USER PREFERENCE FOR TRAIL SURFACE MATERIAL

A Thesis Presented to the Faculty of Graduate Studies of the University of Manitoba

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In partial fulfillment of requirements for the degree of Masters of Landscape Architecture

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MASTER OF LANDSCAPE ARCHITECTURE

ABSTRACT

Recreational trails are often not usable by all people regardless of age, knowledge or ability. Literature is currently available regarding the functional needs of many trail users, as well as the design considerations, however, user preference is often lacking. This thesis strives to fill gaps in knowledge with regards to the preference for trail surface materials of certain groups of trail users.

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1.0 INTRODUCTION

> *"Trails provide all the myriad personal and social benefits generated by participation in outdoor recreation, such as improved health and fitness, relaxation, challenge and adventure, family togetherness, and an increased awareness of nature".*
>
> *Moore & Ross, 1998*

1.1 Background

Historically trails have been used by humans primarily as a means of transportation from point A to point B. Moore and Ross (1998) relate that many trails were used for hunting and traveling by Native Americans and later by explorers and settlers. Later still, many of these trails evolved over time to become roads and freeways. Correspondently, many foot and bridle paths from the 1800's became recreational trails (Moore & Ross, 1998).

By the 1960's, the North American public began to recognize the significance of recreational trails. In 1966, for example, a report entitled "Trails for America" was released by the U.S. Government Department of Interior which found that "walking, hiking, and bicycling were simple pleasures within the economic reach of virtually all citizens". The report recommended that ideally all metropolitan areas should develop trail systems (U.S Government, 1966 in Moore & Ross 1998). During this same period, nature based activities and tourism were also gaining in popularity.

Schaller (n.d.[1]) notes that by the 1980's alternative forms of tourism began attracting attention. He describes tourism locations for the masses giving way to places geared towards smaller groups of people in a more naturalistic[2] setting. These new tourism experiences were grouped under various categories such as nature tourism, soft tourism, green tourism and ecotourism[3]. The goal of such tourism was to promote and protect the natural environment.

Today, many natural sites and parks, established and/or administered by government or public agencies, are not equipped with trails systems that are usable by all of the public, regardless of age, disability or social-economic status. Increasingly, this issue is drawing more attention from recreational and disability organizations alike. As Peat (1997) notes: "Barriers to movement and communication in the physical environment prevent people with disabilities from enjoying the same rights, privileges and opportunities as other members of society".

The primary focus of this thesis is to examine recreational trail surfaces as they relate to the functional requirements and preferences of various trail users. A key component of this study is accessibility. With regards to accessibility of trails, four questions are relevant:

[1] No date is available for the source.
[2] Naturalistic: "Of natural history" (Webster's New World Dictionary, 1975).
[3] Ecotourism became the prominent term (Schaller, n.d.); The Ecotourism Society defines ecotourism as: "Purposeful travel to natural areas to understand the culture and natural history of the environment, taking care not to alter the integrity of the ecosystem, while producing economic opportunities that make the conservation of natural resources beneficial to local people" (McCormick, 1994).

i) Why are some recreational trails inaccessible?

For people with disabilities, several recreational trail characteristics play a key role in determining if an individual can negotiate a trail. These physical characteristics include the slope, the cross slope, the width of the trail, the surface material and the types of obstacles present on the trail (Beneficial Designs, n.d.). These trail characteristics, however, are not always the biggest deterrent to trail usage. People with disabilities are often deterred from using a trail not because of particular physical trail characteristics in and of themselves, but rather simply because of lack of information regarding the trail's physical attributes such as slope, surface material and length. "The main obstacle people face in outdoor environments is not lack of access – but rather lack of information. If properly informed, everyone can enjoy the great outdoors" (*Off the Beaten Track*, 1997[4]). Making such information regarding trails readily available is a simple way of assisting individuals to make informed decisions regarding their level of ability in comparison to the level of challenge presented by the trail's characteristics.

ii) Why should recreational trails be accessible?

People with disabilities deserve the same rights and opportunities as the rest of society. Indeed, Section 15 of the Canadian Charter of Rights and Freedoms grants people with disabilities the right to equality under the Constitution. Unfortunately, public places such as National Parks are often physically inaccessible to people with various disabilities. "Because people with disabilities are often denied their basic human rights, in 1993 the United Nations General Assembly adopted a set of standard

[4] Author unknown

rules to ensure that disabled people were accorded the same rights, freedoms and obligations as other members of society" (Malcolm, 1997). Currently, these rules are merely suggestions, and are not compulsory in Canada.

While some may think that people with disabilities participate less in recreational activities than people without disabilities due to physical constraints, the National Survey on Recreation and the Environment, conducted in 1995 by the US Forest Service, indicates that although this is true overall, it is not necessarily true for all activities. The survey reached 17,216 Americans over the age of fifteen, 1200 of who had acknowledged that they had a disability. The majority of the people with disabilities reported mobility problems as the category most descriptive of their disability. The second largest category of disability was illnesses/diseases such as cancer and heart problems.

The results of the above study demonstrated that people with disabilities participated in more recreation than people without in both the oldest and youngest age category. The results for the middle age categories showed findings to the contrary. Overall, the survey found that people with disabilities participated in walking and nature related activities (i.e. bird watching) more per year than people without disabilities. These finding were thought to be linked to the fact that of the people surveyed, people with disabilities were found to have fewer time constraints. These findings support the importance of designing universally accessible trails.

iii) What is universal design?

A recreational trail can become accessible to people with disabilities through universal design. Universal design strives to enhance the environment for all users regardless of ability, age or knowledge (Mace 1995, in Ringaert 1997). A design that is universally accessible should benefit not only people with a disability but also people of various ages, people with children, and the general public as a whole.

iv) Why is universal design important?

Statistics Canada (1991) reported that 4.2 million Canadians reported having disabilities in 1991. With the estimated increase in the population of seniors, it is expected that the number of people with disabilities will also increase (Ringaert, 1997). Universal design does not, however, benefit only people with disabilities. Universal design strives to improve environments for the benefit of everyone. For obvious reasons the seniors, parents pushing strollers, people with temporary or permanent mobility impairments, people who are obese, people in with various levels of fitness, and people with various mental ability levels are particular beneficiaries of universal design.

Beneficial Designs Inc.[5] (2001) states that "decreasing mortality rates for a variety of disabling illnesses and injuries are resulting in an increase in the length of time that people live with functional limitations (i.e., people are living longer with less

[5] Beneficial Designs Inc., which was founded by Peter Axelson, strives for universal accessibility through research, design and education.

function)". This quote emphasizes the importance of recognizing the broad audience of trail users and designing to offer people more independence: "We must remember that we are all only temporarily able-bodied. Disability after all is a state most of us pass through sometimes" (Caplan, 1992 in Ringaert, 1997).

1.2 The Goal of this Thesis

The goal of this thesis is to determine user preferences for trail surfaces materials. Although universally accessible trail surfaces are a major focus of this thesis, the sole focus will not be on trail users with disabilities. Universal design is meant to improve the environment for all people. This thesis will examine trail surface materials in the context of various non-motorized trail users[6]. These user groups are:

1) hikers/walkers,
2) joggers/runners,
3) equestrians,
4) cyclists,
5) people who use wheelchairs/scooters,
6) people with an ambulatory disability,
7) people with a visual impairment,
8) parents with young children, and
9) seniors (60+).

The trail users who were selected for study in this thesis represent people with mobility impairments or concerns as well as many typical non-motorized trail users.

[6] The exception here is people who use power wheelchairs or scooters.

For all of these users the following information will be gathered: 1) trail surface design considerations, and 2) user preferences with regards to trail surfaces.

1.3 Objectives

The objectives of this thesis are to:

1) Review existing codes and guidelines regarding trail surfaces (*see Chapter 3.0*).
2) Research existing literature regarding the trail surface design considerations and preferences of nine groups of trail users, and to identify where knowledge gaps exist (*see Chapter 3.0*). The nine trail users are as listed above.
3) Examine literature pertaining to six trail surface materials and how they relate to trail use (*see Chapter 3.0*). The six trail surfaces are commonly used for recreational trails in Manitoba:
    - asphalt
    - wooden boardwalk
    - compacted crushed stones
    - dirt
    - grass
    - woodchips
4) Survey trail users in an attempt to fill knowledge gaps (*see Chapter 4.0*).

1.4 Relevance of Thesis Topic to Landscape Architecture

Trails are commonly associated with parks – provincial, federal and otherwise. The importance of the findings from this thesis, nevertheless, goes beyond the design of park space. For landscape architects, every space that is designed to include human movement must consider the impacts of the surface and what users prefer.

2.0 THESIS METHODOLOGY

> *"In order to meet the needs of a broad group of sidewalk and trail users, designers must have a true understanding of the wide range of abilities that will occur within the population and how design parameters can influence those abilities".*
>
> *Beneficial Designs Inc, 2001*

2.1 Research Methodology

The research regarding trail surfaces was gathered using two research methods to obtain results: 1) a literature review, and 2) a survey. The flow chart below outlines the procedural steps used to acquire the necessary information as well as the approximate chronological order in which the research occurred. The actual data gathering was a continual process. Therefore, there were overlaps within the proposed research steps as well as in their chronological occurrence. The flow chart was not restrictive, but served rather as a guideline for the assemblage and proposed usage of the accumulated information.

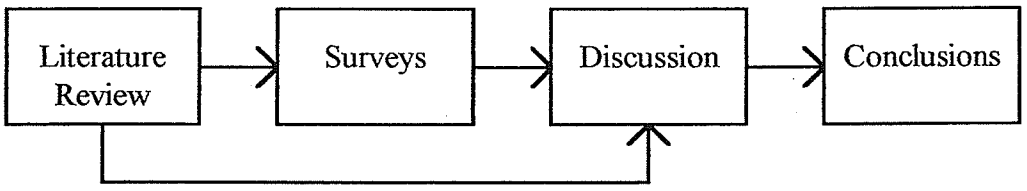

Figure 1. Flow Chart of Research Method

2.2 Literature Review

The literature review was the first step in the research process and provided a basis for subsequent research. This stage of the research was used to identify where the knowledge gaps existed as well to develop an understanding of issues pertaining to trail surfaces, in particular universal accessibility and environmental impact. The

literature review continued until the information gathered from the various sources became repetitive and new information was, more often than not, unavailable or scarce. The data was collected from journals, books, newspapers, pamphlets, and websites. Keywords used in the searches included, but were not restricted to, combinations of the following: access, accessibility, aggregate, barrier-free, blind, boardwalks, children, disability, dirt, ecotourism, equestrians, forests, grasslands, handicap, hikers, horses, impacts, jogging, landscapes, nature, paths, prairie, recreation, running, trails, tourism, seniors, surface materials, users, universal accessibility, universal design, walkers, wilderness, wheelchairs, woodchips.

Various organizations were contacted by e-mail or phone to request information. Organizations that were contacted often dealt with issues of biking, forestry, trails, hiking, people with disabilities, wilderness, etc. The most relevant contacts included the both Parks Canada and the Conservation and Environment libraries, US Federal Highway Administration (FHWA), Colorado Easter Seals, and Partners for Access into the Woods. Other organizations were contacted but frequently were either unable or unwilling to provide information.

The literature that was reviewed for this thesis pertained to trail surface materials and falls into three broad categories:

1) Building codes and guidelines *(see Chapter 3.0)*
2) User trail surface design considerations and preferences (*see Chapter 4.0*)
3) Six trail surfaces (*see Chapter 5.0*)

Chapter 3.0 reviews what various organizations feel are the appropriate needs of trail

users with regards to trails surfaces, Chapter 4.0 considers the actual needs and preferences of trail users and Chapter 5.0 examines characteristics of various surfaces. The literature review will outline the type of information that is available and identify perceived gaps in knowledge. The literature review also serves to acquaint the reader with key issues pertaining to the design of accessible trail surfaces.

2.3 Survey

The purpose of the survey was to determine the preferences of trail users in regard to various trail surface materials. The interview questions were formulated based on the knowledge gaps identified in the literature review which pertained to the user preference for trail surface materials (*see Chapter 4.0*). The survey was administered both in person and by means of mail-in surveys. Participants were recruited from the following organizations, all within Winnipeg Manitoba:

- Canadian National Institute for the Blind
- Canadian Paraplegic Association
- Fort Whyte Centre
- Inter-Organizational Access Committee
- Manitoba Runners Association
- Manitoba Naturalist Society
- Manitoba Cycling Association
- Manitoba Horse Council
- Manitoba League of Persons with Disabilities Inc.

Each organization was contacted with regard to potential participants and an appropriate time and place to meet to distribute the surveys was agreed.

The survey questionnaires were composed of nineteen questions each (*see Appendix A*). The questions consisted of a mixture of multiple choice and opened ended questions. The planned approach was to target one hundred and eighty people in total; twenty people from each of the user groups[7] discussed in this thesis.

1) hikers/walkers,
2) joggers /runners,
3) equestrians,
4) cyclists,
5) people who use wheelchairs/scooters,
6) people who have an ambulatory disability,
7) people with a visual impairment,
8) parents of young children, and
9) seniors.

Obtaining the target of twenty people from each user groups was often very difficult for reasons that will be discussed in Chapter 8.0. In the some cases, a low response rate affected the reliability of the results[8].

[7] In the article *Recreation for Deaf People* (1978), Pemeroy & Zaccagnini wrote that: "When a deaf individual visits the park system, he/she is physically capable of maneuvering himself – his only handicap is communication with a hearing person". Recognizing this, people who are deaf will not be addressed as a special user group within this thesis, nor will people with mental disabilities.
[8] Primarily respondents who have ambulatory disabilities, and to some degree people who use wheelchairs/scooters.

Survey participants were given one of two surveys which were essentially the same, except one of them was targeted particularly towards parents/guardians of young children and thus was identified as such. For participants with visual impairments who were unable to read the survey the survey was read or e-mailed[9] to them and their responses were noted accurately.

As a requirement of the University of Manitoba, an "Ethics Protocol Submission Form" detailing the scope of the research and the potential impact to the respondents had to be completed and returned for approval. Once approval was obtained, participants were recruited. As part of the university's requirements, a letter of consent had to be signed prior to the completion of survey (*see Appendix A*). The research survey did not put any participants at risk nor attempt to deceive any participants. Participants were given no compensation or payment of any kind for completing the survey.

The research method was qualitative because of the need to document personal perspective, preference, and experience. The information gathered had to be interpreted and synthesized in order to arrive at conclusions regarding user preference for trail surfaces.

[9] People with a visual impairment often had a computer program which would read text messages to them and help them to respond.

3.0 LITERATURE REVIEW

> *"It is not possible to design any facility or area to cater to all people. As with the rest of the population, disabled people want to be independent and object to segregated facilities. Recreation should be an enriching experience for all people. It must therefore be physically accessible to the widest possible range of people, and provide stimulating sensory experiences and opportunities for maximum participation and enjoyment".*
>
> *Kidd, 1982*

Literature pertaining to trails and trail usage is available from various fields including, among others, ecology, landscape architecture, physical education, psychology and medicine. The different sources of information offer different perspectives on trail design. The literature review conducted for this thesis accumulated information that can be broken subdivided into three categories, each of which will be discussed in this chapter:

1) building codes and design guidelines,
2) trail users, and
3) trail surface materials.

3.1: Building Codes and Design Guidelines

i) Building Codes

The National Building Code of Canada (Canadian Commission on Building and Fire Codes, 1995) states that "exterior walks" that are "barrier-free" should be "slip-resistant", "continuous", and "even". There is no further discussion regarding

accessible surfaces in this code. The Manitoba Building Code (1998) makes no mention of exterior walks, paths or trails.

ii) Design Guidelines

In contrast to codes, guidelines are typically used to govern minimum design standards for buildings. Guidelines can be, and often are, more geared towards trail design. While not mandatory, guidelines generally go into more detail regarding the accessibility of trail surfaces and the appropriateness of the materials in the context of environments that are geared to nature. Such literature tends to go into more descriptive details in addition to stating the proposed minimum standards. Sometimes "ideal" guidelines are even proposed. The following are some examples of existing guidelines pertaining to trails.

a) In their publication Guidelines for Barrier-Free Access, Manitoba Provincial Parks discusses trail surfaces in the context of trail users with disabilities. The document notes that accessible trail surfaces should be "...hard non-slip, all weather surfaces such as asphalt, concrete, unit pavers, hard packed fines, decking". These surfaces should be properly maintained to avoid cracks, uneven edges or other "irregularities". This source provides design details depicting change of surface materials, slopes, widths and ramps (*see Appendix B*).

b) Mickelson's Parkland Access for the Disabled (1985) is also a source dedicated to the design of natural environments for people with disabilities. With regards to trail surfaces, Mickelson states that trail surfaces must be "hard/hard packed".

Mickelson expands on this by recommending some surfaces to use, as well as some to avoid. Rock dust, road mulch and boardwalks are recommended surfaces. Pavement was discouraged as he notes that it is costly and not aesthetically appropriate. Similarly, he suggests avoiding bark mulch, sand, sawdust, gravel, soft or loose soil, stepping-stones and rocks. As a source that recognizes the character and challenges presented by "parkland" environments, Mickelson's work is a valuable contribution to literature on universal accessibility and design. Indeed, Parkland Access for the Disabled offers suggested materials to use for accessible trail design instead of offering the sort of blunt statements regarding trail characteristics that are typical of much of the literature on trail design.

c) Another one of the better sources for information on universal accessibility and trail design is the U.S. Department of the Interior – Heritage Conservation and Recreation Service. Their publication, A Guideline to Designing Accessible Outdoor Recreation Facilities, recommends a system of trail classification. This resource notes surfaces that are most appropriate for various levels of accessibility. The suggested surfaces, in decreasing order of accessibility, are as follows: 1) concrete and asphalt, 2) wooden boardwalks, 3) solidly packed fine crushed rock, 4) well compacted pea gravel, 5) bound woodchips, 6) coarse gravel, 7) rock, 8) unbound woodchips, and 9) sand. Aggregates ranging in size from coarse gravel to sand were not recommended for accessible paths. The detailed information presented in this source provides readers with practical information for the selection of trail surface materials.

d) The fourth chapter of Universal Access to Outdoor Recreation: A Design Guide (PLAE Inc., 1993) lists guidelines based on the Federal Americans with Disabilities Act Accessibility Guidelines (ADAAG) and other research pertaining to accessible outdoor environments. In regards to "outdoor recreation trails" PLAE Inc. states that their proposed guidelines are the same as ADAAG's: "stable", "firm" and "slip-resistant". PLAE Inc. lists materials which they believe meet the above guidelines. These materials are: "concrete, asphalt, pavers set on concrete, well maintained compacted crushed stone, and wood decking".[10] PLAE Inc. does, however, explain that other materials may also meet their criteria for accessibility and that the guidelines may vary according to regional practice.

In addition to providing positive alternatives for trail surfaces, PLAE Inc. also describes surfaces that do not work well as accessible trail surfaces. They note that "soft, loose surfaces", "wet clay" and "irregular surfaces such as cobblestones" can create tripping/slipping hazards for people who use mobility aids and can be problematic for people who use wheelchairs. PLAE Inc. provides a definition for slip resistance as well as a description detailing how slip resistance can be measured *(see Appendix B)*. This source offers useful information and rational pertaining to the universal design of trail surfaces.

[10] PLAE Inc. note that wood decking may be not be "slip-resistant" when wet, although it can be modified to provide better footing.

e) The Canadian Heritage Branch of Parks Canada is another prospective source for information regarding standards for trail surfaces. Their publication Design Guidelines for Accessible Outdoor Recreation Facilities: Access Series (1995) quotes the Canadian Standards Association's (1990) standard: "ground surfaces shall be firm, stable and slip-resistant", and expands on this by providing definitions for "firm", "stable" and "slip-resistant". Following the definitions are descriptions of ten different materials in decreasing order of accessibility. Each description is accompanied by an unlabeled cross-sectional diagram through the path as well as a verbal description of special considerations associated with the type of material used *(see Appendix B).* The publication Design Guidelines for Accessible Outdoor Recreation Facilities: Access Series is among the most useful sources available regarding specific trail surface materials and accessibility.

f) During the course of this thesis, an the Access Board (an American federal agency, has been developing guidelines for the recreational facilities to supplement the Americans with Disabilities Act Accessibility Guidelines (ADAAG). ADAAG currently suggests technical requirements for accessibility to buildings and facilities, but does not go into detail about exterior recreational environments. Although the recreational facilities guidelines were not available at the time of publication for this thesis, it would likely provide useful information once complete.

iv) Findings: Building Codes and Guidelines

From the review of codes and guidelines, it is clear that guidelines are far more useful than codes relative to the design of trails and landscapes in general. Guidelines, however, can and do vary greatly in terms of both their suggested materials and widths. It is therefore both beneficial and necessary to examine several sources in order to achieve consistency of information.

Existing codes tend to be quite broad and inadequate with regard to landscapes. Indeed, anyone who has had to use crutches for even a few days will recognize that existing codes and environments are often imperfect and thus accessibility can be extremely difficult. The National Building Code of Canada (Canadian Commission on Building and Fire Codes, 1995), specified only that accessible exterior surfaces should be "firm", continuous", "slip resistant" and "even". These terms are not associated with specific surfacing materials. Codes need to better discuss what surfaces can be accessible in the outdoor environments and ought to be enforced.

Guidelines for trail design also often state requirements for trail surface materials, such as slip resistant, stable, firm, smooth, etc. With the exception of a few good sources, these attributes can be insufficient, as there is often no discussion of what these surfaces might. In particular, it would be useful to discuss trail guidelines in various "natural" settings.

User preferences are not often discussed in trail guidelines. The few sources that do actually address this issue tend to most frequently focus on hikers, cyclists, and occasionally equestrians.

3.2 Trail Users

The following user profiles describe general functional characteristics of various non-motorized trail users. An outline of the subsequent design considerations will follow each description. As previously mentioned in the literature review, information regarding the preferences of certain user groups is often lacking. In an attempt to fill these gaps of knowledge, a survey was conducted (*see Chapter 6.0 for survey results*).

i) Hikers/Walkers

a) Functional Description

Walkers and hikers tend to travel at relatively slow speeds, generally ranging from five to eleven kilometers an hour (Ryan, 1993).

b) Trail Surface Design Considerations

The specific design requirements needed for these users are less then the needs of other user groups (Ryan, 1993). Ryan (1993) notes that users included within the category of pedestrians (including walkers and hikers) tend to prefer softer surface materials such as crushed aggregate, woodchips or a dirt path. A study conducted by Westphal and Lieber (1986) that analyzed various trail attributes as they relate to user satisfaction, echoes Ryan's findings. Wesphal and Lieber

concluded that for the most part, the preferred trail surface material for hikers was dirt[11]. Ryan suggests that the preference for softer material is due to the desire for protection against "knee, shin and foot injuries".

ii) Joggers/Runners

a) Functional Description

Encarta World Dictionary (2002) describes jogging as: "running as exercise: a fitness or recreational activity that involves running at a moderate pace, often over long distances".

b) Trail Surface Design Considerations

Ideally trail surfaces for joggers should be cushioned in some fashion. Westphal and Lieber (1986) found that joggers generally favored trails made of woodchips on a relatively flat terrain. A Step Ahead Foot and Ankle Centers (2002) caution that grass surfaces can have small holes, which can cause tripping and falling and that asphalt can be jarring. They recommend that joggers may find suitable dirt paths or cushioned synthetic track surfaces at schools or parks.

iii) Equestrians

a) Functional Description

"Next to walking, horseback riding is one of the oldest and most popular forms of transportation" (Alberta Recreation & Parks, 1986). Kelley (1998) in his presentation for the National Symposium on Horse Trails in Forest Ecosystems

[11] No mention was made if the preference was for loose dirt, compacted dirt, stabilized dirt, or so forth.

states that horses [before their domestication] were originally plains animals. He notes that their primary concern was self-preservation and to escape predators. Sight, smell and instincts could trigger a "fight or flight" response. Horses have a 340° field of vision. Their eyes can move independently of one another and they can use binocular or monocular vision. The assumption is, that horses have poor depth perception and no color vision. In spite of horses' excellent vision, they have a fear of small, tight places.

Kelley describes that horses can be quite fragile. Horses are susceptible to injuries that are similar to those of human athletes. Popped tendons, torn ligaments, broken bones or twisted joints are common injuries. He notes that such injuries can lead to associations of fear in a horse's memory. Thus potential injuries play an important role in determining appropriate trail surfaces.

b) Trail Surface Design Considerations

As previously mentioned, horses have a "fight or flight" response to perceived danger. Unexpected or unfamiliar movement can trigger these responses. Thus multiuse trails can be of concern as cyclists or others may startle horses (Kelley, 1998). Correspondingly, since horses fear small, narrow, dark places, single-track trails though forested environments may be less than ideal places for them (Kelley, 1998).

As horses are prone to injury, Ryan (1993) suggests that equestrians should avoid hard surfaces such as asphalt. Instead, Ryan proposes riding on granular stone

and dirt surfaces. Ryan also notes that if a multiuse trail is designed with a hard surface, the design should also incorporate a 1.5 meter trail of a softer material if it will be used by horseback riders. When possible, however, equestrians prefer their own trail. Overhead clearance should be a minimum of three meters with horizontal clearance of at least a meter and a half (Ryan 1993). Regardless of the trail surface, however, Ryan (1993) recognizes the importance of proper underlying material. He states: "...make sure the subbase and subgrade of your trail are solid and properly prepared. Horses are unlikely to damage a trail surface unless the subgrade is poorly prepared, since the surface is merely a reflection of what lies underneath".

iv) Cyclists

a) Functional Description

Sagazio (1995) states that there are three basic types of bikes, and that other bikes are combinations of the characteristics of the three. The basic bikes described by Sagazio are: 1) touring bikes, 2) racing bikes, and 3) mountain bikes. The touring bike is designed for a comfortable ride and not so much for abrupt moves. In contrast, the racing bike, with its low handlebars for increased aerodynamic quality, is geared towards excitement and speed. The mountain bike is more rugged than touring and racing bikes. It has wide, soft tires that are designed to enhance traction and provides cushioning for maneuverability in backcountry environments. The mountain bike is designed to absorb impact and to ride up steep, rocky trails and uneven terrain but can still be ridden on a pavement

(Sagazio, 1995). Mountain bikes can be ridden in the snow and tires can be modified to adapt to icy conditions (Crowther, 1996).

Cessford (1995) surveyed numerous mountain bikers in order to determine their preferences regarding setting and experience. In terms of trail location, the general preference was for forested environments with a dislike for farmland environments. Cessford noted that beginner and casual mountain bikers were most interested in riding for exercise whereas more experienced riders rode for excitement and challenge. More experienced mountain bikers consequently preferred a rougher, narrower trail with more topological changes. In contrast, less experienced mountain bikers favored wider, sealed surfaces and were more tolerant of gravel roads. A survey conducted by Westphal and Lieber (1986) also found that cyclists were partial to paved trails. Their survey made no mention of the skill level of the cyclist or type of bike used.

b) Trail Surface Design Considerations

The trail preferences of a cyclist vary with their ability (Ryan 1993; Cessford, 1995; Westphal and Lieber, 1986). A survey conducted by Cessford (1995) notes that when mountain bikers are presented with trail options, most will choose a broad trail (perhaps formerly a road) rather than a narrow, rougher trail, generally used by hikers. The cyclists who do choose the narrower, more natural trails, tend to be more skilled and dedicate (Cessford, 1995 in Cessford, 1995). Kelley (1998) had similar findings. He states that experienced mountain bikers prefer narrow, winding trails with topographical changes and obstacles as opposed to

smooth, wide, open trails. Loose stones, however, can be problematic as they can decrease traction and may even cause the rider to loose control (Cowther, 1996).

McCoy (1992) presents a different perspective on the discussion of trail characteristics. He notes: "Clear, smooth trails...allow bicyclists to confidently increase their speed and, in some instances, this can be a problem. Leaving slightly rougher, natural surfaces may encourage bicyclists to ride more slowly. Protruding rocks, roots bumps, downed trees, and gravel can work to slow bicyclists and other users in appropriate settings". McCoy also recognizes that rougher trail surfaces may pose difficulty when mountain bikers want to brake quickly. Earth trails with a high clay content are also problematic. Very fine clay creates a slippery surface reducing traction. (Crowther, 1993) These surfaces are not ideal for cyclists.

Cessford (1995) describes surfaces that are difficult if not impossible for mountain bikers: "Regulations aside, there are still some places mountain bikes simply can't go. Steep boulder-strewn mountain trails are still the domain of the horse and hiker. Deep sand is nearly impossible to negotiate on a bike, as are swamps, bogs and wet meadows". Similarly, Viehman (2001) notes that steep slopes are often impassable for many mountain bikers.

v) People who use Wheelchairs/Scooters

a) Functional Description

Thomson (1984) defines a wheelchair user as "a disabled person who depends on a wheelchair for mobility". People who use wheelchairs vary widely in their physical capabilities and strength (Thompson, 1984; Kidd, 1982). Kidd (1982) explains: "Many [wheelchair users] with intact arms and upper body strength are extremely mobile and can independently propel themselves over long distances. Others with weak arms and upper body, or frail elderly people, or even children in prams, will need to be pushed, or use electric wheelchairs" (Kidd, 1982). Thompson (1984) divides wheelchair users into two groups: 1) people who can use a wheelchair independently, regardless of whether the wheelchair is powered or self- propelled, and 2) those who require assistance to push them in the wheelchair. Thompson explains that both groups have individuals who rely on the wheelchair as well as people who are partially ambulatory but require wheelchairs for longer distances.

Kidd (1982) explains why understanding the physical capabilities of people who use wheelchair is so critical for the appropriate design of trails: "Just as there is no 'average human being' so there is no average wheelchair user. If a design were to be based on the average reach, half the wheelchair users simply could not function" (Kidd, 1982). Thompson (1984) suggests that as a general rule of thumb a well designed trail should meet the needs of independent wheelchair users and that by doing so the needs of people who require assistance are likely to be met as well.

Thompson (1984) considers people who are wheelchair users as "the most handicapped group in terms of mobility in buildings and exterior environments". Thompson states that people who use wheelchairs face barriers not only because of their disability, but also because by being in a wheelchair they are at a lower height than most other adults. They require more width and their mobility is often restricted to places where wheels are able to traverse.

In their publication Determination of New Dimensions for Universal Design Codes and Standards with Consideration of Powered Wheelchair and Scooter Users, Ringaert, Rapson, Dr. Qui, Dr. Cooper and Dr. Shwedyk (2001) researched the dimensions of "powered mobility devices" as well as the reach range, turning radius, required widths and dimensions of landings. Their goal was to "explore changes that must be made to pertinent sections of codes/standards...to take into account the requirements of powered chair and scooter users" (Ringaert, Rapson, Dr. Qui, Dr. Cooper and Dr. Shwedyk, 2001 p.17). Among the conclusions reached, they note that the "dimensional requirements of power mobility users" were not reflected in existing codes/guidelines and that the cited dimensions in codes often needed to be increased in order to facilitate mobility (Ringaert, Rapson, Dr. Qui, Dr. Cooper and Dr. Shwedyk, 2001 p.45).

b) Trail Surface Design Considerations

"Wheelchairs are generally designed for use on smooth surfaces. Small changes of level, or cross slopes and excessive cambers[12] can cause instability. Wheelchair users are therefore unable to safely negotiate uneven, soft or muddy ground, steps, steep gradients and cambered surfaces..." (Kidd, 1982). Proper trail design for wheelchairs should ensure a smooth transition from the trail surface to the surrounding ground level to minimize the likelihood of problems or accident should a wheelchair happen to leave the trail.

The physical ability of a wheelchair user to use any given trail depends not only on the trail surface itself but other factors as well. Such factors may include the type of disability that an individual has, the limbs or part of body affected by the impairment, the extent of paralysis, the degree of muscle capability, the overall limb mobility, and the restrictions associated with the wheelchair (Kidd, 1982).

Since wheelchairs require more width than an ambulatory person, an extra wide path is needed (Ryan 1993). The trail width required for wheelchair users depends on two primary factors: 1) the size of the wheelchair, and 2) the users ability to maneuver the chair (State of Illinois Department of Conservation, 1978).

[12] Presumably, in this context, Kidd (1982) refers to cambers as a slightly arching surface.

vi) People who have Ambulatory Disabilities

a) Functional Description

People with a disability affecting their mobility but who are still able to walk[13] are generally referred to as having an ambulatory disability (Thompson, 1984). "The majority of disabled people are ambulant..." (Kidd, 1982). People with ambulatory disabilities may have one or more conditions due to a temporary illness, an accident, a degenerative disease, damage to the nervous system, respiratory problems, restricted leg movement, unsteady balance, or other ailments. These causes of mobility impairment leave individuals with varying degrees of ability to move around. By and large, extended periods of physical exertion may be difficult or even impossible. Many times people with mobility problems have difficulty negotiating stairs or steep gradients due to physical problems such as respiratory difficulties, restricted leg movement or unsteady balance (Countryside Commission, 1981; Kidd, 1982).

b) Trail Surface Design Considerations

People who use mobility aids or have a prosthetic leg have their mobility affected and as such often have slower traveling speeds (Beneficial Designs, 1999, and Kidd, 1982). Likewise, people who use walking aids require more energy to traverse a surface (Beneficial Designs, 1999). Stairs and steep grades are often difficult to due to limited leverage and possible limited use of limbs (Kidd 1982). Icy surfaces can be especially dangerous and difficult for people with ambulatory disabilities to traverse (Beneficial Designs, 1999).

[13] With or without a mobility aid.

Canes are used by people with various types of mobility impairments such as blindness, injury to a limb, arthritis, rheumatism, multiple sclerosis, or aging. (Countryside Commission, 1981; Kidd, 1982). Kidd (1982) describes the importance of width for various mobility aid users. He notes that people who are blind and use canes often require a large clearance area and that people who use walkers require less clearance width than those who use crutches. This is due in part to the fact that lateral movement is limited to the confines of the walker's frame. Kidd states that in regards to crutches the clearance width needed may increase if the user has severe arthritis or cerebral palsy.

vii) People who have a visual impairment

a) Functional Description

People can suffer either partial or complete visual impairments. The majority of people with visual impairments, however, have only a partial impairment. Thus it is possible, for example, for many to distinguish light and large objects ("Who are the Handicapped?", 1974[14]). Often people with visual impairments are seniors, many of whom may also be affected by unsteadiness or other afflictions associated with old age. Similarly, people with a visual impairment may also have a mental or physical disability (Countryside Commission, 1981; Kidd 1982). Generally speaking, however, an individual's blindness or visual impairment is the only disability that the individual is affected by (Kidd, 1982).

[14] Author unknown.

People with visual impairments can use various types of mobility aids. The white cane is used to detect obstacles, as a support, and as a means of wayfinding. A variation of the white stick, the long cane, is made of aluminum tubing and has a nylon tip at the end. The user swings the cane back and forth in front of them at an angle of approximately thirty degrees. As the name 'long cane' would suggest, the cane is longer than the white stick but it cannot be used for support. The danger or limitations of the long cane and white stick is that neither can detect obstacles above waist height, such as branches. Electronic sounds waves can be used for detection of obstacles at any height but the technology can be expensive (Countryside Commission, 1981).

Another relatively common aid for people with visual impairment is the guide dog. Beneficial Designs (1999) notes that guide dogs are specially trained to respond to hand and voice signals. Beneficial Designs goes on to describe that guide dogs are not trained to make decisions for their owners but rather to avoid obstacle of varying height.

b) Trail Surface Design Considerations

For people with partial vision, color differentiation can be beneficial (State of Illinois Department of Conservation, 1978; Kidd. 1982; Thompson, 1984). The State of Illinois Department of Conservation (1978) states: "Visually impaired individuals can perceive contrasting colours if the surface material contrasts with the surroundings". Changes of colour are beneficial to alert the user of hazards or changes to the path. "Providing an even-colored, light surface which contrasts

with the natural vegetation is preferable to providing a white guideline down the center of a dark asphalt path" (State of Illinois Department of Conservation, 1978).

For people who are totally blind, textural changes to a trail surface can be used as a wayfinding device or to warn of hazards (Countryside Commission, 1981; State of Illinois Department of Conservation, 1978; Anstruther, 1980; Thompson, 1984). This is because people with visual impairments are generally able to feel the difference between various trail surface materials (Anstruther, 1980). Different trail textures, for example, can be used to distinguish between primary access trails, and secondary. In order to establish this distinction, each trail type must maintain a consistent surface material that is distinguishable from that of the other trails. Ramps, curbs, steps and other changes of surface plane are usually detectable by cane and thus do not require special tactile warning (Kidd, 1982).

"For blind people, a smooth surface for walking may be lower priority than for those in wheelchairs. While obstacles would clearly be a nuisance, variations may be appreciated as an added interest... since the blind are often more aware of the changes underfoot than sighted people" (Countryside Commission, 1981). The National Park Service (1978) suggests that people with visual impairments "prefer the feel of natural surface when walking though a wooded area" but they do not provide any factual or statistical information to substantiate the statement or any indication of what the preferred natural materials were.

Kidd (1982) notes that having a continuous "tapping rail" located along the length of one of the sides of the trail can help people with visual impairments navigate. Kidd states that the rail should be between 150mm and 400mm above ground. In addition to this, he suggests having a shoulder of firm material adjacent to the trail in the event accidental meandering off the trail. The shoulder should be of similar height, ideally within 10mm of the path surface, and should run a minimum width of 300mm on either side. Kidd (1982) describes that the width of the trail itself should be no wider than 2000mm, as excessive widths can be disorienting for people with a visual impairment.

viii) Parents with Young Children

a) Functional Description

The National Park Service published guidelines in Trends magazine (1978) pertaining to people with special needs and suggests ways that parks might better accommodate them. Although most of the suggestions deal with ways that park personnel can help people, there is valuable information that deals with the needs of various people. The article discusses the needs of children of various age groups. They found that children from the age of two to six years old, more so than any other age group, have the tendency to stay close to their parents or guardians. Children in this age group generally have short attention spans and high energy levels, but this energy is not sustainable as frequents breaks may be required. Children between the age of seven and twelve years like to be self-sufficient and to explore.

Fogg and Fulton (1994) book Leisure Site Guidelines for People over 55 provides general profiles of the capability and interests for people of various ages. They note that infants (age 0-3) have limited, yet increasing, mobility. During the first two years of life, sensory and motor skills development occupies much of a child's time. From the age of two to three, mobility skills are improving and mental understanding and functioning is being further developed. Fogg and Fulton acknowledge that during this stage, infants require a lot of adult assistance. They describe children of this age group as requiring close supervision, places for individual play, and opportunities to develop fine and gross motor skills and explore their surroundings.

Beneficial Designs (1999) also recognizes that children generally have a third less peripheral vision than adults. In addition, they note that children are less able to judge speed and distance and have problems locating the direction of sounds. Despite this, Beneficial Designs note that children generally are overconfident.

b) Trail Surface Design Considerations

Integrated Play Environments for Children is a report written by Paul Wilkinson (1982) for the Recreation Branch of the Ontario Ministry of Tourism and Recreation. The report discusses surface material in the context of childrens' play areas, circulation paths and walks. Wilkinson notes that trail circulation systems should be surfaced in a hard material.

Wilkinson further explains that circulation routes should "encourage a 'natural' flow" and promote unobstructed easy movement by avoiding right angles turns.

Moore, Goltsman and Iacfofano (1987) provide suggested criteria and guidelines for pathways in their publication Play for All Guidelines: Planning, Design and Management of Outdoor Play Settings for All Children. They note that accessible routes must be a "continuous", "even" surface and that strollers must be accommodated. With regards to trail surface materials, the following criteria is suggested:

- "stable": no unpredictable movement.
- "firm": resistant to deformation caused by concentrated pressures.
- "flat": no irregularities or sudden changes in level.
- "non-slip", "slip-resistant" and "antiskid": not slippery

ix) Seniors

a) Functional Description

Loss of hearing, sensory perception and sight are common impairments associated with seniors. Physical changes pertaining to mobility may include a reduced range of joint movement and decreased endurance as well as diminished dexterity, balance, and steadiness problems (Beneficial Designs, 1999). This is often combined with a decrease in reaction time and self-confidence (Countryside Commission, 1981; Beneficial Designs, 1999). In addition to this, some colours and textures may become difficult to distinguish. Progressive instability and

difficulty in walking, use of mind altering medications, visual or neurological impairment, and dementia make older people especially vulnerable to falls (National Recreation and Park Association, 1994). For many seniors the physical environment can become confusing and frustrating. Pathways may seem long and can lead to disorientation. Medication can be used to help minimize these effects. To address some of these problems through design, however, the Countryside Commission (1981) notes that landmarks can be used to reduce disorientation and appropriate lighting levels can reduce glare and shadows.

b) Trail Surface Design Considerations

The National Park Service (1978) recognizes the importance of appropriate trail design for seniors. It notes that many elderly people walk slower than others but generally do not admit to being over-tired. Similarly, since some seniors may also have physical impairments (Beneficial Designs, 1999), designing for accessibility and inclusion is important. In regards to trails, the National Park Service (1978) warns that while precautions should be taken to minimize the chance of falls, a softer surface may be appropriate to cushion falls.

x) Findings: Trail Users

This chapter reviewed many useful sources regarding surface design considerations for trail users. Perhaps the most significant finding from this portion of the literature review is, however, the gaps in knowledge regarding the trail surface preferences of certain trail users (*see Table 1*). Determining user preference is important, as preferred surfaces may be different from the surfaces

that are most useable by a particular user. By filling these gaps in knowledge, trails can be better designed to meet the needs and desires of all users, regardless of age, knowledge or disability.

Table 1. Literature Review Summary: Surface Design Considerations for Various Trail Users

Trail User	Functional Description[15]	Trail Surface Design Consideration	User Preference
4.1 hikers/ walkers	• relatively slow travel speeds (Ryan, 1993)	N/A	• soft surfaces such as crushed aggregate, woodchips and dirt (Ryan,1993) • dirt (Westphal and Lieber, 1986)
4.2 joggers/ runners	• moderate travel speeds (Encarta World Dictionary, 2002)	• grass can camouflage holes, roots, etc. (A Step Ahead Foot and Ankle Centers, 2002) • hard surfaces can be jarring; surfaces should be firm but cushioning (A Step Ahead Foot and Ankle Centers, 2002)	• woodchips (Westphal and Lieber, 1986)
4.3 equestrians	• horses are susceptible to popped tendons, torn ligaments, broken bones and/or twisted joints (Kelly, 1998)	• avoid hard surfaces such as asphalt (Ryan, 1993) • subgrade should be solid and properly prepared (Ryan, 1993)	N/A
4.4 cyclists	• 3 main types bikes, geared towards different trail experiences (Sagazio, 1995) • mountain bike is designed to absorb impact and to ride up steep, rocky trails and uneven terrain but can still be ridden on a pavement (Sagazio, 1995)	• rough surfaces are often problematic when rider brakes quickly (McCoy, 1992) • dirt trails with high clay content are often slippery when wet (Crowther, 1993) • sand, swamps, bogs and wet meadows are generally inaccessible to bikes (Cessford, 1995)	• more experienced mountain bikers preferred a rougher trail; less experienced riders favor sealed surfaces and were more tolerant of gravel roads (Cessford, 1995; Westphal and Lieber 1986)
4.5 people who use wheelchairs/Scooters	• users vary in physical capabilities and strength (Kidd, 1982; Thompson, 1984) • manual wheelchairs, as well as powered and scooters • users may or may not be able to propel themselves (Kidd, 1982)	• ensure appropriate trail widths for traveling, passing and turning – a relatively smooth even surface is beneficial in case of meandering off of a trail (Kidd, 1982) • avoid excessive slopes/cross slopes and abrupt changes in level (Ryan, 1993) • eliminate, wherever possible obstacles on the trails surface (Ryan, 1993) • most wheelchairs are designed for smooth surfaces and may have problems negotiating uneven, soft, or muddy surfaces (Kidd, 1982)	N/A

[15] Generalizations based on literature review

Trail User	Functional Description[15]	Trail Surface Design Consideration	User Preference
4.6 people who have ambulatory disability	• varying ability to move around (Kidd, 1982) • may have unsteady balance, restricted leg movement, limited endurance and require more energy to traverse a surface (Countryside Commission, 1981; Kidd, 1982) • slower traveling speeds (Beneficial Designs, 1999; Kidd 1982)	• obstacles, soft surfaces, and rough terrain can be problematic • stairs and steep grades can be difficult (Kidd, 1982) • icy can decrease already precarious steadiness (Beneficial Designs, 1999) • often requires more clearance width (Kidd, 1992)	N/A
4.7 people who have a visual disability	• visual impairments can be partial or complete therefore some people may be able to distinguish light and large objects ("Who are the Handicapped?", 1974) • may use various types of mobility aides such as canes and guide dogs (Countryside Commission, 1981)	• contrasting colours/textural changes can alert user of hazards or can be used for wayfinding (State of Illinois 1978; Kidd, 1982; Thompson, 1984) • a tapping rail can help users navigate (Kidd, 1982) • excessive widths may be disorienting (Kidd, 1982) • adjacent surfaces should be firm and level incase users meander off the trail (Kidd, 1982) • canes cannot detect overhead obstacles (Countryside Commission, 1981)	N/A
4.8 parents of young children	• young children have limited agility, endurance and move in unpredictable patterns (Beneficial Designs, 1999)	• obstacles may threaten a child's balance • soft surfaces and rough surfaces can be difficult for a child to negotiate – therefore hard surfaces are useful (Wilkinson, 1982) • soft surfaces can cushion falls	N/A
4.9 seniors.	• loss of hearing, sensory perception and sight are common (Beneficial Designs, 1999) • often decreased endurance, range of movement, reaction time, steadiness, self confidence (Beneficial Designs, 1999) • colours/textures may be difficult to distinguish (Countryside Commission, 1981)	• if using colour or texture to convey meaning, should be bold (Countryside Commission, 1981) • take precautions to minimize falls: remove roots, provide a level surface – same height adjacent surface (National Park Service, 1978)	N/A

3.3 Trail Surface Materials

Trail surface materials are conventionally broken down into one of two:

1) hard surfaces (i.e. asphalt, concrete, wooden boardwalk, crushed compacted stones and soil cement), and
2) soft surfaces (i.e. dirt, grass and wood chips)

This chapter reviews the literature as to the relative advantages and disadvantages of these commonly used trail surfaces.

i) Hard Surface Materials

a) Wooden Boardwalk

Wooden Boardwalks can be used for whole trails or for portions of the trail. It is often recommended that boardwalks be used to span soft or wet areas (Miclelson, 1985; Peepre, n.d.). Regardless of location, planks should preferably be laid perpendicular to the direction of travel for safety reasons[16] (Countryside Commission, 1981; Heritage Parks Canada, 1994). A maximum gap between planks is usually suggested in the literature to ensure that heels of shoes, canes and small wheels do not get caught within the space. Similarly, consideration of a minimum gap space is often given to allow for organic debris and precipitation to pass through (Kidd 1982). Sources vary in terms of the amount of recommended gaps between planks. Most sources recognize that gaps should be a minimum of 6mm (Countryside Commission, 1981) and a maximum of between 10mm and 16mm (Countryside Commission, 1981; Heritage Parks Canada, 1994).

[16] It is likely more feasible that a bike tire or even a potion of a person's shoe could span across the missing plank.

One potential problem with the use of wooden boardwalk as a trail surface is that it can often become slippery, especially when wet (Countryside Commission, 1981; Kidd, 1982). Frost or moisture on a boardwalk can, for example, reduce the traction, therefore causing problems to cyclists (McCoy, 1992) and other user groups. In damp and wet areas, slipperiness caused by algae growth on wood decking can be problematic. Proper ventilation and/or chemical applications of products such as creosote can help prevent this (Kidd, 1982). A wooden ramp can be made more slip resistant by the addition of metal or wooden strips placed perpendicular to the direction of travel. Such strips should be no higher than 12mm (Countryside Commission, 1981; Kidd, 1982). Another method of increasing the slip resistance of boardwalks is to spray the surface with epoxy and spread grit on top (Countryside Commission, 1981).

b) Asphalt

There are two types of asphalt: hot mix and cold mix. The major differences between these two types in terms of trail design is that cold mix asphalt does not need to be transported to site in as large a truck as the hot mix asphalt (Anstruther, 1980) and is workable for a longer period of time (Alberta Recreation & Parks, 1986).

As with most materials, there are advantages and disadvantages to using asphalt as a trail surface material. Asphalt is traversable for most trail users (Ryan, 1993). Because asphalt surfaces are most commonly smooth, imperfections to the

trail surface such as potholes and cracks can be easily spotted. As a trail surface, asphalt is durable, works well under various climatic conditions and is low maintenance. The problems associated with both types of asphalt, however, are similar (Anstruther, 1980). Environmental factors may affect the accessibility of asphalt. For example, freeze/thaw cycles as well as tree roots may lead to heaving and cracking of the trail surface (Ryan, 1983; Anstruther, 1980).

When considering trail surface materials for wilderness sites materials such as asphalt that are usable by the widest range of users may not be aesthetically or environmentally appropriate. The Countryside Commission (1981) notes: "For a disabled person on foot or in a wheelchair, the best type of surface is one which is smooth, firm and non-slip. Consequently the most appropriate materials would be tarmac, asphalt, concrete, bricks (not engineering or other non-porous bricks) or paving slabs. Unfortunately these surfacing materials are not always the most appropriate in a country-side setting". Similarly, Mickelson (1995) notes that although asphalt and concrete may be the ideal surface material for people with disabilities, the surfaces are not always the most appropriate aesthetically for wilderness and backcountry environments.

"Asphalt should also be carefully laid and maintained. An epoxy finish, coated with sand, may be used to give a natural appearance to the pathway and reduce softening in very sunny locations" (Canadian Heritage Parks Canada, 1995). The Alberta Recreation & Parks Department (1986) states that asphalt is a usable surface for all trail users with the exception of horseback riders. Ryan (1993)

explains why asphalt is unsuitable for equestrians: "Equestrians generally cannot use an asphalt trail because it is hard on horses' legs, and the hooves can leave imprints in hot weather". Batten (1977) recognizes that such a hard surface may not be ideal for joggers either as it can lead to injury. Batten suggests, however, that proper footwear can help compensate for the lack of cushioning that a hard surface provides.

c) *Compacted Crushed Stones*

The Alberta Recreation & Parks Department (1986) describes three types of compactable aggregate. The aggregates they describe are gravel, crushed limestone and fine shale between 10 and 16mm in size. The Department notes that all surfaces can be compacted into a smooth durable surface and that gravel tends to be a dustier surface compared to crushed limestone. It notes that all these aggregate surfaces, although they are moderately priced and relatively low maintenance, require resurfacing. Similarly, Ryan (1993) comments that re-grading and patching may need to be done every 7-10 years.

"Crushed Aggregate Screenings (CAS) can be any decomposed granite, crushed stone, chat, limestone, quarry fines or stone dust that is 6 mm (1/4 inch) or finer in size. Trails or pathways surfaced with CAS can be accessible if correctly designed and constructed and adapted to regional climatic conditions. A soil binder can be used to stabilize the surface" (Canadian Heritage Parks Canada, 1995).

Aggregate (often limestone, sandstone or other crushed rock) can be broken into a variety of sizes. When compacted and firm, Ryan (1993) notes that finely crushed aggregate can accommodate a wide range of user types including cyclists, equestrians, and wheelchairs provided that the diameter of the aggregate does not exceed 10mm. User groups which may not be able to use granular surface even with a 10mm maximum diameter include rollerbladers and skateboarders (Ryan 1993). The Countryside Commission (1982) states: "Well-compacted crush rocks, gravel or hoggin generally provide the most satisfactory surface in terms of durability and harmony with the natural environment[17]".

Ryan (1993) describes the importance of the size of the aggregate used for trails especially in relation to moisture. He notes that the ability of water to drain through crushed stone trails varies with the size of the aggregate. Finely textured stones will retain moisture more readily than trails constructed using a larger aggregate size with the consequent that this water retention could lead to the growth of vegetation on the trail[18]. In contrast, Ryan notes that well drained compacted crushed stone trails can provide accessibility in wet areas, provided the size of aggregate used is not too large. If rock fragments are too large, the trails surface becomes too uneven for safe and comfortable movement. Conversely, if the aggregate fragments are too fine, in too deep of a layer, or are not compacted properly, wheels can get stuck easily. On the other hand, if a layer of aggregate

[17] When properly designed
[18] Geotextiles can be used to suppress such growth

that is not deep enough, the surface material may separate and displace or erode easily (Ryan, 1993).

Sources vary on the amount of aggregate they feel is required for good trail design. Ryan (1993) notes that aggregate should be spread at least 100mm thick and then compacted over a prepared subgrade surface. The Manitoba Parks Branch (1983) describes the depth of the surface material and the degree of soil compaction as being dependant on the soil conditions of an area, the intensity of use, and the materials used. It suggests a 50-100mm aggregate depth range. Anstruther (1980) states that depending on the sub-base, in some instances the aggregate layer may only need to be 25mm thick. In contrast, the Alberta Recreation & Parks Department (1986) state that aggregate surfaces should be approximately 100mm in depth and that the depth of the sub-base varies according to the soil conditions. It notes that for areas where the soil is soft, a base of 70-100mm of "compacted pit gravel" should be used while well drained soils may be able to have the surface material applied directly on the soil.

The Bradford Woods National Center on Accessibility, located in Indiana, researched various stabilizers (Mountain Grout, Road Oyl Resin Modified Emulsion, and Stabilizer) combined individually with a by-product of crushed limestone (Quart Minus Limestone), size #11 limestone, and soil. The stabilized surfaces were tested by means of a Rotational Penetrometer, which measures the depth of penetration of a eight-inch pneumonic wheel with forty pounds of constant pressure. Test plots were located along a main path. Monitoring took

place over a period of two years during which time the surfaces were subject to an average of 75 trail users per day. Each of the test plots was measured in various locations five times per month. The combination of surface and stabilizer type that was found to withstand the most wear was the Quarter Minus Limestone with Mountain Grout Soil Stabilizer. This surface had an average penetration of between 0.0229 to 0.0762 centimeters. The researchers deemed the combination as very firm and stable. The Quarter Minus Limestone when combined with Road Oyl Resin Modified Emulsion also demonstrated little wear: 0.1270 to 0.2032 centimeters rendering the surface moderately firm. Both these surface combinations were found to be appropriate for use by people with mobility aids.

McCoy (1992) comments that when cyclists use trails designed for people with disabilities ruts may develop and allow water to accumulate therefore decreasing the accessibility of the trails. McCoy suggests that to solve this problem the aggregate could be mixed with soil and re-compacted. In addition, it may be beneficial to consult with a soil specialist to determine the most appropriate mix of aggregate.

ii) Soft Surface Materials

Generally, soft materials can be problematic for people with mobility or vision impairments. Kidd (1982) explains: "Soft surfaces such as soil, grass, crushed rock, sand and tanbark[19] should be avoided for paths and tracks. Although low installation cost can make them appealing, maintenance costs can be extremely high. Soft

[19] Any type of bark with tannic acid in it.

surfaces make walking difficult for people with impaired mobility and vision, for the elderly, for people with prams and strollers, and make passage virtually impossible for wheelchair users". Despite these drawbacks, the State of Illinois Department of Conservation (1978) notes that well maintained soft surfaces can provide some protection against falls. The Department points out at the same time, however, that sharp, dangerous objects such as pieces of broken glass, can be easily camouflaged or concealed within such trail surfaces.

a) Grass

Grass is a common soft trail surface, particularly in prairie or parkland environments. "A grass surface can be passable if it is level and well maintained. Grass can be reinforced using commercially produced sub-surface matting" (Canadian Heritage Parks Canada, 1995). Wire and plastic reinforcing product used on existing vegetated surfaces may pose problems if exposed since mobility aids and shoes can get caught in them. Therefore, such reinforcing products are best used in areas that will be seeded or have sod laid on top of them (Countryside Commission, 1981).

Batten (1997) notes that there are there are both benefits and drawbacks to jogging on grass surfaces. He describes that grass has cushioning effect that helps prevent injuries to ankles, knees and other joints, but cautions that uneven terrain and protruding roots can be camouflaged or hidden by the grass which may appear "deceptively even". Such obstacles can result in injuries to a jogger by causing them to lose balance or by straining their ligaments. Grass though usually

not a problem for mountain bikers, can be extremely difficult for them when long and tough (Crowther, 1996). Common experience would also suggest that wet grass can also be a problem.

b) Dirt

Dirt[20], of course, is also a common trail surface. "Untreated soil is highly variable. Some situations may be acceptable and others more difficult. Soil is likely to change significantly due to precipitation, erosion, or wear" (Canadian Heritage Parks Canada, 1995).

According to Ryan (1993), soil trails are economical, low maintenance and easy to modify. Soil surfaces, however, have obvious drawbacks. They are not usable in all weather. They develop ruts when wet and can be subjected to erosion. They also can quickly become uneven and dusty. Kidd (1982) recognizes these problems and notes that the addition of stabilizers can help make a surface more accessible by rendering the surface firmer and less muddy. The National Center on Physical Activity and Disability's website (2001) classified trail surfaces into five categories based on material characteristics. Hardened soils and soils with stabilizers were given as examples of "hard" surfaces — firm and stable, but not necessarily slip resistant. This problem is recognized by the Countryside Commission (1981) as they note that reinforced soil is often impermeable and therefore added precautions need to be taken to ensure proper drainage.

[20] Referring to earth/soil.

Obviously, the suitability of a soil as a trail surface varies with site conditions (State of Illinois Department of Conservation, 1978; Peepre, n.d.). Soil surfaces that consist of more than 60-70% of clay are poor choices for trail surfaces as they become slippery and contain water when wet (Peepre, n.d.; State of Illinois Department of Conservation, 1978). Soft soils such as sandy loams and sandy clay are also problematic as trail surfaces because their lack of firmness causes wheelchairs to tend to sink into them (State of Illinois Department of Conservation, 1978).

Bradford Woods National Center on Accessibility (1995), as previously mentioned, conducted research on the accessibility of various surfaces when combined with certain stabilizers. Soil[21] without any stabilizers yielded the worst results and proved to be problematic or even inaccessible for people with mobility impairments when wet. The depth of penetration ranged from 0.9144 to 1.2986 centimeters which rendered the soil in the "not firm" to "moderately firm" category according to the ANSI/RESNA Standard for Ground and Floor Surfaces. In terms of stability, the soil tested ranged from "not stable" to "stable". When the soil was combined with Mountain Grout Soil Stabilizer (later renamed Klingstone 400), the depth of penetration was reduced to 0.5334 to 2.2098 centimeters. This slightly changed the results of soil so that it became categorized "not firm" to "very firm", and "moderately stable" to "very stable".

[21] The type of soil (i.e. sandy loam, clay loam etc.) was not noted

c) Woodchips

The Canadian Heritage branch of Parks Canada remarks that small sized woodchips can be an attractive trail surface which is passable albeit challenging for people with disabilities. The Alberta Recreation and Parks Department (1986) finds woodchips problematic for bikes and horses in addition to wheelchairs but comfortable for hikers. Similarly, Ryan (1993) states that woodchips provide a soft surface which is enjoyed by hikers and joggers, and he found woodchips to be an appropriate surface material for equestrian usage.

Many sources deal with the desired depth of woodchips as trail surface material. The Alberta Recreation and Parks Department (1986) found that ideally woodchip trail surfaces should be 75-100mm in depth. Anstruther (1980) and the Manitoba Parks Branch (1983) concur that woodchip surfaces should be at least 75mm thick. Woodchip surfaces permit the infiltration of surface water (Anstruther, 1980; Manitoba Parks Branch, 1983) while still retaining moisture (Manitoba Parks Branch, 1983). The Alberta Parks and Recreation Department describe that no base material needs to be added for woodchips surfaces unless the soils is soft, in which case it should be excavated and replaced with a more suitable soil or gravel.

One environmental factor to consider when designing woodchip trails is that woodchips are biodegradable (Anstruther, 1980; Ryan, 1993). During warmer

weather woodchips can decompose rather quickly. Thus woodchip surfaces typically may need to be replaced every two years (Ryan, 1993).

iii) Findings

It is difficult to say with any certainty whether any trail surface materials can be deemed "accessible" in and of themselves as research has shown that accessibility is highly dependant on whether the trail has been: 1) properly sited to avoid problem areas, 2) designed to ensure adequate depth of materials and proper drainage, 3) modified with the addition of stabilizers or geotextiles, 4) constructed as specified, and 5) maintained properly.

Having said this, there is one surface that seems in a general sense to correspond to the needs of all users as well as being somewhat aesthetically appropriate to backcountry environments and areas that stress preservation. Compacted crushed stones trails with stabilizer, when designed, sited, constructed and maintained properly, can provide a surface that is usable for all non-motorized user groups discussed in this thesis. This is certainly not to say that all trail users will prefer the surface, but rather that this surface can be used without major problems. In this regard, compaction and stabilization is one of the key considerations determining the accessibility of crushed stones.

The following table identifies and summarizes design considerations for the trail surface materials discussed in this chapter. Other useful tables compiled by others can be found in Appendix B.

Table 2. Design Considerations for Trail Surface Materials

Surface	Design Considerations
Asphalt	• durable and low maintenance (Ryan, 1983; Anstruther, 1980). • traversable by most users (Ryan, 1993) • can cause injuries to horses (Ryan, 1993) • hooves may leave imprints (Ryan, 1993) • freeze/thaw cycles and roots can lead to heaving and cracking of the surface (Ryan, 1983; Anstruther, 1980).
Wooden Boardwalks	• useful to span wet/soft/uneven surfaces (Michelson, 1985; Peepre, n.d.) • lay planks perpendicular to direction of travel (Countryside Commission, 1981; Heritage Parks Canada, 1994) • ensure proper distance of planks of between 6mm min (Countryside Commission, 1981) and 10mm-16mm max (Countryside Commission, 1981; Heritage Parks Canada, 1994) • to reduce slipperiness, ensure proper ventilation, apply chemical products (Kidd, 1982), apply epoxy and grit (Countryside Commission 1981) and/or add wooden or metal strips, no higher than 12mm (Countryside Commission 1981; Kidd, 1982) • may become slippery (Countryside Commission, 1981; Kidd, 1982)
Crushed Compacted Stones	• moderate cost and low maintenance (Alberta Recreation and Parks Department, 1986) • requires periodic resurfacing (Alberta Recreation & Parks Department, 1986; Ryan, 1993) • aggregate can be compacted into a smooth surface (Alberta Recreation and Parks Department, 1986) • stabilizers can enhance firmness (Canadian Heritage Parks Canada, 1995) • if designed properly, can accommodate most trail users (Ryan 1993) • drainage ability depends on size of aggregate and presence of stabilizers users (Ryan 1993) • cyclists may leave ruts in surface therefore reducing accessibility (McCoy, 1992) • loose aggregate can reduce traction (Cowther, 1996)
Woodchips	• can be problematic for cyclists and wheelchairs (The Alberta Recreation and Parks Department, 1986) • good for hikers and joggers (Ryan, 1993) • can decompose with time (Anstruther, 1980; Ryan, 1993)
Dirt	• economic and relatively low maintenance (Ryan, 1993) • untreated soil varies in terms of accessibility based on soil type, precipitation, erosion and wear (Canadian Heritage Parks Canada, 1995) • stabilizers can increase accessibility (Kidd 1982)
Grass	• geotextiles can increase accessibility, but can be an obstacle if exposed (Canadian Heritage Parks Canada, 1995; Countryside Commission, 1981) • cushioning effect for joggers (Batten, 1977) • long grass can be problematic for cyclists (Crowther, 1996) and wheelchair users • can camouflage obstacles (Batten, 1977)

4.0 SURVEY RESULTS: Charts by Question in Numerical Order [22]

4.1 Categorization of Survey Respondents

To facilitate the comparison of the results with the profiles from the literature review, the questions 4, 5 and 6 of the survey were designed to provide a framework for the categorization and profiling of trail users. The figure below diagrams the filtration process that occurred to arrive at the nine categories of trail users discussed in this thesis. These nine categories are highlighted by both bold type and a bold border.

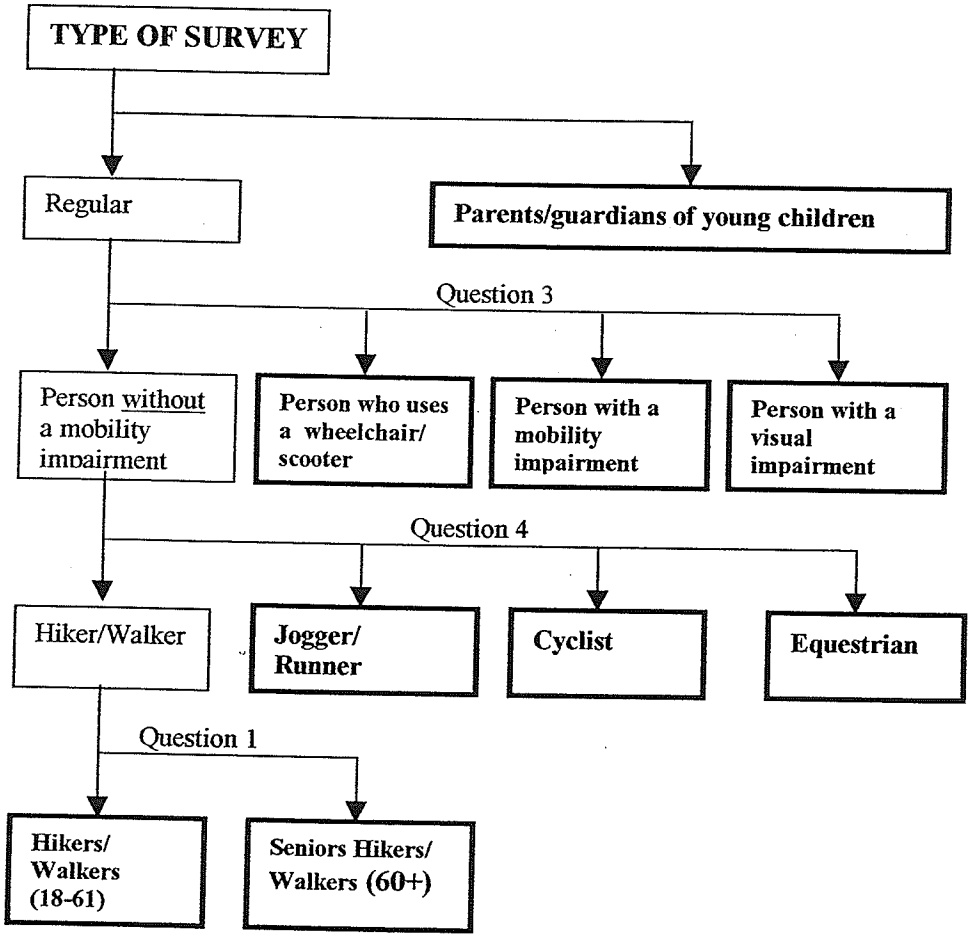

Figure 2. Categorization of Survey Respondents

[22] Note: Graphs present results for all categories of trail users unless otherwise noted

4.2 Response Rate

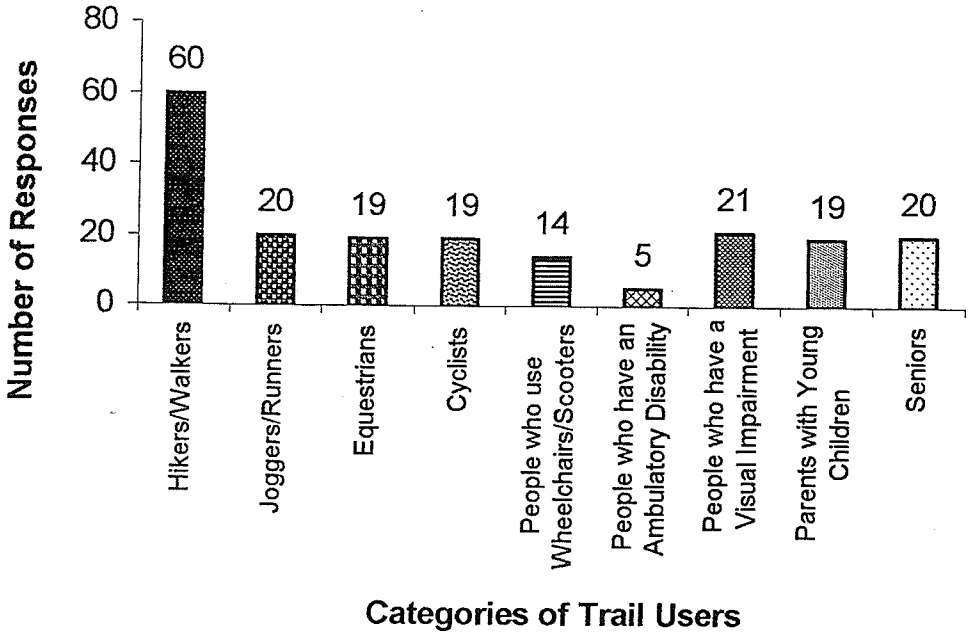

Figure 3. Response Rate by Category of Trail User

A hundred and ninety-seven people responded to the survey. Of the respondents, 60 were categorized as hikers/walkers, 20 as joggers/runners, 19 each for equestrians and cyclists, 19 who were parents with young children and 20 seniors. Of the people with a disability, 14 used wheelchairs/scooters, 5 had an ambulatory disability and 21 had a visual impairment.

4.3 Survey Responses

i) Age (Question 1)

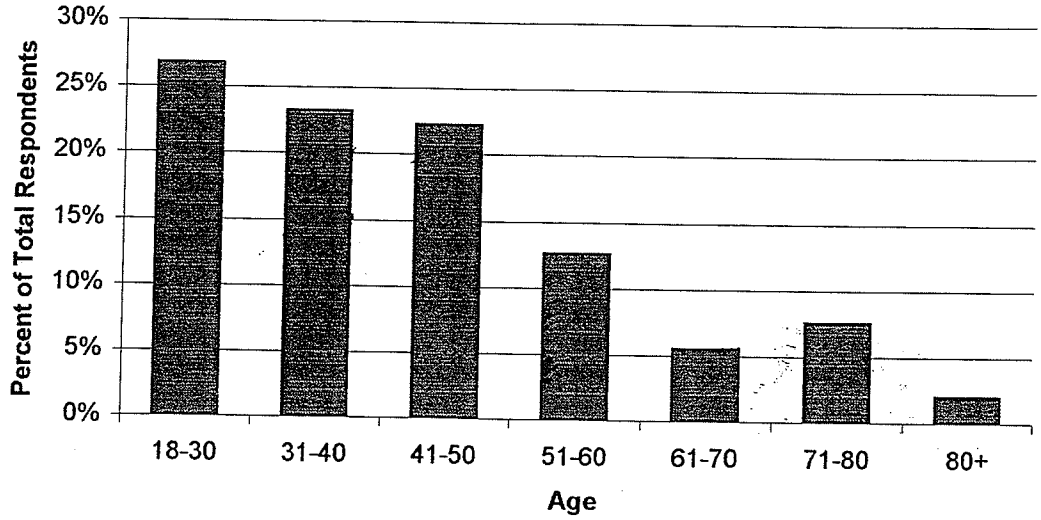

Figure 4. Responses to Question 1: *Age*

The youngest category of age (18-30) had 27% of total responses, while the oldest category (80+) had 2%. Cyclists had the highest percentage of respondents in the youngest age category (58%) while parents with young children had the highest percentage (63%) in the 31-40 category. Joggers and equestrians had a higher percentage of respondents for the 41-50 category (33% and 37%) in comparison to the total. The categories of people who use wheelchairs/scooters and people with a visual impairment both had fewer responses in the age grouping of 18-30 (14% and 5%) in comparison to the percentage for all trail users.

ii) Gender (Question 2)

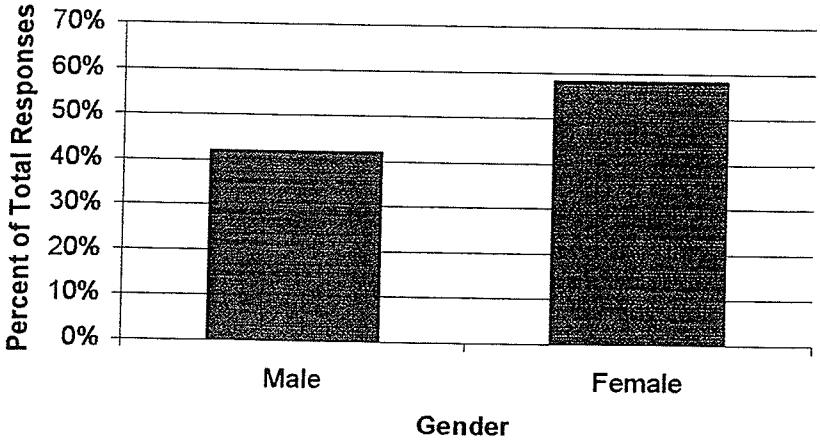

Figure 5. Responses to Question 2: *Gender*

The results of Question 2 showed that nearly half of all respondents (42%) were male, while 58% were female. The gender distribution for hikers/walkers, joggers/runners, cyclists, people with visual a visual impairment and parents with young children was within 15% of the total gender distribution. The survey findings indicate that a higher number of respondents were male in the categories of people who use wheelchairs/scooters (64% vs. 36%) and seniors (65% vs. 35%). In contrast the results showed a higher percentage of female respondents in comparison to the total in the categories of equestrians (89% vs. 12%) and people who have an ambulatory disability (80% vs. 20%).

iii) Category of trail users[24]:

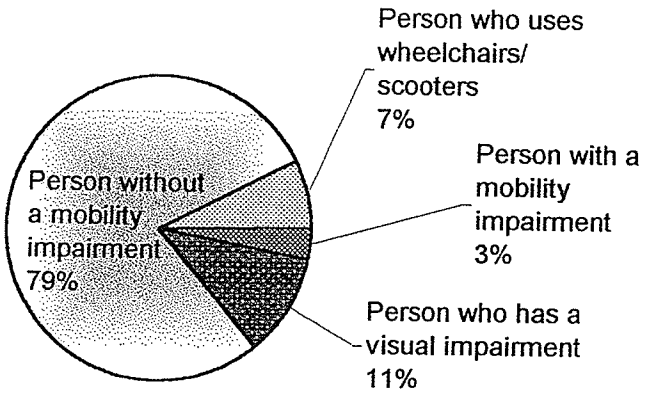

Figure 6. Responses to Question 3: *What category best describes you as a trail user?*

The majority of respondents (79%) indicated that the category of "person without a mobility impairment" was most characteristic of them. The category that received the second highest number of responses (11%) was "person who has a visual impairment". People who use wheelchairs/scooters comprise 7% of total respondents, while respondents with a mobility impairment represented the remaining 3% of respondents.

[24] Percentages of categories of respondents are biased as people from all categories were sought as respondents.

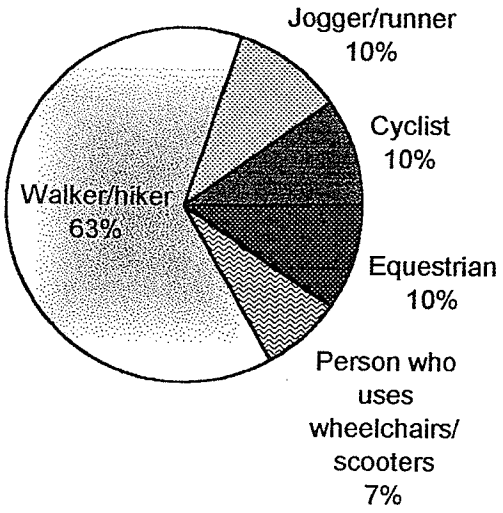

Figure 7. Responses to Question 4: *What category best describes you as a trail user?*

Over half of all respondents indicated that the category of "walker/hiker" was most descriptive of them. The categories of "jogger/runner", "cyclist", and "equestrian" each received 10% of the total responses, while the category of "person who uses wheelchairs/scooters" received 7% of responses.

iv) Trail usage as affected by a disability (Questions 5)

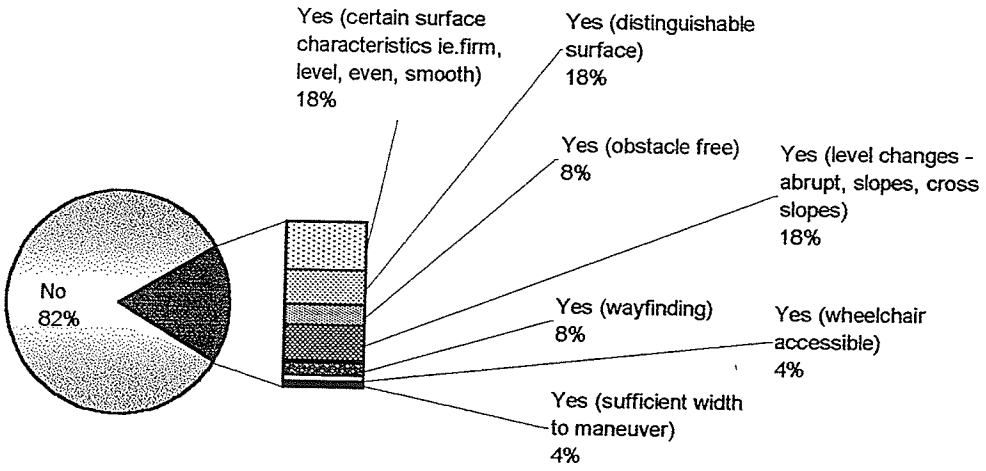

Figure 8. Responses to Question 5: *Do you have a disability? - If yes, please describe how, if at all, it affects your ability to use a trail.*

The overwhelming majority of respondents (82%) indicated that they did not have a disability, while 18% answered in the affirmative. Of the respondents with a disability, 18% noted that certain surface characteristics affected their ability to use the trail; another 18% responded that trail usage was influenced by level changes, and third characteristic that received 18% of responses was "distinguishable surfaces". Several of respondents (8%) described that they prefer/require a surface to be obstacle free, while wayfinding affects trail usage for an additional 8% of respondents. Wheelchair accessibility (4%) or sufficient widths to maneuver (4%) were also listed as factors affecting usage.

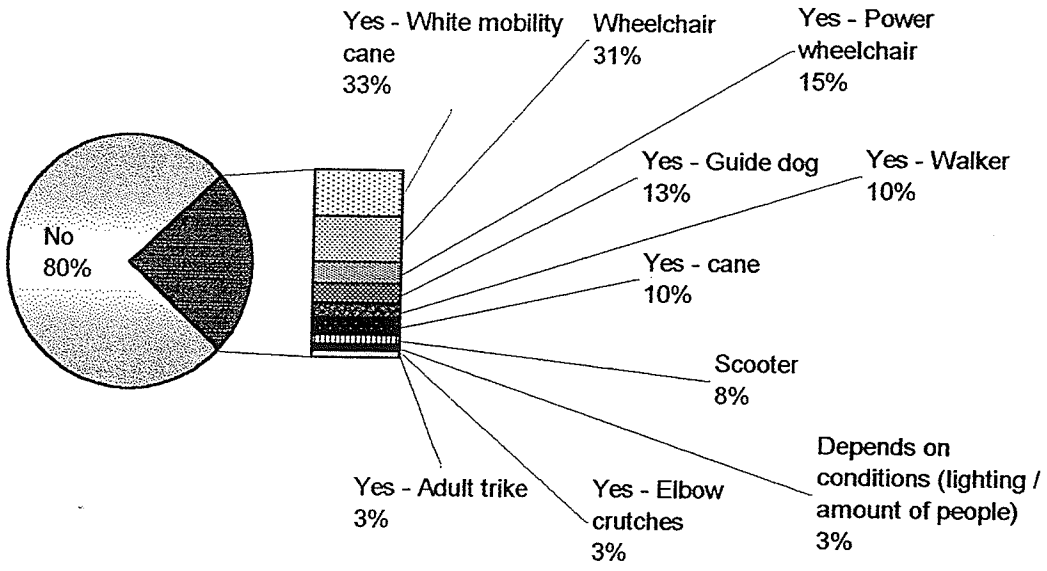

Figure 9. Responses to Question 6: ***Do you use a mobility aid? If yes, please describe what type of mobility aid you use.***

The overwhelming majority of respondents (80%) answered that they do not use a mobility aid, while 20% responded in the affirmative. Of the respondents who indicated that they use a mobility aid, a third utilize a white mobility cane and with an additional 10% using a "cane" (no mentioned was made regarding the type of cane). Power wheelchairs were used by 15% of respondents who require a mobility aid, while 31% of respondents noted "wheelchair" with no mention of type. Guide dogs (13%), walkers (10%), adult trike (3%) and elbow crutches (3%) were also listed as types of mobility aid used.

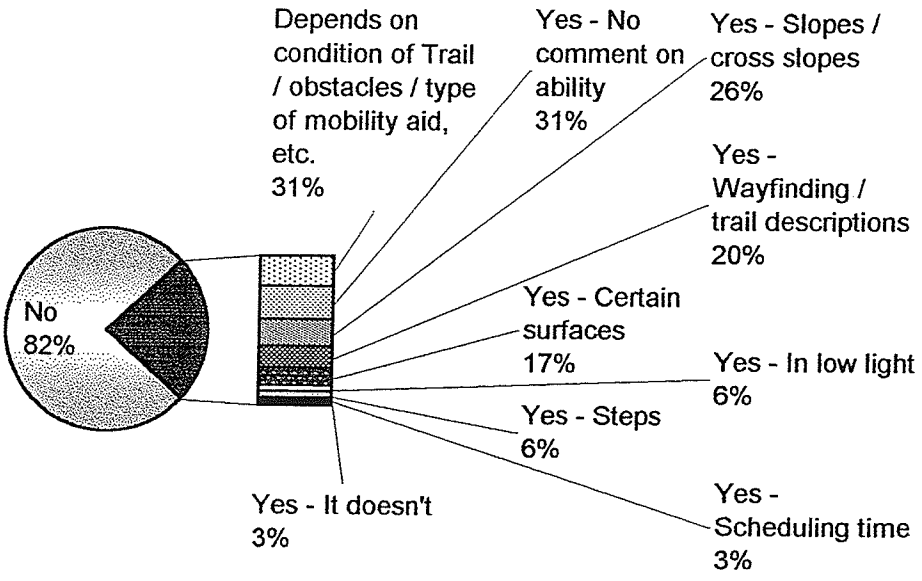

Figure 10. Responses to Question 7: *Do you ever require assistance when using a trail? If yes - describe how, if at all, it affects your ability to use a trail.*

When asked if they required assistance when using a trail, 18% of total respondents and 87.5% of respondents with disabilities responded in that they did. Of the respondents who indicated that they required assistance, 31% responded that their need for assistance was dependant on trail conditions or the type of mobility aid that they use. Many respondents listed factors that causes them or might cause them to require assistance. These factors include: slopes/cross slopes (26%), certain surfaces (17%), low light (6%), and steps (6%). A fifth of people who require assistance (20%), require assistance with regards to wayfinding or trail descriptions. For 3% of respondents, requiring assistance affected their ability to use a trail by requiring them to schedule time with the person providing them with assistance. Correspondingly, 3% of respondents described that requiring assistance does not affect their ability to use a trail.

v) Frequency of Trail Usage (Question 8)

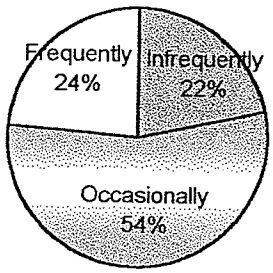

Figure 11. Responses to question 8: *How often do use recreational trails?*

Approximately half of total respondents (54%) use a trail "occasionally", with the remaining responses being fairly evenly distributed between "frequently" (24%) and "infrequently" (22%). This trend was fairly consistent (±10%) throughout all of the categories with the exception of joggers/runners, cyclists and parents of young children, all of which had a slightly higher response rate in the "frequently" category (32% for all three categories) as opposed to "infrequently".

vi) Most important aspects of trail experience (Question 9)

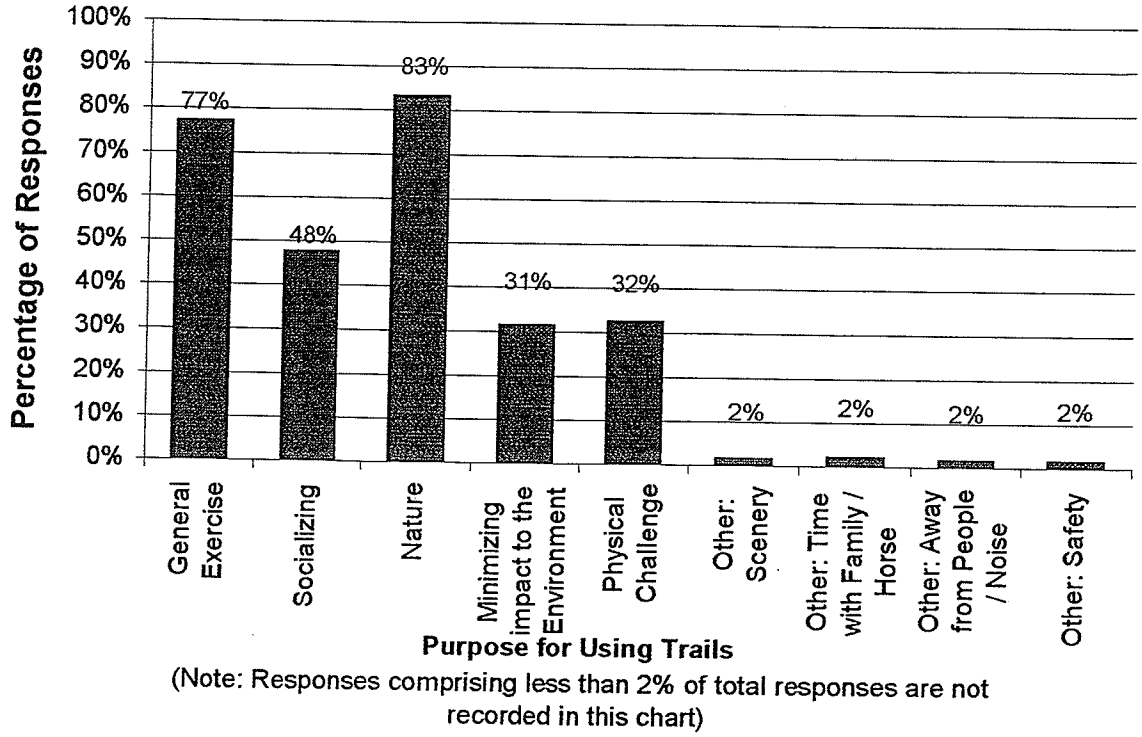

Figure 12. Responses to Question 9: *When using a trail, what are the most important aspects of your trail experience*

The overwhelming majority of trail users (83%) responded that being in and viewing nature was the most important aspect of their trail experience, closely followed by those who stated that general exercise (80%) was the most important aspect. Nearly half of all respondents (48%) noted socializing with the people they are with as being important, while minimizing impacts to the environment and physical challenge were important to nearly a third (31% and 32%) respectively. These trends are characteristic of all categories with the exception of equestrians and cyclists who demonstrate a higher rate of responses for minimizing impacts to the environment (47% and 42%) and physical challenge (57% and 52%).

vii) Ideal trail characteristics (Questions 10 &11)

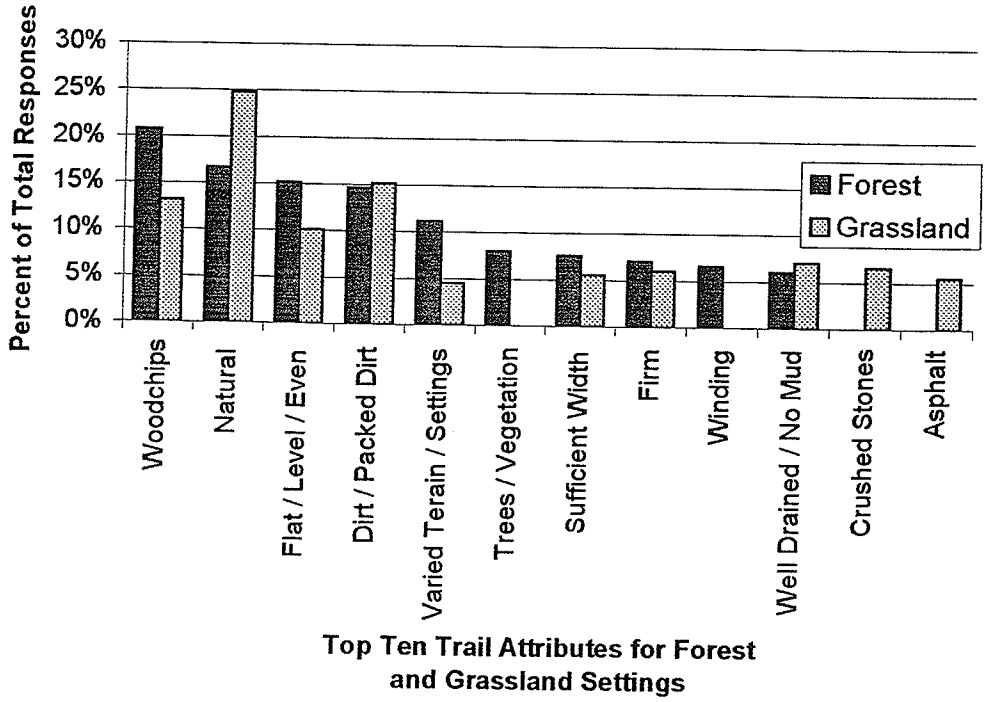

Figure 13. Responses to Questions 10 and 11: *Describe your ideal trail (in particular trail surface) for use in a forest / grassland setting.*

The most frequently used term to describe the ideal trail/surface for use in a forest setting was "woodchips" (21% of responses). "Natural" was the second most frequently used term with 17% of responses. The characteristic with the third highest number of responses for use in a forest setting was "flat". For use in a grassland setting, "natural"[25] received the highest number of responses for ideal trail/surface, followed by "dirt" (15%). "Woodchips" had the third highest number of responses at 13%.

[25] The word natural in the context refers to a trail that is not constructed.

The following table summarizes the findings by category for questions 10 and 11.

Table 3. Top Two Preferences for Trail Surfaces or Trail Characteristics Ranked by User Group and Setting

User Groups	Forest		Grassland	
	Highest number of responses	**Second highest number of responses**	**Highest number of responses**	**Second highest number of responses**
Hikers/walkers	Natural (33%)	Woodchips (23%)	Natural (33%)	Woodchips (22%)
Joggers/runners	Varied Terrain/Setting (35%) Woodchips (35%)	Trees (20%) Winding trail (20%)	Natural (25%) Dirt (25%)	Woodchips (20%)
Equestrians	Well drained/no mud (42%)	Dirt/packed dirt (37%)	Well drained/no mud (37%) Natural (37%) No holes (37%)	Dirt/packed dirt (32%)
Cyclists	Varied Terrain/Setting (21%)	Woodchips (16%) Natural (16%) Dirt/packed dirt (16%) Firm (16%) Quiet (16%) Obstacles (16%)	Natural (32%)	Varied Terrain/Setting (21%)
People who use wheelchairs/scooters	Firm (50%)	Sufficient width (29%)	Firm (43%)	Sufficient width (29%) Crushed stones (29%)
People who have an ambulatory disability	Flat (60%)	N/A	Flat (60%)	N/A
People with a visual impairment	Dirt/packed dirt (33%)	Flat (19%) Well defined (19%)	Well defined (29%)	Dirt/packed dirt (24%)
Parents of young children	Woodchips (37%)	Flat (21%)	Natural (35%)	Dirt/packed dirt (16%) Woodchips (16%)
Seniors	Woodchips (35%)	N/A	Natural (35%)	Woodchips (15%)

viii) Trail characteristics that create problems (Question 12)

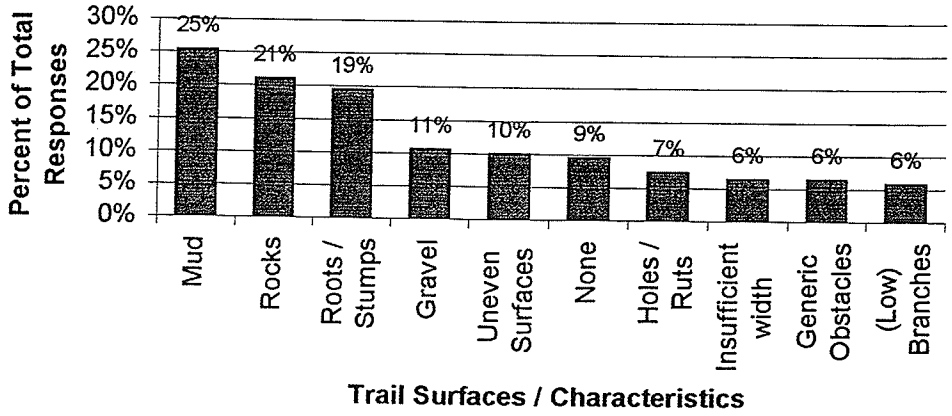

Figure 14. Responses to Question 12: *What trail surfaces and / or other trail characteristics create problems for you when you use a trail?*

Nearly a third of the respondents described that mud can be problematic for them when they use a trail (29%). Approximately a fifth of respondents (21%) stated that rocks are problematic. Roots and stumps received the third highest number of responses (19%). The two most frequent responses for each category of trail user are listed in the table below.

Table 4. Top Two Trail Characteristics that Create Problems for Trail Users by User Group

User Group	Highest number of responses	Second highest number of responses
Hikers/walkers	None (24%)	Roots/stumps (18%)
Joggers/runners	Roots (30%)	Rocks (25%)
Equestrians	Rocks (58%)	Mud (53%)
Cyclists	Mud (21%)	N/A
People who use wheelchairs/scooters	Slopes (36%)	Insufficient width (29%)
People who have an ambulatory disability[26]	N/A	N/A
People with a visual impairment	Roots/stumps (43%) Rocks (43%)	Holes/ruts (29%)
Parents of young children	Mud (58%)	Gravel (21%)
Seniors	Mud (20%)	Gravel (15%)

[26] There was an insufficient number of responses to draw conclusions.

ix) Surfaces Used: Question 13

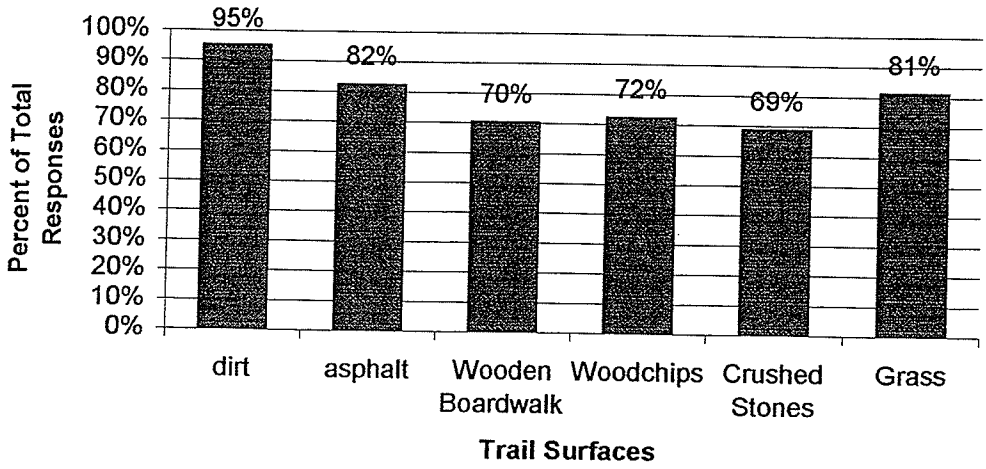

Figure 15. Responses to Question 13: *Which of the following surfaces have you used?*

Virtually all respondents (99%) have used a dirt trail surface. The overwhelming majority have also used asphalt (86%) and grass (85%) surfaces. The people who have used wooden boardwalks, woodchips and compacted crushed stones was relatively the same (73%, 75% and 72%). Three categories of trail users diverged from these percentages by more than ten percent for at least three surfaces. Equestrians used asphalt, wooden boardwalks, woodchips and compacted crushed stone surfaces less frequently (59%, 32%, 59% and 47%) but used grass more frequently (95%). Wheelchair users, on the other hand, had a higher rate of usage for asphalt (79%) and compacted crushed stones (86%), but a lower rate of usage for woodchips (50%). Parents with young children had higher rates for wooden boardwalk (89%), woodchips (89%) and compacted crushed stones (84%).

x) Most Preferred Trail Surfaces: Question 14 and 15

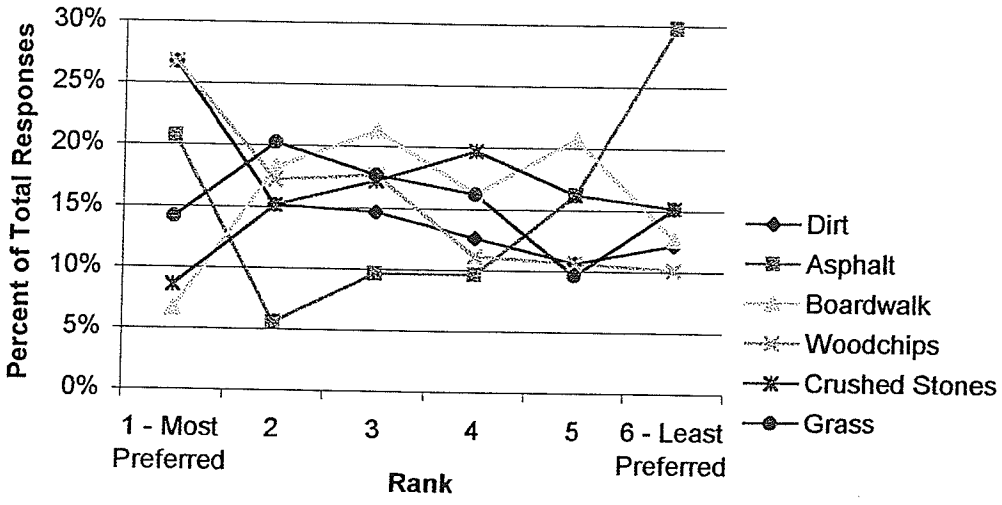

Figure 16. Responses to Question 14: *Rank each of the following surface according to preference for use in a forest setting.*

Woodchip and dirt surface materials received the highest number of responses as the most preferred surface for use in a forest setting (27% each). These surfaces also ranked low in terms of least preferred surfaces (dirt 12% and woodchips 10% - the lowest of any surface). Woodchips had the greatest range between the most and least preferred surface at 17%. Dirt had the second greatest range at 15%. Notably, at 30%, asphalt had the highest number of responses for least preferred surfaces.

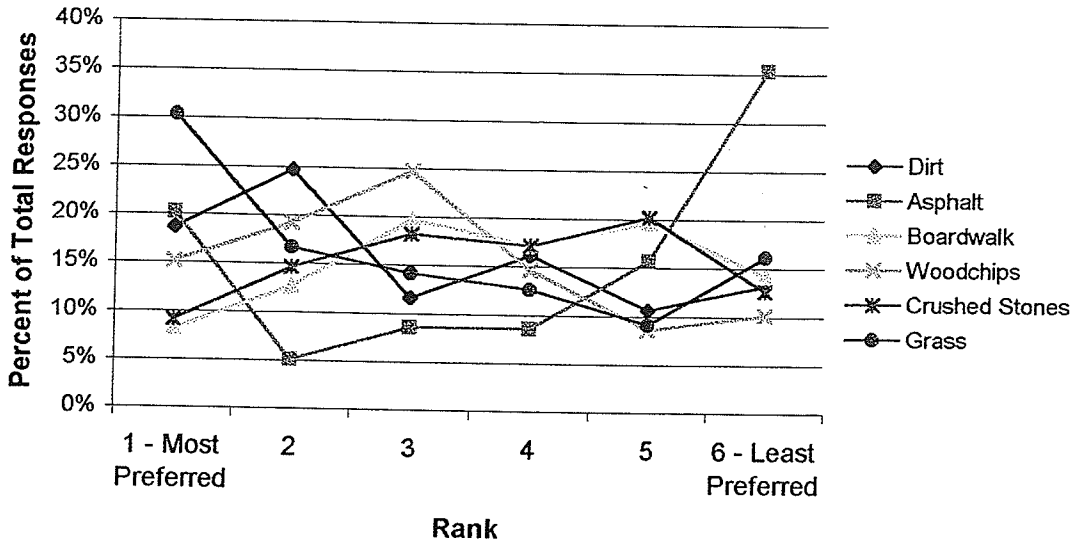

Figure 17. Responses to Question 15: *Rank each of the following surface according to preference for use in a prairie grassland setting.*

Grass was the most preferred surface in a grassland setting at 30% but received the second most responses for the least preferred surface (16%). The range between the number of respondents who marked grass as their most and least preferred surface was 14%. As with use in a forest setting, asphalt had the highest number of responses for least preferred surface (35%), but here had the second highest number of responses (20%) as most preferred surface. The range for asphalt as the most and least preferred surface was 15%.

Table 5. Top Two Most Preferred Trail Surfaces by User Group for Use in Forest and Grassland Environments[27]

User Group	Forest		Grassland	
	Highest number of responses	**Second highest number of responses**	**Highest number of responses**	**Second highest number of responses**
Hikers/walkers	Woodchips (33%)	Dirt (30%)	Grass (37%)	Woodchips (13%)
Joggers/runners	Woodchips (50%)	Dirt (35%)	Dirt (30%) Woodchips (30%)	Grass (20%)
Equestrians	Dirt (63%)	Woodchips (16%)	Dirt (47%)	Grass (37%)
Cyclists	Dirt (42%)	Woodchips (26%)	Dirt (37%)	Grass (32%)
People who use wheelchairs/scooters	Asphalt (57%)	Dirt (14%)	Asphalt (79%)	N/A
People who have an ambulatory disability	Asphalt (60%)	N/A	N/A	N/A
People with a visual impairment	Asphalt (38%)	Compacted Crushed Stones (35%)	Asphalt (38%0	Compacted Crushed Stones (35%)
Parents of young children	Woodchips (37%)	Asphalt (32%)	Grass (47%)	Woodchips (21%)
Seniors	Woodchips (35%)	Asphalt (30%)	Grass (9%)	Woodchips (25%)

[27] Note: Percentages are based on the number of responses per category of trail users; i.e. 35% of Seniors prefer Woodchip trail surface material for use in a forest setting.

Table 6. Least Preferred Trail Surfaces by User Group for Use in Forest and Grassland Environments[28]

User Group	Forest		Grassland	
	Highest number of responses	**Second highest number of responses**	**Highest number of responses**	**Second highest number of responses**
Hikers/walkers	Asphalt (40%)	Compacted Crushed Stones (23%)	Asphalt (53%)	Compacted Crushed Stones (17%)
Joggers/runners	Boardwalk (30%)	Asphalt (20%)	Boardwalk (47%)	Asphalt (20%) Compacted Crushed Stones (20%) Grass (20%)
Equestrians	Asphalt (32%)	Boardwalk (26%)	Boardwalk (47%)	Asphalt (32%)
Cyclists	Asphalt (42%)	Woodchips (16%)	Asphalt (47%0	Woodchips (16%)
People who use wheelchairs/scooters	Woodchips (50%)	Dirt (21%)	Woodchips (50%)	Dirt (21%)
People who have an ambulatory disability[29]	N/A	N/A	N/A	N/A
People with a visual impairment	Grass (35%)	Boardwalk (21%)	Grass (48%)	Woodchips (16%) Boardwalk (16%) Dirt (16%)
Parents of young children	Asphalt (58%)	Compacted Crushed Stones (21%) Grass (21%)	Asphalt (53%)	Compacted Crushed Stones (21%)
Seniors	Dirt (35%)	Compacted Crushed Stones (20%)	Dirt (30%)	Asphalt (25%)

[28] Note: Percentages are based on the number of responses per category of trail users; i.e. 35% of Seniors marked dirt as their least preferred trail surface material for use in a forest setting.
[29] There was an insufficient number of responses to draw conclusions.

xi) Surface difficulty: Question 16

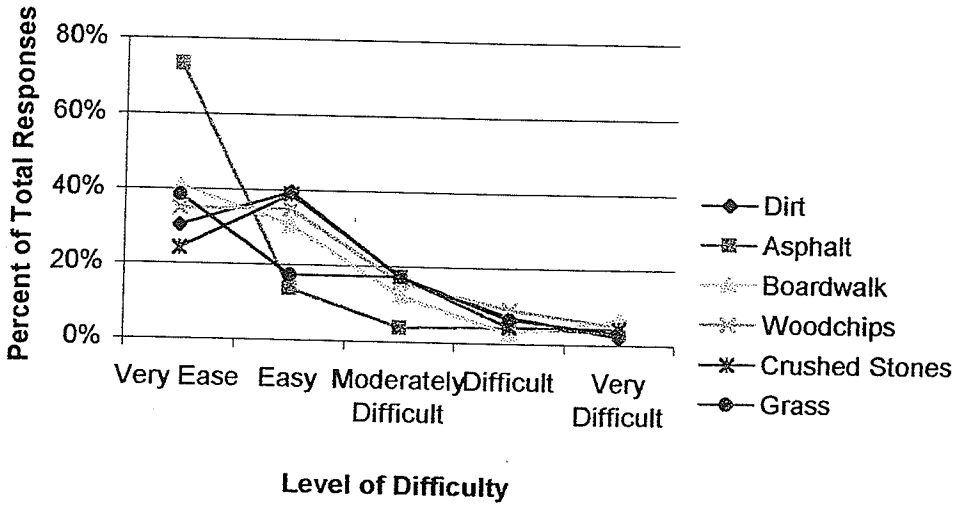

Figure 18. Responses to Question 16: *For each trail surface, complete the following statement: Using a ____(trail surface) is generally _____ (level of difficulty).*

The majority of respondents (73%) found asphalt "very easy" to use. The range between the percent of respondents who found asphalt "very easy" to use and "very difficult" to use was the largest range indicated for any surfaces surveyed (70%). All of the respondents who found asphalt "difficult" to use were equestrians (3% of total respondents representing 32% of equestrians). Wooden boardwalks had the second highest frequency of response for "very easy" (41%). The trail surface with the third highest frequency of response (38%) for "very easy" was grass. None of the respondents that noted this used a wheelchair or scooter. 35% of trail respondents found woodchip surfaces "very easy" to use, although none of the respondents used a wheelchair or had an ambulatory disability. Nearly a third of the respondents (30%) noted that dirt was "very easy" to use. The only category of trail users that had no respondents who found dirt surfaces "very easy" to use was people who use

wheelchairs/scooters. Similarly, neither people with ambulatory disabilities or those who use wheelchairs/scooters indicated that a woodchip surface was "very easy" to use. The trail surface that had the lowest number of responses for "very easy" was compacted crushed stones (24%).

Approximately a third (31% to 39%) of respondents found dirt, boardwalk, woodchips, and compacted crushed stones "easy" to use. Approximately a sixth of respondents found grass and asphalt surfaces "easy" to use (17% and 14%) while 12% to 17% of respondents noted that dirt, boardwalk, woodchips, compacted crushed stones and grass were "moderately difficult". Asphalt was found by 4% respondents to be "moderately difficult" to use. There was a narrow range between the percent of respondents that found all surfaces "difficult" (a range from 3% to 9%), and slightly smaller range for "very difficult" (a range from 2% to 6%).

xii) Reasons for leaving a trail: Question 17

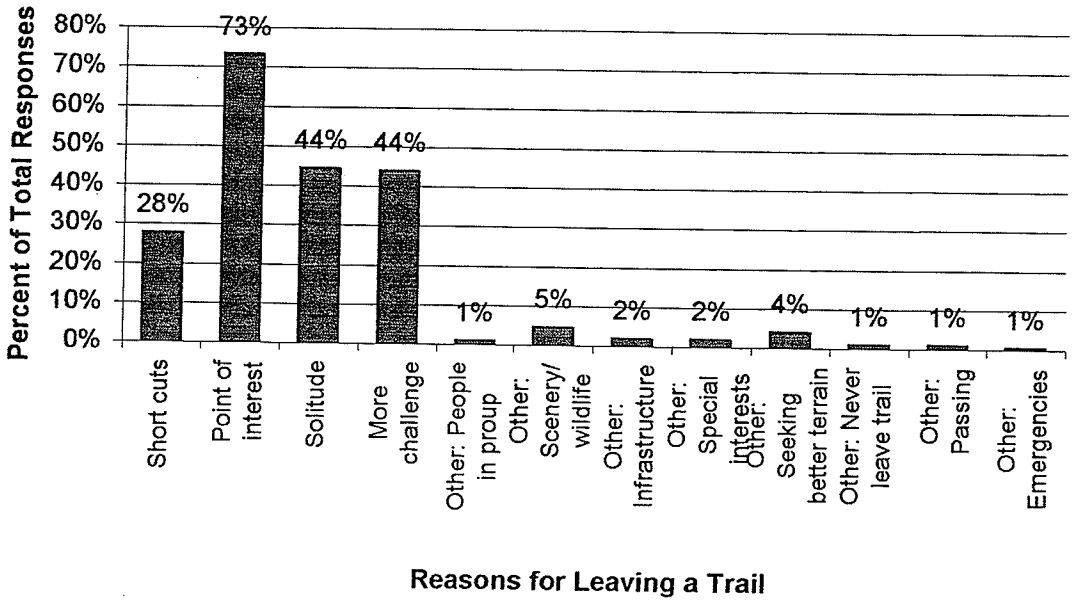

Figure 19. Responses to Question 17: *What factors would likely prompt you to move / hike / ride off of a trail?*

The results show that a large majority of people (73%) would leave a trail because of a point of interest. Seniors, however, had a relatively low frequency of response to potentially leaving a trail for a point of interest (40%). Nearly half of the respondents (44%) answered that they would likely leave a trail to seek solitude or more challenge. None of these individuals had a mobility impairment. Equestrians, joggers and cyclists had a significantly higher number of respondents noting that they would leave the trail for more challenge (58%, 63% and 70%). Short cuts were recognized as a potential factor that would prompt approximately a quarter (28%) of respondents to leave a trail. For this question, respondents were given the option of indicating other reasons they would leave a trail. Some respondents (5%) recorded

that they might leave because of scenery or wildlife. Only 1% of the total respondents said that they would never leave a trail but all of these respondents had a visual impairment.

xiii) Responses to using a trail after a heavy rain: Question 18

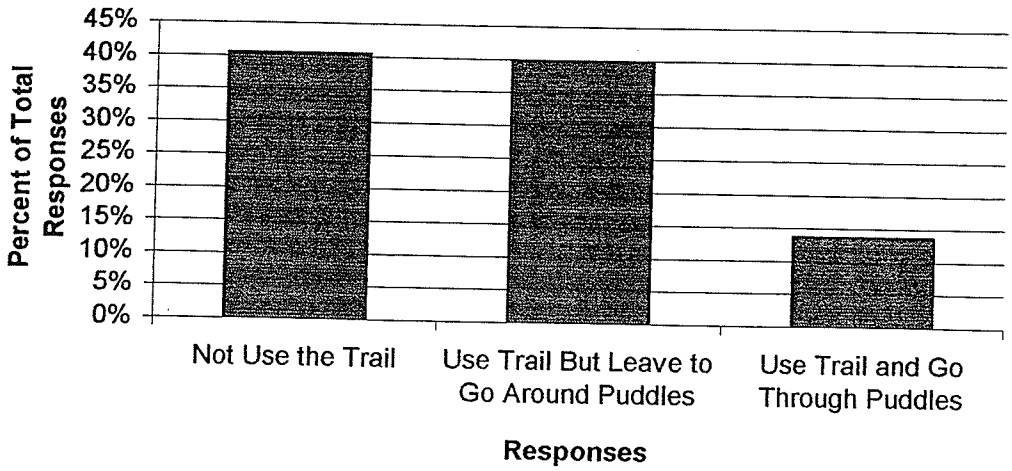

Figure 20. Responses to Question 18: *If you knew that water had accumulated on a trail after a heavy rain, what would you do?*

The percentage of total respondents that would not use a trail after water had accumulated on the trail was the same as those who would try to use it, but leave to go around puddles (40% each). Two thirds of people with a visual impairment (67% of category) answered that they would not use the trail and 68% of parents with young children responded that they would use the trail but leave to go around puddles.

There were significantly less respondents who noted that they would use the trail and go through puddles (14%). Of these, equestrians and cyclists tended to have a higher

percentage of respondents who would go through puddles (42% and 26% of category) but no people with an ambulatory disability or seniors indicated that they would do so.

xiv) Modifications to trail surfaces: Question 19

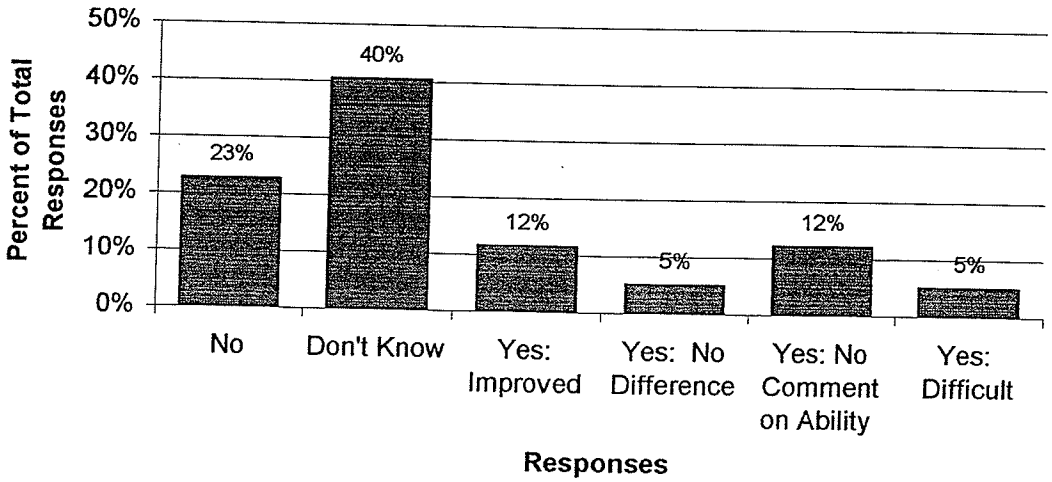

Figure 21. Responses to Question 19: *Have you ever been on a dirt, grass, or crushed stone trail where you noticed that a material has been added to modify the trail surface or to control erosion? If yes, describe how it affects your ability ...*

Question nineteen asked respondents if they had ever been on a dirt, grass or crushed stone trail where they noticed that a material had been added to modify the trail surface or to control erosion. Nearly a quarter of respondents (23%) responded "no" while 40% said that they did not know and 34% answered "yes". Of total respondents (12%) described that the change to the surface improved their ability to use the trail, while 5% noted that it made the trail more difficult to use. There were no noteworthy trends for individual categories of trail users.

5.0 DISCUSSION

5.1 Hikers/Walkers

The category of hikers/walkers had a response rate that was higher than any other category. This could be explained in part by the lower impact nature of hiking, or by the lack of design considerations that were identified in the literature review. Indeed, when asked which characteristics create problems for them, the most frequent response for hikers/walkers was "none". This apparent freedom from constraints likely contributes to the fact that for hikers/walkers the setting itself swayed preferences for trail surface materials. The highest number of hikers preferred woodchips for a forest setting and grass for a grassland environment. This finding was somewhat anticipated as Ryan (1993) found that woodchips were among the preferred surfaces for hikers.

The findings for hikers would suggest that the selection of a trail surface material for hiker/walkers should be based on setting. A trail designed for hikers and walkers might focus less on the removal of obstacles than in some other categories.

5.2 Joggers/Runners

The most preferred trail surface for joggers/runners was woodchips for a forest setting with the responses for most preferred surface in a grassland setting being evenly divided between woodchips and dirt. These findings were expected as the literature review found that joggers prefer woodchip surfaces (Westphal and Lieber, 1986). The literature review also revealed that hard surfaces could be jarring and that grass

surfaces can camouflage obstacles[30] (A Step Ahead Foot and Ankle Centers, 2002) which helps explain why certain other surfaces were not chosen as the most preferred.

For joggers/runners, the setting did not sway the preference for a woodchip surface, thus suggesting that the design of a trail to accommodate joggers/runners should take into account their functional requirements. The preference for woodchip surfaces for a forest setting would suggest that a trail designed for a jogger/runner would also accommodate a hiker, although for joggers/runners obstacles are more of a concern.

5.3 Equestrians

Equestrians often had responses that were different than the overall trend for all categories combined. For example, nearly half of respondents (42%) identified that boardwalk surfaces were difficult to use. Several of the respondents commented that wooden boardwalks could be slippery when wet and thus could be unsafe for the horse. Several more respondents noted that the sound of the hooves against the boardwalk could startle horses. As the literature has revealed, this can be problematic, in that strange noises can trigger a "fight or flight" response for horses (Kelly, 1998). Another interesting finding, albeit not unexpected, is that the only respondents who found asphalt surfaces difficult to use were equestrians. Some of the respondents noted that asphalt surfaces are hard on horse hooves and joints. This is in keeping with the findings from the literature review. The surface that received

[30] Naturally occurring obstacles were identified by the survey conducted for this thesis as the most problematic characteristic for joggers.

the highest number of responses for most preferred surface regardless of setting was dirt, followed by grass for a grassland, and woodchips for a forested setting,

The findings suggest that equestrians would benefit from having their own trail, as opposed to a multi use one, primarily because of the potential triggers of a "fight or flight" response discussed in the literature review. With regards to trail surfaces, the preference is towards soft surfaces (dirt, woodchips and grass). As the survey revealed that well drained trails were desired (response to questions 10 and 11), a trail designed for equestrians should be located on well-drained soils or elevated terrain. Poorly drained clay soils should be avoided as they can deform easily when wet, thus leaving ruts which when dry could be a hazard.

5.4 Cyclists

Research has shown that more experienced cyclists prefer a rougher surface (Westphal and Lieber, 1986). The results from this survey are reflective of this finding. The survey found that cyclists used trails more frequently as compared with the average for all categories. As dirt surfaces can be rough, it is understandable that for cyclists, the most preferred surface regardless of setting was dirt. The second most preferred surface varied with setting: grass for use in a grassland, and woodchips for a forested environment. This finding was surprising, as research has shown that woodchip surfaces (The Alberta Parks and Recreation Department, 1986) and long grass (Crowthers, 1996) can be problematic for cyclists. Also, woodchips had the second highest number of responses for least preferred surface regardless of

setting. A potential explanation for this could be because cyclists exhibited a stronger preference for physical challenge and obstacles than the average for all users. The desire for obstacles is virtually exclusive to cyclists[31].

5.5 People who use Wheelchairs/Scooters

With regards to respondents who use wheelchairs/scooters, none indicated that grass, dirt or woodchips were very easy to use. This can be rationalized, as the above-mentioned surfaces do not coincide with the most preferred trail characteristic for use in either a forest or a grassland setting, namely firmness. For people with disabilities, research has shown that soft, uneven or muddy surfaces can be problematic (Kidd, 1982). This is likely why asphalt, a surface commonly associated with having the characteristics of accessibility[32], was chosen most frequently by respondent who use wheelchairs/scooters as the most preferred surface for use in a forest or a grassland setting. Surprisingly, dirt surfaces had the second highest number of responses for most preferred trail surface for use in a forest setting.

This finding hints at the possibility that accessibility is not the foremost concern even for people with disabilities. This is relevant because although universal design strives to provide access for all, not every trail needs to be, or rather should be, accessible. Rather, if designing circulation through a natural site, an option might be to provide a trail which is "accessible" to key features of a site, with subsidiary routes of a different material, less commonly associated with accessibility.

[31] With the exception of one respondent with a visual impairment.
[32] For example: firm, stable, slip-resistant and obstacle free.

5.6 People who have an Ambulatory Impairment

(Insufficient number of responses to draw conclusions)

5.7 People with a Visual Disability

In examining the survey responses from people with a visual impairment, responses to several questions pointed to the shortcomings of grass as a trail surface material. Firstly, when asked how their disability affected their ability to use a trail (*Question 5*), a third of all respondents with a visual impairment stated that they prefer/require a surface to be distinguishable. Similarly, when asked to describe their ideal trail/trail surface for use in a grassland setting, the key characteristic that arose from the responses was the desire for a well-defined trail. In their response to the survey question 16 several people with a visual impairments commented that grass surfaces can be indistinguishable from the surrounding environment. Therefore, it is not surprising that for people with a visual impairment the least preferred surface for use in a grassland setting was grass; correspondingly, the most preferred surface for use in both forest and grassland settings was asphalt. In contrast to grass, when designed, constructed and maintained properly, asphalt surfaces are continuous, firm and distinguishable in a natural setting. In addition, asphalt surfaces can minimize the occurrence trail surface of rocks, holes, roots and stumps, all of which were listed as characteristics that cause problems for respondents with a visual impairment (*Question 12*).

The survey findings for this category offers insight into how, through proper design, trail surfaces can be more distinguishable from the environment. As a third of people with a visual impairment responded that they sometimes require assistance for wayfinding, it is important that trails designed to include people with disabilities make provisions for wayfinding. For example, if a grass surface must be used in a grassland environment, a strip of a distinguishable surface or tapping rails could be used to help define the intended path. This would be most effective if the trail was not excessively wide.

5.8 Parents of Young Children

Parents of young children preferred woodchips in a forest setting and grass in a grassland setting. Regardless of setting, asphalt was the least preferred surface, despite the fact that it ranked second in terms of most preferred surface for a forest setting. This difference could be attributed to some parents noting that they prefer asphalt when their child is in a stroller and another surface otherwise. Often parents would note concerns with regard to other materials, for example that compacted crushed stones could cause skinned knees if their child were to fall.

The findings for parents with young children demonstrated the most preferred surfaces is consistent with hikers/walker, but that preference is affected by the age of the child and the means of transportation. A shortcoming of the survey conducted for this thesis was that it did not provide a framework for which parents could list the age of their children and if they their child is usually in a stroller when using trails.

5.9 Seniors

The preferred surface for seniors echoes somewhat the preference of hikers/walkers and parents of young children. Seniors preferred woodchip surfaces for forest settings and grass for grassland environments. The similarities between the preferences of hikers/walkers, a parent of young children and seniors do not extend to the least preferred surface. For hikers/walkers and parents of young children, the least preferred surface regardless of setting was asphalt, while seniors indicated dirt. The preference for surface materials did not correspond with the level of trail difficulty.

The survey results hint at the benefits of designing a woodchip or grass trail (depending on setting) to accommodate senior, parents of young children and hikers/walkers. As the highest number of senior respondents indicated that dirt was their least preferred surface, experienced cyclists and seniors would likely not be satisfied by a shared trail accommodating seniors.

5.10 All Categories

As stated in Chapter 4.0, the overwhelming majority of all categories of trail users (83%) responded that "being in and viewing nature" was one of the most important aspect of their trail experience (*Question 9*) therefore it stands to reason that "natural" was the most frequently used term used to describe an ideal trail/trail surface for a grassland setting (*Question 11*) and the second most frequently used term with

regards to a forest setting (*Question 10*)[33]. Woodchips and dirt received equal number of responses as the most preferred surface for a forest setting. These surfaces also ranked low in terms of least preferred surface for a forest setting. Grass was the most preferred surface for a grassland setting followed by asphalt. Both surfaces also had a high number of responses for least preferred surface.

Although the overall preference was for more natural surface materials, for people with disabilities, asphalt was consistently the most preferred surface. Therefore it would be to the advantage of many people with disabilities if a trail system designed for the masses would also include a trail designed for them that would extend to connect key features and views.

[33] Woodchip surface(s) received the highest number of for a forest setting.

6.0 CONCLUSIONS

> *Among any group of individuals, there will be a wide range of abilities for each of the functions that affect the accessibility or usability of the sidewalk or trail".*
>
> *Beneficial Designs, 2001*

6.1 The Goal of this Thesis

The goal of this thesis was to determine user preferences for trail surfaces materials. This goal was met, as previously summarized in the Table 5 presented in Chapter 4.0. The results shown in the table indicate that there is not one surface that will meet the preferences of all trail users, or even all users within a category.

One of the findings from the literature review states that when designed, constructed and maintained properly, compacted crushed stones could be used by all categories of trail users. The survey found nothing to contradict this statements, however, it did discover that only one category of trail users had compacted crushed stones as one the two most preferred surfaces[33], whereas four listed it as one of the top two least preferred surface material. Another surface which was not examined for this thesis but could potentially accommodate all categories of trail users might be recycled rubber surfaces. Rubberized surfaces would provide cushioning for users including hikers, joggers, seniors and parents of young children, but would likely also accommodate people with disabilities, cyclist and equestrians. Although rubber

[33] People with visual impairments.

surfaces for many would not be aesthetically appropriate in more remote or wilderness settings, it would be environmentally friendly in that it makes use of waste material.

6.2 Obtaining Survey Results

One of the objectives of the survey was to obtain a random sample of twenty respondents for each of the nine trail user groups examined in this thesis. This proved to be much more difficult than anticipated. Often there was a significant lack of people in a particular trail user category who were both available and willing to complete a questionnaire regarding trail surface preferences. As a result, the data secured is slightly biased by low participation rates for some user groups. In the case of equestrians, people who use wheelchairs/scooters, and people who have a visual impairment, any willing respondent who matched the category was accepted.

Beneficial Designs Inc. (2001) recognized two types of barriers that affect a persons' ability to use a trail or sidewalk:

1) A movement barrier restricts a person's ability to physically move through an environment.
2) An information barrier restricts a person's ability to recognize/absorb information.

In addition to these barriers, a third became evident while trying to obtain survey results namely:

3) A socio–economic barrier restricts a person's ability to access trails due to social or financial status.

Trail usage for people with disabilities was not only affected by the trail surface, width, slope, cross slope and obstacles, but also by social and economic factors. Many survey respondents indicated that getting to recreational trails was a key issue and could be quite difficult as they relied on pubic transportation, friends or family for transportation. When asked to help arrange for the distribution of surveys to people with disabilities, Ms.Unruh, Resource Coordinator for Special Needs at the University of Winnipeg (2002) remarked that she could not think of a single disabled student she was working with who had the economic means even to pay for the transportation necessary to access recreational trails in the city. None, for example, owned their own vehicle. Indeed, she remarked, even the cost of city bus tickets to access an urban park trail was often financially problematic for the students she worked with. In addition, students often faced a social barrier when it came to accessing trails as most of the students were single and did not have partners to accompany or assist them in accessing a recreational trail.

The continued search for people with mobility impairments to participate in the survey offered important insight into the practical difficulties of securing such participants. Even more importantly, the search for participants clearly pointed to a social-economic barrier that can and does affect the ability of individuals to access recreational trails, particularly if they have a disability. While it is outside the scope of this thesis, the fact that such a social-economic barrier exists for many people with

disabilities suggests it is all the more important that good design take into account other, physical barriers such as trail surfaces which may inhibit access and perhaps that wilderness environments and trail systems become better integrated within cities.

6.3 Selection of Trail Surface Materials

The results of the survey have shown that preference for trail surface material varies with the type of trail user and environmental setting (i.e. forest or grassland). So how should designers go about selecting a trail surface? Beneficial Designs (2001) suggests: "[the] selection of trail surface material should be based on the type of trail user groups, the distance of the trail, the type of setting or experience desired and the characteristics of the natural environment". Expanding on this, while choosing a trail surface material one should also consider which trail users may not be able to negotiate through an environment because of the surface.

Designers and planners should realize, if a trail is designed to exclude horseback riding or mountain biking, the equestrian or the mountain biker can still presumably use the trail as a pedestrian. When a trail is designed to the exclusion of people with disabilities such as wheelchair users, often they have no other way of accessing a trail and its environment.

6.4 Enhancing Accessibility through Trail Information

For people with disabilities, simply stating that a trail is "accessible" or indicating such accessibility with a wheelchair symbol on signage is insufficient. Kidd (1982)

notes: "Accessibility to outdoor recreation facilities can be significantly enhanced by the availability of information relevant to the needs of the disabled people". Good design aimed at maximizing accessibility for people with disabilities will not only want to be based on good research and design to facilitate accessibility, it should also provide access to a trail description. Information regarding the length of a trail, the minimum widths, surface types, typical and maximum slopes/cross slopes, and obstacles to anticipate should be made readily available[34]. This allows individuals to make choices about which trail they should go on based on their knowledge of their own ability and the desired experience.

6.5 Shortcomings of Survey

Although the goal of thesis was reached, there were a few aspects of the survey that in hindsight could have been improved on:

- Question 8 – The words "frequently", "infrequently" and "occasionally" are subjective. Instead of using these terms, respondents should have been asked been asked to check off how many times per month or year they use a trail.
- Parents of young children should have been asked to record the age of their children and indicate whether they walked or were in a stroller.
- The intent of question nineteen was to discover if people found that soil stabilizers or geotextiles improved their ability to use a trail. Although the results demonstrated that 12% of respondents found modifications to trail surfaces improved their ability to use a trail, the question should have

[34] Beneficial Designs Inc. offers a Universal Trail Assessment Process workshop to facilitate the evaluation of trails.

provided a framework for respondents to describe the alteration, to answer why they thought the materials were there, and to describe how they thought it approved their ability to use the trail.

6.6 Future Research Pertaining to Trails

The realm of nature based tourism and accessibility offers many opportunities for future research, including:

- Enhancing information through trail information systems
- Universal design of trails in ecotourism destinations
- Universal design and environmental impact of trails
- Environmental impacts of trail materials as they relate to specific ecosystems
- Trail surface accessibility and geotextiles/stabilizers
- Wayfinding in wilderness environments

6.7 Concluding Statement

Trails and paths are fundamental in providing circulation through not only parks but also any site that includes human movement. As designers, however, it is critical that we not only provide site circulation but also understand the needs of various trail users and what surfaces they prefer. We must not impose our own assumptions or biases on other users, as they could be misguided or misguided.

With regards to universal accessibility, surfaces commonly associated with accessibility, such as asphalt, are not necessarily the most preferred surface for all

would likely use the trail, and then determine how, if appropriate, other users might be accommodated.

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Appendix A

Ethics Approval

APPROVAL CERTIFICATE

22 June 2001

TO: **Kristin Koenker** (Advisor L. Ringaert)
Principal Investigator

FROM: **Wayne Taylor, Interim Chair**
Joint-Faculty Research Ethics Board (JFREB)

Re: **Protocol #J2001:056**
"User Preferences for Trail Surfaces"

Please be advised that your above-referenced protocol has received human ethics approval by the **Joint-Faculty Research Ethics Board**, which is organized and operates according to the Tri-Council Policy Statement. This approval is valid for one year only.

Any significant changes of the protocol and/or informed consent form should be reported to the Human Ethics Secretariat in advance of implementation of such changes.

Survey Introductory Letter

Researcher: Kristin Koenker, Graduate Student Ph XXXX
Faculty Advisor: Dr. Marcella Eaton
Faculty of Architecture:
Department of Landscape Architecture
201 Russell Building
University of Manitoba
Winnipeg, Manitoba
Canada R3T 2N2

Date: November 19, 2001

Hi, my name is Kristin Koenker. I am a graduate student in the Landscape Architecture program at the University of Manitoba. I am currently working on my thesis regarding trail surfaces. I am requesting your participation in a brief survey regarding user preferences for various trail surfaces. Indeed, the survey is entitled "**User Preferences for Trail Surfaces**".

I am interested in surveying various trail users of different age, ability, and experience. One hundred and eighty people will be surveyed in total. Participation is completely voluntary and participants may drop out at any time. The study is composed of twenty questions and takes approximately fifteen minutes to complete. The University requires that a consent form be distributed prior to completion of the survey. Signing the consent form, however, does not obligate you to complete the survey.

If you have any questions or if you are willing to participate, I would appreciate receiving a phone call or an e-mail. My phone number is XXXX and my e-mail is: XXXX I look forward to discussing your participation or receiving your completed survey. Thank you for your kind assistance.

Sincerely,

Kristin Koenker

Ethics Protocol Submission Form

1. Summary of Project

The purpose of this survey is to determine the preferences of trail users in regards to various trail surfaces. The survey will be administered by focus groups, interviews and/or mail-in surveys. Participants will be recruited from one of the organizations listed below under the "Study Subjects" portion of this form (see appendix A-1 for the letter of explanation that will be given to the organizations).

Each organization will be contacted in regards to potential participants and an appropriate time and place to meet for interviews/focus groups. Mail in surveys will only be used in the event that enough participants cannot be reached for interview/focus groups.

Each of the surveys will take approximately fifteen minutes to complete. One hundred and eighty people will be surveyed in total. This is because I discuss nine user groups in my thesis: 1) hikers, 2)cyclists, 3) equestrians, 4) people with visual impairments, 5) people who use wheelchairs, 6) people who use a mobility aid, 7) seniors and 8) parents of young children. Therefore the goal is to reach twenty people of each user groups.

2. Research Instruments

Survey questionnaires have 20 questions and take approximately fifteen minutes to complete (see A-2 & 3). There are two surveys that are essentially the same, with the exception that one of them is particularly targeted at parents/guardians of young children. When the survey is distributed, the participants will be asked if they often their children with them on trails. The surveys will then be distributed accordingly.

3. Study Subjects

Some participants will have visual impairments. For people with visual impairments who would be unable to read the survey, the survey will be read to them and their responses will be accurately noted. The study will recruited participants from among the following organizations:

- Manitoba Runners Association
- Manitoba Naturalist Society
- Manitoba Wilderness Experience
- Friends of Manitoba Trails
- Manitoba Cycling Association
- Manitoba Horse Council
- Manitoba Riding for the Disabled Association
- Manitoba League of Persons with Disabilities Inc.
- Inter-Organizational Access Committee

- City of Winnipeg Access Advisory Committee
- Independent Living Resource Center
- MS Society
- Manitoba League of Persons with Disabilities Inc
- Manitoba League of Persons with Disabilities Inc
- Canadian Paraplegic Association – Audrey -
- Manitoba Society of Seniors
- Manitoba Child Care Association
- Manitoba Camping Association
- Manitoba Recreational Trail Association
- Lakeshore condominiums
- Epiphany Church

4. Informed Consent

Consent for the survey participation will be obtained (see appendix A-4). The participants will be explained the "nature of the study and participation" by the following description:

Hi my name is Kristin Koenker. I am a graduate student of landscape architecture program at the University. I am currently working on my thesis regarding trail surfaces. I am requesting your participation in a brief survey regarding user preferences for various trail surfaces. Participation is completely voluntary and you may drop out at any time. The study is composed of twenty questions and takes about ten to fifteen minutes to complete. If you agree to participate, the University of Manitoba requires me to distribute a consent prior to the survey. Signing the consent form, however, does not obligate you to complete the survey.

5. Deception

The research survey does not attempt to deceive any participants.

6. Feedback/Debriefing

Feedback will not be given unless requested because the results are not thought to be of particular value to the participants.

7. Risks and Benefits

The participants will not be at risk. The survey will only take up their time. There will be no direct benefit to the participants, as no payments will be given for completing the survey.

8. Anonymity and Confidentiality

There will be names only on the consent forms. The results of the survey will not identify participants or provide any descriptions that might allow identification of the participants.

9. Compensation

Participation is strictly voluntary. No compensation will be given.

Letter of Consent: Researcher's Copy

Researcher: Kristin Koenker, Ph# XXXX
Faculty Advisor: Dr. Marcella Eaton
Department of Landscape Architecture, 201 Russell Building
University of Manitoba, Winnipeg, Manitoba
Canada R3T 2N2

This consent form acknowledges that I, _____
(Please print first and last name) agree to take part in the survey "User Preferences for Trail Surfaces" which is being administered as part of Kristin Koenker's thesis for the University of Manitoba and understand that she is surveying trail users of different ages, abilities, and experience in an effort to determine user preferences. Two copies of this consent form are needed: one for myself (the participant) and one for the researcher.

For the following, please check off all boxes that apply.

I have been given:

- ☐ The researchers name (Kristin Koenker) and phone number XXXX
- ☐ The name of the researcher's faculty advisor (Dr. Marcella Eaton)
- ☐ The University's address (see above)
- ☐ A verbal and/or written explanation of the survey

I am aware that:

- ☐ The Joint-Faculty Research Ethics Board has approved this survey (see attached form).
- ☐ If I have any complaints regarding a procedure, I may contact the Human Ethics Secretariat (474-7122) or the Head of the Landscape Architecture department (474-7173) for referral to the Research Ethics Board.

I understand that:

- ☐ My participation in the survey is completely voluntary and no form of payment will be given to participants.
- ☐ I am able to withdraw from the survey at anytime.
- ☐ I can refrain from answering questions.
- ☐ The survey takes approximately five to fifteen minutes to complete.
- ☐ My name will be kept confidential.
- ☐ No recording devices will be used other than the survey sheets.
- ☐ There are no expected risks from completing this survey.
- ☐ Survey results will not be available to the participants unless specifically requested.

Date

Signature of Participant

Signature of Witness

I, Kristin Koenker, have explained to _____ (please print first and last name) the nature and purpose of this survey by means of an information sheet.

Date

Researcher: Kristin Koenker

Trail Surface Survey

PART 1 – USER PROFILE QUESTIONS

1. Age

☐ 18-30

☐ 31-40

☐ 41-50

☐ 51-60

☐ 61-70

☐ 71-80

☐ 80+

2. Gender

☐ Male

☐ Female

3. What category BEST describes you as a trail user? (Check one only!)

☐ Person without a mobility impairment or disability

☐ Person has a visual impairment

☐ Person who uses a wheelchair/scooter

☐ Person with an mobility impairment

4. What category BEST describes you as a trail user? (Check one only and ANSWER CONSEQUETIVE QUESTIONS ACCORDINGLY!!!)

☐ Walker/hiker

☐ Jogger/runner

☐ Cyclist

☐ Equestrian

☐ Person who uses a wheelchair/scooter

5. Do you have a disability?

☐ No

☐ Yes - If yes, please describe how, if at all, it affects your ability to use a trail. _____

_____

_____

_____

_____

_____

6. Do you use a mobility aid?

☐ No

☐ Yes - If yes, please describe what type of mobility aid you use._____

_____

_____

_____

_____

7. **Do you ever require assistance when using a trail?**

☐ No

☐ Yes - If yes, please describe how, if at all, it affects your ability to use a trail. _____
_____
_____
_____
_____

8. **How often do you use recreational trails? (Check one only!)**

☐ Infrequently

☐ Occasionally

☐ Frequently

PART 2 –QUESTIONS REGARDING TRAIL PREFERENCES

9. **When using a forest or prairie trail, what are the most important aspects of your trail experience? (Check all that apply)**

☐ General exercise

☐ Socializing with the people you are with

☐ Being in and viewing nature

☐ Minimizing impacts to the environments

☐ Physical challenge

☐ Other (Describe)_____

10. Describe your ideal trail (in particular TRAIL SURFACE) for use in a FOREST setting. _____

_____

_____

_____

_____

_____

11. Describe your ideal trail (in particular TRAIL SURFACE) for use in a PRAIRIE GRASSLAND setting. _____

_____

_____

_____

_____

12. What trail surfaces and/or other trail characteristics create problems for you when you use a trail? _____

_____

_____

_____

_____

13. Which of the following surfaces have you used? (Check all that apply)

☐ Dirt

☐ Asphalt

☐ Wooden Boardwalk

☐ Woodchips

☐ Compacted crushed stones

☐ Grass

14. Rank each of the following trail surfaces according to preference for use in a FOREST setting from most preferred (= 1) to least preferred (= 6).

Dirt____

Asphalt____

Wooden Boardwalk____

Woodchips____

Compacted crushed stones____

Grass____

Comments _____

_____

15. Rank each of the following trail surfaces according to preference for use in a PRAIRIE GRASSLAND setting from most preferred (= 1) to least preferred (= 6).

Dirt____

Asphalt____

Wooden Boardwalk____

Woodchips____

Compacted crushed stones____

Grass____

Comments _____

_____

16. For each trail surface complete the following statements by checking one box for each surface.

Using a **dirt** trail is generally:

☐ very easy ☐ somewhat easy ☐ moderately difficult ☐ difficult ☐ very difficult

Comments:_____

Using an **asphalt** trail is generally:

☐ very easy ☐ somewhat easy ☐ moderately difficult ☐ difficult ☐ very difficult

Comments:_____

Using a **wooden boardwalk** trail is generally:

☐ very easy ☐ somewhat easy ☐ moderately difficult ☐ difficult ☐ very difficult

Comments:_____

Using a **woodchips** trail is generally:

☐ very easy ☐ somewhat easy ☐ moderately difficult ☐ difficult ☐ very difficult

Comments:_____

Using a **compacted crushed stone** trail is generally:

☐ very easy ☐ somewhat easy ☐ moderately difficult ☐ difficult ☐ very difficult

Comments:_____

Using a **grass** trail is generally:

☐ very easy ☐ somewhat easy ☐ moderately difficult ☐ difficult ☐ very difficult

Comments:_____

17. What factors would likely prompt you to move/hike/ride off of a trail? (Check all that apply)

☐ Short cuts

☐ Point of interest

☐ Solitude

☐ More challenge

☐ Other _____

_____

18. If you knew water had accumulated on a trail after a heavy rain, what would you do? (Check one only!)

☐ Not use the trail

☐ Try to use the trail, but leave the trail to get around puddles.

☐ Try to use the trail, but walk or ride through puddles.

19. Have you ever been on a dirt, grass, or crushed stone trail where you noticed that a material had been added to modify the trail surface or to control erosion?

☐ No

☐ Don't know

☐ Yes - If yes, please describe how, if at all, it affects your ability to use a trail. _____

_____

_____

Thank-you so much for your help !!!!!!!

Trail Surfaces Survey:
For Parents or Guardians of Young Children

PART 1 – USER PROFILE QUESTIONS

1. Age

☐ 18-30

☐ 31-40

☐ 41-50

☐ 51-60

☐ 61-70

☐ 71-80

☐ 80+

2. Gender

☐ Male

☐ Female

3. What category BEST describes you as a trail user? (Check one only!)

☐ Person without a mobility impairment or disability

☐ Person has a visual impairment

☐ Person who uses a wheelchair/scooter

☐ Person with an mobility impairment

4. What category BEST describes the primary mode of transportation for you and your child/children as a trail user? (Check one only and ANSWER CONSEQUETIVE QUESTIONS ACCORDINGLY!!!)

☐ Walker/hiker

☐ Jogger/runner

☐ Cyclist

☐ Equestrian

☐ Person who uses a wheelchair/scooter

5. Do you have a disability?

☐ No

☐ Yes - If yes, please describe how, if at all, it affects your ability to use a trail. _____

_____

_____

_____

_____

_____

6. Do you use a mobility aid?

☐ No

☐ Yes - If yes, please describe what type of mobility aid you use._____

_____

_____

_____

_____

7. Do you ever require assistance when using a trail?

☐ No

☐ Yes - If yes, please describe how, if at all, it affects your ability to use a trail. _____
_____
_____
_____
_____

8. How often do you use recreational trails with your child/children? (Check one only!)

☐ Infrequently

☐ Occasionally

☐ Frequently

PART 2 –QUESTIONS REGARDING TRAIL PREFERENCES

9. When using a forest or prairie trail with your child/children, what are the most important aspects of your trail experience? (Check all that apply)

☐ General exercise

☐ Socializing with the people you are with

☐ Being in and viewing nature

☐ Minimizing impacts to the environments

☐ Physical challenge

☐ Other (Describe)_____

10. Describe your ideal trail (in particular TRAIL SURFACE) for use with your child/children in a FOREST setting. _____

_____

_____

_____

_____

_____

11. Describe your ideal trail (in particular TRAIL SURFACE) for use with your child/children in a PRAIRIE GRASSLAND setting.

_____

_____

_____

_____

_____

12. What trail surfaces and/or other trail characteristics create problems for you and your child/children when you use a trail? (please describe)_____

_____

_____

_____

13. Which of the following surfaces have you used with your child/children? (Check all that apply)

☐ Dirt

☐ Asphalt

☐ Wooden Boardwalk

☐ Woodchips

☐ Compacted crushed stones

☐ Grass

14. Rank each of the following trail surfaces according to your preferred use with your child/children in a FOREST setting from most preferred (= 1) to least preferred (= 6).

Dirt____

Asphalt____

Wooden Boardwalk____

Woodchips____

Compacted crushed stones____

Grass____

Comments _____

_____

15. Rank each of the following trail surfaces according to your preferred use with your child/children in a PRAIRIE GRASSLAND setting from most preferred (= 1) to least preferred (= 6).

Dirt____

Asphalt____

Wooden Boardwalk____

Woodchips____

Compacted crushed stones____

Grass____

Comments _____

_____

16. For each trail surface complete the following statements by checking one box for each surface.

Using a **dirt** trail with my child/children is generally:

☐ very easy ☐ somewhat easy ☐ moderately difficult ☐ difficult ☐ very difficult

Comments:_____

Using an **asphalt** trail with my child/children is generally:

☐ very easy ☐ somewhat easy ☐ moderately difficult ☐ difficult ☐ very difficult

Comments:_____

Using a **wooden boardwalk** trail with my child/children is generally:

☐ very easy ☐ somewhat easy ☐ moderately difficult ☐ difficult ☐ very difficult

Comments:_____

Using a **woodchips** trail with my child/children is generally:

☐ very easy ☐ somewhat easy ☐ moderately difficult ☐ difficult ☐ very difficult

Comments:_____

Using a **compacted crushed stone** trail with my child/children is generally:

☐ very easy ☐ somewhat easy ☐ moderately difficult ☐ difficult ☐ very difficult

Comments:_____

Using a **grass** trail with my child/children is generally:

☐ very easy ☐ somewhat easy ☐ moderately difficult ☐ difficult ☐ very difficult

Comments:_____

17. What factors would likely prompt you and your child/children to move/hike/ride off of a trail? (Check all that apply)

☐ Short cuts

☐ Point of interest

☐ Solitude

☐ More challenge

☐ Other _____

_____

18. If you knew water had accumulated on a trail after a heavy rain, what would you do? (Check one only!)

☐ Not use the trail

☐ Try to use the trail, but leave the trail to get around puddles.

☐ Try to use the trail, but walk or ride through puddles.

19. Have you ever been on a dirt, grass, or crushed stone trail where you noticed that a material had been added to modify the trail surface or to control erosion?

☐ No

☐ Don't know

☐ Yes - If yes, please describe how, if at all, it affects your ability to use a trail. _____

_____

_____

_____

_____

Thank-you so much for your help !!!!!!!

Survey Responses: Raw Data

Table A1. Responses to Question 1: Age

Categories of Trail Users	Age							
	18-30	31-40	41-50	51-60	61-70	71-80	80+	Total
Hikers	21	10	15	14	0	0	0	60
Joggers/Runners	7	5	7	1	1	0	0	21
Equestrians	6	5	7	1	0	0	0	19
Cyclists	11	2	3	3	0	0	0	19
People who use Wheelchairs/Scooters	2	2	4	2	1	3	0	14
People who have an Ambulant Disability	0	1	1	0	2	1	0	5
People who have a Visual Impairment	1	9	5	4	1	1	0	21
Parents with Young Children	5	12	2	0	0	0	0	19
Seniors	0	0	0	0	6	10	4	20
Total	53	46	44	25	11	15	4	198

Table A2. Responses to Question 2 Gender

Categories of Trail Users	Gender		
	Male	Female	Total
Hikers/Walkers	24	36	60
Joggers/Runners	11	9	20
Equestrians	2	17	19
Cyclists	10	9	19
People who use Wheelchairs/Scooters	9	5	14
People who have an Ambulant Disability	1	4	5
People who have a Visual Impairment	7	14	21
Parents with Young Children	6	14	20
Seniors	13	7	20
Total	83	115	198

Table A3. Responses to Question 3: What category best describes you as a trail user

Responses			
Person Without a Mobility Impairment	Person wh has a Visual Impairment	Person who Uses a Wheelchair / Scooter	Person with an Mobility Impairment
158	14	5	21

Table A4. Responses to Question 4: What category best describes you as a trail user?

Responses				
Walker / Hiker	Jogger / Runner	Cyclist	Equestrian	Person Who Uses a Wheelchair / Scooter
126	20	19	19	14

Table A5. Responses to Question 5: Do you have a disability? - If yes, please describe how, if at all, it affects your ability to use a trail.

	Responses							
Category of Trail Users	No	Yes (Certain surface characteristics ie.firm, level, even, smooth)	Yes (Distinguishable surface)	Yes (Obstacle free)	Yes (Level changes - abrupt, slopes, cross slopes)	Yes (Wayfinding)	Yes (Wheelchair accessible)	Yes (Sufficient width to maneuver)
Hikers	60	0	0	0	0	0	0	0
Joggers/Runners	20	0	0	0	0	0	0	0
Equestrians	19	0	0	0	0	0	0	0
Cyclists	18	0	0	0	0	0	0	0
People who use Wheelchairs/Scooters	0	7	0	0	6	0	1	1
People who have an Ambulant Disability	1	1	0	0	0	0	0	0
People who have a Visual Impairment	0	2	7	4	1	3	0	0
Parents with Young Children	19	0	0	0	0	0	0	0
Seniors	17	0	0	0	0	0	0	0
Total	154	10	7	4	7	3	1	1

Table A6. Responses to Question 6: Do you use a mobility aid? If yes, please describe what type of mobility aid you use.

	Responses										
Categories of Trail Users	No	Yes - White mobility cane	Wheelchair	Yes - Power wheelchair	Yes - Guide dog	Yes - Walker	Yes - cane	Scooter	Depends on conditions (lighting / amount of People)	Yes - Elbow crutches	Yes - Adult trike
Hikers	60	0	0	0	0	0	0	0	0	0	
Joggers/Runners	20	0	0	0	0	0	0	0	0	0	
Equestrians	19	0	0	0	0	0	0	0	0	0	
Cyclists	19	0	0	0	0	0	0	0	0	0	
People who use Wheelchairs/Scooters	0	0	10	6	0	0	0	3	0	1	
People who have an Ambulant Disability	1	0	2	0	0	4	0	0	0	0	1
People who have a Visual Impariment	1	13	0	0	5	0	4	0	1	0	
Parents with Young Children	19	0	0	0	0	0	0	0	0	0	
Seniors	20	0	0	0	0	0	0	0	0	0	
Total	159	13	12	6	5	4	4	3	1	1	1

Table A7. Responses to Question 7: Do you ever require assistance when using a trail? If yes - describe how, if at all, it affects your ability to use a trail.

	Responses									
Categories of Trail Users	No	Depends of Condition of Trail / Obstacles / type of mobility aid	yes - No comment on ability	Yes - Slopes/cross slopes	Yes - Wayfinding / trail descriptions	Yes - Certain surfaces	Yes - At Night / Low Light	Yes - Steps	Yes - scheduling time	Yes - It doesn't
Hikers	60	0	0	0	0	0	0	0	0	0
Joggers/Runners	21	0	0	0	0	0	0	0	0	0
Equestrians	19	0	0	0	0	0	0	0	0	0
Cyclists	19	0	0	0	0	0	0	0	0	0
People who use Wheelchairs/Scooters	3	6	3	8	0	6	0	1	0	0
People who have an Ambulant Disability	1	1	2	1	0	0	0	0	0	0
People who have a Visual Impariment	1	4	6	0	7	0	2	1	1	1
Parents with Young Children	19	0	0	0	0	0	0	0	0	0
Seniors	20	0	0	0	0	0	0	0	0	0
Total	163	11	11	9	7	6	2	2	1	1

Table A8. Responses to question 8: How often do use recreational trails?

	Responses		
Categories of Trail Users	**Infrequently**	**Occasionally**	**Frequently**
Hikers/Walkers	17	31	12
Joggers/Runners	2	13	5
Equestrians	3	11	5
Cyclists	1	12	6
People who use Wheelchairs/Scooters	5	7	3
People who have an Ambulant Disability	1	3	1
People who have a Visual Impairment	6	10	5
Parents with Young Children	2	11	6
Seniors	6	10	4
Total	43	108	47

9. Responses to Question 9: When using a trail, what are the most important aspects of your trail experience

	Responses											
Categories of Trail Users	**General Exercise**	**Socializing**	**Nature**	**Minimizing impact to the Environment**	**Physical Challenge**	**Other: Scenery**	**Other: Stress Relief**	**Other: Time with Family / Horse**	**Other: Away from People / Noise**	**Other: Safety**	**Other: Pleasant for Horse**	**Other: Developing Trails**
Hikers/Walkers	43	25	57	23	15	2	0	1	0	0	0	1
Joggers/Runners	17	7	12	5	7	0	0	0	0	0	0	0
Equestrians	17	9	16	9	11	0	0	2	2	2	1	0
Cyclists	16	8	15	8	10	0	1	0	0	0	0	0
People who use Wheelchairs/Scooters	4	6	14	1	5	1	0	0	0	0	0	0
People who have an Ambulant Disability	3	2	4	3	0	0	0	0	0	0	0	0
People who have a Visual Impairment	18	15	14	2	5	0	1	0	0	0	0	0
Parents with Young Children	19	13	15	3	4	0	0	1	1	1	0	0
Seniors	9	5	11	4	3	0	0	0	0	0	0	0
Total	146	90	158	58	60	3	2	4	3	3	1	1

Table A10. Responses to Questions 10: Describe your ideal trail (in particular trail surface) for use in a forest setting.

	Responses																																									
Categories of Trail Users	Woodchips	Natural	Flat / Level / Even	Dirt / Packed Dirt	Varied Terrain / Settings	Trees / Vegetation	Sufficient Width	Firm	Winding	Well Drained / No Mud	Point of Interest / Wildlife	Gravel / Packed Gravel	Crushed Stones	Quiet / Away from Public	Sandy	Well Marked	Asphalt	Grass	Paved	No Roots / Stumps	Minimal Environmental Impact	Challenging	Not Rocky	No Ruts / Potholes	No Obstacles	No Overhead Obstacles	Pine Needles / Leaves	Soft	No Gravel	Boardwalk	Unpaved	Cushioning	Well Defined	Obstacles	No ATVs	Well Maintained / Planned	Little to No Cross Slope	Safety	Never Been	Narrow
Hikers/walkers	14	20	4	7	9	5	2	0	4	1	2	0	2	4	0	4	1	0	1	1	2	1	0	0	0	0	1	0	2	2	3	0	0	0	0	2	1	0	0	2
Joggers/ Runners	7	2	3	1	7	4	1	0	4	2	3	2	1	1	1	2	1	1	1	1	1	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Equestrians	2	3	6	7	2	3	5	0	0	8	0	0	1	1	6	1	0	2	0	2	1	2	3	3	3	2	4	3	1	0	1	4	0	0	2	1	0	0	0	0
Cyclists	3	3	2	3	4	2	2	3	2	0	2	2	0	3	0	0	0	1	1	1	2	2	0	0	2	1	0	0	0	1	0	0	0	3	1	0	0	0	0	0
People who use Wheelchairs/ Scooters	0	0	2	1	0	0	4	7	1	0	1	0	3	0	0	0	2	0	2	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	2	0	2	0
People who have an Ambulant Disability	1	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
People who have a Visual Impairment	2	0	4	7	0	0	0	2	1	0	1	3	3	0	0	1	2	0	0	1	0	0	2	2	0	3	0	0	0	0	0	0	4	1	0	0	0	0	1	1
Parents with Young Children	7	3	4	2	0	2	0	1	1	0	1	2	0	0	0	0	1	2	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
Seniors	7	2	2	1	0	0	0	1	0	1	1	2	0	1	1	0	0	2	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Total	43	33	30	29	22	16	15	14	13	12	11	11	10	10	8	8	8	8	8	7	7	7	6	6	6	6	5	5	5	5	4	4	4	4	3	3	3	3	3	3

Table A11. Responses to Questions 11: Describe your ideal trail (in particular trail surface) for use in a grassland

	Responses																																					
Categories of Trail Users	Natural	Dirt	Woodchips	Smooth / level . Flat	Dry / well drained / no mud	Crushed stones	Firm / hard surface	Sufficient width	Asphalt	Varied	Well marked	Gravel / packed gravel	No obstacles	Winding	Natural cut	Point of interest / wildlife	No ruts / potholes	Low impact	Boardwalk	Well defined	Paved	Vegetation	Soft	No steel inclines	Quiet	No gravel	Unpaved	Challenging	No Stones	No roots	Boardwalk for wet areas	Water	Flat	Sandy	Cushioning	Visibility	Public transportation
Hikers/Walkers	20	7	13	5	3	1	1	2	3	2	5	2	0	1	3	0	0	3	4	0	1	1	0	0	0	1	3	1	1	0	1	0	0	0	1	0
Joggers/Runners	5	5	4	2	1	0	0	0	0	2	0	2	2	2	1	0	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0
Equestrians	7	6	1	3	7	1	0	3	0	1	1	0	3	0	1	0	7	0	0	0	0	1	4	0	1	2	1	0	3	2	1	2	2	2	2	2	0
Cyclists	6	2	0	0	2	1	2	1	1	4	1	1	0	2	0	1	0	2	2	0	1	1	0	0	2	0	0	2	0	0	1	1	1	1	0	0	1
People who use Wheelchairs/ Scooters	0	2	0	3	1	4	6	4	2	0	0	0	0	1	0	2	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
People who have an Ambulant Disability	0	0	0	3	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
People who have a Visual Impairment	0	5	3	2	0	3	2	0	3	0	1	3	1	0	1	1	0	0	0	6	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	2
Parents with Young Children	7	3	3	1	0	2	1	0	1	0	0	0	0	1	0	2	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Seniors	5	0	3	1	0	1	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0	0	0
Total	50	30	27	20	14	13	12	11	11	9	8	8	8	7	7	7	7	6	6	6	5	5	5	4	4	4	4	4	4	4	4	4	3	3	3	3	3

Table 12. Responses to Question 12: What trail surfaces and/or other trail characteristics create problems for you

	Responses																																		
Categories of Trail Users	**Mud**	**Rocks**	**Roots / Stumps**	**Gravel**	**Uneven Surfaces**	**None**	**Holes / Ruts**	**Insufficient width**	**Generic Obstacles**	**(Low) Branches**	**Slopes**	**Woodchips**	**Improperly Maintained Trails**	**Sand**	**Long / Thick Grass**	**Indistinguishable**	**Soft**	**Boggy Areas**	**Poorly Marked**	**Cross Slope**	**Paved / Asphalt**	**Boardwalk**	**Very Hard Surfaces**	**Insufficient Passing Space**	**Surfaces Changes**	**Cyclists / ATVs**	**Overhead Obstacles**	**Noisy**	**Dirt**	**Irregular Spacing (Steps / Logs)**	**Steps / Stairs**	**Fallen Trees**	**Crushed Stones**	**Slippery Surfaces**
Hikers/Walkers	9	9	11	2	4	14	0	1	0	2	1	0	2	2	1	0	0	0	2	1	1	0	0	0	0	0	0	0	1	0	1	2	0	1
Joggers/Runners	2	5	6	2	3	0	2	1	1	0	0	1	1	0	0	1	0	0	0	1	1	1	2	0	0	0	0	0	1	1	0	0	1	1
Equestrians	10	11	5	2	3	0	5	2	2	5	1	0	0	0	3	0	0	3	1	0	2	0	2	4	0	3	0	3	0	0	1	1	0	1
Cyclists	4	1	2	2	0	1	0	1	2	0	0	2	2	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
People who use Wheelchairs/Scooters	3	1	1	3	2	0	0	4	2	1	5	2	0	3	0	0	2	0	1	3	0	1	0	0	0	0	1	0	0	1	0	0	0	0
People who have an Ambulant Disability	2	0	0	2	1	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
People who have a Visual Impairment	3	9	9	0	2	0	6	2	4	2	0	0	0	0	0	5	0	1	0	0	0	1	0	0	4	0	2	0	0	0	0	0	0	0
Parents with Young Children	11	3	1	4	3	1	1	0	0	0	1	3	2	1	1	0	2	1	1	0	0	1	0	0	0	0	0	0	0	1	1	0	1	0
Seniors	4	1	2	3	1	2	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	2	1
Total	48	40	37	20	19	18	14	12	12	11	10	9	8	7	6	6	5	5	6	5	4	6	4	4	4	3	3	3	3	3	3	3	4	4

Table A13. Responses to Question 13: Which of the following surfaces have you used?

	Responses					
Categories of Trail Users	Dirt	Asphalt	Wooden Boardwalk	Woodchips	Compacted Crushed Stones	Grass
Hikers/Walkers	57	48	49	47	40	47
Joggers/Runners	20	18	10	15	13	15
Equestrians	19	11	6	11	9	18
Cyclists	18	17	12	14	13	14
People who use Wheelchairs/ Scooters	13	13	10	7	12	12
People who have an Ambulant Disability	5	5	5	3	3	3
People who have a Visual Impairment	18	18	15	14	17	18
Parents with Young Children	19	17	17	17	16	17
Seniors	19	16	15	15	13	17
Total	188	163	139	143	136	161

Responses to Question 14: Rank each of the following surface according to preference for use in a forest setting.

	Surface and Rank (1-most preferred to 6-least preferred)																																	
	Dirt						Asphalt						Boardwalk						Woodchips						Compacted Crushed Stones						Grass					
Categories of Trail Users	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Hikers/Walkers	18	11	6	7	6	8	7	3	3	4	14	24	4	10	11	15	12	4	20	11	14	5	5	2	3	5	12	14	10	14	12	15	11	7	5	8
Joggers/Runners	7	5	2	3	1	1	1	2	5	3	5	4	1	0	2	5	4	6	10	5	1	3	0	1	2	3	3	4	3	3	1	2	6	2	3	3
Equestrians	12	2	2	1	2	0	2	0	0	3	6	6	1	8	3	1	6	5	3	4	9	1	1	1		1	3	7	5	1	2	10	4	2	0	1
Cyclists	8	1	2	3	2	1	2	2	3	3	0	8	1	5	3	0	7	1	5	3	2	2	2	3	2	4	5	4	3	0	3	4	3	4	1	2
People who use Wheelchairs/ Scooters	2	0	2	3	1	3	8	1	2	0	0	1	1	4	4	1	2	0	0	0	0	2	2	7	1	6	1	1	2	0	1	0	3	4	2	2
People who have an Ambulant Disability	0	0	2	3	0	0	3	0	0	0	1	1	1	2	2	0	2	1	1	0	0	1	2	1	0	1	1	1	0	2	1	1	0	0	1	2
People who have a Visual Impairment	4	4	3	5	3	2	8	2	3	3	2	3	2	4	4	4	3	4	1	6	4	2	6	3	7	2	5	2	3	2	0	2	5	4	4	7
Parents with Young Children	2	5	5	0	4	2	4	0	0	1	2	11	2	1	8	4	1	2	6	3	3	4	1	2	1	2	2	3	6	4	4	5	2	3	0	4
Seniors	0	2	5	0	2	7	6	1	3	2	2	1	0	2	5	2	4	2	7	2	2	2	2	0	1	6	2	3	0	4	4	1	1	6	3	1
Total	53	30	29	25	21	24	41	11	19	19	32	59	13	36	42	32	41	25	53	34	35	22	21	20	17	30	34	39	32	30	28	40	35	32	19	30

Table A15. Responses to Question 15: Rank each of the following surface according to preference for use in a grassland setting.

Categories of Trail Users	Surface and Rank (1-most preferred to 6-least preferred)																																	
	Dirt						Asphalt						Wooden Boardwalk						Woodchips						Compacted Crushed Stones						Grass				
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5
Hikers/Walkers	10	15	10	8	6	9	6	3	3	3	10	32	7	6	15	14	11	3	13	16	10	14	2	2	2	6	12	10	18	10	22	12	17	5	5
Joggers/Runners	6	5	1	4	2	1	2	2	4	2	4	4	0	0	2	5	5	7	6	1	9	1	1	2	1	5	0	5	2	4	4	3	3	2	2
Equestrians	9	6	0	0	3	0	2	0	0	3	7	6	0	2	0	3	4	9	1	3	14	1	0	0	0	1	2	10	4	1	7	6	3	1	0
Cyclists	7	3	1	4	1	2	2	1	3	3	1	9	2	3	2	1	9	1	1	3	6	3	1	3	1	6	5	4	2	2	6	4	0	4	4
People who use Wheelchairs/Scooters	1	1	2	3	2	3	11	0	1	0	0	1	1	4	3	1	1	1	0	0	0	1	3	7	1	5	2	1	2	0	0	1	2	5	1
People who have an Ambulant Disability	0	0	2	3	0	0	2	1	0	0	1	1	1	2	0	1	1	0	0	1	0	1	2	1	1	0	2	0	0	2	1	1	0	0	1
People who have a Visual Impairment	3	4	3	6	3	3	8	2	3	3	3	2	1	4	7	3	3	3	2	7	2	2	5	3	7	1	6	2	4	1	2	1	3	3	2
Parents with Young Children	1	6	3	4	2	2	4	0	1	1	2	10	3	2	6	2	2	3	2	6	4	3	1	2	1	1	3	1	7	4	9	3	0	3	0
Seniors	0	9	1	0	2	6	3	1	2	2	3	5	1	2	4	4	3	1	5	1	4	3	2	0	4	4	4	1	1	1	9	2	0	2	3
Total	37	42	23	32	21	26	40	10	17	17	31	70	16	25	39	34	39	28	30	38	49	29	17	20	18	29	36	34	40	25	60	33	28	25	18

Table A16. Responses to Question 16: For each trail surface, complete the following statement: Using a ____(trail surface) is generally _____ (level of difficulty).

Categories of Trail Users	Dirt					Aspalt					Boardwalk					Woodchips					Compacted Crushed Stones					Grass				
	Very Easy	Easy	Moderate	Difficult	Very Difficult	Very Easy	Easy	Moderate	Difficult	Very Difficult	Very Easy	Easy	Moderate	Difficult	Very Difficult	Very Easy	Easy	Moderate	Difficult	Very Difficult	Very Easy	Easy	Moderate	Difficult	Very Difficult	Very Easy	Easy	Moderate	Difficult	Very Difficult
Hikers/Walkers	20	30	8	1	0	49	7	0	2	0	39	15	3	0	0	29	23	5	3	0	17	29	12	1	0	31	23	3	1	0
Joggers/Runners	6	8	3	1	0	10	6	2	0	0	3	5	7	1	3	5	10	2	1	0	4	6	3	3	1	1	9	4	2	1
Equestrians	16	2	0	1	0	3	3	3	3	6	1	5	2	2	8	12	4	3	0	0	1	9	3	4	1	15	4	0	0	0
Cyclists	6	7	4	1	1	16	1	1	1	0	7	8	2	0	0	4	7	4	2	0	5	10	1	2	1	3	10	5	1	0
People who use Wheelchairs/Scooters	0	6	5	0	2	11	1	0	0	0	1	0	0	0	0	0	1	3	4	4	3	4	2	3	1	0	7	4	2	0
People who have an Ambulant Disability	0	1	2	2	0	3	1	0	1	0	1	3	0	0	0	0	0	1	2	2	0	0	1	2	0	1		1	1	2
People who have a Visual Impariment	4	8	7	1		14	5	0	0	0	9	5	6	1	0	4	6	8	1	1	6	7	3	3	1	5	1	8	4	2
Parents with Young Children	4	8	2	4	1	18	0	0	1	0	9	8	1	1	0	6	5	3	3	2	7	3	3	2	2	10	6	3	0	1
Seniors	4	8	3	3	0	15	2	1	0	0	7	9	2	0	1	6	10	1	1	0	3	6	5	3	1	7	6	5	1	0
Total	60	78	34	14	4	139	26	7	8	6	77	58	23	5	12	66	66	30	17	9	46	74	33	23	8	73	66	33	12	6

Table A17. Responses to Question 17: What factors would likely pron you to move / hike / ride off of a trail?

	Responses										
Categories of Trail Users	Short Cuts	Point of Interest	Solitude	More Challenge	Other: People in Group	Other: Scenery/ wildlife	Other: Infrastructure	Other: Special interests	Other: Seeking better terrain	Other: Never Leave Trail	Other: Passing
Hikers/Walkers	12	52	28	24	2	4	0	0	2	0	0
Joggers/Runners	3	12	10	14	0	1	0	0	2	0	0
Equestrians	8	13	11	11	0	1	0	1	2	0	1
Cyclists	7	14	10	12	0	1	0	1	1	0	0
People who use Wheelchairs/ Scooters	7	12	7	5	0	1	2	0	1	0	0
People who have an Ambulant Disability	2	5	3		0	0	0	0	0	0	0
People who have a Visual Impairment	4	12	4	7	0	0	1	1	0	2	1
Parents with Young Children	8	17	8	9	0	0	0	1	0	0	0
Seniors	4	8	7	5	0	1	1	0	0	0	0
Total	55	145	88	87	2	9	4	4	8	2	2

Table A18. Responses to Question 18: If you knew that water had accumulated on a trail after a heavy rain, what would you do?

	Responses		
Categories of Trail Users	Not Use the Trail	Use Trail But Leave to Go Around Puddles	Use Trail and Go Through Puddles
Hikers/Walkers	21	31	5
Joggers/Runners	10	7	3
Equestrians	7	4	8
Cyclists	6	7	5
People who use Wheelchairs/Scooters	7	4	3
People who have an Ambulant Disability	3	2	0
People who have a Visual Impairment	14	5	2
Parents with Young Children	5	13	1
Seniors	7	6	0
Total	80	79	27

Table A19. Responses to Question 19: Have you ever been on a dirt, grass, or crushed stone trail where you noticed that a material has been added to modify the trail surface or to control erosion? If yes, describe how it affects your ability ...

	Responses					
Categories of Trail Users	No	Don't Know	Yes: Improved	Yes: No Difference	Yes: No Comment on Ability	Yes: Difficult
Hikers/Walkers	7	31	10	4	7	
Joggers/Runners	3	9	1	1	4	3
Equestrians	7	4	3	1	4	1
Cyclists	4	5	1	2	4	2
People who use Wheelchairs/Scooters	4	7	2			
People who have an Ambulant Disability	1	2	2			
People who have a Visual Impairment	13	4	1		2	1
Parents with Young Children	3	9	2	1	2	1
Seniors	3	9	1	1	1	2
Total	45	80	23	10	24	10

Appendix B

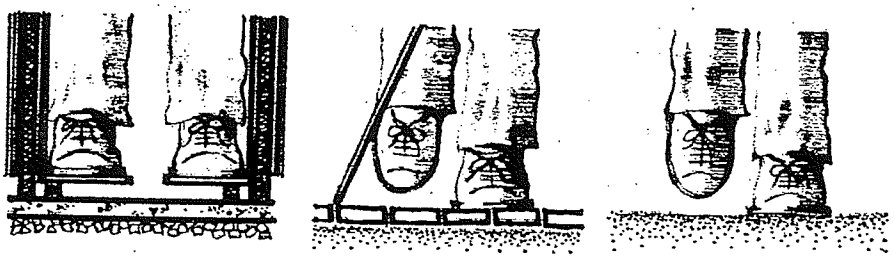
Trail Surfaces and Accessibility

3.2 Ground Surfaces

3.2.1 General

Ground surfaces shall be firm, stable and slip-resistant (CSA 3.3.1).

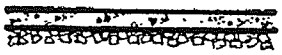
A **firm** surface is highly resilient to deformation under concentrated loads. For example, the bearing surface of a crutch, cane tip or wheelchair tire is considerably smaller than the net area of the average shoeprint. A **stable** surface is one that does not move unpredictably when subjected to pedestrian traffic. A **slip-resistant** surface is, by definition, not slippery under wet or dry conditions.



In decreasing order of accessibility, the following surfaces offer different levels of challenge.

Consideration should be given to selecting surfaces that blend with the environment, whether urban, natural or historic.

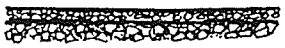
Concrete:
Concrete must be placed on a well prepared base that is clean and free of debris. Finishes should have a light texture4 such as a broom finish - so that the surface is not slippery when wet. The trail or pathway should drain the water off the surface so that it does not stand or freeze.



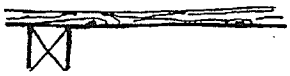
Source: Canadian Heritage Parks Canada; Design Guidelines for Accessible Outdoor Recreation Facilities: Access Series, Minister of Canadian Heritage, Canada, 1995

Asphalt:
Asphalt should also be carefully laid and maintained. An epoxy finish, coated with sand, may be used to give a natural appearance to the pathway and reduce softening problems in very sunny locations.

Crushed Aggregate Screenings:
Crushed aggregate screenings (CAS) can be any decomposed granite, crushed stone, chat, limestone, quarry fines or stone dust that is 6 mm (1/4") or finer in size. Trails or pathways surfaced with CAS can be accessible if correctly designed and constructed, and adapted to regional climatic conditions. A soil binder can be used to stabilize the surface.



Wood Decking:
Wood decking may be used for trails and pathways, providing joints are less than 13 mm wide and the planks are laid perpendicular to the direction of travel. Warpage and movement of the material should be controlled.



Concrete Pavers:
Concrete pavers, set on a properly constructed base, can provide an accessible surface. However, movement of the material over time may cause unacceptable irregularities.

Source: Canadian Heritage Parks Canada; Design Guidelines for Accessible Outdoor Recreation Facilities: Access Series, Minister of Canadian Heritage, Canada, 1995

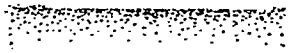
Grass:
A grass surface can be passable if it is level and well maintained. Grass can be reinforced by using commercially produced sub-surface matting.

Untreated Soil:
Untreated soil is highly variable. Some situations may be acceptable, and others more difficult. Soil is likely to change significantly due to precipitation, erosion, or wear.

Gravel:
Loose gravel is not recommended. It can be difficult for a person in a wheelchair or with walking aids. Packed gravel may be suitable for challenge opportunities.

Wood Chips:
Small gauge chips make an attractive surfacing material. When well compacted, wood chips may be passable for challenge opportunities.

Sand:
Loose sand is not recommended for trail surfaces. Packed sand may be passable.



14 DESIGN GUIDELINES FOR ACCESSIBLE OUTDOOR RECREATION FACILITIES

Source: Canadian Heritage Parks Canada; Design Guidelines for Accessible Outdoor Recreation Facilities: Access Series, Minister of Canadian Heritage, Canada, 1995

Surfacing

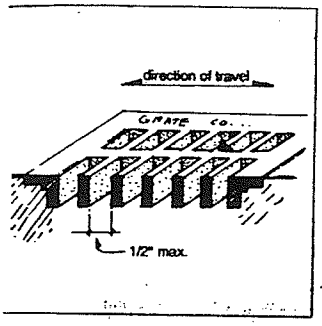


Figure 4-6

If the surface of an outdoor recreation access route changes in level more than 1 inch in urban/rural and roaded natural settings or more than 2 inches in semi-primitive settings, it must be accomplished by means of a curb ramp, graded surface, elevator, or platform lift. Although elevators and platform lifts are generally not part of the outdoor recreation environment, they are sometimes found in recreation sites in urban/rural settings. If elevators or platform lifts are used, designers should consult ADAAG 4.10 and 4.11. An outdoor recreation access route may not include stairs, steps, or escalators (ADAAG 3.5).

4.4.7 Gratings (ADAAG 4.5.4)

If gratings are located in the walking surface, they must have spaces no greater than 1/2 inch (13 mm) wide in one direction. If gratings have elongated openings, they shall be placed so that the long dimension is perpendicular to the dominant direction of travel (Figure 4-6).

4.4.8 Surfacing (ADAAG 4.5.1)

The surface of outdoor recreation access routes must be stable, firm, and slip-resistant. Soft, loose surfaces such as loose sand or gravel, wet clay, and irregular surfaces such as cobblestones, can significantly impede the movement of a wheelchair and create slipping and tripping hazards for people using other mobility aids.

"Slip resistance" refers to the frictional force necessary to keep a shoe heel or crutch tip from slipping on the walking surface under conditions likely to be found on the surface. This frictional force is complex and varied in practice, but can be measured in terms of its "static coefficient" to provide a close approximation of the slip resistance of a surface. Contrary to popular belief, some slippage is necessary to walking, especially for persons with restricted gaits; a truly "non-slip" surface could not be negotiated. The Occupational Safety and Health Administration recommends that walking surfaces have a static coefficient of friction of 0.5.

Source: PLAE, Inc.; Universal Access to Outdoor Recreation: A Design Guide; PLAE Inc.; USA; 1993

Firmness, Stability and Slip Resistance

Surface Material	Firmness	Stability	Slip Resistance (dry conditions)
Asphalt	firm	stable	slip resistant
Concrete	firm	stable	slip resistant*
Soil with Stabilizer	firm	stable	slip resistant
Packed Soil without Stabilizer	firm	stable	not slip resistant
Soil with High Organic Content	soft	unstable	not slip resistant
Crushed rock (3/4" minus) with Stabilizer	firm	stable	slip resistant
Crushed rock without Stabilizer	firm	stable	not slip resistant
Wood Planks	firm	stable	slip resistant
Engineered Wood Fibers that	moderately	moderately	not slip
comply with ASTM F1951	firm	stable	resistant
Grass or Vegetative Ground Cover	moderately firm	moderately stable	not slip resistant
Engineered Wood Fibers that do not comply with ASTM F1951	soft	unstable	not slip resistant
Wood Chips (bark, cedar, generic)	moderately firm to soft	moderately stable to unstable	not slip resistant
Pea Gravel or 1-1/2" Minus Aggregate	soft	unstable	not slip resistant
Sand	soft	unstable	not slip resistant

*A broom finish significantly improves the slip resistance of concrete.

Beneficial Design Inc.; Designing Sidewalks and Trails for Access: Best Practices Design Guide Part 1of 2; n.p, 2001

Recommendations for Surface Firmness/Stability

Surface Rating for Firmness	Displacement of Caster on Portable Wheelchair Measuring Device
Firm	0.3 in or less
Moderately firm	0.4 in to 0.5 in
Not firm	greater than 0.5 in

Table 15-3. Recommendations for Surface Stability

Surface Rating for Firmness	Displacement of Caster on Portable Wheelchair Measuring Device
Stable	0.5 in or less
Moderately stable	0.6 in to 1.0 in
Not stable	greater than 1.0 in

Beneficial Design Inc.; Designing Sidewalks and Trails for Access: Best Practices Design Guide Part 1of 2; n.p, 2001