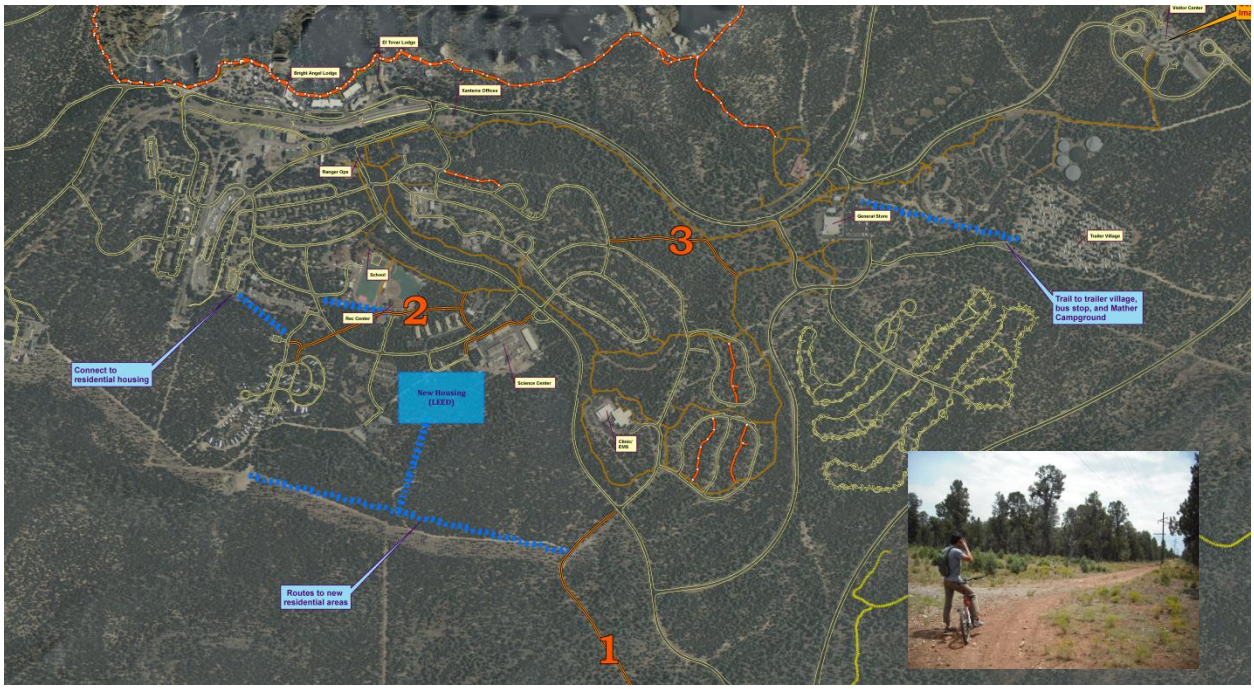

DEVELOPING ELEMENTS OF A COMPREHENSIVE MASTER BIKE PLAN TO SERVE GRAND CANYON VILLAGE

A Partnership Project of the Grand Canyon National Park and
Northern Arizona University's Landsward Institute

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ABSTRACT

The purpose of this study was to assess the trail system within the residential areas of the Grand Canyon Village in regard to its efficiency, effectiveness, and overall utility, and to develop a concept master bicycle transportation plan for the South Rim area for implementation by the National Park Service. This report presents current conditions, a concept plan, and recommendations for future action. Key findings include: 1) extremely high levels of use and support for trails among village residents, for both commuting and recreational use, at levels far above the average in other cities in the USA; and 2) significant gaps in connectivity requiring improvements to increase access and safety for users. The concept plan recommends connecting heavily used “social” trails into a paved trail network with a focus on increasing connectivity between residential areas and high use destinations. Key elements include: 1) Immediate paving of three social trail segments that connect the school/recreation center, the general store, and the maintenance/support center; 2) extending trails to within 50 feet of key buildings in the village core; 3) extending the trail system to connect newer residential areas in the southwest part of the village to the village core and General Store; and 4) integrating the residential trail system with the recreational trail system and key recreational sites.

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I. EXECUTIVE SUMMARY

The purpose of this study was to assess the trail system within the residential areas of the Grand Canyon Village in regard to its efficiency, effectiveness, and overall utility and to develop a concept master bicycle transportation plan for the South Rim area to be implemented by the National Park Service. An integrated system of trails will be significant element in moving Grand Canyon National Park toward more sustainability. This report presents current conditions, a concept plan, and recommendations for future action.

Key findings from resident surveys, on-the-ground assessments, and formal and informal interviews with Grand Canyon Village residents include:

1. Extremely high levels of use and support for trails among village residents, for both commuting and recreational use, at levels far above the average in other cities in the USA.
2. Significant gaps in connectivity in the village trail system which need improvements to increase access and safety for users.

The concept plan recommends connecting heavily used "social" trails into a paved trail network with a focus on increasing connectivity between residential areas and high use destinations. Key elements of the plan include:

1. Immediate paving of three social trail segments that connect three high use destinations - the school/recreation center, the general store, and the maintenance/support center.
2. Extending trails to within 50 feet of key buildings in the village core.
3. Extending the trail system to connect newer residential areas in the southwest part of the village.
4. Extending the trail system to connect the General Store with all residential areas.
5. Integrating the residential trail system with the recreational trail system and key recreational sites.

The following strategies are recommended to complete the concept plan.

1. Pave the most used trails. Use is an indication of demand, thus a simple method for prioritization.
2. Increase public participation through a series of workshops or focused interviews to gather specific routing suggestions from trail users. Public engagement with trail planning will assist in developing a more integrated paved trail system to link existing and future land use. It would also be a good beginning for creation of a public participation process in creating a more sustainable Grand Canyon Village.
3. Conduct a behavioral study of trail users to further identify specific use areas and problem areas.

Key considerations for the design phase of implementation include:

1. Designing a trail system that is separate from motor vehicle traffic as much as possible to safely connect bicycle and pedestrian commuters with their workplaces.
2. Designing trails that minimize environmental disturbance by using already disturbed areas and using paving that allows for minimal disturbance through erosion.
3. Developing a trail map supplemented by signage to orient trail users.
4. Enhance trails where possible with lighting and offer parking, changing facilities, and showers at high use destinations.

Related issues deserving additional study include connectivity between the village trail system and trails serving visitors, providing bicycle access along the Rim Trail, addressing the bottleneck of multimodal traffic along South Portal Drive near the bicycle rental concessionaire, and taking a broader look at integrated park and regional planning to improve transportation efficiency and sustainability overall.

II. INTRODUCTION

The purpose of this study was to assess the trail system within the residential areas of the Grand Canyon Village in regard to its efficiency, effectiveness, and overall utility and to develop a concept master bicycle transportation plan for the South Rim area to be implemented by the National Park Service. This concept plan is a significant step toward a sustainable, climate friendly Park. The following study is designed to provide the conceptual basis for a trail plan that serves the residents of the Grand Canyon Village.

The project team included three student interns and a faculty advisor from the Northern Arizona University (NAU) Department of Geography, Planning and Recreation in collaboration with Linda Jalbert, Grand Canyon National Park project liaison. Work was supported by staff from NAU's Landsward Institute.

Vision

The Grand Canyon National Park is without doubt a "flagship park," representing the best of the unique natural environments in the US, indeed the entire planet. In this time, when the earth's ecosystems are in danger, it is important that the National Park Service extend its mission of preservation to creating models of how to preserve and maintain a vibrant ecological and social community. While the issue of global climate change is overarching, there are also significant problems related to resource depletion, vegetation change, soil erosion, and the sheer impacts of large numbers of people concentrated in small areas. Grand Canyon National Park has its share of these problems but it also has the knowledge, the mission, and commitment to protect the ecosystem and create a more sustainable community within its boundaries. This requires examining the Grand Canyon Village as a community, and as one with a residential public that is largely self-selected to support many strategies of sustainability. One of the most important of these strategies is alternative transportation systems which includes a trail system that enables residents to move more easily by walking and bicycling than by motor vehicle.

Goals and Objectives

The study has the following general goals:

1. Assess the degree to which residential trails are serving the residents of the Grand Canyon Village located on the South Rim of the Grand Canyon.
    a. Examine trail demand, use, and issues through a survey of the residents.
    b. Use Geographic Information Systems (GIS) analysis to map and examine the degree to which the trail system serves the residents.

2. Propose a concept plan to improve the trail system for the village.
    a. Develop a regional classification to identify areas in most need of trails.
    b. Provide an example of an approach to specific trail planning that involves the village residents at an individual or small group level.
    c. Propose alternative trails to improve resident access to three high use areas – the Grand Canyon School/Recreation Center, the General Store, and the Maintenance/Support Center.
    d. Build upon discussion of the alternatives to propose a concept plan that recommends and prioritize trails to be built over the next few years.

3. Discuss more detailed trail design issues that can be used to develop design guidelines and integrate trails with road and transit systems.
    a. Minimize environmental impacts.
    b. Enhance trail safety and usability.

For this analysis, we have assumed that trails suitable for bicycles would be designated as multiple-use trails for any non-motorized travel. Our focus has been on bicycle connectivity, but the trails would serve other users as well. It is not the intent of this project to design a comprehensive trail system for the Grand Canyon Village, but to outline key concepts of area coverage, resident demand, and community-based approaches that can be used as the basis for planning. The concept plan proposed in this document should be followed with a more extensive public discussion with residents in the Grand Canyon Village. We urge development of a comprehensive trail system in coordination with a comprehensive transportation and land-use plan.

Background: Grand Canyon National Park

The Grand Canyon National Park is located in the Southwest region of the US, which is noteworthy for its aridity, rough terrain, and biodiversity. The residential and commercial center of the park is at Grand Canyon Village on the South Rim, where the majority of park's residents live, work, and socialize. The environment here is ideal for bicycle use due to relatively flat terrain, arid soil, and the potential interconnectivity of numerous trails. This setting offers high potential for an efficient and effective means for residents to commute to and from work.

Environment

The Grand Canyon National Park covers approximately 1,218,375 acres on the southern edge of the Colorado Plateau encompassing both sides of a 277-mile stretch of a the Colorado River. The geology consists of strata layers beginning from the basement Vishnu Schist to a cap of the Kaibab Limestone, which rises over a mile above the river. Elevation at the South Rim is approximately 7,000 feet. The park contains several major ecosystems from the Mohave Desert scrub of the lower canyon to the coniferous forest of the North Rim. The area is home to over 355 bird species, 89 species of mammals, and 56 reptile and amphibian species. The distinct and diverse environment provides a wide variety of recreational opportunities within the park.

On the South Rim, summer temperatures are relatively pleasant, ranging from 50° to 80° Fahrenheit; ideal for trail use. In winter, temperatures reach as low as 0° F with snow and ice. Trail use is possible during winter months. Paved trails are regularly plowed, but use is lower during these winter months, although, it is possible to cross-country ski on unplowed trails.

Transportation

Residents and visitors have a variety of transportation options while at the Grand Canyon's South Rim; from walking and biking the trail system, to driving or using the shuttles. Most visitors use private vehicles to enter the Park, although there is shuttle service available from Tusayan and to various South Rim destinations. A survey conducted as a part of this project suggests an estimated 88% of village residents use the trail system (paved and unpaved) for commuting and recreation use.

Visitors

The Grand Canyon Village offers highly concentrated tourism opportunities including lodging, dining, camping, shopping, biking, walking, and viewing along the rim. A total 4,491,141 people visited the park in fiscal year 2008, with all but 68,549 visiting for recreational purposes. Visitation has been increasing yearly as the Grand Canyon becomes an ever more popular destination for US and international visitors.

Employment

There are several large employers at the South Rim. During the peak months, Xanterra Corporation employs roughly 1,300 people, the National Park Service employs about 1000, Delaware North employs 350, and the Grand Canyon Association employs 32. There are a few other smaller employers in the park as well. Employees and their families make up the bulk of residents within the village.

Trail System

The current trail system within the Grand Canyon Village is an important means of transportation for residents and visitors alike. There are fifty-five miles of paved trails, roughly eighty-five miles of paved roads, and fifty-nine miles of dirt road in the vicinity of Grand Canyon Village. These trails are used for commuting and recreational purposes, such as walking and biking.

There are many areas within the Grand Canyon Village which have adequate trail coverage. However, many of the trails do not connect to other trails or roads in a logical manner. Some paved trails do not actually lead to a specific destination, and therefore are not useable for commuting by the park residents. A more interconnected system of paved trails would foster the use of the trail system for commuting.

III. APPROACH

Working with Agency/Company Personnel

Throughout the project, the research team collaborated with personnel from various agencies, organizations, and private companies in the Grand Canyon Village. The project team consulted with staff from the National Park Service, Grand Canyon Association, Xanterra, Grand Canyon School, and Delaware North.

Needs Assessment Survey

Preliminary interviews were used to identify issues and develop a needs assessment survey which was sent to all Xanterra, Delaware North, National Park Service, and Grand Canyon Association employees (see Appendix A). Completed surveys were analyzed to identify the needs, wants, and current use of the trail system serving residents in the village. The information gathered by these surveys also directed the questions asked in focused interviews of village residents, and was incorporated into recommendations for future management and projects.

Focused Interviews

Interviews were conducted with employees of Delaware North and Grand Canyon School, as well as with key individuals working at the Maintenance/Support Base to find out specifically which trails were used to get to and from work and which were used for recreation (see Appendix B). The interviews were conducted at work sites. During the interviews, respondents were asked a series of questions about how they used the trail system, as well as whether they had any concerns or comments regarding the management of the trail system. They were also asked to draw on the screen of a tablet PC displaying an aerial photograph exactly which trails and routes they used and where they would like to see new trails installed or existing trails improved.

Technology

Technology played a vital role in this project. Statistical analysis software (SPSS-Statistical Package for the Social Sciences) was used to analyze survey data, calculating frequency of driving, bike use, and use of the bus system. This information will be discussed further in section IV.

Geographic Information Systems (GIS) analysis was used to generate maps and to analyze spatial data relating to the project (see Appendix C). Using spatial data provided by the National Park Service, maps were generated for project meetings, presentations, and interaction with the public. Specific areas of the Village were identified with a lack of trail coverage by spatially analyzing the cross-streets noted on the surveys. Identifying residential and commercial buildings within 50 feet of the trail system using GIS provided a measure of the accessibility of trails.

Tablet PCs with GIS software were used to conduct interviews with Grand Canyon Village residents. Using this method, the residents were able to draw directly on the screen and the information was saved into map documents for later analysis. The interviewers were able to take site-specific notes on trail use and concerns regarding each route marked on the map document.

On-site Evaluation

The interns conducted an on-site evaluation of the trail system in order to observe first-hand the condition of the trail system (see Appendix D). The trail system was evaluated for such items as connectivity, maintenance, navigability/signage, access to the greenway and the bus system, and issues related to trail use on school property (see Appendix B).

Planning Team Review

The faculty supervisor met with a Park planning team in summer 2010 to review proposed alternatives (see Appendix E) with the objective of moving from a variety of alternatives to a concept. The concept presented in this report is a direct result of that review.

Development of Zones

Review of records of park and concessionaire management indicated that there was no regional subdivision of the village area. For ease of analysis, we developed zones based roughly on land use with major roads as borders. Zones are shown in Figures 1.1 (portfolio map) and 3.1 with major roads for reference. It would be helpful for future planning for this or another regional zoning scheme to be adopted.

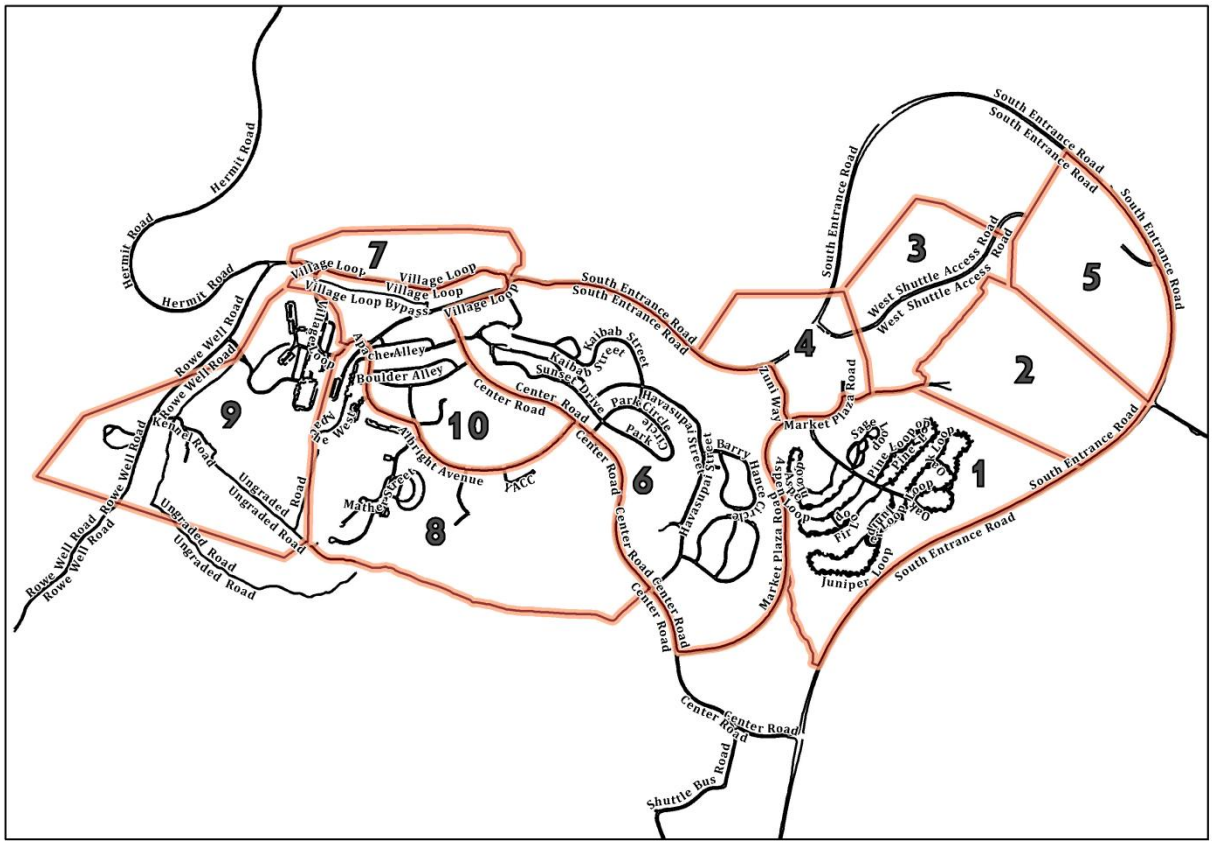

Figure 3.1: Zones Used in the Analysis

IV. CURRENT CONDITIONS

The current coverage by paved trails is shown in Figure 1.2 (portfolio map). Current paved trail connectivity is incomplete and should be improved to meet the high demand from resident commuters. There is a trail from the Visitor Center to the Bright Angel Lodge complex and one along Center Road, but linkage to the residential areas is incomplete and most areas are not served by paved trails. Most trails are found in the area we have called Zone 6, and even there, we found gaps in connectivity.

Trail System Characteristics

Length and Density

Table 4.1 is a synopsis of the GIS analysis of paved trail length and density in the planning zones. Of the 28 miles of dedicated trails in the South Rim area, 14 are found within the built-up area and can be construed as serving the residents. The highest proportion of paved trails is found within Zone 6, followed by Zones 10, 4 (General Store), and 7 (Rim Hotels). Highest trail density (miles per acre) is found within Zones 4, 6, and 7, which also can be seen as the center of park work areas. Trail length and density by itself is only a rough measure of trail accessibility.

Table 4.1: Trail Coverage within Planning Zones

Zone	Acres	Miles of Existing Trail	% of Trail in Zone	Miles of Trail/Acre
Zone 1	178.2	1.02	3.6%	0.006
Zone 2	98.1	0.74	2.6%	0.008
Zone 3	81.6	0.46	1.6%	0.006
Zone 4	61.9	1.48	5.2%	0.024
Zone 5	98.2	0.51	1.8%	0.005
Zone 6	272.2	5.96	21.1%	0.022
Zone 7	44.6	1.19	4.2%	0.027
Zone 8	217.4	0.73	2.6%	0.003
Zone 9	183.0	0.55	1.9%	0.003
Zone 10	110.5	1.74	6.2%	0.016
Total inside of zones	1345.8	14.40	50.9%	n/a
Total outside of zones	n/a	13.88	49.1%	n/a
Total (absolute)	n/a	28.28	100%	n/a

Trail Access from Buildings

Table 4.2 completes the analysis of trail coverage by assessing the number of buildings located within 50 and 100 feet of a trail. We estimated 50 feet as the optimal distance for people pushing a bicycle and 100 feet, a less ideal, but acceptable distance.

The village has 1,078 established structures (residences and workplaces), of which only 187 are within 50 feet of trails. This means that approximately 12% of the buildings have adequate access to existing trails. The GIS analysis demonstrates a weakness of the trail system in the village area. Zone 7 (the Rim hotel area) has the highest

frequency of buildings within 50 feet of the trail system, with 40.4%, followed by Zone 6 (historic residential core) with 28.3%. Zone 6 coverage is good along its perimeter, but the central area is underserved by trails. Zone 7 is the area with fewer but larger buildings. The outlying zones (1, 2, 3, 4, 5, 8, 9, and 10) are not as well covered, limiting trail access to users and reducing connectivity to the trail system. In those areas, it is expected that bicyclists and walkers spend more time on the streets. While these residential streets tend to have low traffic volume, there still could be a hazard when bicyclists, pedestrians, and motor vehicles share the same roadway.

Table 4.2: GIS Analysis of Building Distance from Trails

Zone	Total Buildings in Zone	Buildings w/in 50' of Trails		Buildings w/in 100' of Trails	
		#	%	#	%
Zone 1	14	3	21.4%	4	28.6%
Zone 2	75	5	6.7%	10	13.3%
Zone 3	16	4	25.0%	6	37.5%
Zone 4	15	8	53.3%	13	86.7%
Zone 5	28	0	0.0%	3	10.7%
Zone 6	307	87	28.3%	140	45.6%
Zone 7	47	19	40.4%	26	55.3%
Zone 8	255	27	10.6%	45	17.6%
Zone 9	94	15	16.0%	29	30.9%
Zone 10	153	12	7.8%	24	15.7%
Total inside of zones	1004	180	n/a	300	n/a
Total outside of zones	74	7	n/a	10	n/a
Total (absolute)	1078	187	n/a	310	n/a

Some residential streets are low traffic volume and can adequately serve as trails even though motor vehicles, pedestrians, and bicycles share the same movement space. However, some streets serving multi-family complexes and workplaces have higher traffic volume travelling at higher speeds. In these situations, trails should be separated from roads. Our GIS analysis was not able to separate low-traffic residential streets from higher volume thoroughfares, which would better indicate trail needs. In the future, it will be important to establish separate trails that parallel all high traffic roads to safely support trail users.

In summary, the current trail system does not offer direct access to most buildings within the village. This is a special concern in areas of multifamily residences or commercial/work sites.

Survey Results

The general purpose of the survey was to obtain information about resident use and demand for trails, as well as gather input on trail design. The survey was distributed in July and August 2009 to an estimated 2682 employees living at Grand Canyon Village. The surveys were distributed by employee mail systems, packaged with paychecks or newsletters in the case of the private businesses, and attached to an email message to NPS personnel. We were unable to get an exact number of NPS recipients, so we have estimated the number distributed, based upon information from our NPS contacts.

Grand Canyon Association	32 surveys
Delaware North	350 surveys
National Park Service	1000 surveys
Xanterra	1300 surveys

A total of 350 surveys were returned for a response rate of about 13%. A response rate of 13% is respectable for a mail survey, but it does lead to the question of how representative it is of the 87% who did not respond. Generally, people who are most interested in a project are the ones most likely to respond. So we assume that the sample is weighted in favor of trail users.

Respondent Characteristics

Two survey questions (see Tables 4.3 and 4.4) were designed to determine whether the survey sample is representative of the village residents. Table 4.3 summarizes respondents by employers. Findings indicate that the response was in rough proportion to the number of surveys distributed, with the exception of a slightly higher response from the Grand Canyon Association (GCA). Because the number of GCA responses was relatively small, it was not considered to have affected the representative quality of the survey in terms of the organizations queried.

Table 4.3: Who is your employer? (N= 348)

Employer	% of respondents
Xanterra	53%
National Park Service	28%
Delaware North	10%
Grand Canyon Association	7%
Other	2%
TOTAL	100%

Table 4.4 indicates that the majority of the survey respondents live in the village year-round, indicating a demand for year-round trails. We were unable to collect data on full-time versus seasonal employees from all of the employers, so have limited ability to determine the representation of the sample to the village population, although we can assume a likely bias toward fulltime employees due to a greater interest in quality of life in the Park. Because the seasonal residential population increases in summer during the best biking and walking conditions, it is likely that this sector of users, which may be underrepresented in this sample, will increase the demand on trails.

Table 4.4: Term of employment (N= 348)

Term of Employment	% of respondents
Seasonal	13%
Fulltime	87%
TOTAL	100%

Trail Use

The following set of questions (Tables 4.5 through 4.9) were to intended to determine overall demand for trails, use for commuting and/or recreation, modes of travel, and frequency of use.

Table 4.5 evaluates residents' commuting preferences. Every respondent was asked to mark all that apply, so percentages add up to more than 100%. This accounts for people using multiple modes of transportation, perhaps driving one day, and biking or walking the next. It is important to note that 78% of respondents reported walking or biking at least part of the time. This provides an indication of the high potential volume of trail users who may increase their frequency of use if the trail system were improved.

Table 4.5: How do you usually commute to work? (N= 350)

Commute Mode	% of respondents
Walk	50%
Bike	28%
Drive	51%
Bus/shuttle	10%
Other	1%
TOTAL	140%

Table 4.6 identifies how respondents currently use the trail system. Again, note that each respondent was able to mark all that apply, so the total percentage adds up to more than 100%. All respondents reported using the local trail system either for recreation, commuting, or both. It is important to note that 86% of respondents use trails for recreation. Thus, a comprehensive trail system that serves the residents must concentrate on both commuting and recreational use.

Table 4.6: What do you regularly use the local trail system for? (N= 333)

Trail Use	% of respondents
Commuting	14%
Recreation	31%
Both	55%
TOTAL	100%

Table 4.7 summarizes the frequency of trail use by residents for commuting. This is a generalized question and will vary by season and memory. Thirty percent of respondents reported that they do not use the trail system to commute, but 70% reported commuting at least once per week, and 42% are dedicated daily users of trails. This can be compared with data from the City of Flagstaff, which indicates that 3.2% of work commute trips in the city are by bicycle, compared with the national average of 0.4%. In the Flagstaff survey, an additional 9% walked to work, compared with 3% in the nation (FMPO, 2007, Hu and Reuscher, 2005). These findings confirm that there is high demand for a commuter trail system in the Grand Canyon Village significantly greater than the national average.

Table 4.7: How often (times/week) do you use trails to commute to work? (N= 342)

Commute Frequency	% of respondents
0	30%
1-3	28%
4-6	26%
7 or more	16%
TOTAL	100%

Table 4.8 illustrates the type of routes the residents in the Grand Canyon Village use to reach their place of employment. Again, note that each respondent was able to mark all that apply, so the total percentage adds up to more than 100%. Also note that residents using roads could be using any of the major modes of transportation including bicycling, walking, driving or taking the bus. We can assume that the people using trails and unpaved roads are commuting using non-motorized means, thus findings indicate that approximately three quarters of the respondents use trails at some time in their weekly commute.

Table 4.8: When you go to work, do you use…? (N= 350)

Commuter Routes	% of respondents
Paved trails	50%
Unpaved trails	39%
Paved roads	73%
Unpaved roads	17%
TOTAL	179%

It is interesting to note that the use of unpaved roads and trails (56%) is slightly higher than use of the paved trails (50%). We can therefore expect to see more people on the unpaved trails and roads than on the paved ones, indicating that planning needs to address the use of both paved and unpaved trails.

Table 4.9 summarizes an open-ended question designed to understand how the trails are used for recreation. Again, note that each respondent was able to mark all that apply, so the total percentage adds up to more than 100%. Most respondents reported using the trails for walking, jogging, cycling, and walking pets. A smaller number of respondents listed other uses including skiing, horseback riding, skateboarding, snowshoeing, rollerblading, running errands, and teaching children to ride bicycles.

Table 4.9: If you use the trails for recreation, how do you use them? (N= 350)

Recreation Use	% of respondents
Walking	84%
Jogging	24%
Cycling	42%
Walking pet(s)	25%
Other	9%
TOTAL	184%

Specific Trail Design Issues

Table 4.10 summarizes the importance of various aspects of trail planning as rated by residents of Grand Canyon Village. Preliminary interviews brought out a number of points about trail design including access, maintenance, hazards, orientation, wildlife encounters, and lighting. All of these points lead to place-centered design issues which should be addressed during the implementation phase. Respondents rated each item on a 1-5 scale where 1 is ‘not important’ and 5 is ‘very important’. Ratings from all respondents were averaged to create a mean rating value for each issue.

Table 4.10: Rating of trail planning aspects

Trail Planning Aspect	Mean Rating Value Rating scale: 1 = Not important to 5 = Very Important
Access to trails	4.31
Regular maintenance	4.07
Snow removal	4.03
Slips, trips, and/or fall hazards	3.98
Availability of a trail map	3.46
Pavement	3.45
Signs	3.38
Wildlife encounters	3.34
Lighting	3.19

Although residents rated all trail planning aspects at least somewhat important, access to trails is clearly the number one issue. This links to the GIS analysis of buildings within 50 feet of a trail, and suggests the overall importance of adding more trails and extending them within an accessible distance to buildings. Issues related to maintenance, snow removal, and hazards are the second level of importance to residents. Pavement is rated as slightly less important but is also related to maintenance and safety.

Still important but of less concern to residents are the availability of a trail map and signage on the trail system. These needs relate to the ability of trail users to orient themselves when navigating the trail system.

Wildlife encounters and lighting were considered slightly less important, but still important to respondents. Wildlife is a special consideration in the village, especially because it is inside a national park. The elk population seems especially bold and can be both an attraction and a potential hazard.

Figure 4.1: Trail Users Should Expect to Encounter Wildlife

Children's Use of Trails

Tables 4.11 and 4.12 help us understand how heavily the trail system is used by children attending the elementary school. Results suggest heavy use of the trail system by school children. Children are the most vulnerable of the trail users. A trail system that accommodates children's recreational and commuting needs will increase safety and decrease the probability that they will commute to and from school on the roadways, whether being driven by car or riding their bicycles on the roadways and cutting through undeveloped areas.

Table 4.11: Do you have children who attend Grand Canyon School? (N= 339)

Children at Grand Canyon School	% of respondents
No	87%
Yes	13%
TOTAL	100%

Table 4.12: If yes, do they use the trails? (N= 44)

Trail Use by Children in School	% of respondents
No	29%
Yes	71%
TOTAL	100%

Focused Interviews

Focused interviews using tablet PCs (Fig. 4.2) were designed to elicit detailed information from a small population group to help the project team develop specific alternatives, an interim step in the concept planning process. Interview results do not represent the opinions of all users of trails in that area, but do represent a commonality among opinions of those who participated.

Delaware North and Xanterra each provided space at their lunchrooms to conduct interviews. Additional interviews were conducted opportunistically as time allowed. The tablet PC was integral to each interview, effectively displaying graphic information and allowing people to locate their trail preferences directly on the screen. This approach proved to be a useful technique that could be applied in future interviews or focus groups to evaluate alternatives for other sites within the village.

Figure 4.2: Focused Interview Using Tablet PC

A total of 15 focused interviews were conducted with employees from the following organizations:

National Park Service	1
Grand Canyon School	1
Delaware North	13
TOTAL	15

Focused interviews were held at the General Store, the Maintenance/Support Center (also referred to as the Firebase or Helibase), and Grand Canyon School. Although interviewees discussed issues related to trails in the vicinity of these destinations, comments and proposals for desired routes extended to the entire trail system. Results are presented in the following text and figures labeled by the location of the interviews.

General Store

Figure 4.3 (page18) illustrates current conditions and proposals from focused interviews conducted at the General Store. Interviews were conducted with 13 Delaware North employees at this site.

The southwest regions of the village, in particular Zones 8 and 9, where a majority of Delaware North employees live, have minimal access to the main trail system. In these two districts there is a lack of formal trails, especially from Rowe Well Road to Center Road resulting in insufficient access for many Delaware North employees to cycle from their residence to their work site. Respondents expressed particular concern about the route that bisects the parking area of the McGee Science Center Building, located in Zone 8. Many residents ride through the parking lot near this building due to the lack of alternative routes. However, there is heavy truck traffic through this parking lot, increasing safety and liability issues. This should be a priority for park management to reduce the hazards to trail users.

Maintenance/Support Center

Figure 4.4 (page 19) shows information collected in an interview with one NPS employee. It is clear that this vital support area is not connected with the village trail system at all, although there are a number of paved and unpaved roads as well as social trails that are used to bicycle out to the site. Issues that need to be examined in this area are trails overlapping with existing roads or need for a separate trail. The overall volume of bicycle commuting to this location also needs to be assessed.

Grand Canyon School

Figure 4.5 (page 20) presents information about trails near the school based on one interview with a school employee. This person was most concerned with the trail that bisects the northeastern side of the elementary school campus (Fig. 4.6). Current trail users have direct access through the school by means of a paved trail that is connected with the main trail system. Unrestricted public access through school grounds during school hours is illegal. This conflict involving legal and safety issues requires blockade and elimination of that trail segment during school hours. This situation affects both trail users and school officials and should be addressed as soon as possible.

There is also a lack of trails and connectivity in the areas encircling the Recreation Center. The main trail system provides an access point which is located on the northeastern side of the baseball field. Also there is one linkage point to the pathway (marked in heavy green on Figure 4.5) between both the soccer and baseball fields. The limited access of the trail system within these highlighted areas minimizes trail connectivity.

FIGURE 4.6: This trail leads directly into the school grounds.

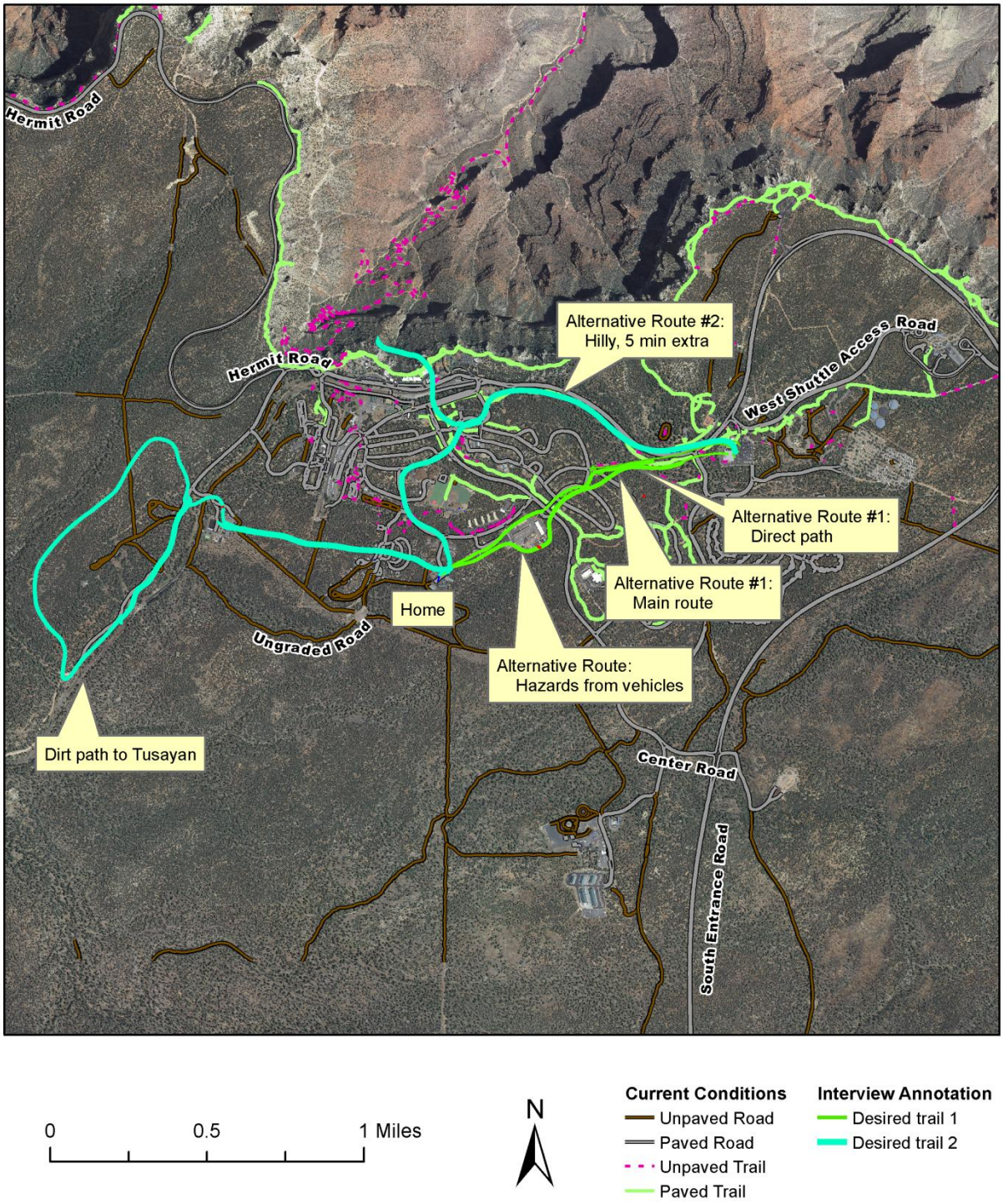

Figure 4.3: General Store Focused Interview Map (13 interviews)

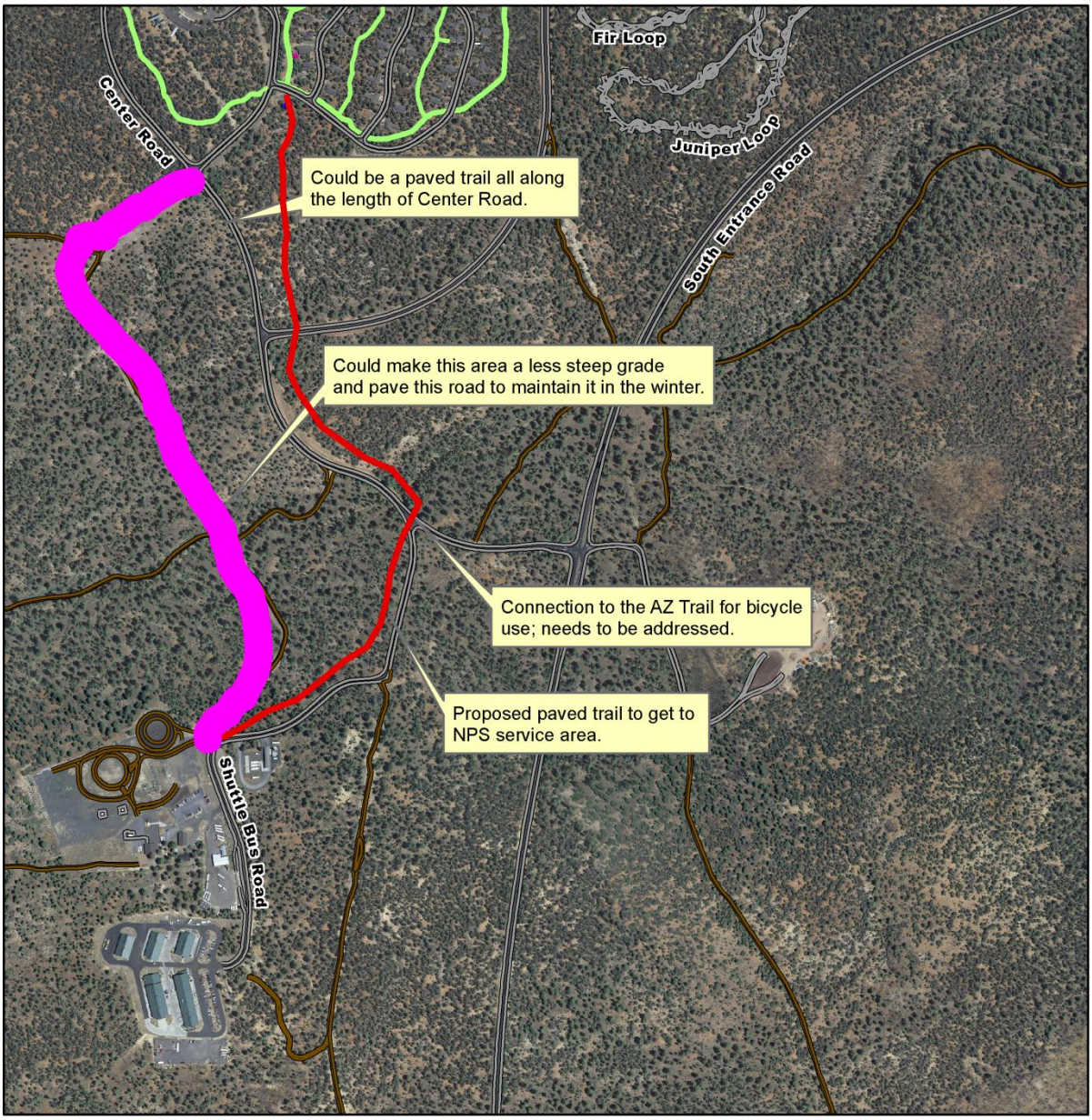

Figure 4.4 Maintenance/Support Center Focused Interview Map (1 interview)

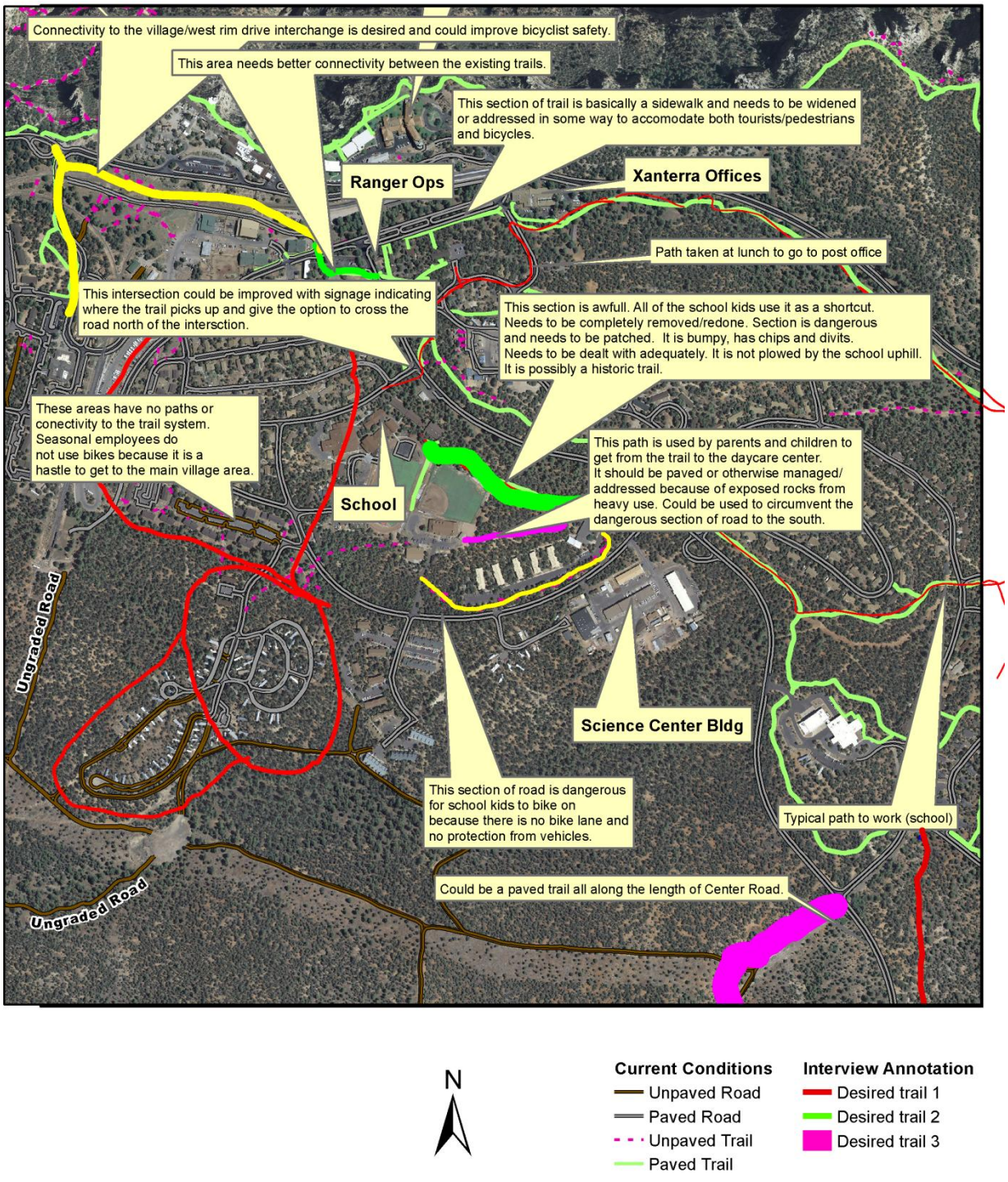

Figure 4.5: Grand Canyon School Focused Interview Map (1 interview)

Summary of Current Conditions

Current conditions can be summarized as follows:

1. Trail demand and use is very high for both recreation and commuting to work sites.
2. Grand Canyon Village has a limited and confusing system of trails, not all of which are interconnected between residences, commercial areas, and work sites in a manner to facilitate and encourage cyclist and pedestrian use.
3. There is a lack of connection between paved trails and roads. There are many areas with less than adequate coverage of paved trails. Due to the lack of coverage, many cyclists and pedestrians use unpaved social trails and roads for commuting to and from work.
4. A segment of the main trail system runs directly through the elementary school, causing concern for the safety and protection of the school children. Addressing this issue should be a priority.
5. A pathway used by Delaware North employees through the McGee Science Center Building parking lot is hazardous due to heavy truck traffic. Addressing this issue should be a priority.

In summary, Grand Canyon Village offers fertile ground for an integrated trail system that would receive a higher level of resident use than most communities in the United States.

V. CONCEPT PLAN

Developing a concept plan from proposed alternatives is an important step in organizing a comprehensive village trail system and was the primary objective of this project. Once concepts are in place, the next step is to locate the trails and make design decisions.

There are three parts to this concept plan:

1. *Concept Plan Map* (Portfolio Map 1.3) - This section includes a map and discussion of three proposed trails that will serve the three highest priority areas: the vicinity of the General Store, Grand Canyon School/Recreation Center, and the Maintenance/Support Center. It also includes general concepts for three future trail segments to connect residential areas with the existing trail system. These concepts were developed in a discussion with a Park planning team facilitated by J. Sell. Note: developing specific concepts for other areas of the trail system required more extensive community input than was possible to complete in the time allotted to this project.

2. *Recommended Actions* - This section outlines a prioritized action plan for completing the concept planning process and implementation, including a process to develop specific concept plan maps for other areas in the village.

3. *Trail Design Concepts* – This section includes basic trail design concepts that can be easily converted into design guidelines.

Concept Plan Map

The Concept Plan map is attached as a separate document (Portfolio Map 1.3). On the map, the double orange lines represent the trails recommended for paving as soon as possible. The adjacent numbers denote their paving priority according to the Park planning team (1 = highest priority).

Maintenance/Support Center

The highest priority trail connects the village to the Maintenance/Support Center, because this is an area of high vehicular traffic and the safety of bicyclists is at risk. For this reason, the recommended alternative route is the one that avoids the paved road and its vehicular traffic. This routing will require building a bridge across a wash, but is justified by the safety factor of using the route that avoids the roadway.

Grand Canyon School/Recreation Center

Second in priority is the linkage to the school and recreation center to address the issue related to heavy public access to the school grounds from the paved trail bisecting the school property. This can be attributed to a lack of signage on the section of trail that goes through the school property and a lack of public awareness that it is not permitted to go through school grounds via the trail. This problem was illustrated when the school's property was unknowingly entered by the interns during the on-site evaluation of the trail system.

There are several ways to solve this problem of unauthorized persons entering school property to use the trail:

1. Place signs at or before the boundary of school property on the trail informing people that they are about to enter school property, and that it is a violation of the law to do so without permission.
2. Place barriers, such as gates or bollards, on the trail at the boundary of school property.
3. Send out mailings to the public informing them of the problem and that it is a violation of the law to cut through school grounds using that particular section of trail.

The preferred connection between the school, recreation center, and trail system would integrate a heavily tracked social trail (behind the Albright Training Center) that should be paved soon to reduce dust and erosion. The connection to the new amphitheater behind the Albright Center also provides extra justification for locating this trail in this location.

General Store

Third in priority is the linkage from the older residential area (Zone 6) to the General Store. There is an existing bike trail from the residential area to the Market Plaza that parallels the road system, but it is a long ride. So the social trail directly connecting the area with the Market Plaza is very heavily used. As visitor bicycle traffic in the Park grows, it will likely increase on the existing trail from the Visitor Center to the hotel district. If this new segment diverts residential traffic from the main bike route, it will reduce congestion on the main route.

The broken blue lines on the concept map point to future trail needs. They should be planned after further study and after the current phase of construction is completed. These linkages connect: (1) the campground and trailer village with the Market Plaza and the rest of the trail system; (2) the higher density housing on the west side; and (3) the new LEED housing which is currently under construction. All of these areas are not well integrated into the existing trail system and will need their own trails, perhaps after completion of new construction.

Recommended Actions

This section is the strategy for implementing a comprehensive trail system. The Goals and Objectives section outlines the policy rationale for the planning of the trail system, both current and future. The goals are the overall policy requirements, and the objectives are measures of success of policy actions which are the action steps. The Strategies section discusses specific strategies for implementing the action steps.

Goals and Objectives

Goal 1. Complete a trail system that serves the residents of Grand Canyon Village.

Objective 1.1. Increase trail coverage serving the three highest priority areas: Maintenance/Support Center, Grand Canyon School/ Recreation Center, and the General Store.

Policy 1.1.1. Pave proposed alternative trail segments per concept map by the end of 2011.

Policy 1.1.2. Address safety issues in McGee Science Center parking lot by the end of 2011.

Objective 1.2. Extend paved trails in the core area (Zones 6, 7, 10) so that 50% of all buildings are within 50 feet of an established trail by 2012.

Policy 1.2.1. Develop community workshops from Zones 6, 7, and 10 to provide information about priority trail access issues, and draw proposed trail extensions.

Objective 1.3. Build connecting trails from Zones 6, 7, and 10 to Zones 8 and 9 by 2012.

Policy 1.3.1. Develop community workshops from Zones 8 and 9 to provide information about trail use and draw proposed trails.

Objective 1.4. Develop a trail system that connects the General Store with all residential areas by 2012.

Policy 1.4.1. Develop community workshops from all residential areas to provide information about trail use and draw proposed trails.

Goal 2. Integrate the residential trail system with the recreational trail system and key recreational sites on the South Rim.

Objective 2.1. Link the Trailer Village (Zone 4) and the Campground (Zone 1) with direct routes to the existing trail system by 2012.

Objective 2.2. Provide multiple direct trail links to the Rim Trail and Arizona Trail systems.

Strategies

1. *Pave the most-used trails*. A simple strategy for extending the trail system is to consider paving the most-used unpaved trails first. A number of unpaved trails have been identified by park residents as having a high traffic volume during the summer, but being rendered unusable by winter conditions. Paving these trails will allow for regular maintenance and snow-removal during the winter, increasing the use of the trail system during winter months.

2. *Increase public participation*. Developing specific alternatives for other areas within the village will require a more extensive effort to involve community members in planning their local trails. The key idea for making this trail system useful to the residents is to involve them in the layout and design of the trails that serve them. The existing trail system does not seem to have included public input, so residents fill gaps by using social trails, the most noteworthy of which is the trail west of the General Store, which shows up clearly on the air photo of the village (see Portfolio Map 1.2).

   Our use of the tablet PC interview format was experimental and proved to be a success. We attempted but were not successful generating the number of interviews needed for an adequate public participation process in the time allowed. However, we are convinced that the tablet PCs can be used in future interviews and focused workshops involving groups of residents from each area of focus.

3. *Conduct a behavioral survey of trail users.* Studying the interaction of the residents with the trail system, presents the opportunity to improve trail management. Improved management will help foster the use of the trail system. The needs assessment survey reported high use by residents but specific use areas and problem areas remain to be identified. It would be useful to conduct either observation studies or trail

intercept surveys of users. This will become more important with growing use of the trail system by visitors.

4. *A trail map should be produced and supplemented on the ground by effective signs.* Signage and orientation are important for all trail users. The trail system as it exists today is confusing, and new users would have great difficulty learning the system and navigating it efficiently. We were somewhat surprised to find that although some maps were reported to exist, we found no comprehensive trail map. A few signs would also be of great benefit at intersections to denote the direction of key destinations. Now that bicycle rental is now available to visitors and as visitor biking increases, it will be even more imperative to create a good map and signs to direct visitors to sites of interest and keep them from becoming lost in the residential areas.

Trail Design Concepts

The survey and on-site assessment revealed a number of issues that should be addressed as design rather than planning concepts. The traffic situation is relatively safe, since there has only been one documented accident between a bicycle and automobile in the last three years (although this should be closely monitored). But as the residential and bicycle user population increases, there are a number of considerations needed to make trail use easy and safe. The list below represents some considerations to be considered as design guidelines when actual trail design is executed.

1. *Separation of trails from roads.* Trails should be separated from roads whenever possible. Physical separation is best, but when that is not possible, the most effective separations use street furniture and differential paving (for example brick instead of asphalt for trails) as a means of separating automobile use areas from bicycle and pedestrian routes.

2. *In cases where bicycles, pedestrians, and automobiles must share the road, a speed limit of 15 miles per hour should be established.* This is a common speed for a bicycle and allows automobile drivers to react quickly in case of potential accidents. The commute distance in the village is not so great that a slow speed limit is much of an inconvenience for automobiles. Presence of wildlife, especially elk, also makes a low speed limit important.

3. *Pavement should minimize environmental disturbance.* Use of existing "social" trails or dirt roads offers one good way to minimize disturbance. Care should be exercised to avoid routing trails through archaeological sites or sensitive habitat. Runoff from paved trail surfaces needs to be carefully managed to avoid erosion problems:

   "Provision should be made in the design to assure positive drainage from the path surface. Pooled or standing water...represents a danger to cyclists everywhere but especially on curves or turns. Shallow standing water may be a hazard even to pedestrians as well if it freezes (Russ, 2002, 128)."

Figure 5.1. Unpaved Trail with Erosion, Rocks, Uneven Surface

4. *The type of pavement to be used must consider safety, maintenance, snow removal, freezing temperatures and water runoff control.* There are many permeable surfaces that can be used for trails, but some of these may be problematic with snow removal equipment. One pervious pavement trial is underway at the Advanced Research Development Building on the Northern Arizona University campus, which may yield important insights to the durability of this material. However, other options for permeable paving are available as well. Additional considerations follow.

    a. Asphalt paving is relatively inexpensive, easy to apply, and easy to clean of snow, however it is also impermeable and can affect drainage. If used, the surface can be designed with breaks in places with high runoff accumulation.

    b. Brick, or block pavers, set loose on sand can absorb runoff and provide an easy to travel, easy to clear, surface, but they are usually the most expensive material and should be used sparingly. This would be the preferred alternative if price and labor cost is not an issue. These also provide that distinctive surface that can differentiate bicycle use areas from motor vehicle lanes, and they have been used as such in urban environments. Pavers would be appropriate where the trail goes along the side of a road.

    c. Gravel or decomposed granite (DG) is loose and not a good riding surface for road bikes. In addition it would be difficult to maintain the surface when snow is removed.

    d. Materials such as the EcoGrid ground reinforcement structures (Fig 5.2) can also be used to provide structure and a permeable surface. These are often used where grass or other ground

covers are planted in the lattice, which is probably not needed in the Grand Canyon Village. There are a variety of products of this nature that may be worth examining.

Figure 5.2 EcoGrid (Terrafirm Enterprises, 2009)

5. *Enhance trails with lighting.* Many residents expressed a desire for lighting on the trail system in the village area in order to use the trails at night. This should be taken into consideration, as it might increase the use of the trail system at night. One possibility might be the installation of low-lumen surface-lights, which would show where the path is without contributing significantly to light-pollution. In open areas these lights could run on solar power.

6. *Bicycle parking, changing facilities, and showers should be provided in high use areas*, *such as the Visitor Center, Headquarters, and near the Rim hotels*. These are LEED requirements and also make bicycling easier for people who need to work directly with the public. In addition, the rental and encouragement of visitor biking also requires some real consideration how to accommodate bicyclists at viewpoints while restricting them from the pedestrian-only trails along the Rim.

   The US Green Building Council standards for LEED (Leadership in Energy and Environmental Design) design concepts related to bicycle commuting follow. The LEED standards for New Construction require either:

   - Secure bicycle racks and/or storage within 200 yards of a commercial/institutional building entrance, and shower and changing facilities within 200 yards of a building entrance for 0.5% of full time equivalent employees, or

   - Covered bicycle storage facilities for 15% or more of building occupants (U.S. Green Building Council, 2005, p. 13).

   The pilot version of the LEED standards for neighborhood development offers the requirement that 50% of all dwelling units and business entrances be within 3 miles of each other on a bicycling network, and all non-residential and multi-family residential buildings provide bicycle parking spaces for no less than 15% of the off-street parking space capacity provided for cars (US Green Building Council, 2008, p.32). Since the entire Village area is less than 3 miles radius, the only relevant LEED needs are to make sure that bicycle parking facilities are improved.

VI. BEYOND TRAILS: PLANNING FOR SUSTAINABILITY IN GRAND CANYON NATIONAL PARK

This report is a student internship project and so has concentrated on examining current conditions, demand for trail use, design issues, and proposing improvements to the trail system that will allow for more freedom of movement for the people who live and work at Grand Canyon. The student interns have benefitted greatly from this experience and hopefully the Park itself will gain from this work. Beyond the educational aspect of this work, a professional view of the Park as a place where people live and work as a community requires further discussion. These comments are the thoughts of the faculty supervisor.

The enhancements to the trail system for Grand Canyon Village are intended to be simple, connecting key areas used by the residents who live and work in the Grand Canyon. Beyond this, the best approach for future trail design is to deeply involve the residents, who know their own use patterns and activity needs for trails. Moreover, as we examined trail use, there were also other issues that we saw that will need to be addressed in the future if the Park continues to move toward sustainability in its planning. This could be especially urgent as the need for climate friendly planning increases.

1. *Visitor/Villager interactions on the trails.* This study has already documented heavy use of trails by residents of the Grand Canyon Village. Park policy has also been supportive of increasing visitor bicycling in the Park. Survey and interview information has already pointed out that visitors often find themselves lost within the residential areas of the Village, which is a matter of improving maps and signs. However, as visitor trail use increases, there may develop a certain amount of congestion which will require more trail options. Trail use should be monitored carefully in the future.

2. *Bicycle access to the Rim viewpoints.* The rationale for not allowing bicycles on the Rim trail is strong, but the visitors on bicycles will want to see what is on the Rim as much as the pedestrians. In the future, it would be worthwhile to consider developing a parallel trail on the inside of the Rim Trail, with "spokes" that lead to bicycle parking near the Rim viewpoints, to accommodate visitors on bicycles.

3. *Bottlenecking of multimodal traffic along South Entrance Road*. At present, with the start of the bicycle rental concession at the new Visitor Center, visitor and resident bicycle traffic, automobiles, RVs, shuttles, pedestrians, and even elk will all be present along the portion of South Entrance Road that stretches from the Visitor Center to the Rim hotels and viewpoints. There is a paved trail that parallels South Entrance Road, but it is here that an overloaded trail will likely result in a spillover of bicyclists into the street, contributing to the congestion and safety hazard. There probably is no need for urgency, but use of this trail should be carefully monitored with an eye toward developing a separate trail for visitors. Another alternative would be to close South Entrance Road to private motor vehicles.

4. *The need to reduce motor vehicle traffic within the Park*. The Park needs to control motor vehicle traffic within its boundaries. This trail plan will help move in this direction, but serious consideration must be made about banning visitor vehicles from the Park. The encouragement of use of the shuttle is a good step, although more study needs to determine how many visitors use the shuttle. While we were unable to obtain a solid count of how many private vehicles went into the Park last year, upwards of 4.5 million visitors suggests that a million motor vehicles per year is not an unrealistic figure. That amounts to a lot of carbon dioxide and a lot of congestion. The Park Service is trying to encourage people taking the shuttle, but it will not be long before a ban on visitor motor traffic will need to be strongly considered.

When that happens, a plan needs to be in place to divert visitors to bicycles, shuttles or perhaps a light rail system.

5. *The need for a comprehensive land use/sustainability plan in the South Rim.* This trail plan consisted of examining land use as it exists and is under construction, and suggesting trails to connect those places. However, it is quite evident that there is no land use plan in place at the South Rim, and construction decisions need to be made after a careful consideration of resident/user needs, water and energy supply, transportation, work places, solar access, and even shopping. I do not see any real comprehensive plan for the Village area as a community. As urban growth continues the need for comprehensive planning grows. Because of the very nature of the Park as a planning unit, a comprehensive plan incorporating sustainability as a primary goal can provide a strong model for planning in the region.

6. *The need for integration into a regional planning framework*. The Grand Canyon National Park serves as an anchor point for tourism in Northern Arizona, but it can also serve as a model of sustainable planning for the region. In addition, many of the issues faced at the Grand Canyon are regional issues. For example, air pollution from coal fired power plants affects scenic quality and automobile exhaust from cars driving to Grand Canyon adds greatly to the world's carbon burden. There are sustainable planning efforts underway in Coconino County, the City of Flagstaff, the Northern Arizona National Monuments, and the nearby Native American reservations, to name a few. Because of ongoing efforts at the Park, it can provide leadership in helping to integrate all of these efforts into a comprehensive regional plan. For example, an electric light rail route to the Park would add to the feasibility of an integrated rail system for northern Arizona, and would be more workable if tied to a ban on private vehicles in the Park. If that rail system could be powered by solar and wind power plants nearby, that would greatly move toward a more climate friendly region. This need for regional sustainability should be explored further. It may not even be possible. But it is time to examine the feasibility of such systemic planning and to at least identify the parameters of such activity.

Figure 6.1: Bicycle Racks on Rim Trail

VII. REFERENCES

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APPENDIX A

SURVEY QUESTIONNAIRE

This 15 question survey is so that you can provide information that is needed for the Grand Canyon National Park Master Bicycle Plan. Please answer the questions as thoroughly as possible. Your answers will be treated as confidential and will not be linked with your personal information.

1. Who is your employer?
    a. Xanterra
    b. National Park Service
    c. Delaware North Companies
    d. Grand Canyon Association
    e. Other: (this may include spouse/partner of employee)

2. Are you employed as:
    a. Seasonal
    b. Fulltime

3. Where do you work? (e.g. El Tovar, Resource Management, etc)

4. What is the nearest cross street to your house?

5. How do you usually commute to work? (circle all that apply)
    a. Walk
    b. Bike
    c. Drive
    d. Bus/shuttle
    e. Other _____

6. What do you regularly use the local trail system for?
    a. Commuting
    b. Recreation
    c. Both

7. How often (times per week) do you use the trails to commute to work?
    a. 0
    b. 1-3
    c. 4-6
    d. 7 or more

8. When you go to work do you use: (circle all that apply)
    a. Paved trails
    b. Unpaved trails
    c. Paved roads
    d. Unpaved roads

9. On a scale of 1 to 5, where 1 is not at all important and 5 is most important, how would you rate the importance of each of the following aspects of planning trails? PLEASE CIRCLE ONE NUMBER FOR EACH CATEGORY

	Not Important				Very Important
Access to trails	1	2	3	4	5
Lighting	1	2	3	4	5
Pavement	1	2	3	4	5
Signs	1	2	3	4	5
Snow removal	1	2	3	4	5
Slips, trips, and/or falls hazards	1	2	3	4	5
Wildlife encounters	1	2	3	4	5
Regular maintenance	1	2	3	4	5
Availability of a trail map	1	2	3	4	5

10. If you use the trails for what purpose do you use them? (circle all that apply)

    a. Walking
    b. Jogging
    c. Cycling
    d. Walking your pet(s)
    e. Other _____

11. Do you have children who attend the Grand Canyon School?
    a. Yes
    b. No

12. If yes, do they use the trails?
    Yes No

13. Do you have any comments or suggestions about the trail system?

APPENDIX B
FOCUSED INTERVIEW/WORKSHOP QUESTIONNAIRE

Introduction:

We are working on the concept plan for trails for residents at the park. We would like to ask you to help us understand how the residents use the trail system and what they think about it. This will also be an opportunity for you to draw in trails that you use and any suggestions that you may have for new trails. The information you give us will be confidential

Case #:

Where do you work?

How long have you worked there?

Can you locate your workplace on the air photo?

Can you locate your home on the air photo?

How do you usually get to work?

- Bike
- Walk
- Drive
- Bus
- Other _____

Do you use the trail system?

- Yes
- No

If no, are there any special reasons why you don't use the trails?

If yes, what is the usual route you take to get to work? (have them draw on screen)

Do you use the trail system for recreation?

- Yes
- No

If yes, what do you do?

What trails do you use for recreation? (have them draw on screen)

Where would you like to see new trails? (have them draw on screen)

Are there things you would like to see on existing trails that would help you get around better?

Do you have any suggestions about trail planning in the park?

Thank you for your help. If you would like to be further involved in the planning process, please contact us.

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APPENDIX C
RECOMMENDATIONS FOR GIS SOLUTIONS

Throughout the course of this project, it was necessary to use GIS data provided by the National Park Service. This data consisted of satellite imagery, a shape file of existing buildings and structures within the Grand Canyon Village, and a shape file of the existing roads and trails within the Grand Canyon Village area.

Satellite imagery was used as background imagery for maps, as well as photo interpretation regarding specific locations of Village assets for which we did not have data. The shape file of existing buildings were used for analysis of the accessibility of existing trails within the Grand Canyon Village. It was also used to identify specific buildings on maps used during the focused-interviews so that the subjects could orient themselves with regard to their place of employment and the area in which they lived. The shape file of existing roads and trails was used for generating maps, analyzing the coverage and connectivity of the trail system in its current condition, analyzing the accessibility of all buildings within the Grand Canyon Village to the trail system, and modifying the trail segments proposed by the residents of the Grand Canyon Village in order to integrate them into the existing trail system in a logical and coherent manner.

The following observations are intended to provide background on practical problems encountered using NPS GIS data for the Grand Canyon Village and offer recommendations for solutions.

1. The National Park Service's current data on roads and trails within the Grand Canyon Village was originally developed for cartographic purposes. Both sides of the streets and trails are digitized, as are curbs and road-shoulders. This type of data is excellent for the purposes of generating maps because it is very accurate with regard to street-width and design. However, because the streets and trails are bordered in this manner, any GIS analysis attempted would result in lengths which are roughly twice as large as the accurate values. This made it necessary to generate a new shape file of trails and roads specifically for analysis within a GIS.

   Recommendation: Develop a new dataset containing the current conditions of the road-and-trail system within the Grand Canyon Village that is conducive to spatial analysis.

2. Data on roads and trails are incomplete. Many of the roads and trails are missing their associated attribute data, such as the names of the streets or the type of trail. This complicated the analysis of the current trail system. While all of the trails were designated as such, some were partially attributed with only the designation "trail", and so were analyzed as "unpaved trail" for the purposes of this report.

   Recommendation: Completion of the attributing of the GIS layer containing the existing road-and-trail system within Grand Canyon Village.

3. Data on buildings within the Grand Canyon Village are incomplete. While the physical locations of the buildings have been digitized, only a small number have their associated attributes. That missing attribute data would have been useful for conducting further analysis on the proximity and accessibility of residential buildings to the current trail system. This would have been useful for understanding how well the residents are served by the current trail system. Without being able to distinguish the residential structures from nonresidential, the analysis used in this report was limited to including all buildings regardless of their use, thus limiting the analysis of the accessibility of the trail system specifically for commuting purposes by residents.

Recommendation: Completion of the attributing of the GIS layer containing the existing buildings within Grand Canyon Village.

4. The department managing the GIS data for the Grand Canyon Village is understaffed. One of the NPS employees responsible for updating and managing the GIS data is currently attached to a second detail in the field at the Grand Canyon. Because of this, the employee must devote a significant amount of time to other responsibilities; time which could be spent completing the data for the Grand Canyon Village and the surrounding area.

   Recommendation: Consider funding internships to extend the capacity of NPS GIS staff and offer students the opportunity to gain valuable on-the-job experience while learning about National Parks.

APPENDIX D
ON-SITE ASSESSMENT OF THE GRAND CANYON VILLAGE TRAIL SYSTEM

In summer 2009, the student interns conducted an on-site investigation of the trail system, essentially riding the trails, observing behavior, and doing a subjective report of the experience. This experience is summarized below.

TRAFFIC

Cyclists using the trail system often use the paved streets as well; either crossing the streets to continue using the trails or riding along the streets themselves when there is not good trail connectivity to their destination. This is often dangerous for the cyclists because there are many streets in the Village which do not adequately accommodate bicycles. There is usually no bicycle lane, which forces the cyclist to compete with vehicular traffic on the road. Sidewalks are usually crowded with pedestrians, making them prohibitive to bicycle use. Center Avenue in particular is extremely dangerous, as it combines a high traffic speed – 45mph – with an extreme curvature and a complete lack of bicycle lanes.

There is a lack of signage on the Village's trail system. There are no signs indicating the destinations of particular trails, which often leads to confusion on the trails, and occasionally forces users to double-back in order to find their bearings. This also leads some users to go away from the trail, cutting across natural areas to try to find another trail or ride along the roads.

GREENWAY/RIM TRAIL

The greenways along the South Rim are a significant part of the Grand Canyon's trail system. They provide cyclists with the opportunity to cycle along the rim itself through a diverse environment with beautiful scenery. The greenways themselves are well-kept and free of litter and hazards. They are easily accessed from the rim road, and are usually accessed directly from bus stops. To get to the greenways, however, cyclists have to ride several miles to the rim and then ride along the rim for several more miles, all the while sharing the road with cars and busses, or load their bikes onto a bus and ride to the greenway.

Riding a bicycle to the greenways is enjoyable, although at times frustrating because riding on the rim trail is either prohibited or unpractical due to its use by pedestrians, and the cyclist has to pull off of the road in order to allow busses to pass.

BUSSES

The bus system is both a benefit and a nuisance to cyclists. It is extremely easy to load a bicycle onto the quick-loading racks located on the front of the busses (Fig. 8.1), and then ride the bus to a preferred destination. This is useful to avoid competing

Figure 8.1. Bike Racks on the Bus

with traffic. However, when cyclists don't use the busses, they are often competing with them for use of the road, having to pull off to the side of the road in order to allow a bus to pass.

CONNECTIVITY

The trail system does not currently provide adequate connectivity. Most of the residential trails do not lead to the main network. Often it is easier to use existing roads to get from one trail head to the next. The lack of interconnectivity and direct routes to popular destinations is especially prevalent in the distant residential areas where trail users must use the main paved trails in order to commute to marketplace, often increasing time and distance in travel. There is, however, connectivity of informal unpaved trails that are accessible and frequently used, providing users more direct pathways. However these unpaved trails are poorly maintained and shuold be managed properly for safety as well as environmental impacts. Outside the residential trail areas, service roads were accessible and frequently used by bicyclists.

MAINTENANCE

The existing paved trails are categorized into two sections: the main paved trail running through most of the village and secondary paved trails. The main trail is well maintained with no breaks in the pavement, providing a smooth and safe ride for commuters. Secondary paved trails are poorly maintained with numerous breaks in the pavement that create safety hazards. Informal unpaved trails frequently have large rocks that obstruct riders' paths, often creating alternative informal "bypass" tracks and increasing environmental degradation.

SCHOOL

Within the trail system there is a section that is interwoven into school property. This section of trail has no signs indicating that it is school property, which leads to its use as a shortcut by residents. As told to us by school staff, "No one is allowed on school property unless authorized," at least during school hours. However, trail use is prevalent in this area because the interconnectivity of the trail and lack of signage.

APPENDIX E
KEY POINTS: PROPOSED ALTERNATIVES

The standard approach to planning requires creation of a set of alternatives to aid in discussion. These alternatives provide a more solid representation of concept solutions, and criticism of the alternatives provides an effective way to find positive and negative aspects that can be used in the final concept. They represent a stage in the planning process. They are included as appendix material for background that may be used for further examination if other planning solutions are needed.

GENERAL STORE (Fig. 8.2)

Focused interviews with Delaware North employees at the General Store showed a lack of trail connection between the residential area and the workplace. Their suggestions were to develop a trail system that resulted in 3 potential alternatives.

Alternative 1

The informal trail system that bisects the parking lot of the McGee Science Center Building is inadequate in connectivity to the main trail system and needs improvement in order to provide a safe and efficient trail.

This alternative provides two routes that encircle the perimeter of the Science Center Building. The trail begins near the south end of Albright Avenue, splitting and forming one route on the eastern side and the other route located on the western side of the Science Center Building. Both of these trails are then redirected back towards a single trail that passes Center Road, Park Circle, and Havasupai Street then follows South Entrance Road east towards Market Plaza.

The advantage to Alternative 1 is that it is a more direct route to the Marketplace. The disadvantage to this alternative is that it may not be successful in deterring trail users from using the Science Center Building parking area. Potential safety issues may still continue even with alternative trails.

Alternative 2

The lack of a connected trail system within Zone 6 to areas of higher concentration of employment facilities and commercial opportunities is an area of concern.

This proposed alternative trail begins at the south end of Albright Avenue and moves northward along Albright Avenue and Boulder Street. The trail then veers northeast, following Boulder Street and passing through Center Road and Tonto Street. The trail continues to Way and eventually terminates at Market Plaza.

The advantages to the Alternative 2 trail will help in providing a direct and efficient route from residents' homes to the workplace, while optimizing the existing South Entrance Road. It connects to the school and outlying infrastructure. It is more integrated with the main trail system.

The disadvantage of this alternative is that it intersects multiple roads and intersections within the village area. This could cause a potential danger to trail users due to vehicle access of these roadways. Increased signage and distinct trail pavement must be incorporated in order to provide safety for both trail users and vehicles.

Alternative 3

This alternative represents a more direct connection to the existing trail system at Sunset Drive. The advantage is that it connects to alternatives 1 and 2 as well as the main trail system. The disadvantage is that it could cut through residential property and overlap with streets.

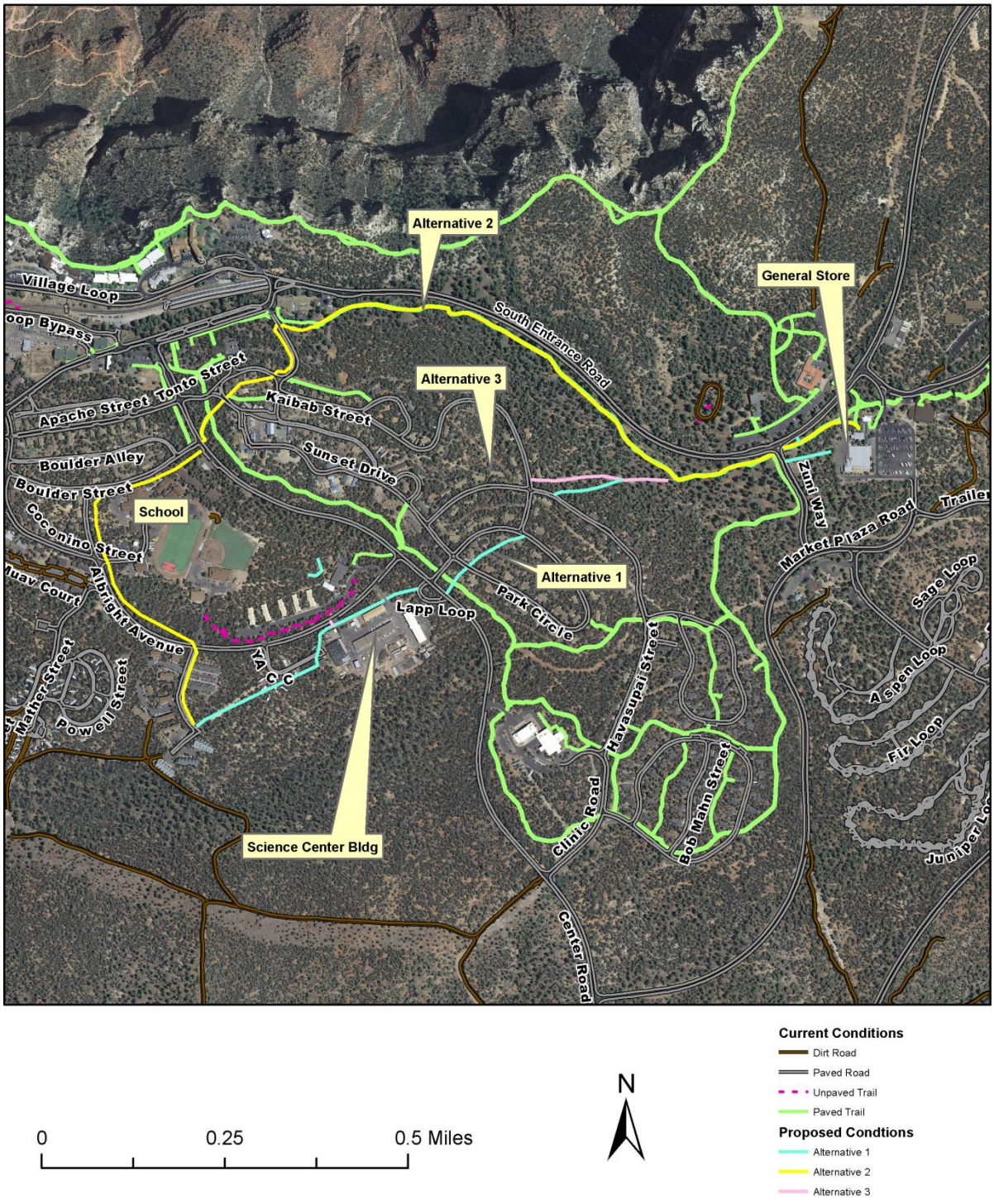

Figure 8.2. General Store Proposed Alternatives

GRAND CANYON SCHOOL/RECREATION CENTER

The school and adjacent recreation center are important destinations for residents, especially children, and should be a central feature of the village trail system. The area is currently poorly served by the existing trails, and in fact, brings adult riders onto school grounds in violation of school policies. Public access onto any school grounds without permission is an illegal activity and the offending trail should be eliminated or blocked during school hours.

Alternative 1 (Fig. 8.3)

This alternative route calls for removal of the trail segment that leads to the "shortcut" through the school (marked in blue). A blockade will be placed to prevent trail users from accessing the existing school route. The blocked segment will be replaced by a new trail along Center Road that also links up to the existing trail (marked in red). The red trail proposal also parallels Boulder Street to provide better access to the school.

Marked in yellow is a proposed alternative that can link up both the recreation center and school on the south side. The alternative link paralleling Albright Avenue and the Albright Center parking lot is on an existing unpaved trail, although the more direct route behind the storage buildings may make more sense and provide more distance from traffic areas. The yellow trail also provides a connection to Alternative 1 from the General Store.

The red alternative provides better linkage to the residential area north of the school. The yellow alternative provides school access from the south side, linkage to the larger trail system from the marketplace, and direct linkage to the recreation center. In addition, the public trail access through the school is eliminated.

This proposed alternative is less direct and the overall trail distance will have increased.

Alternative 2: (Fig. 8.4)

This alternative provides a shorter route than Alternative 1. The location of the barricade positioned in front of the school grounds will offer an additional trail shortcut to the existing trail, increasing efficiency.

The proposed alternative may not deter trail users from creating alternative informal trails and locating access points that allow travel through school grounds. Retention of the trail segment north of the recreation fields without a major physical barrier at the school grounds will likely not prevent people off of school grounds.

Alternative 3 (Fig. 8.5)

This alternative proposes maintaining all existing trails and paving the social trails in the area. This would not eliminate access through the school.

The advantage is that it connects with the existing trail and provides a more direct route to the recreation area, as well as using the existing informal social trail and connecting with proposed Alternative 1 connecting the trail to the general store.

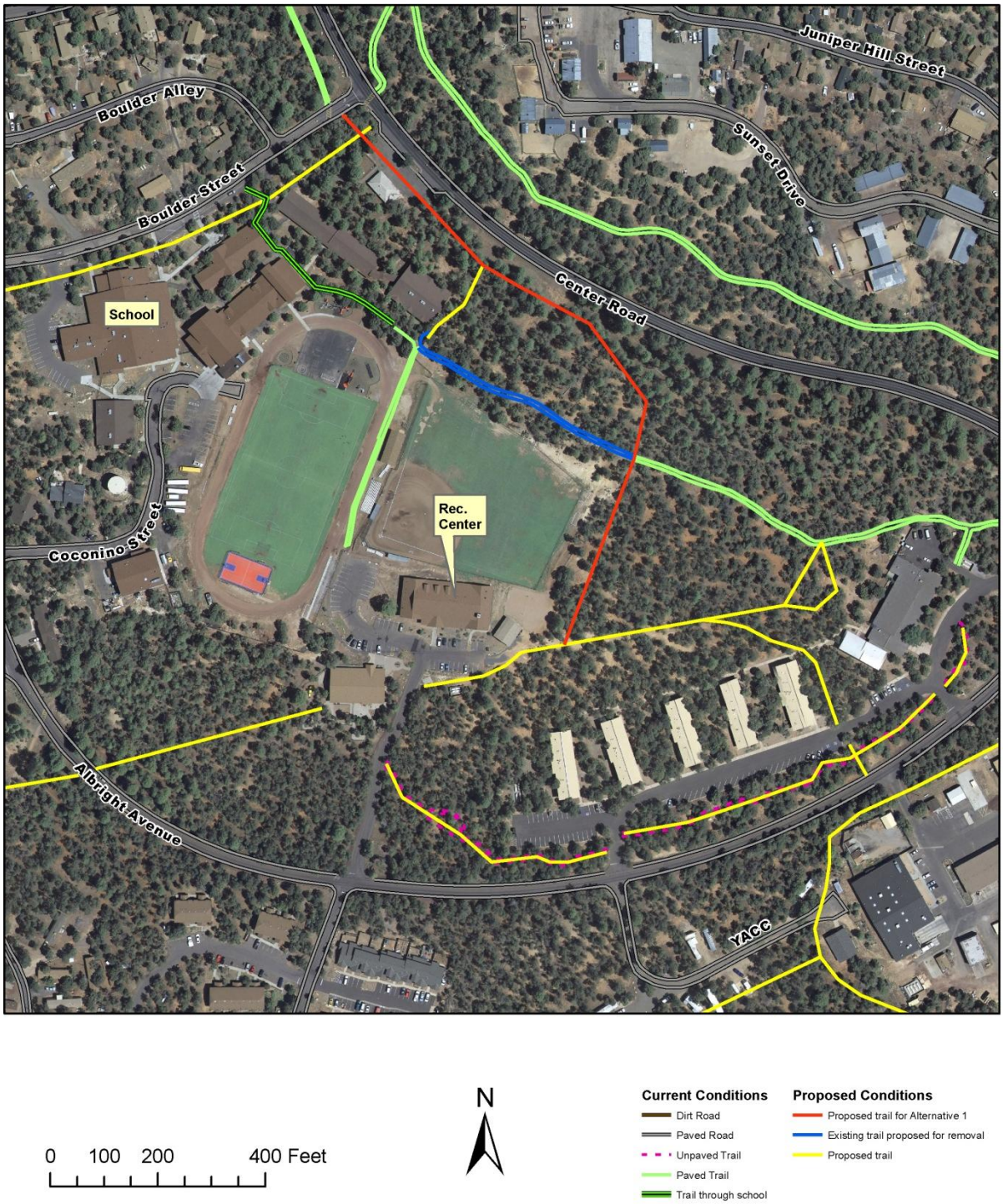

Figure 8.3: Grand Canyon School/Recreation Center Proposed Alternative 1

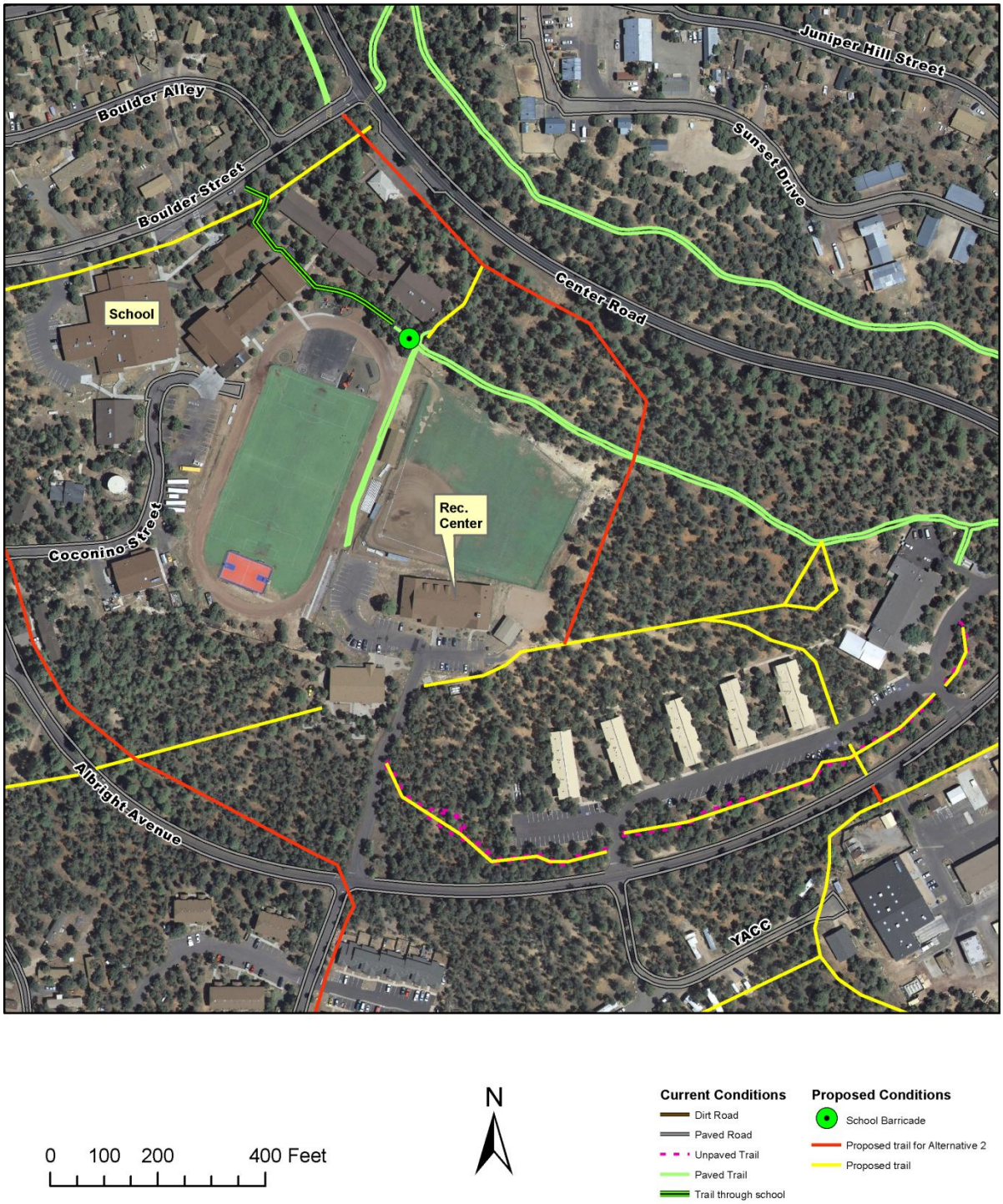

Figure 8.4 Grand Canyon School/Recreation Center Proposed Alternative 2

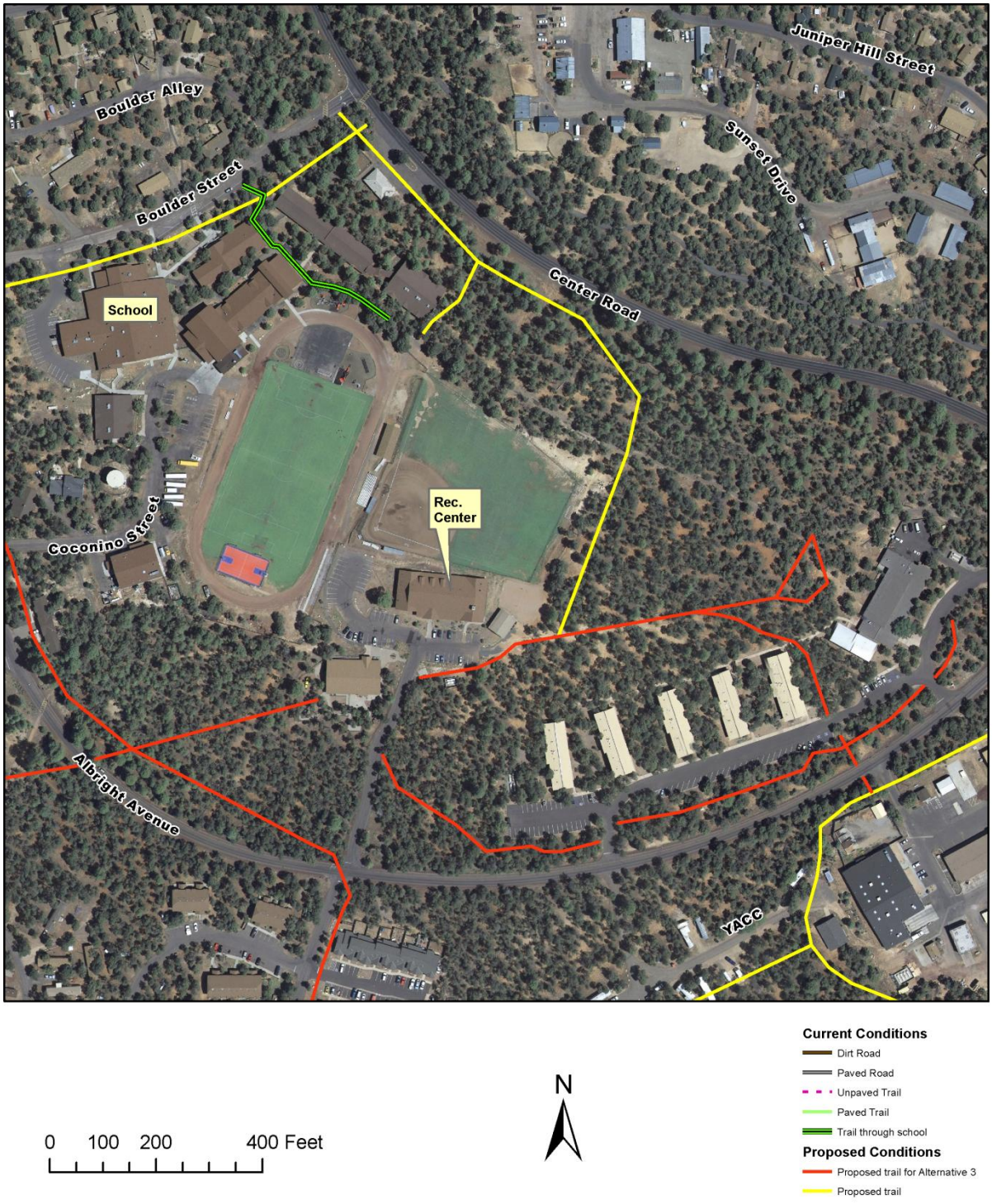

Fig. 8.5 Grand Canyon School/Recreation Center Proposed Alternative 3

MAINTENANCE/SUPPORT CENTER (Fig. 8.6)

Our discussion of these alternatives is based on an interview with one person and should be expanded to include more users of the Maintenance/Support Center. The area surrounding the Maintenance Center lacks trails from the southern point of Zone 6 to the facility. It prevents employee access and trail commutes to the base because of the disconnection from the main trail system.

Alternative 1

This alternative connects at the intersection of Clinic Road and Center Road and uses existing disturbed areas on the west side of Center Road to connect more directly with the Maintenance Center.

The advantage of this alternative is that it is a direct route to residential areas, uses already disturbed habitat (an old access road) and is completely separated from all vehicular traffic.

The disadvantage is there needs to be a bridge built to cross a stream channel. This would add to the expense of construction.

Alternative 2

This alternative connects with the existing trail system between Randy Thompson Circle and Market Plaza Road. Also it connects to Shuttle Bus Road leading to the Firebase.

The advantage of this alternative is that it connects to the existing trail, requires less engineering, and will reduce disturbance to the natural environment.

The disadvantage to this alternative is the trail connects to paved/unpaved roads and could create conflicts with traffic. This is the main road to the Maintenance Center and its heavy vehicular traffic is more of a safety hazard than the first alternative.

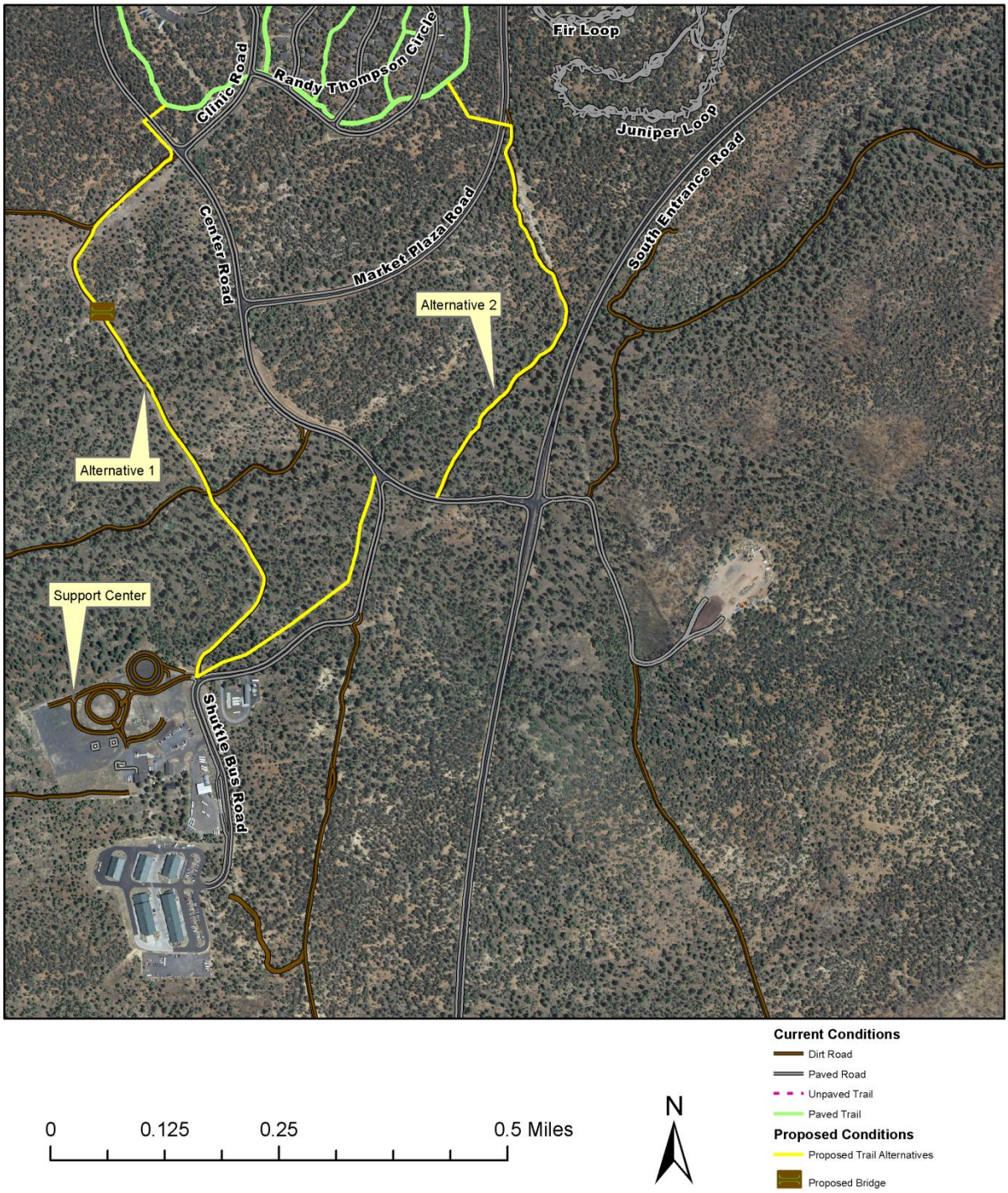

Figure 8.6 Maintenance/Support Center Proposed Alternatives