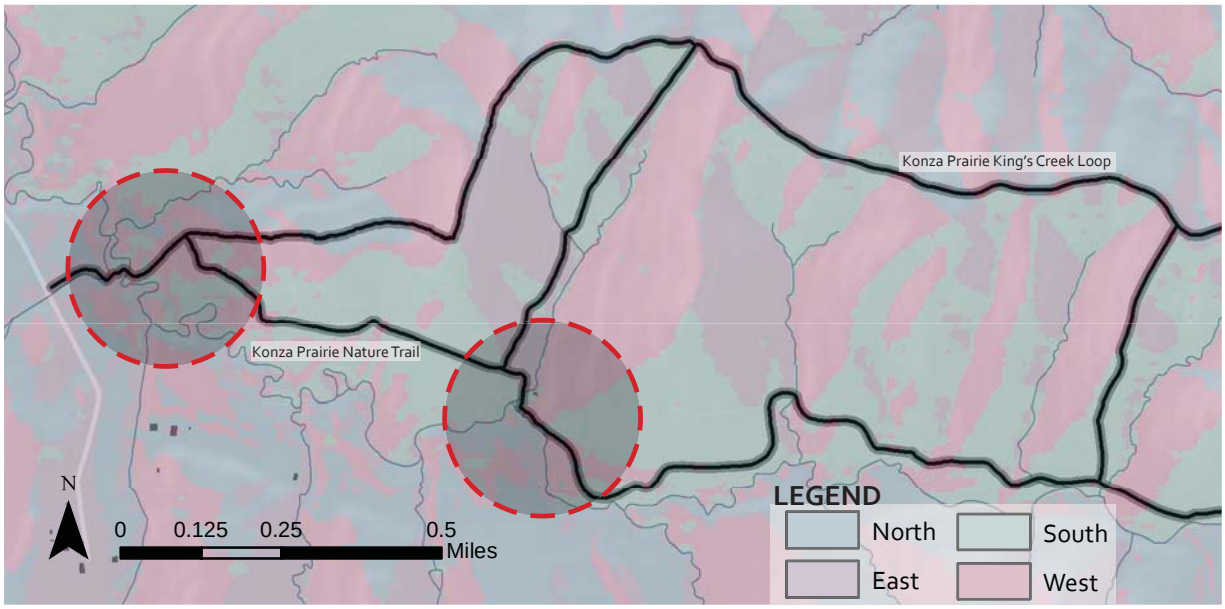

Figure 7.33: Slope Aspect of the Konza Prairie

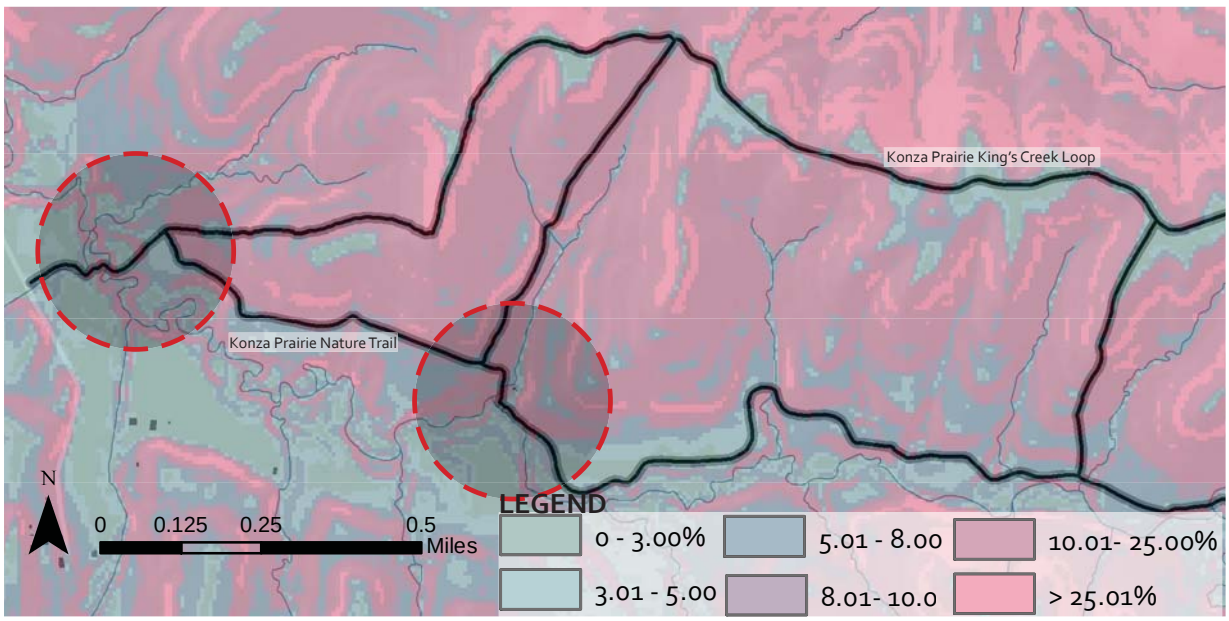

Figure 7.34: Surrounding Slope Percentage of the Konza Prairie

DESIGN 01: REROUTING KONZA TRAIL SEGMENTS

In response to the inaccessibility of portions of the existing Konza Prairie trail system, a new route is designed (**Figure 35**). The route follows topography to create a trail with a lower slope percentage to make travel easier for those with disabilities. Additionally, multiple trail loops are available to give people with a variety of abilities opportunities to choose from a variety of trail lengths. The new route gives trail users the ability to experience a wide diversity of sensory and cognitive experiential benefits, by traveling along water and through a variety of terrain and degrees of enclosure/exposure. The experiential elements addressed through the additional route can be seen in **Table 7.21-7.23**.

DESIGN STRATEGIES

- Route trail with variety of slopes and alignments
- Route trail through a variety of vegetation types, topography, Eco-transitions
- Route trail through a variety of environments and near water
- Route trail near visible natural systems
- Route trail through a variety of sun exposure conditions
- Route trail adjacent to water features
- Introduce ADA requirements for width, length, slope, and surface materials
- Introduce loops/route options for least challenge

PHYSICAL EXPERIENCE: KONZA		
FEATURE	ELEMENTS	1
Ability	Trail	●
	Access points	
	Amenities	
Movement	Path alignment	●

Table 7.21: Rerouting the Konza Physical Elements

Figure 7.35: Rerouting Portions of Konza Trails

SENSORY EXPERIENCE: KONZA		
FEATURE	ELEMENTS	1
Vision	Clear wayfinding	●
	Visual landmark	
	Seasonal vegetation	
	Lighting	
	Trail edge condition	
	Scenic views	
Sound	Wildlife sounds	
	Vegetation sounds	
	Material sounds	
	Disturbing sounds	
	Water sounds	●
Scent	Aromatic vegetation	
	Disturbing scents	
Touch	Vegetation	
	Path	●
	Water	
	Wildlife	
	Sun exposure	●
	Amenities	
Taste	Vegetation	
Movement	Path alignment	●

Table 7.22: Rerouting the Konza Sensory Elements

COGNITIVE EXPERIENCE: KONZA		
FEATURE	ELEMENTS	1
Involvement	Education	●
	Interaction	
	Surrounding environment	●
Challenge	Variety in terrain	●
	Obstacles	●
	Path alignment	●
Mystery	Topographic concealment/ revealment	●
	Vegetation concealment/ revealment	●
Feeling of Safety	Amenities	●
	Lighting	
	Separation from disruptions	●
	Wayfinding	
Body Identification	Enclosure/exposure	●

Table 7.23: Rerouting the Konza Cognitive Elements

DESIGN 02: ACCENTING LANDMARKS

The design, Accenting Landmarks, uses trail alignment to draw attention to a landmark existing on the Konza Prairie (**Figure 7.36**). The alignment of the trail guides users to appreciate the rock outcrops along a rolling hill. Trail alignment along with views of native landmarks addresses multiple sensory and cognitive elements, **Tables 7.25-7.26**. The trail also follows ADA requirements to provide physical experience elements, **Table 7.24**.

DESIGN STRATEGIES

- Route trail near visual landmark
- Create frames for views
- Route trail with a variety of slopes and alignments
- Introduce ADA requirements for width, length, slope, and surface materials
- Route trail through a variety of environments
- Route trail through vegetation with tactile qualities
- Route trail with alignment that strategically conceal/ reveal interesting features
- Route trail through a variety of vegetation types, topography, Eco-transitions
- Introduce loops/route options for least challenge

PHYSICAL EXPERIENCE: KONZA		
FEATURE	ELEMENTS	2
Ability	Trail	●
	Access points	
	Amenities	
Movement	Path alignment	●

Table 7.24: Accenting Landmarks Physical Elements

Figure 7.36: Accenting Landmarks

SENSORY EXPERIENCE: KONZA		
FEATURE	ELEMENTS	2
Vision	Clear wayfinding	
	Visual landmark	●
	Seasonal vegetation	
	Lighting	
	Trail edge condition	
	Scenic views	●
Sound	Wildlife sounds	
	Vegetation sounds	
	Material sounds	
	Disturbing sounds	
	Water sounds	
Scent	Aromatic vegetation	
	Disturbing scents	
Touch	Vegetation	
	Path	●
	Water	
	Wildlife	
	Sun exposure	●
	Amenities	
Taste	Vegetation	
Movement	Path alignment	●

Table 7.25: Accenting Landmarks Sensory Elements

COGNITIVE EXPERIENCE: KONZA		
FEATURE	ELEMENTS	2
Involvement	Education	
	Interaction	
	Surrounding environment	●
Challenge	Variety in terrain	
	Obstacles	
	Path alignment	●
Mystery	Topographic concealment/ revealment	
	Vegetation concealment/ revealment	●
Feeling of Safety	Amenities	
	Lighting	
	Separation from disruptions	
	Wayfinding	
Body Identification	Enclosure/exposure	●

Table 7.26: Accenting Landmarks Cognitive Elements

DESIGN 03: CULTURAL CONNECTION

Cultural Connection provides trail users with the ability to connect with a historic site along the Konza Prairie trail (**Figure 7.37**) . The design provides users with disabilities, along with general users, an opportunity to interact with the historical Hokanson Homestead by routing the trail adjacent to it. Along with routing, a change in trail surface material provides trail users with vision impairments a warning of an interactive element. This design provides multiple physical, sensory, and cognitive elements to the experience of the Konza Prairie, seen in **Tables 7.27-7.29**.

DESIGN STRATEGIES

- Introduce ADA requirements for width, length, slope, and surface materials
- Introduce loops/route options for least challenge
- Introduce explanatory signage
- Create touchable amenities
- Introduce a variety of trail surface materials
- Route trail near cultural landmark
- Amplify visual landmark

PHYSICAL EXPERIENCE: KONZA		
FEATURE	ELEMENTS	3
Ability	Trail	●
	Access points	
	Amenities	●
Movement	Path alignment	●

Table 7.27: Rerouting the Konza Physical Elements

Figure 7.37: Cultural Connection

SENSORY EXPERIENCE: KONZA		
FEATURE	ELEMENTS	3
Vision	Clear wayfinding	
	Visual landmark	●
	Seasonal vegetation	
	Lighting	
	Trail edge condition	●
	Scenic views	●
Sound	Wildlife sounds	
	Vegetation sounds	
	Material sounds	
	Disturbing sounds	
	Water sounds	
Scent	Aromatic vegetation	
	Disturbing scents	
Touch	Vegetation	
	Path	●
	Water	
	Wildlife	
	Sun exposure	●
	Amenities	●
Taste	Vegetation	
Movement	Path alignment	●

Table 7.28: Rerouting the Konza Sensory Elements

COGNITIVE EXPERIENCE: KONZA		
FEATURE	ELEMENTS	3
Involvement	Education	●
	Interaction	●
	Surrounding environment	●
Challenge	Variety in terrain	
	Obstacles	
	Path alignment	●
Mystery	Topographic concealment/ revealment	
	Vegetation concealment/ revealment	●
Feeling of Safety	Amenities	●
	Lighting	
	Separation from disruptions	
	Wayfinding	
Body Identification	Enclosure/exposure	

Table 7.29: Rerouting the Konza Cognitive Elements

CONCLUSION

Through the implementation of the framework, a rerouting design is created to expand the users able to experience the Kansas native landscape at the Konza Prairie. Additionally, two designs are created to enhance the sensory and cognitive experience of existing elements. **Table 7.30** and **Table 7.32,** shows the cognitive and sensory elements addressed through the two designs. Additionally, the designs address physical elements, seen in **Table 7.31** through rerouting considerations. As a result, by the implementation of the designs and rerouting, the Konza Prairie better addresses physical, sensory and cognitive experience, improving the trail for persons with disabilities, in addition to general users.

COGNITIVE EXPERIENCE: KONZA						
FEATURE	ELEMENTS	EXISTING	OPPORTUNITY	1	2	3
Involvement	Education	**1**, 3, **18**		●		●
	Interaction		**30**			●
	Surrounding environment			●	●	●
Challenge	Variety in terrain			●		
	Obstacles			●		
	Path alignment			●	●	●
Mystery	Topographic concealment/ revealment	4, 20, 21		●		
	Vegetation concealment/ revealment	14, 15, 17, 24, 25, 26, **27**		●	●	●
Feeling of Safety	Amenities	**29**		●		●
	Lighting					
	Separation from disruptions			●		
	Wayfinding	**2**, 6, 12, **16**, 19				
Body Identification	Enclosure/exposure	7, **8**, 22, 23, **28**	5	●	●	

Table 7.30: Konza Cognitive Elements

PHYSICAL EXPERIENCE: KONZA					
FEATURE	ELEMENTS	LIMITATION	1	2	3
Ability	Trail	1, 2, 3, 4, 5	●	●	●
	Access points				
	Amenities				●
Movement	Path alignment		●	●	●

Table 7.31: Konza Physical Elements

SENSORY EXPERIENCE: KONZA						
FEATURE	ELEMENTS	EXISTING	OPPORTUNITY	1	2	3
Vision	Clear wayfinding			●		
	Visual landmark	1, 2, 13, 20, 24, 25, 28, 29	6, 15, 27		●	●
	Seasonal vegetation					
	Lighting					
	Trail edge condition					●
	Scenic views	7, 8, 23, 31, 32	11, 12		●	●
Sound	Wildlife sounds	10				
	Vegetation sounds					
	Material sounds					
	Disturbing sounds					
	Water sounds	1, 2, 13, 20, 24, 25, 28, 29	27	●		
Scent	Aromatic vegetation					
	Disturbing scents					
Touch	Vegetation					
	Path	3, 4		●	●	●
	Water	1, 2, 13, 20, 24, 25, 28, 29	27			
	Wildlife					
	Sun exposure			●	●	●
	Amenities	9, 33, 34				●
Taste	Vegetation					
Movement	Path alignment			●	●	●

Table 7.32: Konza Sensory Elements

08 Conclusion

RESEARCH & FINDINGS

Research by others shows that a lower percentage of persons with disabilities participate in physical activity. A great way to give people opportunity to have a physically active lifestyle is through providing access to natural trails. Natural trails encourage health benefits through physical activity and also provide mental health benefits by connecting trail users to nature. However, natural trails may not be accessible to persons with disabilities, or do not promote a multi-sensory experience. This led to the research question: "How can trail planning and design in natural settings better provide for the physical, sensory, and cognitive experience of users, particularly those users with a disability?"

A review of the literature revealed interconnections between nature, and a broader definition of human experience (physical experience plus the sensory and cognitive aspects) that trail design guidelines typically do not address. This broader definition of experience is particularly relevant to trail users who have varying degrees of disability. In addition to the literature review, user profiles and trail precedents were studied, to further gain understanding of trail design and user groups.

Results from the literature research, trail precedent review, and user profile compilation, were synthesized into a framework for developing natural trail design guidelines. The framework applies experiential accessibility to natural trails by distinguishing features necessary to provide physical, sensory, and cognitive experience to trail users. The user profiles added considerations regarding user needs, specifically persons with mobility, vision or hearing impairments. The precedent studies added strategies of trail designs recognized as being successful.

The spatial analysis portion of the framework results in identifying existing experiential elements and locates opportunities for enhancing the trail user experience to be more multi-sensory. The design strategy portion of the Natural Trail Design Guidelines seeks to provide specific strategies to enhance the trail experience

for persons with disabilities and also for the general user. Designing a trail to be entirely physically accessibility by all users may be impossible; however, designing portions of the trail to be more experientially rich in the sensory and cognitive dimensions will be more fulfilling for all users, particularly those with disabilities.

LIMITATIONS

Although much time was devoted to understanding a broader definition of experience and the implications to different trail user types, the development of trail design guidelines, and planned application to a specific site, no actual implementation and assessment was conducted. This project did, however, prepare a foundation for ongoing work.

One of the primary limitations of the study regards a partial understanding of persons with disabilities and the inability to specifically address vision, mobility, and hearing impairments. To accommodate the time constraints of this project, research only permitted a general knowledge of each disability type. Time also prevented the ability to conduct interviews of persons with impairments. With interviews, a further understanding of the opportunities and limitations that persons with disabilities face when using trails could have been gleaned. Although all research aspects were not completed, a general understanding of the different impairments was gained to enable the project to move forward.

Additionally, lack of time prevented application of the design guidelines all four types of trails. Instead they were applied to just the Urban Park trail type. Although the application was just completed for one trail, the framework is considered fairly complete.

FUTURE RESEARCH

Recommendations for future research include the testing of the developed guidelines in different cities, and further research on specific disabilities. The testing of guidelines in different locations would advance the guidelines further to verify the general applicability. This would advance the understanding of different locational factors, challenges, and opportunities to enhance the trail experience in natural settings for persons with disabilities.

Another recommendation is furthering research on a specific disability. This could be done through interviews of people with an impairment. Interviews would help further understand different degrees of needs and wants from people with a disability. The more understanding and empathy a designer can have towards someone, the better they can design for them. As a result, design strategies could be further advanced to accommodate a wider range of abilities.

CONCLUSION

The study concluded with design guidelines intended to enhance the natural trail experience of persons with disabilities, and also for the general public. The guidelines add the sensory and cognitive dimensions of user experience to trail design guidelines that previously only addressed the physical aspects of trail design. Persons with disabilities are often unable to access the entire trail, but with the implementation of the natural trail guidelines, the portions they do experience should be more enriching.

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Citations

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