Wichita Mountains Wildlife Refuge

Comprehensive Alternative Transportation Plan

May 2014

DOT-VNTSC-FWS-14-01

Prepared for:
U.S. Fish and Wildlife Service

U.S. Department of Transportation
John A. Volpe National Transportation Systems Center

Notice

This document is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The U.S. Government assumes no liability for use of the information contained in this document. This report does not constitute a standard, specification, or regulation.

The United States Government does not endorse products or manufacturers. Trademarks or manufacturers' names appear herein only because they are considered essential to the objective of this document.

Quality Assurance Statement

The U.S. Fish and Wildlife Service provides high-quality information to serve Government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. The U.S. Fish and Wildlife Service periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	May 2014	Final Report

4. TITLE AND SUBTITLE	5a. FUNDING NUMBERS
Wichita Mountains Wildlife Refuge – Comprehensive Alternative Transportation Plan	VXN3
6. AUTHOR(S)	5b. CONTRACT NUMBER
David Daddio, Benjamin Rasmussen, Jonathan Frazier, Erica Simmons, Luis Mejias	51VXN30000 MJ696
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Department of Transportation John A Volpe National Transportation Systems Center Transportation Planning Division 55 Broadway Cambridge, MA 02142-1093	8. PERFORMING ORGANIZATION REPORT NUMBER DOT-VNTSC-FWS-14-01
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) US Department of Interior US Fish and Wildlife Service Wichita Mountains Wildlife Refuge 1839 C Street NW Washington, DC 20240	10. SPONSORING/MONITORING AGENCY REPORT NUMBER
11. SUPPLEMENTARY NOTES	
12a. DISTRIBUTION/AVAILABILITY STATEMENT This document is available to the public at http://ntl.bts.gov/lib/52000/52700/52788/DOT-VNTSC-FWS-14-01.pdf.	12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)
The Comprehensive Alternative Transportation Plan for Wichita Mountains Wildlife Refuge in southwestern Oklahoma analyzes a range of transportation and resource management challenges and documents a holistic set of alternative transportation strategies that the refuge can implement in the short, medium, and long term. The Plan consists of four interrelated products: a traffic analysis study, a pedestrian and bicycle, a multi-modal network alternatives analysis, and a transit assessment.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Alternative transportation, public lands transportation, pedestrian and bicycle transportation, transit, shuttle bus service, recreational transportation	183
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18
298-102

Report Notes and Acknowledgments

The U.S. Department of Transportation John A. Volpe National Transportation Systems Center (Volpe Center), in Cambridge, Massachusetts, prepared this report for the Wichita Mountains Wildlife Refuge. The project team consisted of David Daddio (project manager), Benjamin Rasmussen, Jonathan Frazier, Erica Simmons, and Luis Mejias of the Transportation Planning Division.

The project team would like to thank the following individuals for graciously providing their time, knowledge, and guidance during the development of this plan:

Wichita Mountains Wildlife Refuge

Tony Booth	Refuge Manager
Ralph Bryant	Deputy Refuge Manager
Susan Howell	Visitor Services Manager
Heidi Beierle	Transportation Scholar
Quinton Smith	Park Ranger, Visitor Services

U.S. Fish and Wildlife Service Region 2

Steve Kettler	Biologist
Robert O'Brien	Regional Transportation Program Coordinator

Central Federal Lands Highway Division

Laurie Miskimins	Transportation Planner

Other

Dr. Ben Cooper	Fit Kids of Southwest Oklahoma
Dwight Cope	Town of Medicine Park
Jonathan Cybulski	John A. Volpe National Transportation Systems Center
Rebecca Gleason	Western Transportation Institute
Doug Kemper	Medicine Park Museum of Natural Science
Aaron Peterson	Fort Sill
Richard Rogalski	City of Lawton Planning Department
Kyle Rogers	Fit Kids of Southwest Oklahoma
Gary Rushing	Lawton Area Transit System
Sharon Sheffert	Oklahoma Department of Transportation
Brenda Spencer-Ragland	Fort Still
Larry Walcott	City of Lawton Public Works

Table of Contents

List of Acronyms

Abbreviation	Term
AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ADT	Average Daily Traffic
ATS	Alternative Transportation System
CATP	Comprehensive Alternative Transportation Plan
CFLHD	Central Federal Lands Highway Division
CMAQ	Congestion Mitigation and Air Quality
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
FLAP	Federal Lands Access Program
FLMA	Federal Land Management Agency
FLTP	Federal Lands Transportation Program
FWS	Fish and Wildlife Service
GIS	Geographic Information System
GPS	Global Positioning System
HSIP	Highway Safety Improvement Program
ITS	Intelligent Transportation System
LATS	Lawton Area Transit System
LETRA	Lake Elmer Thomas Recreation Area
LMPO	Lawton MPO
LOS	Level of Service
MUTCD	Manual on Uniform Traffic Control Devices
NEPA	National Environmental Policy Act
NPS	National Park Service
NWR	National Wildlife Refuge
NWRS	National Wildlife Refuge System
ODOT	Oklahoma Department of Transportation
PBCAT	Pedestrian and Bicycle Crash Analysis Tool
PBIC	Pedestrian and Bicycle Information Center
PTSF	Percent Time Spent Following
RTP	Recreational Trails Program
SRTS	Safe Routes to School
STP	Surface Transportation Program
TAG	Transportation Assistance Group
TAP	Transportation Alternatives Program
TRIPTAC	Transit in the Parks Technical Assistance Center
USGS	United States Geological Survey
WMWR	Wichita Mountains Wildlife Refuge

Executive Summary

Wichita Mountains Wildlife Refuge (WMWR) faces many transportation and recreation challenges associated with its current visitation patterns, including:

- Parking lot congestion, which often requires refuge law enforcement resources
- Heavy visitation to sensitive natural areas on the western side of the refuge
- Bicyclist roadway safety issues within and approaching the refuge
- Limited access opportunities for populations without access to a private vehicle

Following transportation improvements presented in a 2010 Alternative Transportation Study (ATS) conducted by the U.S. Department of Transportation John A. Volpe National Transportation Systems Center (Volpe Center), the refuge received funding for the construction of a nonmotorized trail, the development of an intelligent transportation system, and completion of this Comprehensive Alternative Transportation Plan (CATP). The 2013 WMWR Comprehensive Conservation Plan (CCP), which sets the management direction for the refuge for the next 15 years, incorporates transportation improvements presented in the 2010 ATS report. This plan, the CATP, is designed to achieve goals identified by refuge staff and outlined in the CCP, including:

Goal 1: Habitat and Environmental Quality - Preserve the biological integrity of southern mixed-grass prairie and Crosstimbers habitats to enhance long-term resiliency of these habitats.

Goal 2: Visitor Experience - Provide a world-class, wildlife-focused experience through public use opportunities that educate and increase the quality of life for current and future generations and that promote the long-term health of the Refuge.

Goal 3: Public Use Facilities - Administer safe, well-maintained, and energy-efficient facilities that allow the public and staff to enjoy and support the purpose of the Refuge and the mission of the National Wildlife Refuge System.

Goal 4: Access - Promote transportation options that provide Refuge access to all visitors, including mobility impaired and transportation-disadvantaged groups.

This plan documents a holistic set of alternative transportation strategies and approaches to help WMWR solve its transportation and recreation challenges. To accomplish this, the study team developed four discrete but interrelated products:

- **Traffic Analysis Study:** Provides baseline information on automobile volume, circulation, and parking data to inform transportation decisionmaking on the refuge. Data collection revealed that parking is constrained at a few key locations, but the road and parking network is functioning well and is projected to continue to do so into the future.

- **Bicycle and Pedestrian Resource Guide:** Presents background information and a suite of tools for the refuge to implement nonmotorized infrastructure and programming. All of the options presented are appropriate to the context of this refuge.

- **Multi-Modal Network Alternatives Analysis:** Outlines nonmotorized network and program options and costs for the refuge and presents three alternative levels of investment that would leave the

refuge with an improved low-impact, nonmotorized transportation network consistent with its CCP.

- **Transit Assessment:** Explores transit alternatives both to and within the refuge, partnership opportunities, and associated costs. Several transit options are feasible and available to the refuge within the next few years.

Rather than proposing preliminary transportation improvement options for further exploration, this plan presents a detailed list of actionable strategies to achieve the refuge's goals. Some can be accomplished with little investment in time and money, while others will require substantial effort, including further analysis, compliance pursuant to the National Environmental Policy Act, and coordination with local partners. Through a site visit, interviews with refuge staff and area stakeholders, and independent analysis, the study team developed the following time-sequenced strategies to achieve the goals of the study (relevant documents and upcoming planning process provided next to each strategy):

Short Term (1-3 Years)

- **Implement low-cost bicycle signage and striping improvements on roadways** to improve bicyclist safety. *See Multi-Modal Network Alternatives Analysis*.
- **Offer special use permits to private bus tour operators** in order to meet demand for organized group travel and temporary visitors to the area from Fort Sill. *See Transit Assessment*.
- **Complete the LETRA Trail and Jed Johnson Tower Trail accessibility improvements** to open these trails to a larger set of visitors. *See Multi-Modal Network Alternatives Analysis and 2012-13 Public Lands Transportation Scholar pre-NEPA analysis.*
- **Publish live parking information** via variable message signs and the refuge website to reduce unnecessary travel to the western side of the refuge. *See Traffic Analysis Study*.
- **Update refuge website and maps** to reflect the emphasis on recreational sites in the eastern area of the refuge.
- **Develop and install wayfinding and trailhead signage** to improve nonmotorized recreation experience. *See Multi-Modal Network Alternatives Analysis. Effort should be coordinated with forthcoming refuge Sign Plan.*
- **Develop biological resource thresholds** to connect parking lot enforcement activities to natural resource management decisions. *Effort should be coordinated with forthcoming Wilderness Stewardship Plan.*

Medium Term (4-10 Years)

- **Initiate a 2 year transit pilot project** with a partner group to test the feasibility of permanent seasonal transit service. *See Transit Assessment*.
- **Design and build the Mt. Scott Summit Trail** to create a comparable, low-impact experience to popular trails in the Charon's Garden Wilderness Area. *See Multi-Modal Network Alternatives Analysis. Effort should be coordinated with forthcoming refuge Visitor Services Plan.*
- **Implement transit accommodations at and approaching the Jed Johnson Tower Trailhead** in order to ensure that the refuge is fully accessible to future tour or transit buses. *See Multi-Modal Network Alternatives Analysis*.
- **Pursue partnerships to develop a bicycle share pilot** between the refuge, Medicine Park, and LETRA to provide a convenient local transportation option for visitors. *See Multi-Modal Network Alternatives Analysis*.

Long Term (11-15 Years)

- **Complete the Environmental Education Center to Visitor Center trail** to provide a safe, nonmotorized link between these popular sites and Doris Campground. *See Multi-Modal Network Alternatives Analysis*.
- **Implement sustained seasonal transit system** depending to the success of the pilot service. *See Transit Assessment*.

1. Introduction

Wichita Mountains Wildlife Refuge
Comprehensive Alternative Transportation Plan

Introduction

Wichita Mountains Wildlife Refuge (WMWR) is one of the busiest refuges in the National Wildlife Refuge System. Approximately 1.5 million visitors a year come to enjoy views of bison, elk, Texas Longhorn cattle, and other species. The refuge encompasses nearly 60,000 acres of mixed-grass prairie and protects the endangered black-capped vireo and one of the oldest mountain ranges on Earth. Refuge staff continue to look for ways to accommodate burgeoning visitation, while protecting the area's invaluable natural resources and limiting facility expansion to the current "disturbed" footprint of existing infrastructure.

The refuge's growing popularity contributes to many transportation and recreation challenges on the refuge, including:

- Parking lot congestion at key sites
- Overuse of natural areas on the western side of the refuge
- Bicyclist roadway safety issues within and approaching the refuge
- Lack of access for underserved populations

These transportation challenges are inextricably linked to larger recreation and natural resource challenges facing the refuge, including overuse of the remote and sensitive areas on the western side of the refuge and increasing on-road bicycling. The purpose of this plan is to develop a set of strategies for the refuge and its partners that pragmatically respond to these challenges, while a) staying true to the refuge's mission and purpose and b) being consistent with the 2013 WMWR Comprehensive Conservation Plan (CCP).

Background and Progress

In order to begin to address transportation and recreation challenges at WMWR, the Fish and Wildlife Service (FWS) requested a Transportation Assistance Group (TAG) site visit, which the Volpe National Transportation Systems Center (Volpe Center) facilitated in the spring of 2009. The TAG report provides a high-level outline for transportation planning goals, alternative transportation options, and partnership opportunities on and around the refuge.

The Volpe Center subsequently produced an Alternative Transportation Study (ATS) in 2010 that expanded upon the TAG report by identifying existing and future demographic and transportation conditions, potential regional partnership opportunities, and experiences with transportation planning at other public lands units. While the ATS report did not provide specific recommendations for action, it provided a broad framework of alternative transportation options for the refuge to consider pursuing including: data collection and analysis, walking and bicycling enhancements, and an intelligent transportation system. Table 1 presents alternative transportation options presented in the 2010 ATS report and their current status as of early 2014.

Table 1-1: Status of Transportation Options in the 2010 Alternative Transportation Study

Type of Recommendation	Transportation Option	Status	Notes
Data collection and Analysis	Traffic Analysis Study	Complete	*See Traffic Analysis Study in this report.*
	Transit Assessment	Compete	*See Transit Assessment in this report.*
Walking and Bicycling Enhancements	LETRA Trail Improvements	Funded and ongoing	*2012-13 Public Lands Transportation Scholar completed pre-NEPA analysis. Refuge awarded funds for environmental compliance, design, and construction.*
	Roadway Shoulder Improvements Extension	Complete	*Constructed 8 foot shoulders on OK—49/OK-115 between Cache and Medicine Park Gates in 2011. The refuge is no longer pursuing large shoulder expansions.*
	Visitor Center to Environmental Education Center and Burma Road Trails	Unfunded	*Burma Road enhancements not carried through in the 2013 WMWR CCP*
	Jed Johnson Tower Parking and Roadway Improvements	Unfunded	*2012-13 Public Lands Transportation Scholar completed pre-NEPA analysis.*
	Wayfinding/Signage	Unfunded, planning compete	*See Multi-Modal Network Alternatives Analysis*
	Bicycle Share Pilot Program/Bicycle Routes	Unfunded, planning compete but partner needs to be identified.	*See Multi-Modal Network Alternatives Analysis*
Visitor Information	Traveler Information System	Ongoing, partial implementation	*FHWA, Central Federal Lands Highway Division selected WMWR as an ITS pilot project for its seven busiest parking lots.*

Refuge staff included many of these options in the 2013 WMWR CCP, which governs all management decisions on the refuge over the next 15 years. This plan completes two of the options (Traffic Analysis

Study and Transit Assessment), lays further groundwork for the six walking and bicycling enhancements, and provides recommendations to improve the refuge's traveler information systems and soon to be implemented intelligent transportation system.

Refuge Goals and Objectives for this Plan

After reviewing the CCP, refuge staff and the Volpe Center developed the following goals and objectives to achieve through the implementation the strategies recommended in this plan.

Goal 1: Habitat and Environmental Quality - Preserve the biological integrity of southern mixed-grass prairie and Crosstimbers habitats to enhance long-term resiliency of these habitats.

- *Objective A*: Distribute visitor impact to the less utilized east section of the Refuge and off-Refuge sites to maintain and protect the Charons Garden Wilderness Area and low density public use zones
- *Objective B*: Reduce local air pollution and the carbon footprint of transportation by reducing reliance on single occupancy vehicles

Goal 2: Visitor Experience - Provide a world-class, wildlife-focused experience through public use opportunities that educate and increase the quality of life for current and future generations and that promote the long-term health of the Refuge.

- *Objective A*: Develop and maintain hiking and bicycling infrastructure to enhance visitor experience in the medium and high density use areas
- *Objective B*: Pursue encouragement strategies that support nonmotorized transportation
- *Objective C*: Utilize new and existing multi-use trails as interpretive opportunities

Goal 3: Public Use Facilities - Administer safe, well-maintained, and energy-efficient facilities that allow the public and staff to enjoy and support the purpose of the Refuge and the mission of the National Wildlife Refuge System.

- *Objective A*: Build, update, and maintain public use facilities that are accessible, comfortable, and conducive to fulfilling the Refuge's purpose (CCP)
- *Objective B*: Increase and improve accessible hiking opportunities
- *Objective C*: Promote public safety in transportation investments and policies

Goal 4: Access - Promote transportation options that provide Refuge access to all visitors, including mobility impaired and transportation disadvantaged groups

- *Objective A*: Develop partnerships and agreements that promote access to all visitors, including transportation-disadvantaged groups
- *Objective B*: Make investments that are accessible and compliant with new U.S. Access Board standards for outdoor recreation areas

The strategies described at the conclusion of this study are measured against these goals.

Report Organization

Building off the transportation options laid out in the 2010 ATS report, WMWR applied for and received funds from Federal Transit Administration through the Paul S. Sarbanes Transit in Parks Program to complete this Comprehensive Alternative Transportation Plan (CATP). This study includes four discrete, but interrelated products:

- **Traffic Analysis Study:** Provides baseline information on automobile volume, circulation, and parking data to inform transportation decisionmaking on the refuge. Data collection revealed that parking is constrained at a few key locations, but the road and parking network is functioning well and is projected to continue to do so into the future.

- **Bicycle and Pedestrian Resource Guide:** Presents background information and a suite of tools for the refuge to implement nonmotorized infrastructure and programming. All of the options presented are appropriate to the refuge context.

- **Multi-Modal Network Alternatives Analysis:** Outlines nonmotorized network and program options and costs for the refuge and presents three alternative levels of investment that would leave the refuge with an improved low-impact, nonmotorized transportation network consistent with its CCP.

- **Transit Assessment:** Explores transit alternatives both to and within the refuge, partnership opportunities, and associated costs. Several transit options are feasible and available to the refuge within the next few year.

2. Traffic Analysis Study

Wichita Mountains Wildlife Refuge
Comprehensive Alternative Transportation Plan

Table of Contents

Table of Figures

Table of Tables

Introduction

The first recommendation from the Wichita Mountains Wildlife Refuge (WMWR) 2010 Alternative Transportation Study (ATS) was to develop a baseline of traffic and parking conditions to inform transportation planning and to measure the effects of changes to the transportation system. This information currently does not exist. For example, the refuge does not know how visitors link their trips, how long they stay at particular sites, or what percentage of motorists on the refuge are actual visitors versus pass-through traffic. The refuge is interested in alternative transportation, such as bicycle sharing and transit, but lacks adequate traffic data to support the planning of such infrastructure and services. The purpose of this transportation assessment is to gather existing available data, perform primary data collection to complement the existing data, and to analyze the data so that this work both supports subsequent parts of the Comprehensive Alternative Transportation Plan (CATP) and informs future transportation planning and implementation on the refuge. In essence, the transportation assessment forms a baseline of existing transportation conditions on the refuge.

This assessment is divided into three sections. The first is a summary of available information on visitation and visitor activities on the refuge, which provides background information on visitor trends and preferences as reported in several data sources. Second is a description and summary of primary traffic and parking data collected as part of this assessment. The third section provides the results of the assessment, including existing and projected future travel and parking patterns on the refuge. Finally, a conclusion discusses how this data can be used to inform transportation planning on the refuge and describes data improvements for any future efforts.

Visitation and visitor activities

This section compiles existing research and data on visitation trends and visitor transportation preferences. These historical trends are one part in predicting visitation patterns in the future, which may cause the refuge to consider altering existing or plan new transportation systems.

Annual Area Population and Visitation Trends and Projected Growth

Local population and WMWR visitation continue to grow on an annual basis. Census Bureau population counts and Oklahoma Department of Commerce population projections show an average annual population increase of 0.62 percent in Comanche County and 0.98 percent in Lawton between 1990 and 2030 (see Table 2-1).

Table 2-1: Local Population Growth, 1990-2030

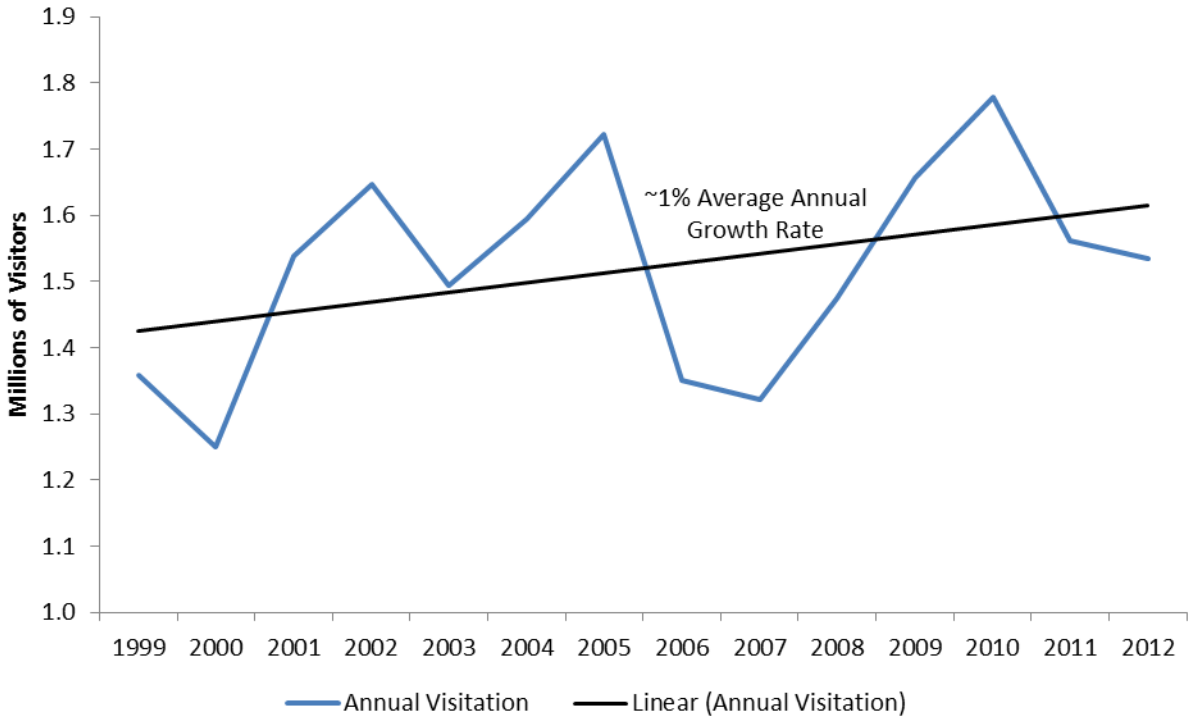
	1990	2000	2010	Projected 2020	Projected 2030	Avg. Annual Increase (1990-2030
Comanche County	111,486	114,996	124,098	132,000	139,200	0.62%
Lawton (incl. Fort Sill)	80,561	92,757	96,867	106,470	112,280	0.98%

Source: U.S. Census Bureau, Oklahoma Department of Commerce – Projections of Cities and Towns in Oklahoma: 2000-2030, http://dev3.okcommerce.gov/v2/Libraries/Documents/Projections_of_Cities_Towns_in_Oklahoma_2000_121004413.pdf, accessed April 28, 2013.

According to traffic counters stationed at WMWR's five gates, the Refuge received over 1.53 million recreational and non-recreational visitors in 2012, making it one of the most visited units in the National Wildlife Refuge System. Since 1999, the Refuge visitation has grown an average of one percent each year (see Figure 2-1).[1]

[1] The refuge calculates visitation based on traffic counts obtained from five inbound traffic counters located at the gates to the refuge. The calculation includes a multiplier that assumes three persons per vehicle. Each month, the refuge adds 6,200 to its visitation total to account for activity at the Treasure Lake Job Corps. The refuge adds 0.5 percent to monthly visitation totals to account for uncounted bicyclists.

Figure 2-1: Wichita Mountains Wildlife Refuge Annual Visitation, 1999-2012



Source: Wichita Mountains Wildlife Refuge.

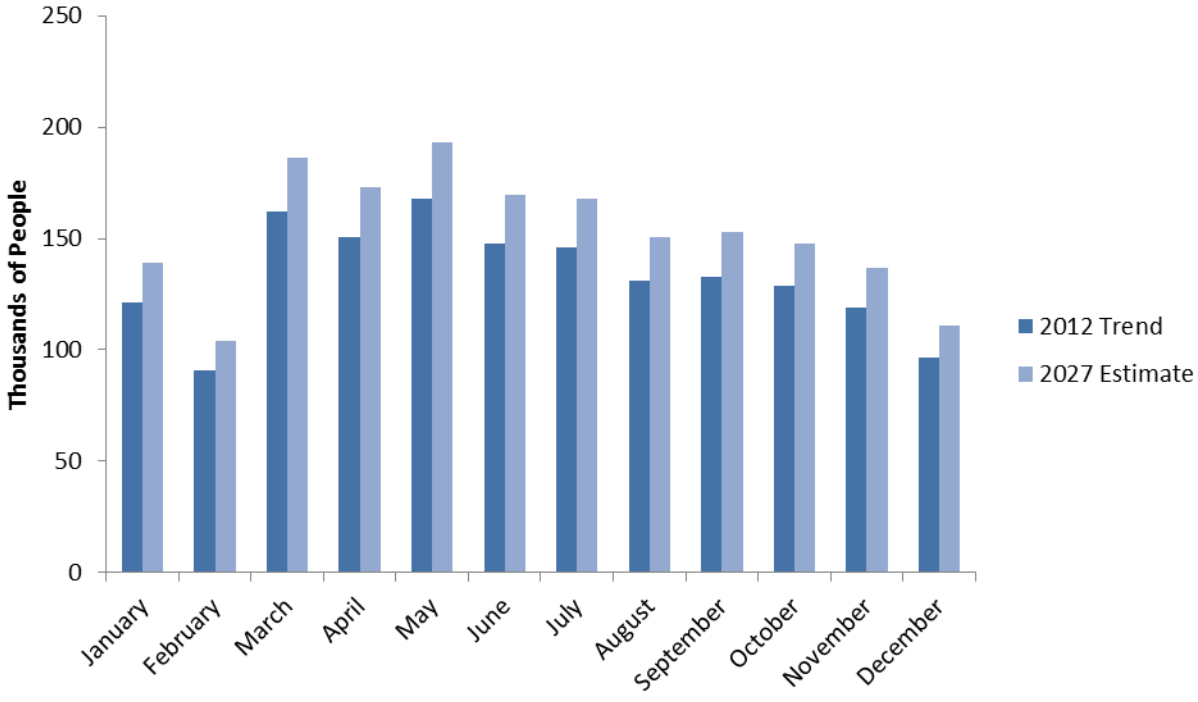
Given projected continued increases in area population and historical visitation patterns, the project team estimates that WMWR visitation will continue to increase an average of one percent over each of the next 15 years.[2] This translates to a projected 1.82 million annual visitors in 2027.

[2] A 15 year time period was chosen to be consistent with the refuge's recently adopted Comprehensive Conservation Plan.

Monthly Visitation Averages and Projected Growth

WMWR visitation is relatively steady over the course of the year, peaking in the spring and declining slightly through the summer and fall. Monthly visitation drops between 25 and 50 percent from the peak during the winter months (see Figure 2-2).

Figure 2-2: Monthly Visitation (2012 Trend and 2027 Estimate)

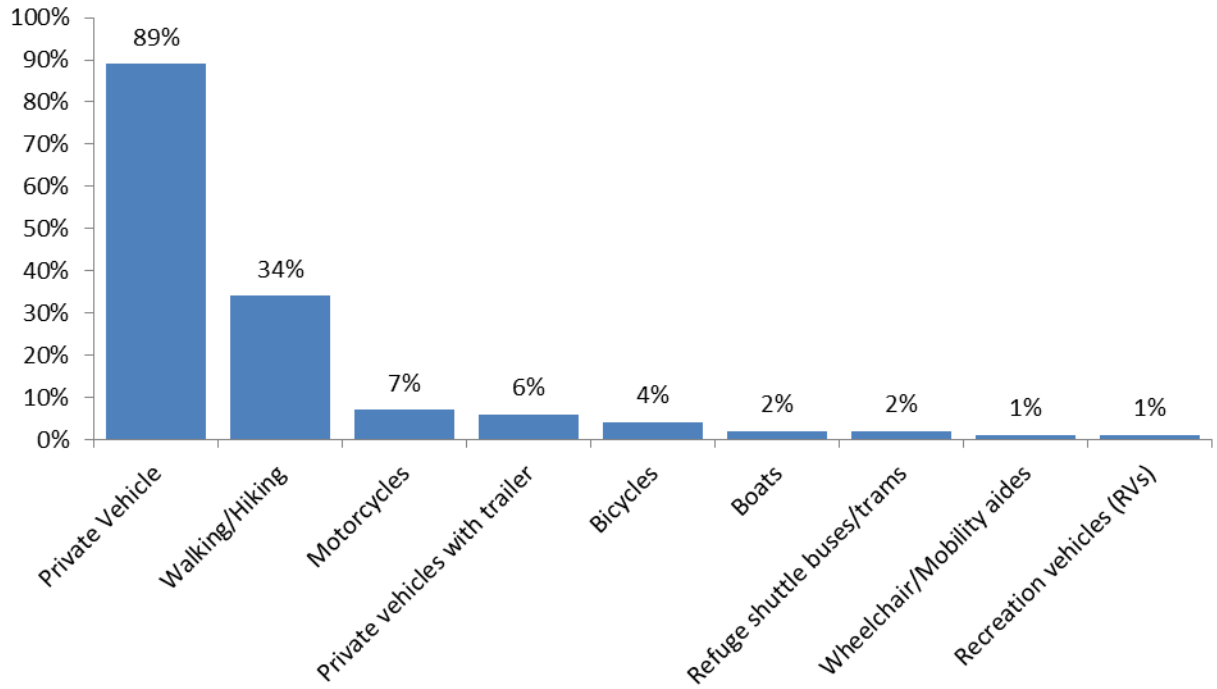


Source: Wichita Mountains Wildlife Refuge.

Visitor Transportation Mode

A recent U.S. Geological Survey (USGS) report found that the vast majority (96 percent) of WMWR visitors use private, motorized transportation on at least one leg of their visit, including seven percent by motorcycle.[3] The next most common mode of transportation on the refuge is hiking (34 percent), however these visitors are likely accessing the refuge by private vehicle and hiking only on the refuge. Four percent of visitors reported traveling by bicycle for one portion of their trip (see Figure 2-3).

Figure 2-3: Mode of Transportation Used During Day of Survey (n=185)



Source: USGS 2011. National Wildlife Refuge Visitor Survey 2010/2011: Individual Refuge Results for Wichita Mountains National Wildlife Refuge.

[3] USGS 2011. National Wildlife Refuge Visitor Survey 2010/2011: Individual Refuge Results for Wichita Mountains National Wildlife Refuge.

Activity Preferences

A visitor survey revealed that during the past 12 months, a majority of visitors participated in wildlife observation, hiking, photography, and driving/touring by car (see Figure 2-4). When asked in which activity they participated at the time of the survey, most said hiking and wildlife observation (see Figure 2-5). The survey was performed as part of a standard national survey effort and so includes some activities (namely migratory bird/waterfowl hunting and upland/small game hunting) that are not available at WMWR.

Figure 2-4: Activities Enjoyed in the Last 12 Months (n=182)

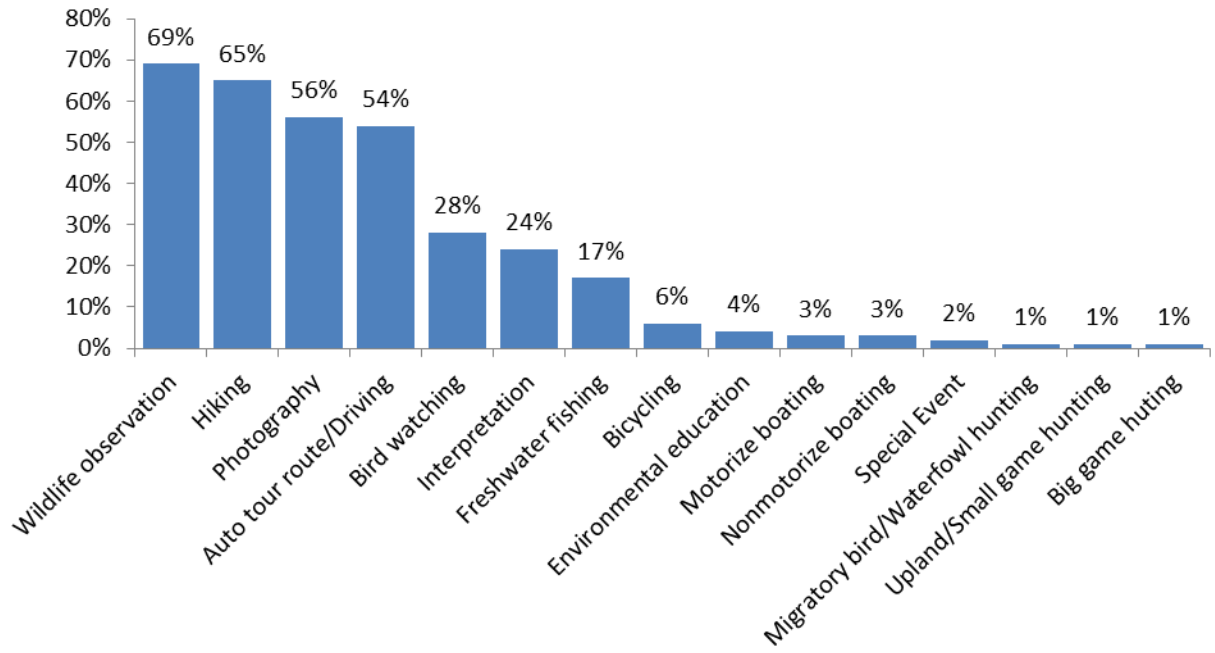


Figure 2-5: Activities Enjoyed During Survey Period (n=168)

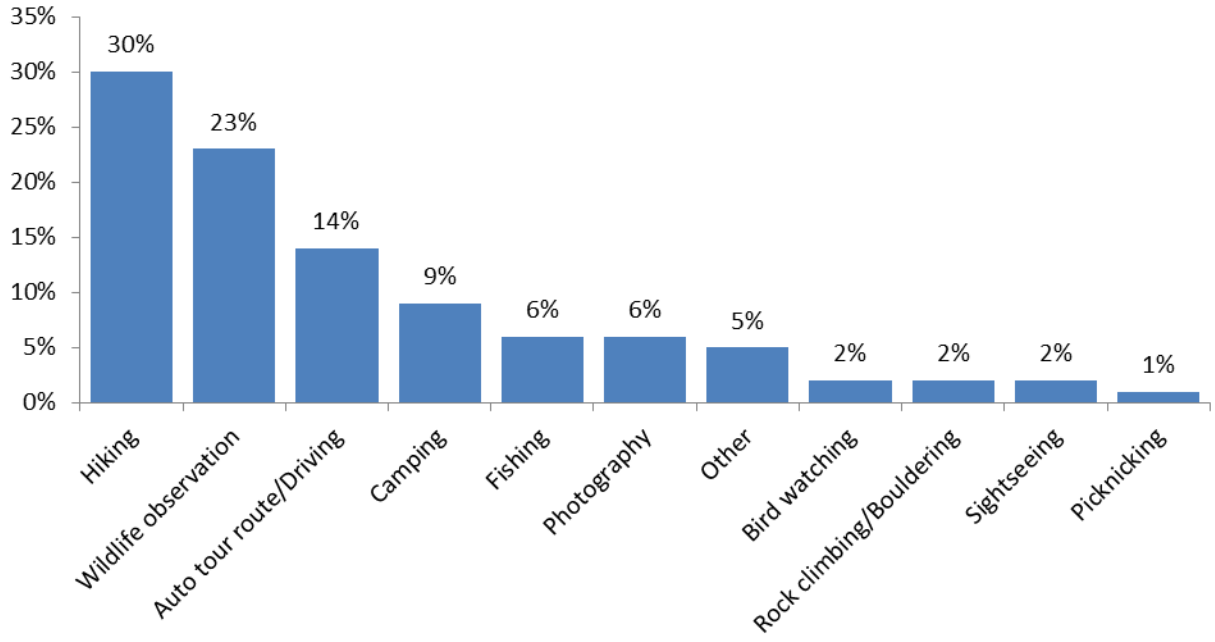


Figure 4 and 5 Source: USGS 2011. National Wildlife Refuge Visitor Survey 2010/2011: Individual Refuge Results for Wichita Mountains National Wildlife Refuge.

Methodology

This section describes the methodology followed in this transportation assessment, including data sources as well as how various metrics were calculated. Data sources include permanent and temporary automated traffic counters (ATCs) and direct observation of vehicle turning movements counts (TMCs) and parking counts. Figure 2-6 shows the location of ATCs and manual data collection sites on the refuge.

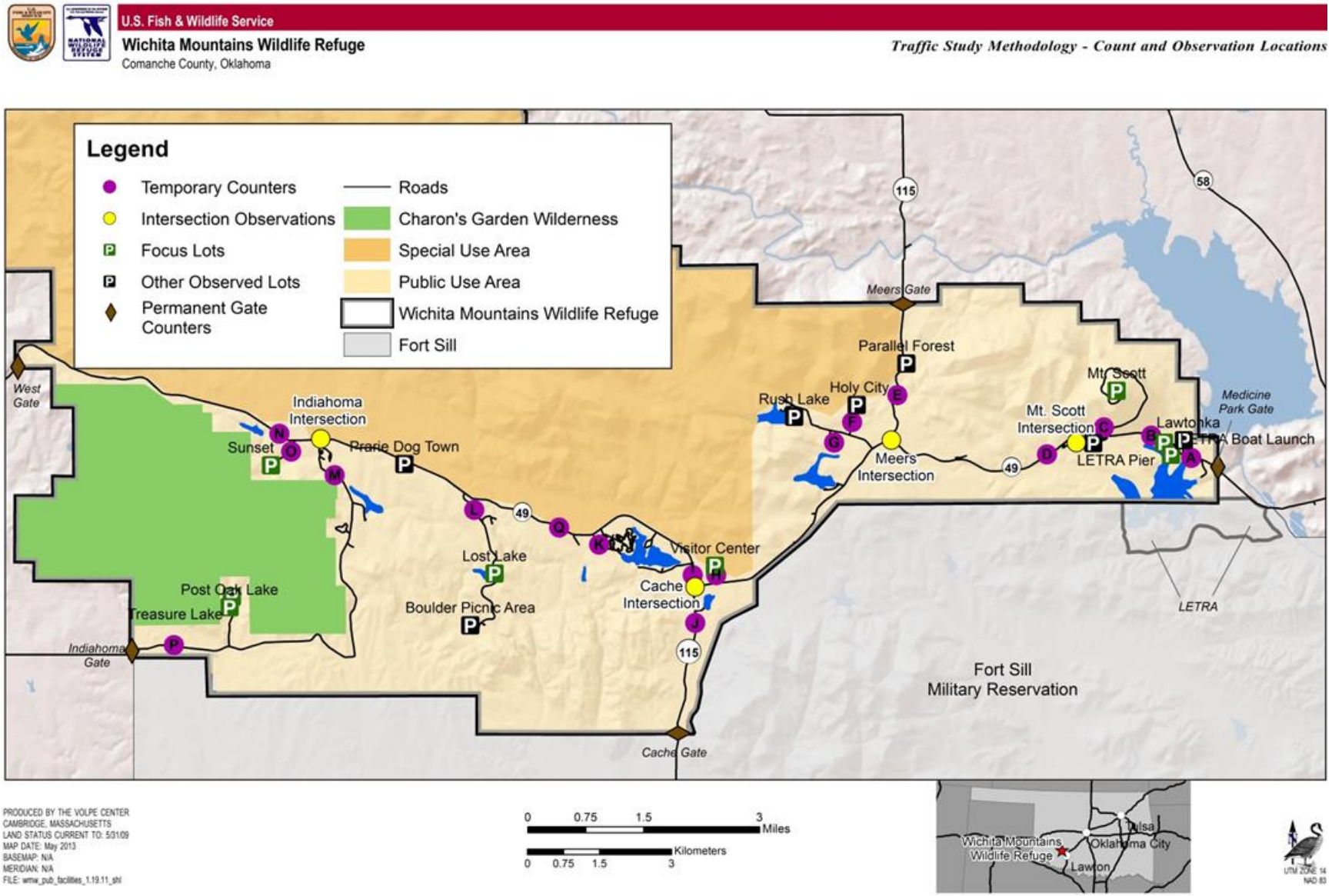
Automated Traffic Counters (Permanent and Temporary)

The refuge maintains ATCs at the five entry gates (Medicine Park, Cache, Indiahoma, West, and Meers). These permanent ATCs, installed in 2012 to replace previous counters, record vehicles as they enter the refuge on an hourly basis. The refuge uses these counters to determine visitation (by applying a multiplier of three persons per vehicle). The primary limitation to the permanent ATCs is that they do not record exiting traffic, how long visitors remain on the refuge, or where they travel once there. Accordingly, determining parking occupancy and circulation are the two main purposes of this assessment. In order to determine general traffic patterns on the refuge, the study team relied on temporary traffic counters deployed at sites across the interior of the refuge and in exit lanes.

The study team used historical visitation data (see Section 2.2 above) to identify October as a good month for data collection. While not the peak season, October provides a representative baseline for the year (e.g., visitation is relatively high, the weather is generally good, etc.). Further, October worked well for the timing of this study and additional temporary ATCs were available for installation. Data from the temporary automated counters were extrapolated to the busier season (i.e., the spring) using the refuge's permanent ATC data to establish patterns.

The temporary ATCs were installed at locations throughout the refuge for a four-week period in October and November 2012, coinciding with the study team's manual traffic and parking collection effort that occurred Friday October 26th through Sunday October 28th. Figure 2-6 shows the 17 locations where temporary ATCs were installed and the location of the five permanent gate ATCs on the refuge. The temporary ATCs were strategically placed to not only provide point data, but also data that would shed light on circulation patterns on the refuge. The ATCs were embedded in the center of travel lane and captured traffic activity in 15-minute intervals. Whereas the permanent ATCs only count vehicles entering the refuge, the temporary ATCs were placed so that they could count vehicles moving in each direction. The ATCs also collected average vehicle speeds. The collection of data in 15-minute intervals was important to understand if there were periods of heavy traffic within the standard one-hour analysis period ("peak of the peak") or if traffic flowed on the refuge in a more regular manner.

Figure 2-6: Refuge Data Collection Sites



Direct observations

The study team collected data through direct observation during the weekend of October 26-28, 2012. This data collection effort helped determine unknowns such as intersection and parking lot activity. Two sets of direct observations were conducted: intersection turning movement counts and license plate inventories at parking lots.

The intersection TMCs were conducted at critical intersections (see Figure 2-6) over the three-day observation period between 6:00 AM and 6:00 PM. Observers noted the number of vehicles and their direction of travel through the intersection in 15- to 30- minute intervals. While traffic counters were installed for several weeks, TMCs were conducted on just three days and therefore represent a snapshot of turning movement activity. Combined with the traffic counter data, these data are used to develop a basic model of traffic circulation patterns on the refuge (see Section 2.5).

Observations were also conducted at several parking lots on the refuge (see Figure 2-6). At these focus lots, observers recorded license plate numbers and also counted the number of visitors in each car as they passed.[4] Every 30 minutes, between 6:00 AM and 6:00 PM, observers noted whether vehicles remained parked or had exited the parking area. Other parking lots were observed on an irregular basis. The data were used to determine parking occupancy and to verify the vehicle occupancy rate and understand how visitors link sites when they visit the refuge.

Capacity Analysis

This section of the report analyzes the capacity of the transportation system, which is a function of the supply and demand of the transportation network including roadways and parking. The existing roadway network and parking infrastructure determine the overall supply while traffic volume and parking activity reflect demand.

Existing and future traffic volumes

Data from the ATCs were used to compute several traffic volume metrics. First, Average Annual Daily Traffic (AADT) provides a general overview of traffic volumes on refuge roads and is the average daily sum of all five entry gate counters. AADT measures the number of vehicles that pass by a given point in a day, averaged out across the year. AADT in this analysis is provided for both the average weekday and average weekend day and was generated using procedures from the Highway Capacity Manual.[5] This section also provides a peak hour level of service (LOS) analysis of refuge road segments based on the data collected from the temporary ATCs.

Average Annual Daily Traffic

AADT is calculated for both an average weekday and average weekend day to describe the total amount of traffic traveling onto the refuge on an average day. Average weekday AADT is calculated as the average from all Tuesdays, Wednesdays, and Thursdays during 2012 from the permanent ATCs. Eliminating Mondays and Fridays from the average helps to provide a more regular estimate of traffic volume during a “typical” weekday, as Mondays and Fridays may be heavily influenced by weekend or

[4] 2.8 was the observed average vehicle occupancy, but it was not always possible to count all occupants since some vehicles had tinted windows and some people – like children in car seats – were difficult to see.

[5] Source: Highway Capacity Manual 2010, Volume 2. Transportation Research Board.

holiday activity. Weekend AADT is calculated based on the average of all Saturdays and Sundays during 2012, in addition to Monday and Friday holidays (e.g., Memorial Day and the day after Thanksgiving) because they are representative of weekend traffic.

The counter data also shows the busiest and least busy entry gates (see Figure 2-7). During the weekday, one-third of refuge traffic enters through each the Cache Gate and Medicine Park Gate, while 15 percent of refuge traffic enters through each the Meers Gate and Indiahoma Gate. Just three percent of refuge traffic enters through the West Gate. On weekends, the Medicine Park Gate is the busiest gate with 46 percent of AADT. The Cache Gate is the second busiest entry point (30 percent) while the Meers Gate, Indiahoma Gate, and West Gate remain the least busy entry points, at 14 percent, six percent and four percent respectively. During the weekend, it is reasonable to assume that a greater proportion of traffic is due to recreational travel. It is worth noting that traffic is busier at the Medicine Park Gate, especially given that the refuge would like to encourage more recreational activity on the eastern part of the refuge.

Figure 2-7: Entry Gate AADT Weekday (left) and Weekend Day (right)

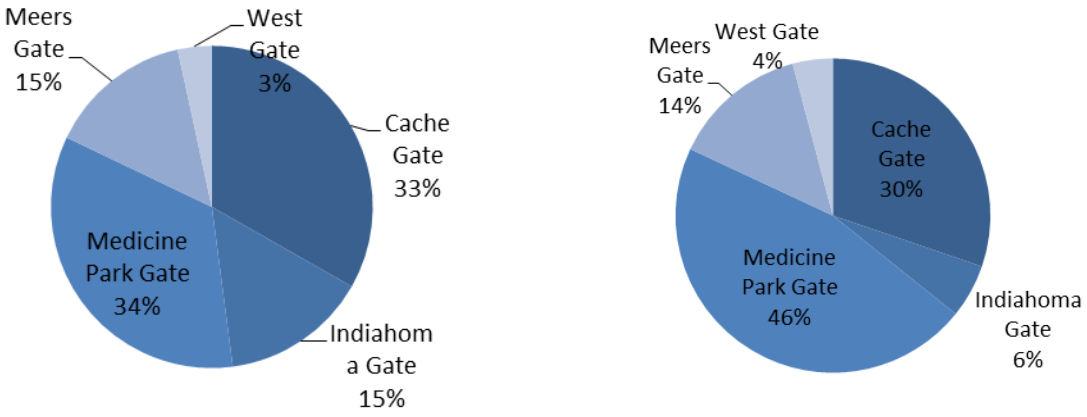
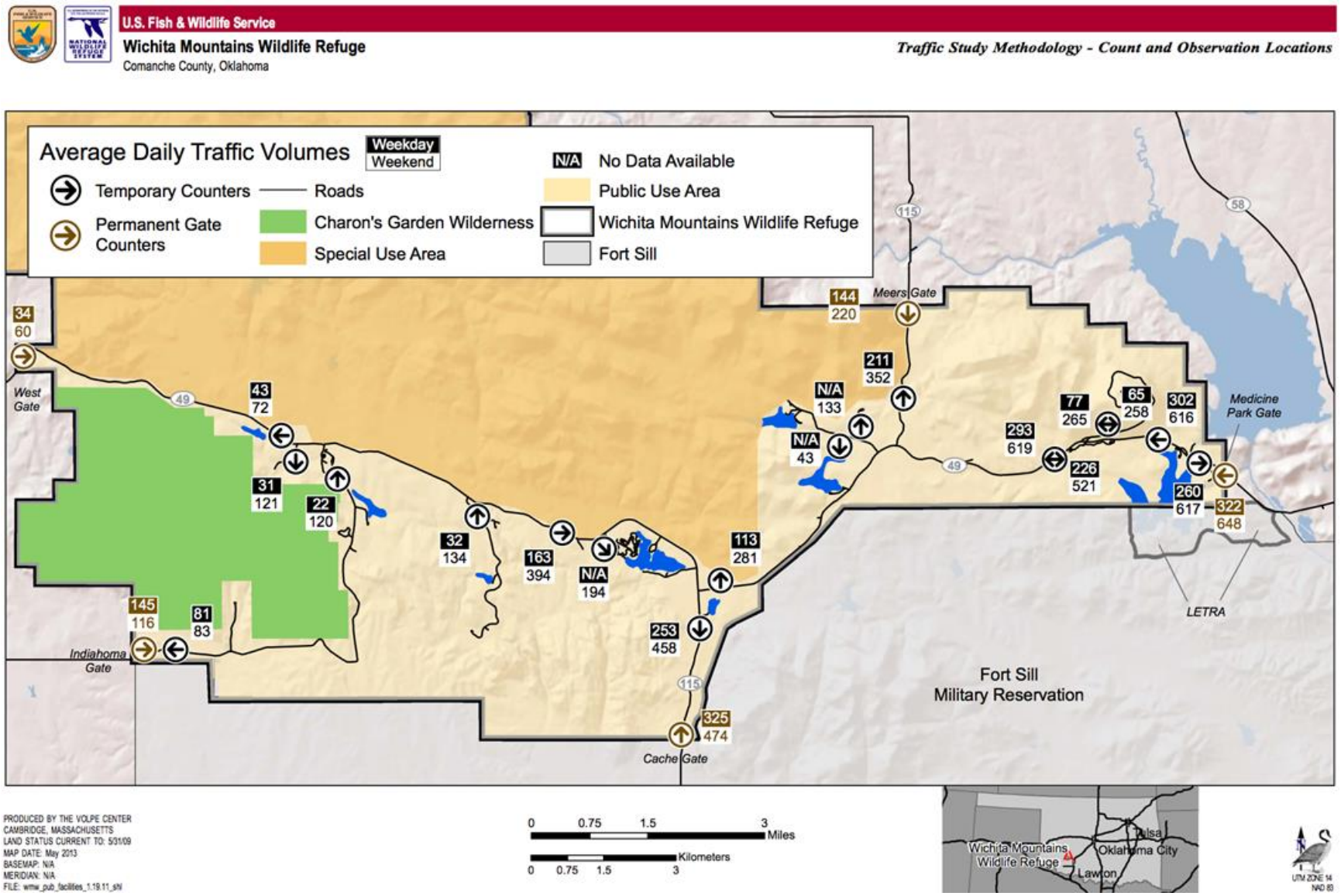


Figure 2-8 shows AADT for weekdays and weekend days, respectively at each counter site. The busiest day refuge-wide was Saturday, March 24th, and the least-busy day was Christmas. Weekend traffic was higher than weekday traffic at almost every site.

Figure 2-8: Average Annual Daily Traffic (Weekday/Weekend Day)



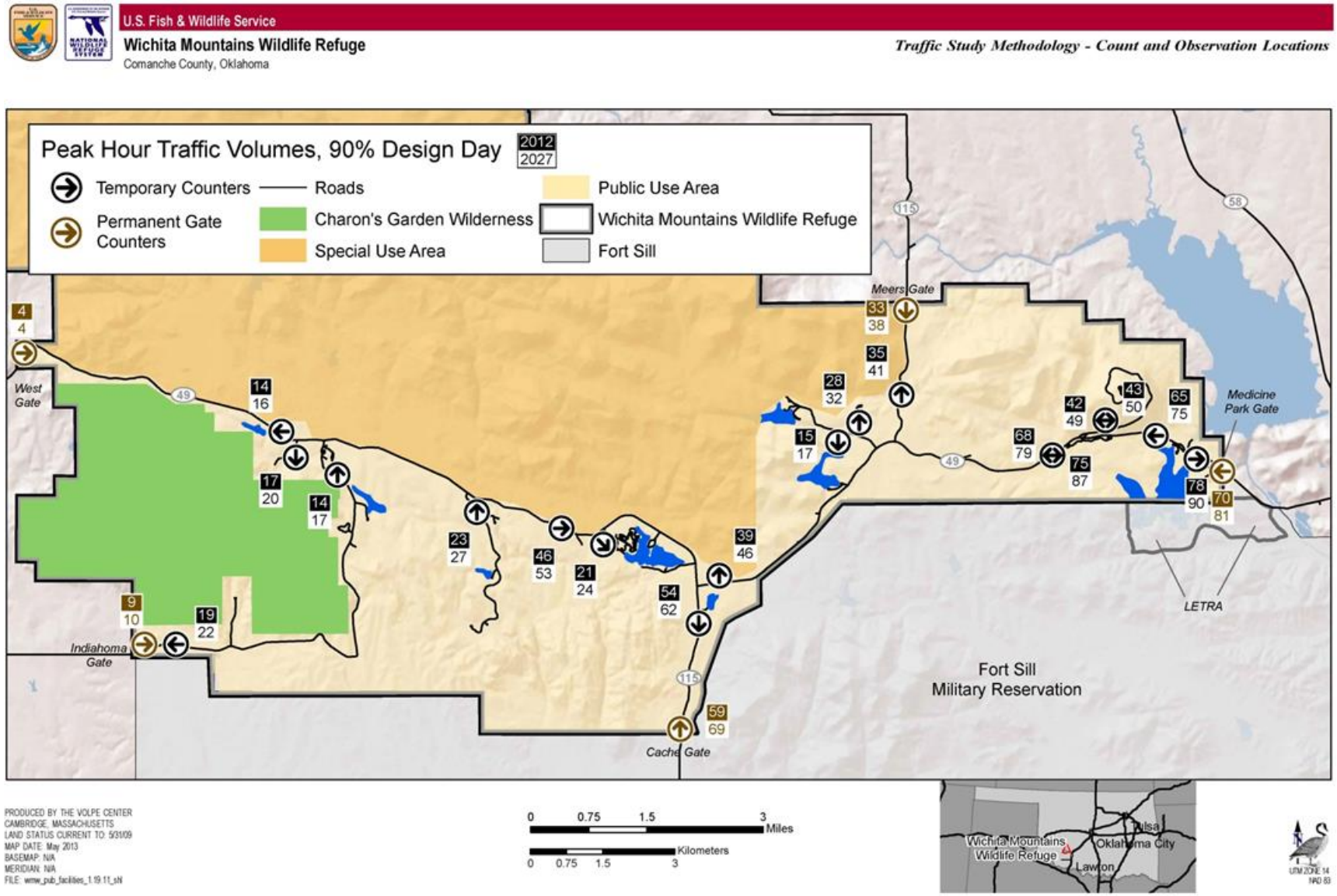
Peak Hour Traffic Volumes – 2012 and 2027 Design Day

This section provides an existing and future peak hour analysis on refuge roads. The data presented in this analysis are based on a "design day," in both 2012 and 2027. The design day is a day that has more visitation than approximately 90 percent of all other days in a year and helps in planning or modifying transportation systems to gauge how well different alternatives and options achieve their objectives.[6] The design day can be thought to represent a busy weekend in June or March, although not quite the peak days seen in April or during holidays. 2027 was selected because transportation decision-making will influence visitation to the refuge well into the future. The refuge may not make transportation changes (such as transit) for many years, necessitating the need to assess potential systems over a longer period of time. Further, the 15-year planning horizon coincides with the refuge's Comprehensive Conservation Plan (CCP), helping the refuge implement transportation-related elements of the CCP.

The 90 percent design day data are based on data collected on October 27, 2012, and were extrapolated based on annual traffic data gathered from the permanent ATCs. The future 90 percent design day is projected using the one percent per year growth rate presented in Section 2.2.1. Figure 2-9 shows traffic volumes during the peak hour 2:00 PM – 3:00 PM (the average peak hour) on the 90 percent design day in 2012 and 2027.

[6] The purpose of using the design day is to plan for transportation strategies that accommodate high-usage days without overbuilding infrastructure and/or transit to accommodate only a few days of the year. A good analogy is parking lot size at a retail store that is designed for the day after Thanksgiving – most of the year much of the capacity goes unused. In lieu of overbuilding hard infrastructure, the refuge may need to include additional management strategies (such as the temporary closing of the entry to Sunset Picnic area to additional vehicles once all designated parking spaces are occupied) to accommodate congestion on those 10 percent of days where visitation exceeds that of the design day.

Figure 2-9: Peak Hour Traffic Volumes on the 90 percent Design Day (2012 and 2027)



Level of Service – 2012 and 2027 Design Day

This section provides a level of service (LOS) analysis of peak hour traffic volumes on refuge roads. Based on volume-to-capacity (V/C) ratios, LOS helps assess the ability of existing transportation infrastructure to meet current and future demand. The existing capacity of roadway lanes on the refuge (OK-49 and OK-115) is 1,600 vehicles per hour, assuming a standard two second following distance between cars.[7] The average hourly volumes are well below this rate on the 90 percent design day both currently and in 2027. The primary issue with regard to roadway capacity in the refuge is vehicles slowing to view scenery and wildlife, which may degrade LOS for very brief periods of time. The refuge is addressing this issue by constructing new roadway shoulders that encourage drivers to pull over, allowing through traffic to safely pass. Another, often related, issue that affects roadway LOS on refuge roads is wildlife activity on or near the roads, which may slow or stop vehicular flow for periods of time. These are random events that are hard to prepare for but which can impact traffic flow, at least for a short while.

LOS on Class II rural highways is defined by the percent of time that drivers follow other traffic. Table 2-2 shows the level of service that results from percent time spent following (PTSF) other vehicles. For example, if the percent time spent following other vehicles is less than 35 percent, the LOS is A. If traffic flow exceeds the capacity of the road, the resultant LOS is F.

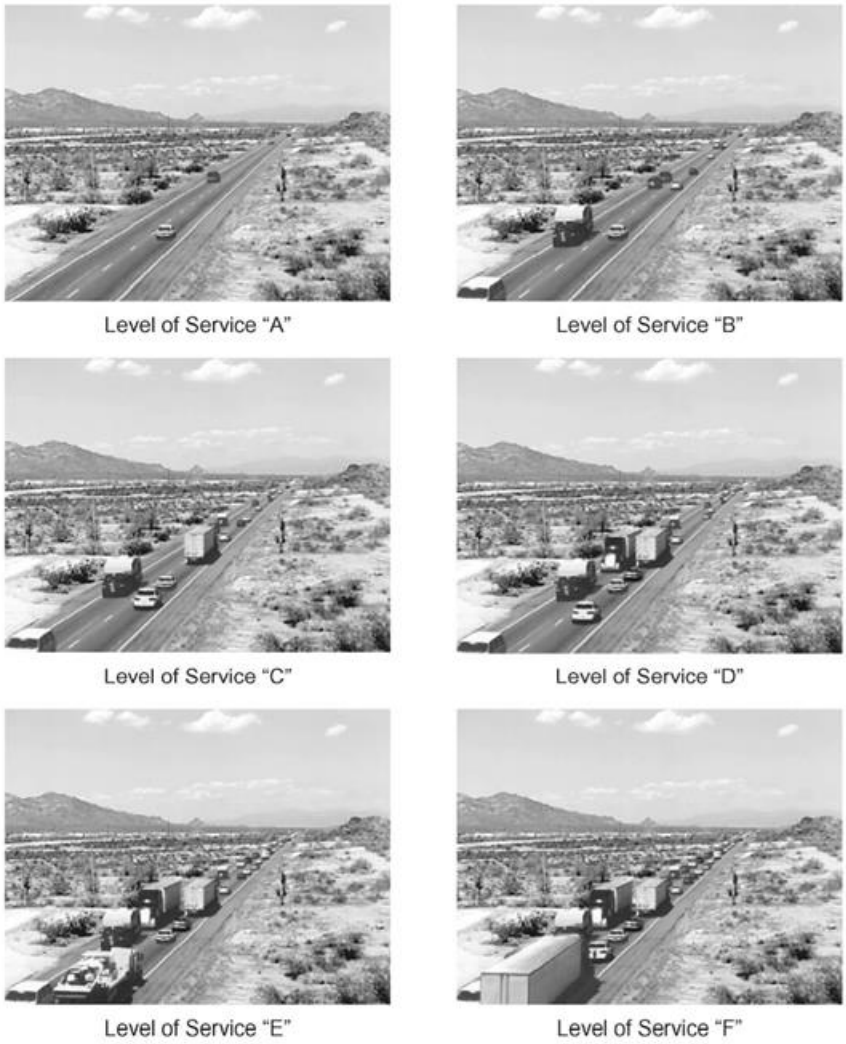
Table 2-2: Percent Time Spent Following and LOS for Class II Rural Roads

PTSF	Resultant LOS
<35%	A
<50%	B
<65%	C
<80%	D
>80%	E
Flow exceeds capacity	F

Figure 2-10 shows a visual example of what traffic looks like on rural two-lane roads for all LOS levels (A through F).

[7] Maximum rural two-lane road capacity is approximately 1,600 vehicles/hour based on findings in the Highway Capacity Manual 2010 and the assumption that drivers maintain a safe two-second following distance.

Figure 2-10: Visualization of Level of Service



Source: Levinson, David, Highway Capacity Level of Service, http://nexus.umn.edu/Courses/ce3201/CE3201-L2-04.pdf, accessed May 8, 2013.

Table 2-3 shows the V/C ratio for all ATCs on the refuge and the percent of time that drivers spend following (PTSF) behind other cars. The primary routes through the refuge are Class II rural two-lane highways as defined by the Highway Capacity Manual (2010), where traffic is low and a large share of drivers are recreational rather than commuters.

Table 2-3: Refuge Volume/Capacity and Percent Time Spent Following at Refuge ATC locations

ID	V/C Ratio (Design Day, 2PM)	V/C Ratio (Design Day, 2027)	PTSF (Design Day, 2PM)	PTSF (Design Day 2027)
A – MP Gate EB	5%	6%	23%	24%
B – Lake Elmer Thomas WB	4%	5%	23%	23%
C – Mt. Scott Down	3%	3%	23%	23%
C – Mt. Scott Up	3%	3%	23%	23%
D- West of Mt. Scott EB	5%	5%	23%	24%
D – West of Mt. Scott WB	4%	5%	23%	24%
E – OK-115 NB to Meers Gate	2%	3%	23%	23%
F – Holy City entrance	2%	2%	22%	23%
G – Jed Johnson entrance	1%	1%	22%	22%
H – VC entrance	2%	3%	23%	23%
J – OK-115 SB to Cache Gate	3%	4%	23%	23%
K – Doris CG Entrance	1%	1%	22%	22%
L – Lost Lake exit	1%	2%	22%	22%
M – Indiahoma Rd SB	1%	1%	22%	22%
N – HW-49 WB to West Gate	1%	1%	22%	22%
O – Sunset entrance	1%	1%	22%	22%
P – Indiahoma RD at Gate WB	1%	1%	22%	22%
Q – HW-49 west of Doris CG EB	3%	3%	23%	23%
Cache	4%	4%	23%	23%
Indiahoma	1%	1%	22%	22%
Medicine	4%	5%	23%	24%
Meers	2%	2%	23%	23%
West	0%	0%	22%	22%

All roads within WMWR operate at LOS A with V/C ratios varying between 0 percent and 5 percent in 2012 and a projected 0 percent and 6 percent in 2027. This indicates that traffic currently flows, and will continue to flow, at free-flow speed. The PTSF at all ATC locations averages 22 percent to 23 percent in 2012 and is projected to average 22 percent to 24 percent in 2027 (see Table 2-3).

Occasional wildlife and vehicle activity may cause LOS to decline to LOS B or C, but only for brief periods of time. Countermeasures such as passing lanes for these temporary, rather than structural, delays are generally not worth the investment while degrading refuge resources. Mount Scott is one of only a few mountain roads in the region, and capacity degrades around some of the tighter turns and scenic

pullouts near areas of limited visibility. However, traffic volumes are still low enough that no significant capacity issues are currently seen or projected.

Turning Movement Counts

Level of service can also be affected by intersection design and activity. The study team conducted intersection observations and counts and found that generally, intersections function well on the refuge, meaning their design does not contribute to significant delays. TMCs were conducted at four critical intersections (see Figure 2-6), with the goal of understanding typical travel patterns on the refuge. These intersections are the two OK-49/OK-115 intersections (Meers T and Cache T), the base of Mount Scott and its intersection with OK-49, and the intersection of OK-49 and Indiahoma Road. The TMCs are used and discussed in the circulation analysis (see Section 2.5)

Parking Capacity

This section analyzes parking activity at several refuge parking lots including Mount Scott, Sunset Picnic Area, Treasure Lake/Post Oak Lake, Visitor Center, Lake Elmer Thomas Pier and Dam, and Lost Lake. Parking capacity is a function of the number of parking spaces and parking space occupancy (how long a vehicle stays in a parking space). The number of parking spaces is a physical value "hard" capacity (defined as marked parking spaces), but can vary based on refuge acceptance of informal parking activity (parking in non-designated spaces), or "soft" capacity. While the refuge permits parking in non-designated spaces much of the time, refuge law enforcement can and often do restrict parking when vehicles start to cause damage to vegetation.

The capacity values for each parking lot are based on physical assessments and estimations by refuge staff. Generally they include the main parking lot for each destination, plus additional satellite lots that are available within immediate walking distance. For example, the hard capacity for Lost Lake includes only the head-in parking at the Lost Lake Picnic Area, while the parking capacity for a site like Treasure Lake also includes a small lot nearby for Post Oak Lake.

Informal capacity can vary day-to-day depending on how parking is enforced and how visitors park their cars in the available spaces. Informal capacity can be increased or decreased by management decisions that weigh the resource and safety risks of informal parking against the benefit of increasing available parking for visitors. Table 2-4 shows both formal parking capacity and informal capacity for select parking areas as well as informal space descriptions, surface type, and restroom availability.

Table 2-4: Parking Lot Capacity and Amenities

Name	Formal Spaces	Informal Spaces	Informal Space Description	Surface type	Restrooms
Sunset Picnic Area	34	20	Parallel parking along wide segments of access road	Paved	Yes
Treasure Lake/Post Oak Lake	15	N/A		Paved	No
Visitor Center	54	N/A		Paved	Yes
Lost Lake	14	20	Parallel parking along wider sections of access road	Paved	No
Mt. Scott	70	N/A	Some unstriped spaces included in the formal parking number	Paved	No
Lake Elmer Thomas Pier and Dam	94	N/A		Paved	Yes

The next step in assessing parking lot capacity is to look at parking space occupancy. Table 2-5 shows the average amount of time a vehicle occupies a parking space and when the parking lots are busiest. As expected, peak parking activity occurs in the early afternoon, consistent with peak traffic activity on the refuge (generally 2:00 PM – 3:00 PM).

Table 2-5: Parking Lot Use at Wichita Mountains Wildlife Refuge

Lot	Average stay time	Peak traffic activity	Peak occupancy
Sunset Picnic Area	2 hours, 56 minutes	10:30 AM -12:30 PM, 1:30 PM – 2:00 PM	2:30 PM
Treasure Lake/Post Oak Lake	1 hour, 19 minutes	10:30 AM – 11:00 AM 2:30 PM – 3:00 PM	3:00 PM
Visitor Center	23 minutes	10:00 AM – 10:30 AM, 2:00 PM – 3:00 PM	2:30 PM
Lost Lake	1 hour, 13 minutes	11:30 AM, 3:00 PM	3:00 PM
Mt. Scott	37 minutes	11:30 AM, 2:00 PM, 4:00 PM	2:00 PM
Lake Elmer Thomas Pier and Dam	43 minutes	11:30 AM	12:00 PM

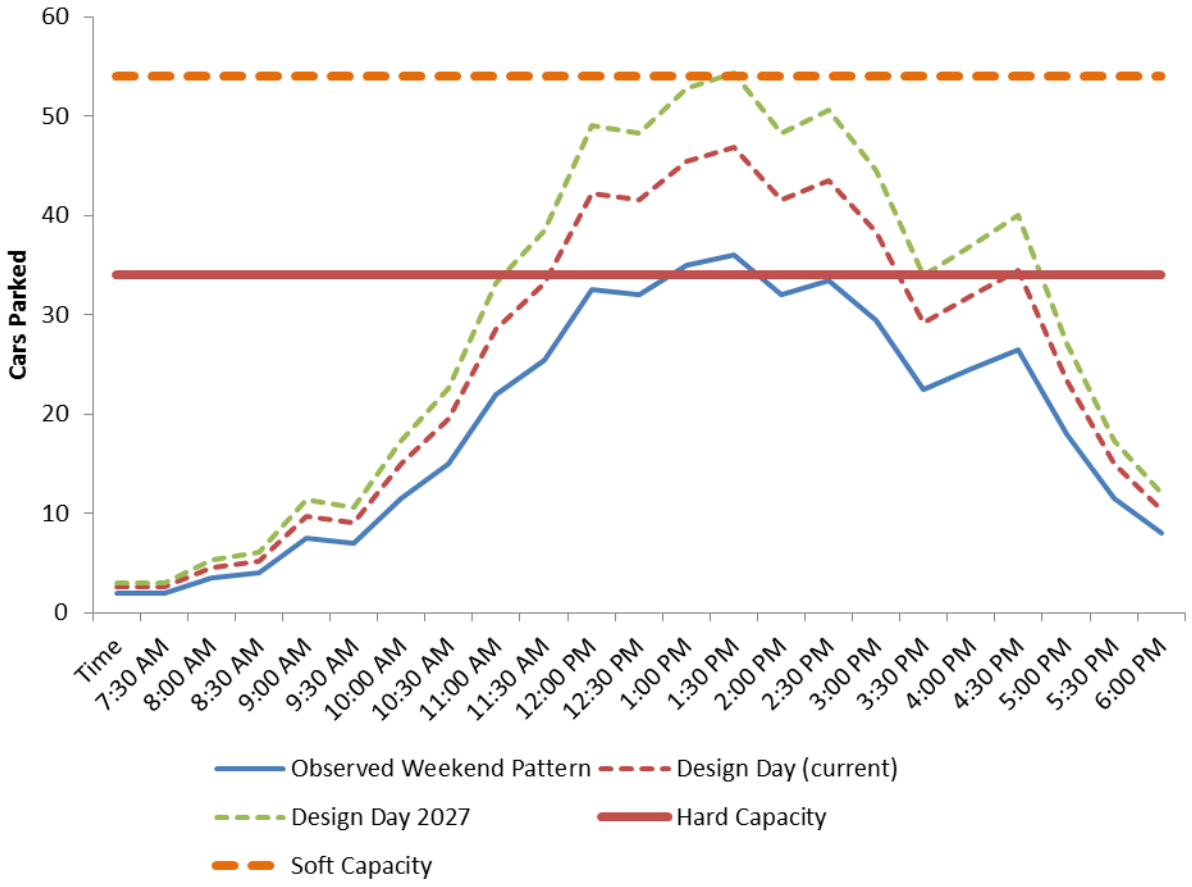
Figure 2-11 through Figure 2-16 show parking activity at study area parking lots by time of day relative to hard capacity and soft capacity on the observed day, the 2012 90 percent design day, and the 2027 90 percent design day. Sunset Picnic Area exceeded capacity in all three scenarios. Lost Lake exceeds hard capacity on the 2012 and 2027 90 percent design day. Mount Scott, Treasure Lake, and the Lake Elmer Thomas Pier and Dam have sufficient capacity now and should have sufficient capacity in the future. Each of these parking lots is described below.

Parking lots currently over capacity

Parking areas that regularly experience overcrowding include Sunset Picnic Area and Lost Lake, with Sunset being more pronounced (see Figure 2-11). On the observed day at Sunset, hard capacity was exceeded around 1:30. Parallel parking along the access road provides overflow space that can help meet periods of high demand, although law enforcement staff must still often redirect visitors to other destinations.

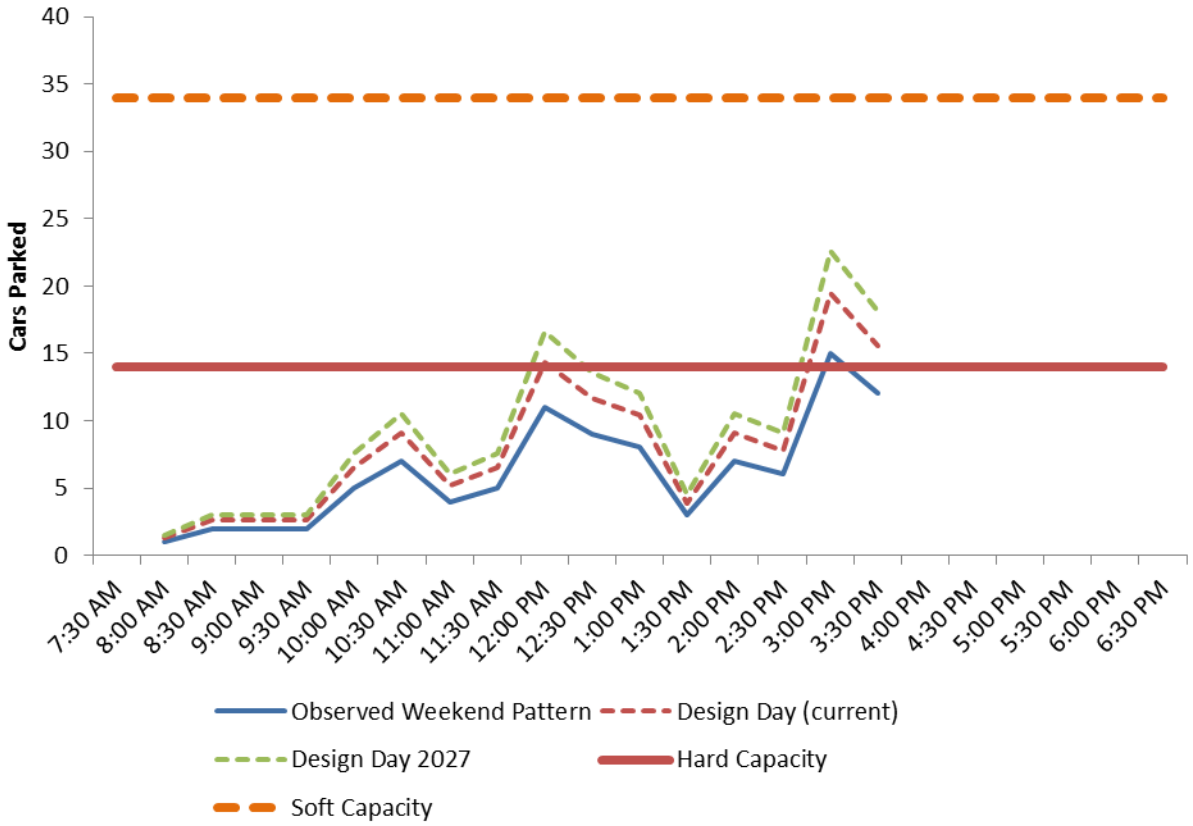
On the 2012 90 percent design day, Sunset is over the hard capacity from about noon until 4:00 PM. In 2027, this interval is from 11:30 AM until 4:30 PM, with a second peak time in the late afternoon also briefly exceeding capacity. As is refuge policy, law enforcement closed the parking area to additional vehicles when it reached capacity and directed people to other sites.

Figure 2-11: Sunset Picnic Area Parking Lot Activity



Parking activity at Lost Lake exceeded hard capacity briefly during the observation period (see Figure 2-12). Parking demand is projected to exceed hard capacity occasionally at the lot, but a large number of informal parking spaces are available to accommodate excess demand.

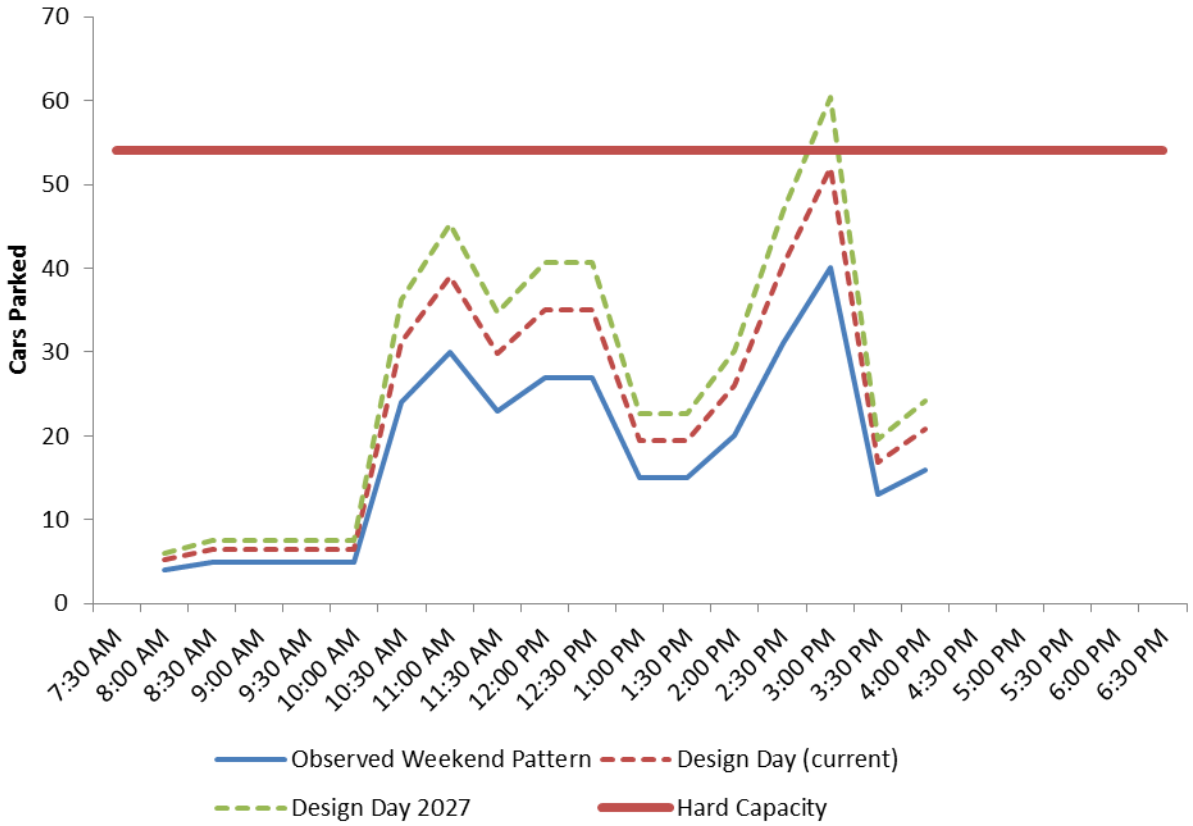
Figure 2-12: Lost Lake Parking Lot Activity



Parking lots projected to be over capacity

The visitor center parking lot currently has sufficient capacity to meet demand (see Figure 2-13); however, by 2027 this parking lot could experience capacity constraints on the 90 percent design day and busier days (total of 37 days per year). The visitor center lot has the shortest average visit of any destination observed at the refuge – only 23 minutes on average – indicating high levels of turnover. Visitors stop in at the visitor center, ask a few questions and then continue on their visit. The large spike in traffic from 2:30 PM to 3:30 PM was consistent with the busiest times at most traffic counters and parking lots on the refuge.

Figure 2-13: Visitor Center Parking Lot Activity



Jed Johnson Tower Parking Area Capacity Limitations.

The parking lot at Jed Johnston trailhead was not included in this parking capacity analysis. It serves what is now a little-used trail and refuge staff have not observed parking congestion at the site. However, as described in other products of this plan, the trailhead is suitable for expanded recreation use in order to draw visitors away from more sensitive areas of the refuge. The Multimodal Network Analysis affirms refuge plans to upgrade the Jed Johnson Tower Trail to be more accessible for visitors, and the Transit Assessment proposes serving the trailhead in several alternatives.

As is described in the Transit Assessment, most of the parking lots at popular refuge destinations are large enough to fit transit vehicles. However, the Jed Johnson Tower trailhead is currently inaccessible to large vehicles. The parking area is a paved bulb at the end of an access road, both limiting its capacity for private vehicles and creating difficulties turning around for even a small transit vehicle. Improving the accessibility for the Jed Johnson Tower Trail will require a parking lot reconfiguration or even expansion, while staying within the existing disturbed footprint as much as possible. The refuge has already preliminarily investigated this project. Reconfiguration of the bulb can both expand capacity for private vehicles and make it possible for buses to drop off and board passengers directly at the trailhead.

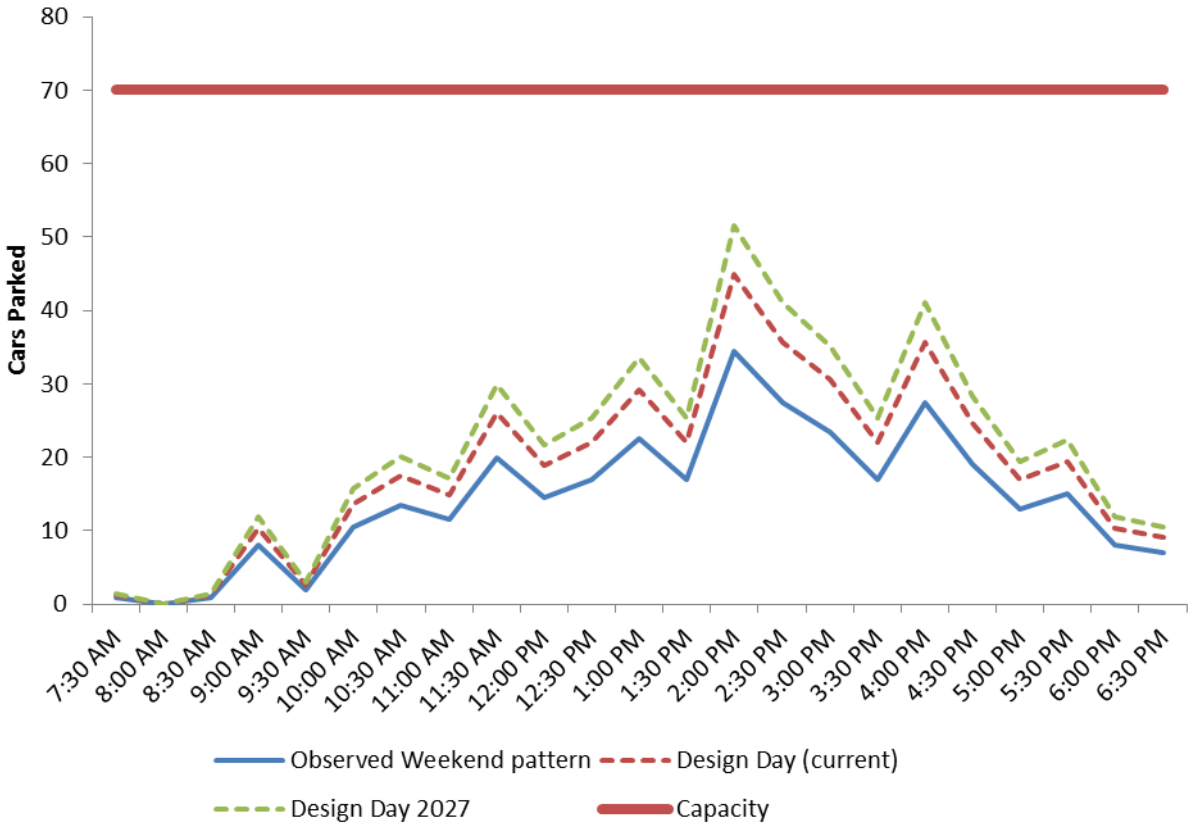
Parking lots currently under capacity

While this analysis shows that most parking areas do not experience overcrowding up to the 90 percent design day, the refuge indicates that they may experience heavy use periodically, for example during

major visitor events or unexpected parking behavior. At Mount Scott, this is mitigated by the fact that the average stay is just 37 minutes. “Peaking” behavior (periods of time that are considered the peak) therefore occurs in short bursts. By comparison, in parking lots where visitors tend to linger, such as Sunset Picnic Area, once a parking lot is full, it remains full for a long period of time.

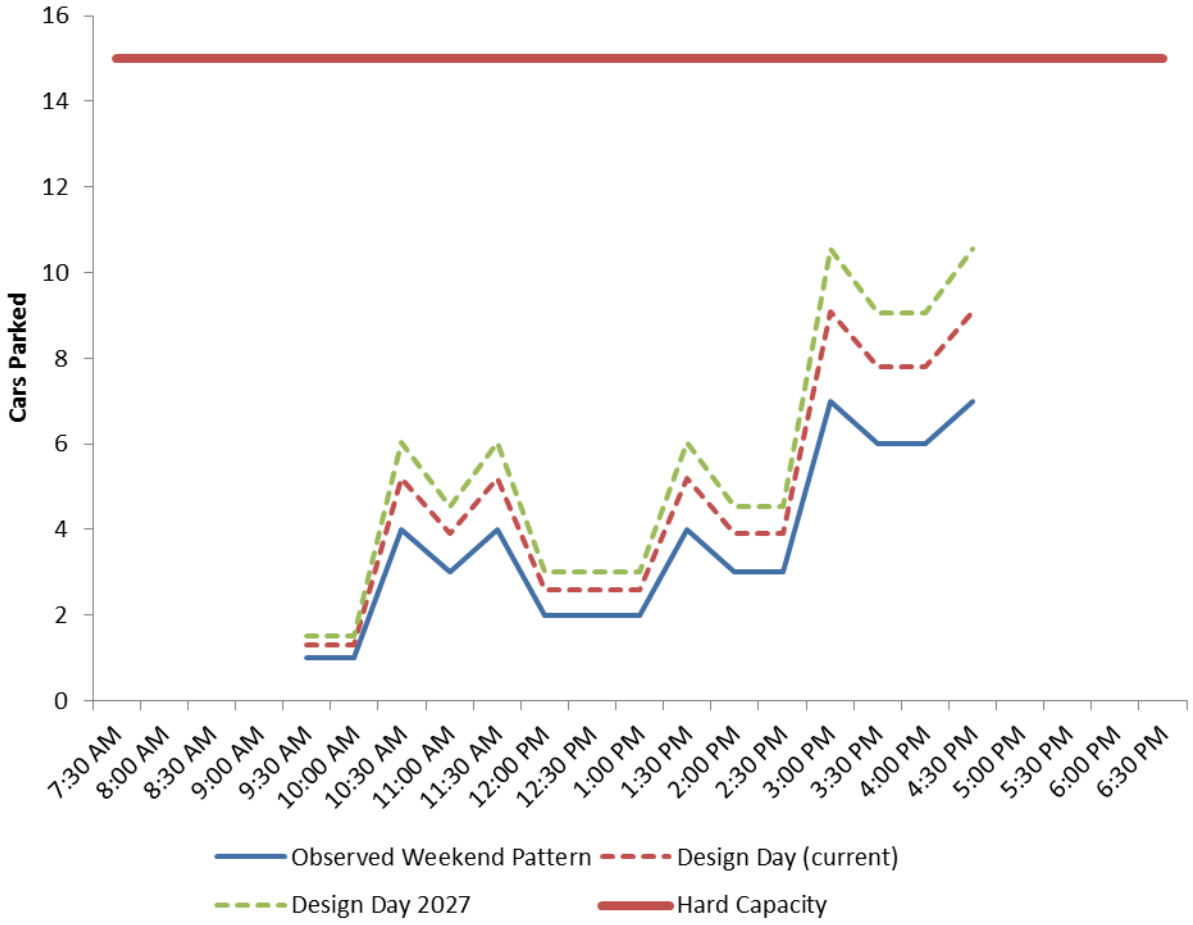
The parking lot at Mount Scott was busy on the observed day (see Figure 2-14), but does not reach capacity on the current or projected 90 percent design days. The summit parking lot is characterized by a high turnover in parking spaces given that most visitors drive to Mount Scott for the views, rather than for longer activities such as hiking or fishing. High parking turnover and instances where vehicles do not park but rather drive around the summit may lead to safety issues where people walking to and from their cars are at risk. However, the parking lot size is sufficient to meet demand.

Figure 2-14: Mount Scott Parking Lot Activity



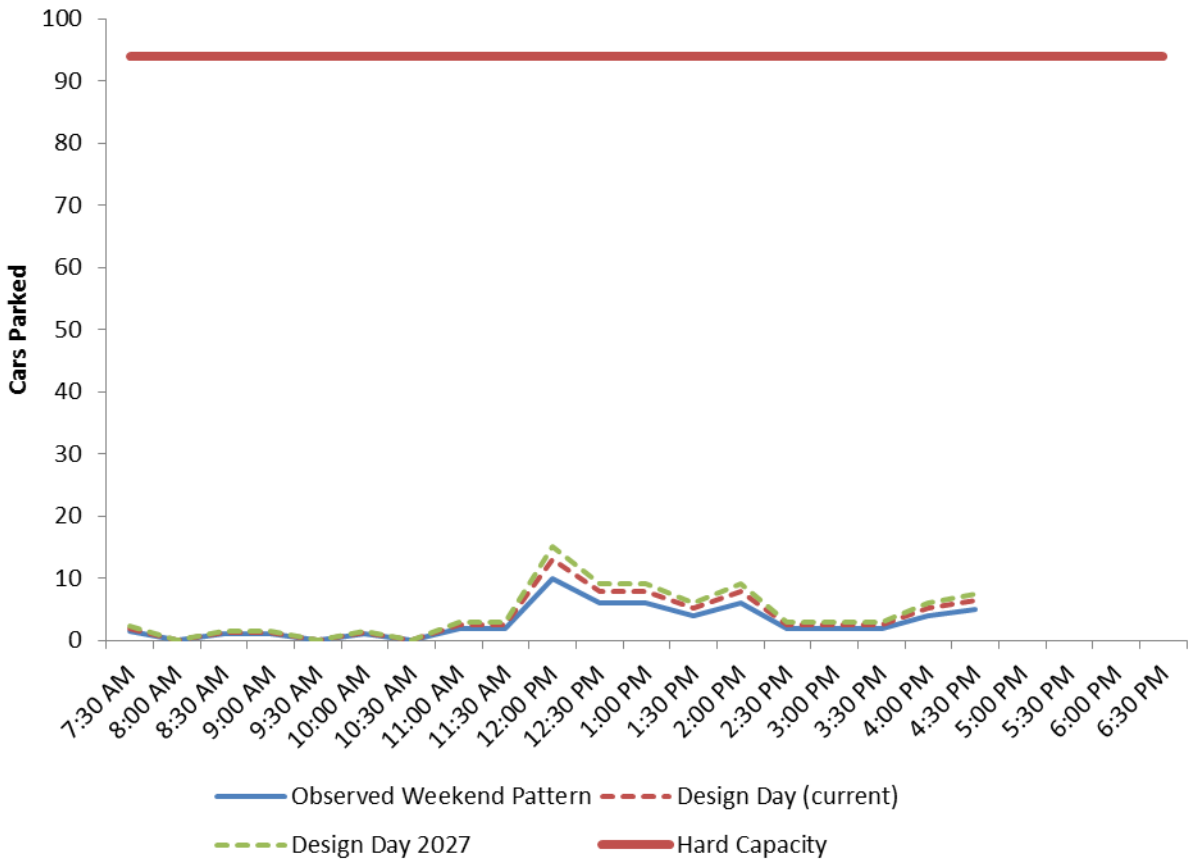
Although the Treasure Lake parking lot is relatively small, parking is sufficient given current and projected demand (see Figure 2-15). Few cars were present during the observation period, and those that were present tended to stay just over an hour.

Figure 2-15: Treasure Lake Parking Lot Activity



Parking in the lots around Lake Elmer Thomas was greatly beneath capacity when the lot was observed in late October (see Figure 2-16). Much of the visitor amenities near the lake are aimed at visitors arriving with boats, and counts were collected during the tail end of the Oklahoma boating season. Parking near the Lake is likely to be busier during the spring and summer.

Figure 2-16: Lake Elmer Thomas Pier and Dam Parking Lot Activity



Parking Capacity Conclusions

Overall, the system of parking lots at the refuge is not significantly stressed. However, local issues present a threat to good visitor experiences and traffic safety at several sites within the refuge either now or in the future. Areas of specific concern include the Sunset Picnic Area, Lost Lake, and Jed Johnson Tower Trailhead.

Beyond the issue of parking capacity is the issue of social and biological resource capacity at the sites beyond trailhead parking lots. Work that improves transportation to a site has the potential to bring more visitors. This can be beneficial when trying to attract visitors to under-utilized areas, but can overload trails in areas more sensitive to the impacts that even well-meaning visitors can create. An understanding of a site's social and biological capacity to handle visitors can help inform future transportation investment.

Circulation Analysis

This section describes circulation patterns on the refuge, providing a basis for understanding general traffic flows. This analysis relies on two sets of data collected in October 2012: Turning Movement Counts and license plate matches. This section also describes modeling visitors at different sites as well as pass-through traffic.

Turning Movement Counts

The TMCs were conducted at various times of the day at four intersections (see Figure 2-6) during the early morning (AM), mid-day, and late afternoon (PM) periods on Friday, Saturday, and/or Sunday, as follows:

- Mount Scott Road/Highway 49 intersection
- Meers T intersection
- Cache T intersection
- Indiahoma T intersection

The AM and PM periods are separate to help assess the effect of traffic that is considered cut-through, or those that travel through the refuge to work or school. The AM and PM periods are defined as weekdays before 9:00 AM and between 4:00 PM and 6:00 PM, respectively. The AM period likely reflects significant commute traffic (work and school trips) through the refuge, while the PM period likely includes a significant amount of recreation traffic that dilutes the commute patterns.

Figure 2-17 and Figure 2-18 show the percentage of TMCs observed for each of the intersections for the commute period and the mid-day period, with the exception of Mount Scott Road, which was closed before sunrise and had little traffic once it opened during the data collection period. Each intersection is described in the following sections.

Figure 2-17: AM/PM Commute Period Turning Movements

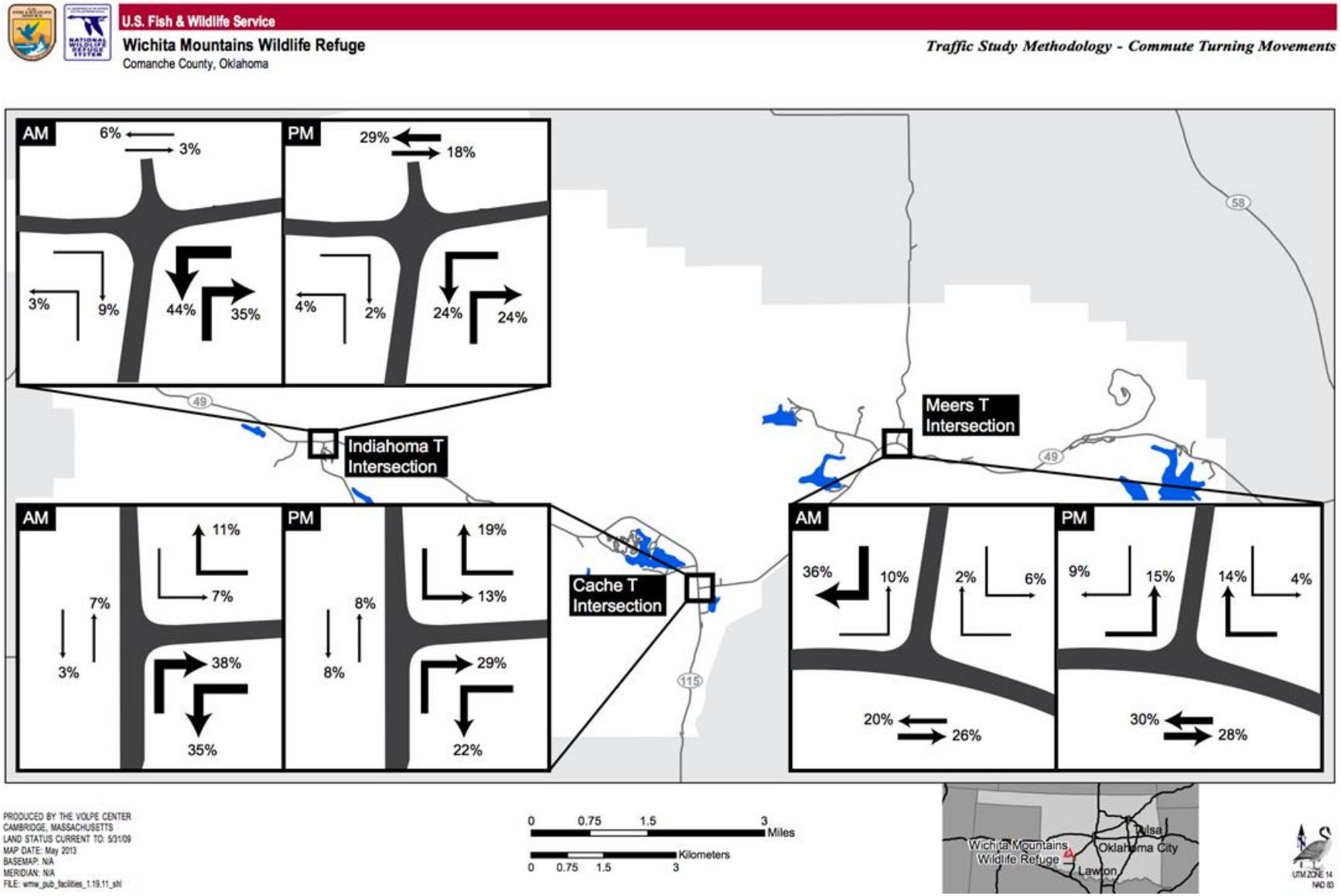
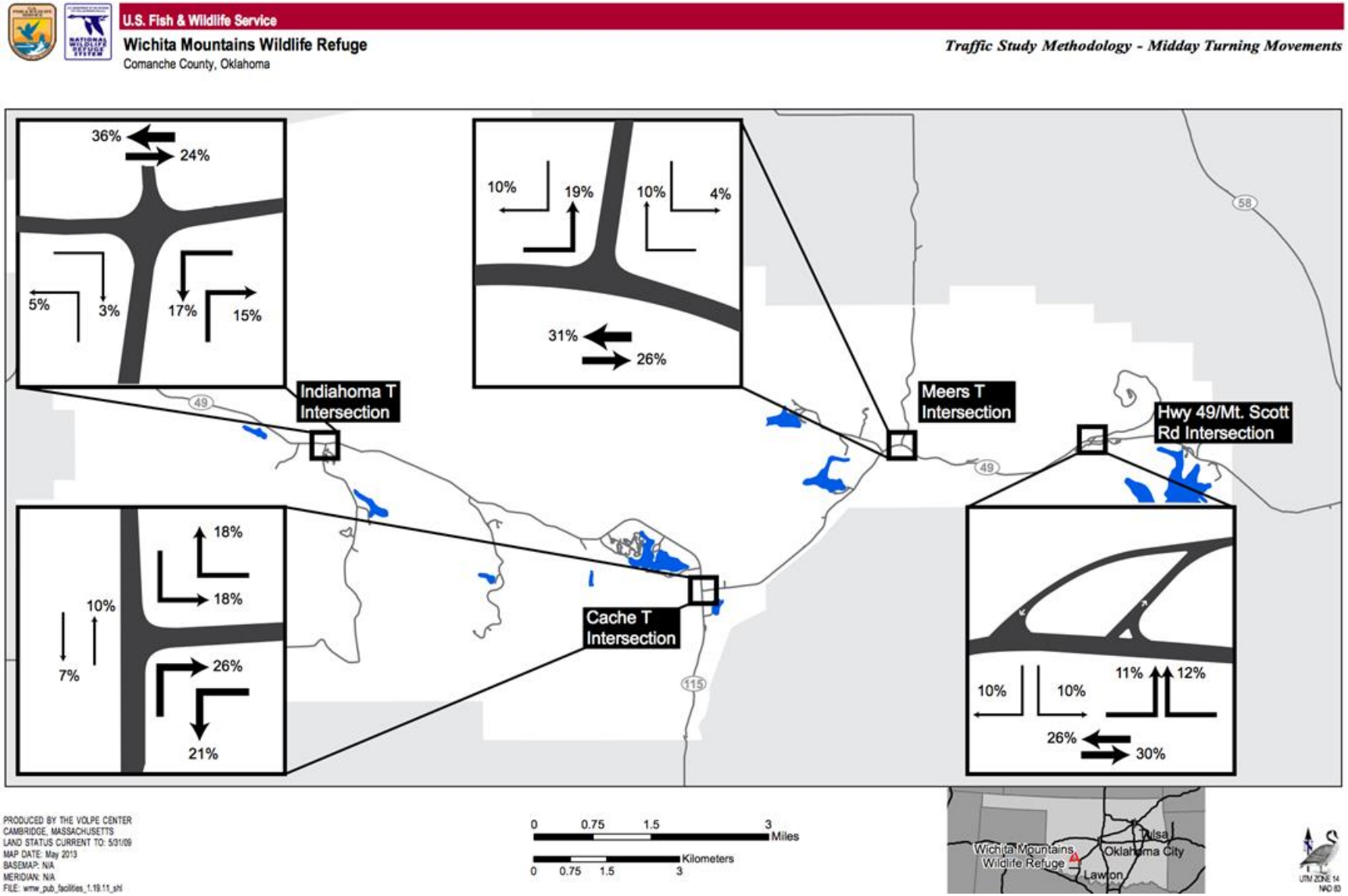


Figure 2-18: Midday Period Turning Movements



Mount Scott Road/Highway 49 intersection

The Mount Scott Road intersection is at the junction of Highway 49 and Mount Scott Road. This intersection generally forms a T, with Mount Scott Road terminating in a southbound direction at Highway 49. Mount Scott Road splits to form two separate one-way intersections with Highway 49; however, for the purposes of this analysis the two intersections are treated as a single intersection. All turning movements are allowed; there is a stop sign for traffic turning from Mount Scott Road onto Highway 49 at the intersection. There is no stop sign for through traffic on Highway 49. There is a left turn lane from Highway 49 onto Mount Scott Road and this traffic must yield to on-coming traffic.

Mount Scott Road is open sunrise to sundown. During the data collection period, the road was closed for a portion of the morning commute period.

Turning movements counts were conducted at the Mount Scott Road intersection on a Saturday. Figure 2-18 shows that traffic through the intersection is fairly consistent throughout the day, with about 26 to 30 percent of the observed intersection volume traveling through the intersection on Highway 49, 23% turning onto Mount Scott Road and 20% turning from Mount Scott Road onto the highway. Meers T

The Meers T intersection is the junction of Highway 49, which runs east-west (west of the intersection it is signed as Highway 49/115), and Highway 115, which splits and runs north to the Meers Gate. All turning movements are allowed; there is a stop sign for Highway 115 southbound at the intersection. There is no stop for through traffic on Highway 49 and there is a turning lane on the eastbound approach so that this traffic must yield to oncoming traffic.

Data was collected for all time periods on both Friday and Saturday at the Meers T intersection. Figure 2-17 shows that 20 to 30 percent of the observed traffic volume through the intersection was through traffic on Highway 49 during both the morning and evening period and the midday period (see Figure 2-18). The highest percentage of traffic through the intersection (36 percent) were right turns from Highway 115 south onto Highway 49/115 west during the morning period. In a typical traffic analysis, it would be expected to see a similar but reverse travel pattern in the afternoon (a large proportion turning left from Highway 49/115 to Highway 115 north), but since travel patterns during the afternoon period is comprised of commuters and recreational travelers, this reciprocal afternoon commute pattern is not apparent.

Cache T

The Cache T intersection is the junction of Highway 49 and Highway 115. Through traffic runs north-south. North of the intersection is Highway 49, south of the intersection is Highway 115, which runs to Cache Gate, and east of the intersection is signed as Highway 49/115. The visitor center is less than 1,500 feet to the east of the intersection on Highway 49/115. All turning movements are allowed. There is a stop sign for Highway 49/115 westbound at the intersection. There is no stop sign for through traffic on Highway 49 northbound or Highway 115 southbound. There are turning lanes on the northbound and southbound approach so that this traffic must yield to oncoming traffic.

Data was collected for all time periods on both Friday and Saturday at the Cache T intersection. Figure 2-17 shows that most traffic (22 to 38 percent) observed during the morning and afternoon periods travels between Highway 115 and Highway 49/115. The north-south through movement between Highway 49 and Highway 115 has the lowest traffic volume during the commute periods (three to eight percent).

Figure 2-18 shows that during the midday, observed traffic patterns are similar to the morning and afternoon period but less pronounced: 21 to 26 percent of traffic volume is between Highway 115 and Highway 49/115. Again, the north-south through movement has the lowest share of traffic through the intersection, between seven and ten percent.

Indiahoma T

The Indiahoma T intersection is the junction of Highway 49, which runs east-west, and Indiahoma Road, which runs south to the Indiahoma Gate. All turning movements are allowed; there is a stop sign for Indiahoma Road northbound at the intersection. There is no stop for through traffic on Highway 49 and there are no turn lanes. Refuge headquarters is approximately 1,000 feet south of the intersection.

Data was collected during the commute periods on Friday and during the midday on Saturday at the Indiahoma T intersection. Figure 2-17 shows that most traffic observed during the morning and afternoon periods travels between Indiahoma Road and Highway 49 east (35 to 44 percent during the morning and 24 percent in the evening). Through traffic on Highway 49 is quite low in the morning (three to six percent) relative to the afternoon period (18 to 29 percent), probably reflecting recreational traffic heading to sites to the west of the intersection, such as to Sunset Picnic Area. The lowest traffic volume movements occur between Indiahoma Road and Highway 49 west (two to nine percent).

Figure 2-18 shows that during the midday period, 24 to 36 percent of the observed traffic through the intersection was through traffic on Highway 49, while 15 to 17 percent of the traffic was between Indiahoma Road and Highway 49 east. As during the commute period, the lowest traffic volumes occur between Indiahoma Road and Highway 49 west.

Summary

Data collection on Friday and Saturday provide for a general understanding of traffic patterns on the refuge. Overall, the general proportional flow of traffic on the refuge during the AM and PM periods is between the north and south, following Highway 115. During the midday period, a greater proportion of traffic moves between the east and west, more reflective of the recreational opportunities that line Highway 49 from the Medicine Park gate in the east to Sunset Picnic Area in the west. Proportional traffic flow should be considered along with overall traffic volumes defined in Section 2.4.1. For example, just 34 vehicles passed through the Indiahoma T intersection during the AM period while 86 vehicles and 98 vehicles passed through the Meers T and Cache T intersection, respectively, during that same period. For this reason, the conclusion above that the general morning pattern is north-south along Highway 115 is accurate, rather than along Indiahoma Road.

Similar analyses in the future, if deemed necessary, should include a more robust data collection effort. For example, the study team was unable to collect data during a more “normal” weekday. While Friday is a weekday, it can sometimes reflect weekend traffic patterns. A more robust analysis should include data collection on a Tuesday, Wednesday or Thursday and separate out weekday versus weekend TMCs and maps. Further, the study team collected data in October, which is a relatively busy time of year but not the peak season. Future analysis should collect data during a busier month, such as March or April. Nonetheless, the observations discussed above provide an initial understanding of the traffic flows through the refuge.

License Plate Match

License plate match observations were conducted at eight parking lots. While the TMCs provide intersection-level data and can help identify general flows of traffic on the refuge, the license plate match attempts to create visitor trip linkages to help understand how visitors circulate through the refuge. Once the license plate match data was analyzed it became clear that the amount of data collected was insufficient to make broad generalizations about trip patterns on the refuge. The license plate data was helpful, however, to analyze the length of stay at various sites (see Table 2-5).

Table 2-6 below shows the results of using license plates to identify visitor trips. The bolded destination names are the first destination where a particular car was recorded, the names and percentages below those show the proportion of cars that were next recorded at each destination. For example, only three trips were identified that started at Holy City, with one trip each going next to Jed Johnson, the Visitor Center, and Mount Scott.

Table 2-6: Circulation at the refuge using license plates

Holy City	**n=3**
Jed Johnson	33%
Visitor Center	33%
Mt. Scott	33%
Jed Johnson	**n=2**
Visitor Center	100%
Elmer Thomas Pier	**n=2**
Mt. Scott	50%
Sunset Picnic	50%
Lost Lake	**n=3**
Sunset Picnic	67%
Prairie Dog Town	33%
Mt. Scott	**n=22**
Visitor Center	50%
Sunset Picnic	23%
Holy City	23%
Lost Lake	5%
Prairie Dog Town	**n=1**
Sunset Picnic	100%
Sunset Picnic	**n=2**
Mt. Scott	100%
Visitor Center	**n=12**
Mt. Scott	**50%**
Sunset Picnic	50%

As seen by the low numbers of observed trips, this information is less useful than the intersection counts for identifying visitor trips within the refuge. Although more than 1,000 cars were recorded at the refuge during the weekend, only 47 linked trips were identified. The low number of observations likely represents limitations in personnel. Every lot did not have a staff member or volunteer counting cars and recording plates at all times. Therefore many of the cars first recorded at a destination next went to destinations that were not counted at the time. Anecdotally, many trips to WMWR are made to a single destination, where visitors come to make one hike, take in one view, or picnic at one site. These trips would not be captured by a point-to-point circulation analysis, but were captured by more comprehensive intersection counts.

Destination Modeling and Drive Through Traffic Estimation

Although no year-round, refuge-wide data coverage of internal roads and parking lots is available, the month-long snapshot of data from these sites can be compared with the year-long ongoing data collection at the refuge gates. This comparison uses the ratio of visitors at each destination to the total number of visitors on the refuge to provide a general estimate of how each destination is used, as well as how many visitors are doing a driving tour or merely passing through the refuge.

The formula below shows how the known ratio between visitors at a site and total visitors on the refuge can be used to model an unknown number of visitors at a specific site on a day when total refuge visitation is known. This approximation helps extend the site-by-site parking counts over the entire year.

$$\frac{Observed\ at\ site}{Observed\ on\ refuge} = \frac{Unknown\ at\ site}{Observed\ on\ refuge}$$

The example below shows how the number of cars at Mt. Scott on a 90% day was modeled:

$$\frac{537\ cars\ at\ Mt.Scott}{2{,}794\ cars\ on\ refuge} = \frac{Unknown\ cars\ at\ Mt.Scott}{1{,}831\ cars\ on\ refuge}$$

The ratio of Mt. Scott vehicles to total refuge vehicles on the left side of the equation works out to 19% which can be applied to solve the unknown variable on the right. The estimated number of cars can then be converted to people using the observed 2.6 people per car as seen on Mt. Scott in autumn 2012. The ratios of all sites only account for about 60% of the visitors who were counted as entering the refuge. This means that about 40% of visitors are either going to sites with no data or are passing through. If performed using weekday data, the share of pass-through travelers would be higher.

Table 2-7 shows the share of visitors known to have visited each site, the modeled annual number of visitors, and the projected number of visitors at each site on a 90% design day, such as a fairly busy Sunday in June.

Table 2-7: Observed and Predicted Site Visitation, Annual and 90% Design Day

Site	Observed Share	Modeled Annual Visitors (people)	90% Day Visitors (people)
Mt Scott Summit	19.2%	223,955	930
Visitor Center	16.8%	158,856	660
Sunset Picnic	8.4%	105,492	438
Lost Lake	7.9%	78,134	324
Holy City	2.1%	25,422	116
Lake Elmer Thomas	1.6%	19,490	60
Treasure Lake	0.8%	10,129	42
Prairie Dog Town	0.7%	14,101	59
Jed Johnson	0.4%	5,084	21
Parallel Forest	0.4%	4,661	19
Lawtonka Mt. Bike Trailhead	0.3%	2,966	12
Other Destinations and Cut-Through	*41.34%*	*535,512*	*2,032*
Totals	**100.0%**	**1,183,801**	**4,713**

This analysis uses a combination of data from automated temporary counters placed at the entrances to parking lots that collected data in October and November, 2012. It also includes manual counts made at lots that were not covered by the automated temporary counters. Staff and volunteers were not in place to make manual counts at the additional lots at all hours, and so the share of visitors at Treasure Lake, Lake Elmer Thomas, Lawtonka, Parallel Forest, and Prairie Dog town are likely higher than reported above. This results in a share listed under "Other Destinations and Cut-Through" that is lower than the actual number. When tested against times in which visitation at a site is known, this approach tends to underestimate visitation at some sites, and so should be considered as the lower end of the true range of visitation.

This analysis provides a general sense of visitation across the refuge, and a way to model visitation at different sites at any point during the year. As will be seen in the report on transit on the refuge, these shares can also be used to estimate ridership on a transit service. Estimating demand is essential when planning nonmotorized facilities and transit routes, as decisions need to be made as to which destinations would draw enough riders to be worth serving.

Conclusions and Next Steps

This traffic analysis is a baseline that FWS can use to make informed decisions when planning and implementing transportation improvements on the refuge. The data in this analysis can also be used to gauge the effect of changes to the transportation system that occur over time or as the result of changes to the refuge transportation system or recreational sites. For example, if the refuge builds a new trail, follow-up count data could be used to help understand how the new trail has increased or reduced traffic or parking issues at specific areas on the refuge.

Road and Parking Capacity

The capacity and circulation analysis for roads and parking indicate that roads have sufficient capacity to meet existing and expected future demand for the next 15 years. Some parking capacity constraints on the refuge are projected to continue and become more acute, specifically at the Sunset Picnic and Lost Lake parking areas. As time progresses, these capacity constraints will become more acute as refuge visitation increases unless mitigation measures are put in place. The information in this baseline assessment can be used to develop mitigation strategies and measure their effectiveness.

Circulation

The circulation data show that most recreational traffic moves in an east-west direction, reflecting the location of recreational sites and visitor origins. Since the Medicine Park Gate is the busiest entry and exit point during the weekend when recreational traffic is at its highest, the opportunity exists to capture more recreational visits to sites on the eastern part of the refuge, consistent with the refuge's CCP. These sites are also relatively close in proximity to each other, creating an opportunity to provide non-motorized links both between refuge sites and off-refuge sites, including those in Medicine Park and on Fort Sill.

The remaining tasks of the CATP will reference the data described in this traffic study and use it to understand activity throughout the refuge. It provides a baseline for future transportation and transportation, recreation, and resource management planning. It is a snapshot of visitation levels and patterns at the refuge in 2012-2013.

Future Opportunities for Traffic and Parking Data Collection

One important item to note is that this analysis and any future work to improve transportation on the refuge will be limited by the availability of robust data. The study team performed data collection using

manual counts and temporary automated counters to supplement the available data and make conclusions about travel patterns on the refuge. In the future the study team advises additional permanent data collection sites, in order to further understand circulation patterns through the refuge. Automated counters allow total coverage at different sites regardless of the number of staff and volunteers available to make counts.

One potential for comprehensive data collection in the near future is the ITS Demonstration Project, which is slated to begin in the summer of 2013. The live data collected at parking lots by this system can be saved similar to data from the existing counters on the refuge entrances and used to better understand daily and seasonal patterns. The limited observations made during fall almost certainly discount visits to sites more popular in spring and summer, such as the refuge's access points to Lake Elmer Thomas. Better data can be of use when targeting future transit service or encouraging visitors to see less sensitive parts of the refuge.

The ITS Demonstration Project also has the capability to help visitors decide where to travel on the refuge. Rather than only having live information on parking lots available at the visitor center, the refuge should consider publishing the data onto the refuge's website as well as on electronic signs near the Medicine Park and Cache gates. This allows visitors to know that if parking lots serving the sensitive wilderness area are full or not before they make a frustrating attempt to park before being turned away by refuge staff. Early warnings when the parking lot is full will help extend the usefulness of the ITS Demonstration Project beyond the visitors who choose to stop at the refuge visitor center.

3. Bicycle and Pedestrian Resource Guide

Wichita Mountains Wildlife Refuge
Comprehensive Alternative Transportation Plan

Table of Contents

Table of Figures

Table of Tables

Introduction

This resource guide is designed to aid Wichita Mountain Wildlife Refuge (WMWR) staff in developing safe walking and bicycling opportunities for the visiting public in light of growing visitation. It draws on nonmotorized transportation literature, including research commissioned by the Federal Highway Administration (FHWA), and best practices at other federal land management units. This document is structured around a set of concise principles and specific strategies for refuge management, engineers, law enforcement officers, and partner groups to consider as bicycling and walking increase at WMWR. The 2013 WMWR Comprehensive Conservation Plan helps guide and bound all findings.

A comprehensive strategy that enhances safe bicycling and walking opportunities begins, but does not end, with planning and constructing infrastructure. "Hard" infrastructure investments should be complemented with a set of "soft" activities, programs, and policies that ensure safety and provide for continual evaluation and maintenance. To emphasize the need for a multi-pronged, well-rounded strategy to make bicycling and walking safer on the refuge, this report is organized around and adapts the "Five Es" approach developed by The League of American Bicyclists (see Figure 3-1).

Figure 3-1: The "Five E's" Approach of Promoting Bicycling and Walking

Adapted from: League of American Bicyclists. http://www.bikeleague.org/programs/bicyclefriendlyamerica/communities/bfc_five-Es.php. Accessed May 23, 2013.

Visitation Trends

According to the CCP, "visitation over the last 10 years has averaged about 1.5 million visitors per year, making it one of the most visited national wildlife refuges. While annual visitation fluctuates, the long-term trend is one of increasing visitation and it is expected that as regional population levels increase, so will the demand for recreation opportunities on the Refuge."

The likelihood for this growth is due to several factors, detailed in the Transportation Assessment section of the Comprehensive Alternative Transportation Plan (CATP). First, the population of Comanche County is projected to grow by about 15,000 people by 2030, which amounts to a 12 percent increase over the county's 2010 population. Second, visitation to the refuge increased by an average of one percent per year since 1999. Given these projected continued increases in local population and historical visitation patterns, the project team estimates that WMWR visitation will continue to increase at an average of one percent over each of the next 15 years. This translates to a projected 1.82 million annual visitors in 2027.

While it is possible that these additional 300,000-plus visitors could use the same mix of transportation modes (driving, bicycling, etc.) to travel to and through the refuge, it is also possible that more of these visitors will bicycle or walk from sites located just off the refuge instead of driving. This possibility is in-line with national trends: bicycling increased by 25 percent as a percentage of all trips made in the U.S. between 2001 and 2009.[8] WMWR is already one of the most visited and bicycled units in the National Wildlife Refuge System, with tens of thousands of walkers/hikers and an estimated 25,000 bicyclists per year.[9]

As a result, the refuge should expect more bicycling and pedestrian activity in the future. This guide provides tools for the refuge to proactively prepare for an increase in bicycling and pedestrian activity, which will lead to safer bicycling and walking conditions on the refuge. The alternative is a reactive approach, one that the refuge would likely take when a safety problem arises, such as an injury or fatality. Refuge goals, including habitat and wildlife preservation, will ultimately guide which approaches are taken.

Safety

Safety is an essential consideration in nonmotorized transportation because of the severity of potential collisions that may result from introducing more nonmotorized users on roadways. As such, safety pervades the Five Es approach. A variety of factors contribute to collisions involving pedestrians and bicyclists, including a combination of infrastructure design and roadway user behavior. These factors are important to consider for any safety countermeasure, whether infrastructure or programmatic.

An analysis of the characteristics of automobile crashes involving nonmotorized users in North Carolina indicates common conditions present during collisions in rural areas, especially on two-lane roadways (see Table 3-1). Given the lack of nonmotorized facilities in these areas, a majority of nonmotorized crashes occur along roadways (rather than at intersections), particularly in areas without paved shoulders. For all types of rural roads, the study found that the majority (59 percent) of rural pedestrian crashes occur at night, while a majority of rural bicycle crashes (66 percent) occur during the day.

---

[8] National Household Travel Survey, http://nhts.ornl.gov/

[9] Central Federal Lands highway Division (2008). *Guide to Promoting Bicycling on Federal Lands*. http://katana.hsrc.unc.edu/cms/downloads/01_promoting_bicycling_entire_document.pdf. Accessed May 24, 2013.

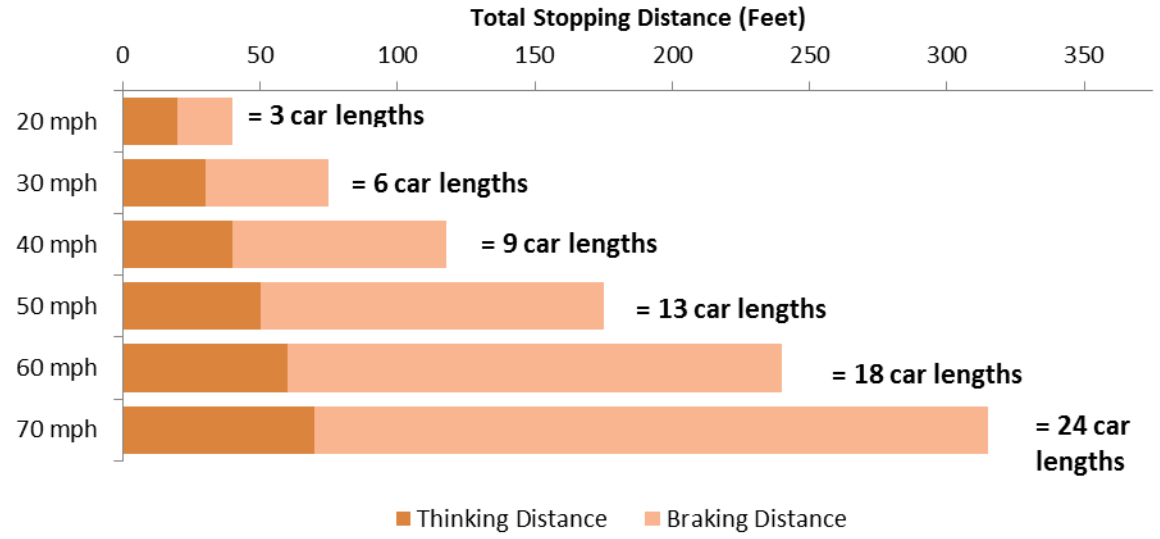
Table 3-1: Common Conditions in Crashes Involving Bicyclists and Pedestrians for all Rural Roads Types in North Carolina

	Percentage of rural pedestrian crashes	Percentage of rural bicyclists crashes
Vehicle Speed (41-60 mph)	46	47
Speed Limit (>50 mph)	57	54
Nighttime	59	34
Unpaved shoulders	71	80
Along roadway (rather than at intersection)	82	77

Source: UNC Highway Safety Research Center (2006). *Factors Contributing to Pedestrian and Bicycle Crashes on Rural Highways – Final Report*.

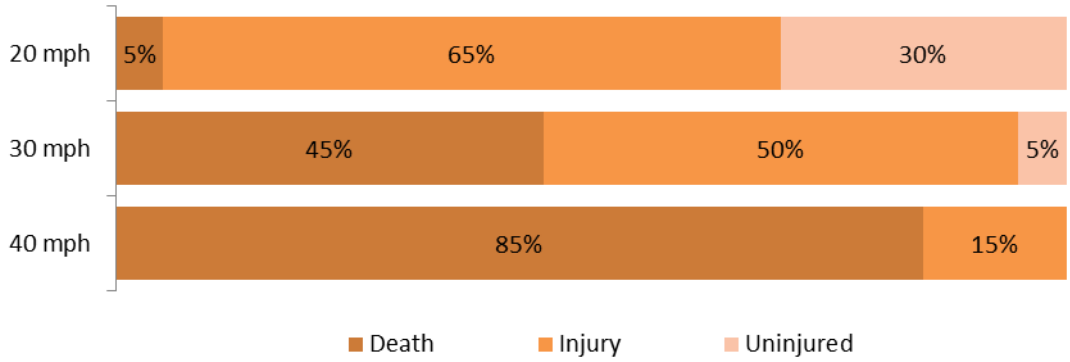
Speed and automobile stopping distance are closely linked with crashes, serious injuries, and fatalities. Higher speeds result in longer stopping distances (see Figure 3-2). This is a key factor in explaining why the majority of all rural nonmotorized crashes occur with vehicles speeds above 40 miles per hour (MPH). As shown in Figure 3-3, the likelihood of a fatality increases from five percent to 85 percent as vehicle speed increases from 20 MPH to 40 MPH. The probability of a pedestrian or bicyclist fatality approaches 100 percent as speeds exceed 50 MPH.

Figure 3-2: Average Stopping Distance by Speed under Normal Conditions



U.K. Department of Transportation (Undated). Typical Stopping Distances, http://www.direct.gov.uk/prod_consum_dg/groups/dg_digitalassets/@dg/@en/@motor/documents/digitalasset/dg_188029.pdf. Accessed May 23, 2013.

Figure 3-3: Pedestrian/Bicycling Injuries at Impact Speeds



Source: U.K. Department of Transportation (1987). *Killing Speed and Saving Lives.*

Management Guidance

The WMWR CCP provides long-term guidance to the refuge's management programs and activities, including nonmotorized transportation. This section summarizes principles that refuge management can follow based on the framework the CCP provides to plan, implement, and evaluate changes to the nonmotorized network.

Relationship between the CCP and the Comprehensive Alternative Transportation Plan

One of the first tasks of the CATP was the development of goals and objectives designed to guide the study. These four goals and related objectives, which were developed based on the CCP and through conversations with refuge staff, can be used to evaluate changes or enhancements of the transportation system.

Consistency with CCP Tenets

Walking and bicycling must be considered in the context of the highest refuge management priorities, which includes protecting fish and wildlife resources and wildlife-dependent recreation uses. The CCP states:

> An important aspect of managing Federal public lands, an aspect as important as maintaining healthy lands and waters, is facilitating and managing public use. The Wichita Mountains Wildlife Refuge provides the public with high quality, diverse public use (recreation) opportunities not found anywhere else in the region. Because the history of recreation on the Refuge dates back to the early 1900s, it is easy to overlook the fact that all national wildlife refuges are closed to public use unless specifically opened to a particular activity. The primary criteria for determining how much recreational use a refuge can support and what activities are acceptable, are found in the legal purpose of the refuge and in the National Wildlife Refuge System Improvement Act (1997). The refuge manager is responsible for determining which

activities are acceptable uses of the particular national refuge and for conducting a Compatibility Determination.[10]

As part of the development of the CCP, the refuge made a compatibility determination that pedestrian activity (hiking, jogging, strenuous walking) and bicycling are appropriate and compatible public uses on refuge lands. WMWR determined that these uses support priority wildlife-dependent uses under the National Wildlife Refuge System Improvement Act of 1997 (hiking, fishing, wildlife observation, photography, environmental education, and interpretation). Accordingly, the CCP includes a moderate amount of proposed new nonmotorized transportation infrastructure development. Nonmotorized transportation can serve as alternative modes of access supportive of the priority wildlife-dependent uses.

The CCP lists bicycling as one of twelve Public Use Area Management objectives. Specifically, the CCP calls for improving "bicycling opportunities on approximately 13 miles of road to encourage Refuge visitation and wildlife observation and to reduce vehicle use on the Refuge within five years of CCP approval."[11] The CCP also outlines a number of off-road trails, which are explored in the Multi-Modal Trail Network Assessment of the CATP. The CCP gives the rationale that providing and improving bicycle and pedestrian access can facilitate the primary wildlife-supported public uses of the refuge (noted above) and can increase the public's awareness, understanding, and appreciation of fish and wildlife resources.[12]

The CCP also provides a broad outline for nonmotorized strategies including the following:

- Revise and update the Visitor Services Plan with specific management direction for bicycle access points and routes.
- Allow bicycling on 50 miles of paved roads and on the 5.8 mile Mt. Scott mountain bike trail/access road.
- Allow bicycling opportunities in the medium and high density use areas using existing developments and disturbed areas. These include the future trail between the Environmental Education Center and the Visitor Center, the trail between the Environmental Education Center and Camp Doris, Jed Johnson tower trail, the future trail between Lake Elmer Thomas Recreational Area (LETRA) and the Refuge (including a connection to the Museum of Natural History), and the Mt. Scott picnic area nature trail.
- Discourage bicycling after dark.
- Improve road shoulders along the section of State Highway 115 and State Highway 49 that extends west from the Medicine Park gate, north to Meers gate, and south to the Cache gate.
- Improve the connectivity of existing routes (LETRA, Lawton, Medicine Park, Meers, and Cache connections).
- Consider the development of a bicycle share pilot program.
- Develop and implement a public use zoning strategy that allows the Refuge to improve the quality and delivery of visitor services to the public while minimizing human impact to wildlife and habitat in the Public Use Area.

---

[10] CCP, pp. 3-73
[11] CCP pp. 4-18
[12] Ibid.

- Focus bicycle activity and developments in the high-density use zone to relieve pressure in the medium density and low density use zones.

Signs, pavement markings, or other forms of communication (maps, digital media, etc.) can be used to provide visitors who choose to experience the refuge by nonmotorized transportation with interpretive and educational information.

The refuge recognizes that "a major issue facing the visitor services program centers on the conflict inherent in managing for both public use and wildlife. Human use increases the occurrence of trash, vegetation trampling, excessive noise, wildlife harassment, and vehicle collisions with wildlife. As visitation increases, these impacts will increase without adequate planning and law enforcement."[13] Any analysis of bicycling and pedestrian improvements should consider these impacts.

Engineering

Infrastructure investments that act as safety counter-measures are key to any successful program designed to increase nonmotorized transportation. This section describes specific infrastructure interventions and context-sensitive strategies the refuge might want to employ as staff seek to reduce motorized transportation on the refuge and accommodate nonmotorized transportation. Implementation and maintenance costs as well as a review of design guidelines that set the parameters for infrastructure investments are provided later.

Infrastructure Interventions

There are a variety of infrastructure interventions the refuge may undertake in the future. The information in this section is intended to provide refuge staff with key considerations when implementing nonmotorized infrastructure projects, including off-road, along road, and crossing measures, as well as bicycle parking and transit accommodation. The content is designed to be concise and derives from extensive best-practices research.

The design information herein can help refuge staff advocate for infrastructure interventions that take into account all road users and is not meant to take the place of formal design guidelines (see Design Guidelines and Manuals),. Other resources are provided for further information, including key research studies and engineering guidelines. Programs that fund infrastructure projects are listed in Appendix 3-A.

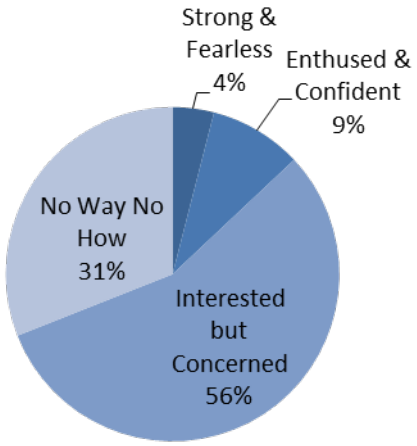
[13] CCP, pp 3-98

Bicycling Comfort Levels

The public has different levels of comfort and experience when it comes to traveling alongside or within automobile lanes. For bicycling, it is important to keep in mind that high vehicle volume and/or speed, especially where there is a lack of bicycling facilities, can inhibit a bicyclist from feeling safe and comfortable. Therefore, any plan for bicycling infrastructure improvements should be developed with the bicycling experience of targeted populations in mind, or "design cyclist."

Figure 3-4 shows a categorization of adults' attitudes relating to their level of comfort riding with traffic, helping establish a set of potential design cyclists.

Figure 3-4: Adult Attitudes towards Bicycling in Portland, Oregon



Source: Dill and McNeil (2012). *Four Types of Cyclists? Testing a Typology to Better Understand Bicycling Behavior and Potential*. http://web.pdx.edu/~jdill/Types_of_Cyclists_PSUWorkingPaper.pdf. Accessed June 3, 2013.

Although not specific to WMWR, this survey conveys an order of magnitude understanding of adult attitudes towards bicycling with implications for families and children. The strong-and-fearless group is very comfortable riding on the road regardless facilities, while the enthused-and-confident group prefers bike lanes, but is comfortable sharing the roadway with cars. The interested-but-concerned group is not comfortable riding in bike lanes and prefers separated facilities. Since this group represents more than half the population and is most likely to change their behavior, they should be the key target market for increasing bicycling at WMWR. Those in the no-way-no-how group are very uncomfortable riding even on separated trails/paths or are physically unable to ride a bicycle. It is also important to note that almost everyone is a pedestrian at some point during their trip to the refuge and bicycling investments can further the ease and comfort of walking.

Off-Road Trails

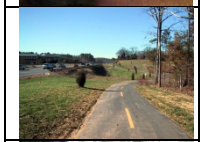
Off-road trails/paths provide an excellent opportunity for WMWR visitors to experience the refuge at a slower pace and lower impact than a car. Trails can range in character from a narrow natural surface hiking trail to a 10-12 foot-wide paved multi-use trail that accommodates all users, including pedestrians, bicyclists, and the mobility impaired or transportation disadvantaged. When choosing a trail surface, the refuge should consider:

- User acceptance and satisfaction
- Accessibility

- Construction and maintenance costs
- Material availability
- Environmental impact

Table 3-2 presents the primary trail surface types suitable for a refuge setting, including key characteristics, advantages, and disadvantages. Construction cost estimates can vary considerably based on local and national economic conditions and material availability.

Table 3-2: Characteristics of Different Trail Surface Type

	Trail Type	Est. Const. Cost (per ft.^{2})	Est. Const. Cost (per mi.)	Maint. Cost	Durability	User Groups	Visual Impact	Notes
	Natural Soil	Variable, but generally lowest	$50-70K	Low	Occasional touch-up work, erodes under heavy use	Hikers and mountain bikes	Low, uses native soil	Can be built and maintained by volunteers using hand tools.
	Soil Cement	Intermediate	$60-100K	Variable	Difficult to use when wet, erodes under very heavy use	Hikers and some wheeled users	Low, uses native soil bonded with cement	While difficult to use when wet and can erode under heavy use, it can support more visitors than natural soil trails.
	Wood Fiber Mulch	$2.23	$65-80K	High, requires frequent replenishment	1-3 years depending on climate	Hikers and equestrians	Rustic appearance	Spongy surface ideal for runners and equestrians, but difficult for other users.
	Gravel	$2.65	$80-120K	Moderate, including grading and gravel replenishment	2-5 years between major overhauls	Hikers and some wheeled users	Low, especially with local aggregate. Can "dust" the area near the trail	Gravel can accumulate downhill from gravel trails. Very vulnerable to flooding.
	Asphalt	$2.92	$200-300K	Moderate, requires touchups and pothole repairs	10 years between asphalt overlays	Suitable for all uses	High, but can be dyed to a more natural color than black	Easily accessible by all trail users. Vulnerable to vegetation.
	Concrete	$5.04	$300-500K	Low; repairs usually wholly replace individual slabs	Very high; 25 year lifespan	Suitable for all uses	Can be dyed or use local aggregate to be a more natural color	Easily accessible by all trail users. Resistant to flooding and most other hazards.
	Boardwalk	Varies by material, but generally high	$1.5M+	Moderate	Varies depending on plank material, but about 10 years	All modes; may be uncomfortable to wheeled uses	Can be built to a rustic appearance, but elevated profile is visible from a distance	Used in many FWS wetland refuges.

Sources: Alta Planning + Design (Undated). *What's Under Foot? Multi-use Trail Surfacing Options*. http://atfiles.org/files/pdf/AltaTrailSurface.pdf. Accessed May 23, 2013.
U.S. Forest Service (2007). *Equestrian Design Guidebook for Trails, Trailheads, and Campgrounds*. http://www.fhwa.dot.gov/environment/recreational_trails/publications/fs_publications/07232816/page11.cfm. Accessed May 23, 2013.
Rails-to-Trails Conservancy. *Trail Surfaces*. http://www.railstotrails.org/ourWork/trailBuilding/toolbox/informationSummaries/trail_surfaces.html. Accessed May 23, 2013.

Along-Road Measures

It is important to take measures to protect and provide for nonmotorized users traveling along refuge highway, access roads, and parking lots since roads are the primary travel corridors through WMWR. Generally, many bicycle and pedestrian collisions occur along roads in rural areas and special consideration of safety must be given in areas where visitors are engaged in active transportation. The Federal Lands Highway Project Development and Design Manual (PDDM) outlines specific design guidelines that FWS staff can refer to when designing and implementing new pedestrian and bicycling facilities.[14]

Sidewalks

Currently, there are no sidewalks along primary or secondary refuge roads and few at key destinations and parking lots. The refuge should consider sidewalks as part of any effort to improve pedestrian connections and accessibility between or to recreation sites. Sidewalks over large distances are likely cost prohibitive. Therefore, FWS should focus on small areas with high amounts of existing or expected pedestrian activity, particularly at popular destinations and adjacent parking lots.

Bicycle lanes, paved shoulders, and signed routes

Bicycle lanes, paved road shoulders, and signed routes utilize a combination of striping, signing, and pavement markings to accommodate bicyclists on existing roadways. These provide differing levels of comfort for bicyclists (see Bicycling Comfort) and are appropriate for different contexts.

Bicycle lanes utilize striping and pavement markings and tend to be best suited for lower speed, often urban streets. They are relatively inexpensive and can often utilize the existing street right-of-way. The PDDM requires a minimum width of four feet (excluding obstacles); however, five feet is preferred. A width of six feet is desirable where motor vehicles operate at speeds exceeding 45 MPH.[15]

Paved shoulders are primarily built for motorist safety, pull-off, and parking. New construction of shoulders can be expensive. Unless the roadway has high rates of bicycling, it may be inappropriate to provide special bicycling markings or signage along the shoulder. Guidelines for shoulder width depend on vehicle speeds, but four feet is a suggested minimum width and five feet is recommended to accommodate bicycle travel. These widths should take into account guardrails, rumble strips, and other roadside barriers.[16]

Signed routes/wayfinding systems utilize signage along routes with paved shoulders, bike lanes, and/or shared-use paths to provide continuity between bicycle facilities. Roadways with high bicycling rates and/or preferred routes that have low vehicle traffic are often signed to alert drivers to the presence of bicyclists and encourage bicycling. [17] More information is provided in the Encouragement section.

---

[14] Federal Lands Highway (2012). *Project Development and Design Manual (PDDM)*. http://flh.fhwa.dot.gov/resources/manuals/pddm. Accessed May 23, 2013.

[15] Federal Lands Highway (2012). *Project Development and Design Manual (PDDM) – Chapter 9*. http://flh.fhwa.dot.gov/resources/manuals/pddm/Chapter_09.pdf#9.3.17. Accessed May 23, 2013.

[16] Ibid.

[17] American Association of State Highway and Transportation Officials (AASHTO) (2012). *Guide for the Development of Bicycle facilities.*

Separated shoulders/cycle tracks/buffered bicycle lanes

A shoulder that is separated from vehicle travel lanes by a buffer space is often used in areas where pedestrian and bicycle volumes and motor vehicle volumes and/or speeds combine to create hazardous conditions. The buffer space can be marked with diagonal pavement markings and range in width from one- to four-feet.[18] Buffers can be as simple as painted hatch marks on the pavement to physical barriers such as small plastic "turtles" or concrete curbs, which can either reinforce the psychological separation of the bike lane or physically prevent cars from entering the bike lane.

Lane Narrowing/Speed Reduction

There are a variety of low-cost measures designed to bring posted speed limits and actual speeds into closer alignment, which has important implications for bicycling and pedestrian safety along roadways. These strategies include lane narrowing, rumble strips, speed reduction markings, and speed feedback signs.[19] According to FHWA research, these strategies could reduce average free-flow travel speed by one-to two-miles per hour. For example, adding buffers to shoulders/bicycle lanes that reduce travel lane width near and between high use sites and parking lots could have the added benefit of slowing vehicles for the safety of all road users as well as wildlife.[20]

---

[18] Federal Highway Administration (2012). *Non-motorized User Safety: A Manual for Local Rural Road Owners*. http://safety.fhwa.dot.gov/local_rural/training/fhwasa010413/. Accessed May 23, 2013.

[19] Ibid.

[20] Federal Highway Administration (2007). *Mitigation Strategies for Design Exceptions.* http://safety.fhwa.dot.gov/geometric/pubs/mitigationstrategies/chapter3/3_lanewidth.htm. Accessed May 24, 2013.

Along Road Measures by Bicycling Comfort Level

Interested-but-concerned

This group of potential bicyclists would feel most comfortable bicycling on off-road dedicated bicycle routes. At areas closest to major destinations and parking areas (within one to two miles) where dedicated bicycle trails are not feasible, roadway shoulders could be separated from the vehicle travel lanes as cycle tracks/buffered bicycle lanes. For example, hatch marks or curbing and a lane separated by pavers in each direction could be installed in road shoulders to provide a safe space for bicyclists while not eliminating the ability for vehicles to pull over in emergencies. These are sometimes referred to as cycle-tracks and their design can vary (see Figure 3-5). These spaces may also be comfortable for pedestrians; however, if pedestrians are expected or encouraged to walk on these, they should be designed accordingly to prevent bicycle-pedestrian conflicts.

Figure 3-5: Segregated Bicycle Lanes

Sources:
Left – Maus, Jonathan. Michigan DOT gives bikes 12-feet of space on state highway. http://bikeportland.org/2012/12/07/michigan-dot-gives-bikes-12-feet-of-space-on-state-highway-81013. Accessed June 4, 2013.
Right – Alta Planning + Design (Undated presentation). Cycle Track – Lessons Learned, http://www.portlandoregon.gov/Transportation/article/228196. Accessed May 23, 2013.

The construction of cycle tracks without increasing the roadway footprint may necessitate a reduction in the width of vehicle travel lanes to widen the shoulder or create a buffer zone, which could help marginally reduce vehicle speeds[21] The shoulder will no longer be able to accommodate regularly parked vehicles.

[21] Mitigation Strategies for Design Exceptions, Federal Highway Administration, July 2007, http://safety.fhwa.dot.gov/geometric/pubs/mitigationstrategies/chapter3/3_lanewidth.htm. Accessed May 23, 2013.

Enthused-and-confident

As distance increases from major destinations and parking areas (two-to four-miles away), this group of cyclists may be inclined to continue bicycling. Because this group of cyclists is more comfortable riding on roadways and in mixed traffic, less separation is necessary compared to interested-but-concerned bicyclists. Design elements that are appropriate include varying pavement colors, striped bicycle lanes and signage and/or pavement markings indicating bike lanes and the presence of bicyclists (see Figure 3-6).

Figure 3-6: Bicycle Lane Markings

Sources: Left: Cycylemania. http://www.flickr.com/photos/cyclemania/2893558308/. Accessed May 23, 2013.
Right: Luton, John. http://www.flickr.com/photos/luton/5285589749/. Accessed May 23, 2013.

Strong-and-fearless

Finally, this group of bicyclists requires the least amount of segregation from vehicular traffic and may feel comfortable riding in mixed traffic on all roads. Design elements that are appropriate include painted "sharrows" in the travel lane (roadways posted at 35 mph or less) and signs indicating to all road users that bicycles may be present (see Figure 3-7). Except where shoulders are present, these conditions are most like those currently on the refuge.

Figure 3-7: Sharrows and Signs

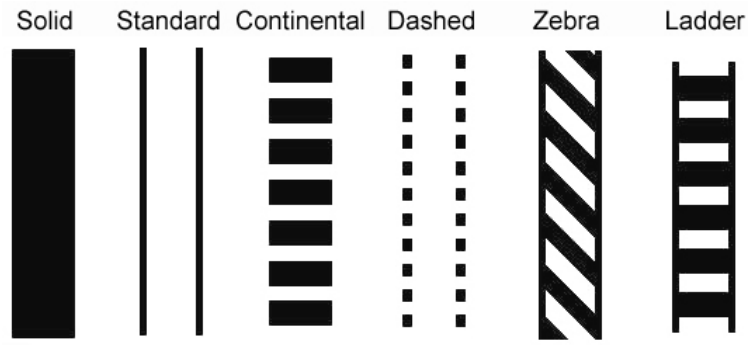
Source: Piedmont Triad Regional Council. http://www.ptrc.org/modules/showimage.aspx?imageid=1201. Accessed May 23, 2013.

Crosswalks

The most important factor to consider when selecting crosswalk treatments is visibility to motorists. Figure 3-8 shows common crosswalk markings. The continental and ladder treatments tend to be the most visible.

Crosswalks should not be slippery when wet and easily traversable by people with diminished mobility or vision. Inlay tape and thermoplastic, which are reflective, long-lasting, and slip-resistant, are preferable to paint. Raised crosswalks add visibility to the crossing and encourage motorists to slow down, but are significantly more expensive than striped crosswalks.

Figure 3-8: Crosswalk Examples



Source: FHWA (2004). *PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System*. www.walkinfo.org/pedsafe/. Accessed May 23, 2013.

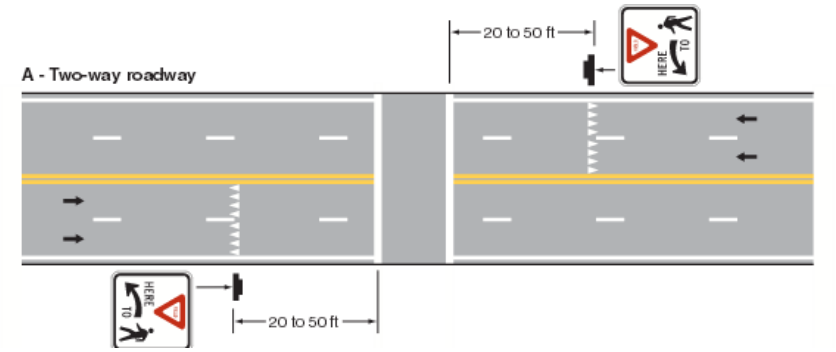
Oklahoma laws have important implications for pedestrians crossing at marked or unmarked locations. Pedestrians are required to yield the right-of-way to vehicles in areas without crosswalks.[22] While vehicles are required to yield to pedestrians in a crosswalk, they may not anticipate pedestrians crossing in a relatively high-speed rural area with low pedestrian volumes. Therefore, a crosswalk may instill a false sense of security for pedestrians, especially in non-intersection locations. In placing any crosswalk treatments on highway 49 or 115, refuge staff should consider warning signage, flashing beacons, and advance yield/stop lines that alert approaching motorists of potential pedestrian crossings (see Figure 3-9 and Figure 3-10).

[22] University of Oklahoma Health Sciences Center. Crosswalks and Pedestrians. http://www.ouhsc.edu/police/PersonalSafety/Crosswalks_Pedestrians.asp. Accessed May 24, 2013.

Figure 3-9: Pedestrian and Trail Crossing Sign Examples

Source: FHWA. Manual of Uniform Traffic Control Devices, 2009 Edition, Page 538. http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/part5.pdf. Accessed May 23, 2013.

Figure 3-10: Pavement Crosswalk Warning Markings



Source: FHWA. Manual of Uniform Traffic Control Devices, 2009 Edition, Page 383. http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/part3.pdf. Accessed May 23, 2013.

Bicycle Parking/Racks

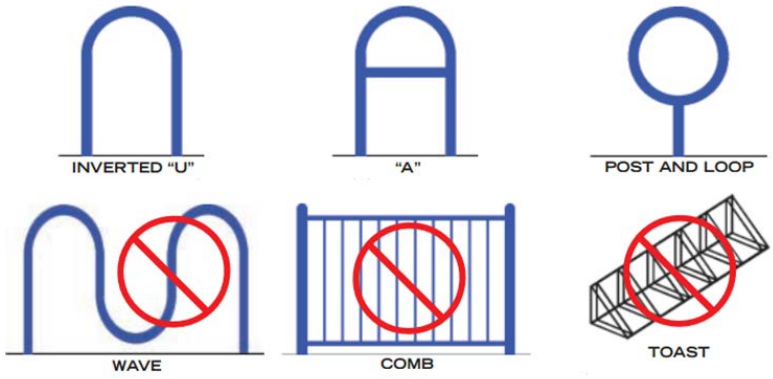
Bike parking should be visible, convenient, and plentiful at key destinations like trailheads and overlooks as well as building entrances. While there are a variety of racks on the market at different price points, the availability of safe and convenient parking is as critical for bicyclists as it is for motorists. Research indicates that bicyclists prefer racks that:[23]

- Support the bicycle frame rather than one wheel to avoid damage
- Allow both the frame and one wheel to be locked to the rack using standard cable or U-shaped locks
- Are securely anchored to the group or another fixed piece of infrastructure

These specifications point towards newer inverted "U", "A", and post-and-loop style racks, over "comb", "toast", and "wave" styles (see Figure 3-11).

[23] Pedestrian and Bicycle Information Center. Bicycle Parking website page. http://www.bicyclinginfo.org/engineering/parking.cfm. Accessed May 24, 2013.

Figure 3-11: Preferred Bicycle Rack Types



Source: Association of Pedestrian and Bicycle Professionals. *Bicycle Parking Guidelines*. www.apbp.org/resource/resmgr/publications/bicycle_parking_guidelines.pdf. Accessed May 23, 2013

These preferred rack types can be purchased either independently and sited on a cement pad or grouped and placed on level ground/hard surfaces. Sometimes the latter are placed in parking lots or roadways in a "corral" format (see Figure 3-12). One automobile space can accommodate about eight bicycles.

Figure 3-12: Bicycle Corral

Source: Pedestrian and Bicycle Information Center Image Library. http://www.pedbikeimages.org/. Accessed May 24, 2013.

Transit Accommodation

Integration between pedestrian, bicycle, and transit modes expands transportation choices and access for all refuge visitors. Any prospective transit system that provides access to or within the refuge should accommodate bicycles either inside the vehicle or on racks or trailers mounted outside the vehicle (see Figure 3-13).

Figure 3-13: Bicycle Rack-equipped Bus

Source: Hitchhiking and Public Transportation around Olympic National Park. http://www.barefootjake.com/2012/10/hitchhiking-and-public-transportation.html. Accessed May 24, 2013.

Context Sensitive Solutions/Design

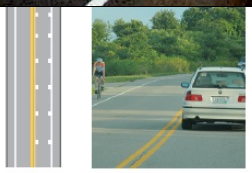
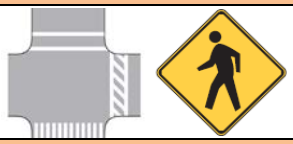
Context sensitive solutions/design is an approach to transportation decisionmaking and design that is responsive to the communities and lands through which infrastructure passes. The approach seeks to balance transportation needs with environmental and historic preservation considerations. If planned and designed properly, bicycle and pedestrian infrastructure on public lands can help move visitors while also minimizing impacts on resources. Installing bicycle and pedestrian infrastructure designed for an urban context into a public lands setting will appear out of place. Options exist to provide the benefits of modern pedestrian and bicycling infrastructure without overly harming the natural and recreational resources of the refuge. For instance, instead of dark black asphalt and bright gray concrete, multi-use paths can be built using dye or overlay colors that closely match the landscape. Local aggregate for gravel trails or mixed into hard-surface trails can provide a closer match when suitable quarries are available.

Signs are necessary to orient visitors, inform them of regulations, share interpretive materials, and to provide a graphic identity for the refuge. The Manual of Uniform Traffic Control Devices (MUTCD) provides some guidance in minimizing sign clutter, which helps preserve natural appearance while providing the best information possible to visitors. When safe and permitted, a context-sensitive materials palette using natural materials can reduce the visual impact of signs. Using trees or boulders as natural signposts can reduce the visual prominence of signs while still allowing them to be easily seen and read by visitors on the trail itself.

Cost and Effectiveness

Table 3-3 provides rough costs and impacts of the above measures

Table 3-3: Cost/Effectiveness Matrix

	Engineering Measure	Cost per Unit	Cost Per Mile (if applicable)	Safety Benefit	Behavioral Impact on Design Bicyclist
Along Road Measures					
	Sidewalks and Walkways	$50 per linear foot (concrete)	$264,000	High	High
	Bicycle Lanes, Paved Shoulders, and Signed Routes	$0.20-1.20 per foot	$1,000-6,000	Medium	Low-Medium
	Separated Shoulders/Cycle Tracks/Buffered Bicycle Lanes	Similar to above	Similar to above	Medium-High	Medium-High
	Lane Narrowing/Speed Reduction	Varies with treatment	N/A	Medium	Medium
Crosswalks					
	Crosswalks (with high visibility signage)	$1,200-$1,440 each	N/A	Medium	Medium
Bicycle Parking/Racks					
	Inverted U, A, Post and Loop	$100-300 each (2 bikes)	N/A	N/A	Medium
	Multi-bike racks	$265-$1,400 each (5-18 bikes)	N/A	N/A	Medium
Transit Accommodation					
	Transit bicycle racks	$750 each	N/A	N/A	Medium

Sources: Pedestrian and Bicycle Information Center. Engineer Bicycle Facilities website page. http://www.bicyclinginfo.org/engineering/. Accessed May 24, 2013.

Alta Planning + Design. *City of Palo Alto Bicycle and Pedestrian Transportation Plan Appendix*. http://www.altaprojects.net/files/7313/1247/9077/Palo_Alto_BPTP_Draft_Appendices_rev_8-3.pdf. Accessed May 24, 2013.

Pedestrian and Bicycle Information Center. Engineer Pedestrian Facilities website page. http://www.walkinginfo.org/engineering/. Accessed May 24, 2013.

Design Guidelines and Manuals

Highway design is generally expected to adhere to established guidelines. While such guidelines do offer specific dimensions for hundreds of potential projects, these dimensions do not represent design 'standards' but rather offer ranges to guide final designs. The engineering community often selects the highest (or lowest value in a range, sometime erroneously believing this will ensure maximized safety. FWS engineers, however, have discretion to make decisions within the bounds of adopted design guidelines (see list below). Information in this resource guide, which is derived from research and best practices, are intended to help refuge staff advocate for design decisions proven to safely accommodate all road users, not just motorists.

- Federal Lands Highway (2012) *Project Development and Design Manual.*
  - http://flh.fhwa.dot.gov/resources/manuals/pddm/
- FHWA (2009), *Manual on Uniform Traffic Control Devices.*
  - http://mutcd.fhwa.dot.gov/
- Oklahoma Department of Transportation (2009). *Roadway Design Standards and Specifications.*
  - http://www.okladot.state.ok.us/roadway/standards.htm
- American Association of State Highway and Transportation Officials (AASHTO) (2012). *Guide for the Development of Bicycle Facilities – Fourth Edition.*
  - https://bookstore.transportation.org/item_details.aspx?id=1943
- FHWA (2008). *Guidance Memorandum on Consideration and Implementation of Proven Safety Countermeasures*
  - http://safety.fhwa.dot.gov/policy/memo071008/

Education

Education, outreach, and training are key to informing visitors, law enforcement, and decision-makers about how nonmotorized transportation can be safe and beneficial. The ultimate goal of these programs should be to change behavior and reduce the potential for hazardous actions by motorists, pedestrians, and bicyclists. Education programs are particularly important for children or people with limited bicycling experience. They can also provide an opportunity to teach people how to properly maintain a bicycle, which may instill confidence in riders taking longer trips and may encourage them to bicycle more frequently when they are not at the refuge, promoting a more healthy lifestyle.

Given existing infrastructure, staff time, and priorities, the refuge should rely on partner groups to market the benefits of nonmotorized transportation to the public; however, the refuge should play an active role in educating visitors on safe driving, bicycling, and walking/hiking skills. This role could include educational events, public campaigns, and promotional materials spearheaded by or in partnership with area municipalities and organizations.

Key Messaging

Succinct, to-the-point messaging is key to any effective education effort or campaign. Below are important points to convey to motorists, bicyclists, and walkers/hikers regardless of education venue.

Motorists

Drivers should learn to look for bicyclists and pedestrians on the roadway as they would check for cars and adjust their driving behavior accordingly. Key messages for motorists include:

- Share the road.
- Know and obey the law. The same laws apply to motorists and bicyclists.
- Be alert. Beware of wildlife in the roadway.
- Motorists must give bicyclists and pedestrians at least three feet of passing distance on roadways in Oklahoma.
- Do not honk. This can startle bicyclists and cause them to swerve.
- Assess bicycle speed when passing and turning. Some bicyclists can travel 25 or 30 MPH, if not faster. Others, particularly children, can be traveling at much slower speeds.
- Many bicycling collisions occur while turning left in front of oncoming bicyclists or turning right after overtaking a bicyclist.

Bicyclists

Bicyclists should learn and practice safe bicycling behaviors. Key messages should be communicated to the public either through printed materials (i.e., on the back of nonomotorized network maps), at special events, or by law enforcement or volunteers. Bicyclists, particularly children, are a more captive, identifiable audience than motorists. The refuge can explore partnerships to host area safe bicycling events like “bicycle rodeos.” Messages to bicyclists should include:

- Share the road.
- Beware of wildlife. Do not approach.
- Avoid riding at night. Doing so is discourages on the refuge.
- Know and obey the law. The same laws apply to bicyclists and motorists.
- Use hand signals to indicate stops and turns.
- Wear a properly fitting helmet.
- Stay hydrated and protected from the sun.
- Ride in the same direction as traffic. Stay to the right and use separated facilities when available.
- Ride predictably.
- See and be seen. Stay alert and wear bright colored clothing and use reflectors.
- Make sure your bicycle is maintained properly and fitted for your height.

Walkers/Hikers

Pedestrians on the refuge participate in a variety of activities including long-distance hiking in the backcountry and wilderness areas and short-distance walking on nature trails. Pedestrians frequently walk along refuge roadways, especially Mt. Scott Road, and cross roadways and parking lots. Hazards range from losing your way or running out of water to being struck by an automobile. Key messages to pedestrians include:

- Be prepared. Carry an emergency kit and extra water and prepare for variable weather.
- Beware of wildlife. Do not approach.
- When on the road, walk facing oncoming traffic when practical. Stay out of travel lanes when practical.
- Know and obey the law. Pedestrians crossing the roadway only have the right of way in a marked crosswalk.

- Dress in layers and avoid cotton because it retains water.
- Stay hydrated and protected from the sun.
- Avoid hiking alone.
- Do not count on cellphone reception. Tell someone where you are going and when you will return.

Encouragement

Nonmotorized transportation offers visitors an opportunity to see and experience the refuge outside of their cars. The strategies outlined below show how refuge staff, along with partners, can make bicycling and walking easy, accessible, and fun. They include maps, wayfinding signage, staff-led tours, and bicycle sharing/rentals. Case studies are provided to illustrate these strategies where appropriate.

Bicycle and Pedestrian Network Maps

The refuge should consider a small combined trail and bicycle route map in collaboration with partner groups. This map could include insets highlighting key areas, especially on the eastern side of the refuge. Maps can illustrate features that attract different user groups, such as:

- On-street routes, separated paths, or hiking trails.
- Links to the larger regional network of dedicated facilities.
- Links to public transportation, as applicable.

The reverse side of this map could include regulatory and safety information, including relevant traffic laws, guidance for encounters with herd animals, and bicycle signaling and helmet use recommendations (see Key Messaging). Maps should be distributed at visitor centers, area lodging and tourist attractions, local bicycle and outdoor shops, and online pursuant to a dissemination plan with partner groups.

Case Studies

- *Rocky Mountain Arsenal NWQ Hiking Trails and Wildlife Drive Auto Tour*: FWS provides a two-sided, black-and-white, integrated on-refuge hiking and auto tour map complete with safety information on the back.[24]
- *Friends of Pathways maps*: A local Jackson Hole, Wyoming-area non-profit provides comprehensive area nonmotorized trail maps in conjunction with the National Elk Refuge, Bridger-Teton National Forest, and Grand Teton National Park.[25]

Wayfinding, map, and trailhead signage

Wayfinding, maps, and trailhead signage help bicyclists and pedestrians find their location and navigate through the refuge. Wayfinding signage emphasizes directions, destinations, and distances, while maps and trailhead signage provide more detailed information and show the relative location of amenities like

[24] Rocky Mountain Arsenal NWR maps. http://www.fws.gov/refuge/Rock_Mountain_Arsenal/map.html. Accessed June 3, 2013.

[25] Friends of Pathways resources. http://www.firendsofpathways.org/resources. Accessed June 3, 2013.

restroom facilities, water, telephone/emergency services, viewing and interpretive areas, and hiking opportunities.

On-Refuge

The refuge intends to develop a sign plan in 2014, which will cover on-refuge directional, informational, and location, aesthetic quality, and quantity of educational sign location. This plan should:

- Identify existing signage location and condition based on the 2009 CFLHD Road Inventory of Wichita Mountains Wildlife Refuge.
- Propose new signs at major trailheads, intersections, and waypoints that provide distances to key destinations in small increments relevant to bicyclists and pedestrians as well as maps where appropriate.
- Develop a context sensitive signage typology that establishes visual and verbal consistency pursuant to the FWS Sign Handbook ("General Guide Signs" chapter) for on-street and off-street locations (see Figure 3-14 and Figure 3-15).
- Propose signs that utilize FWS, National Scenic Byway, and municipal/military/partner logos, when possible and applicable. Most FWS-approved signs are designed to meet MUTCD design standards, which must be followed for signs intended for viewing from roads open to the public.
- Guide the development of signage for the designated auto tour envisioned in the refuge's Comprehensive Conservation Plan. Distinguishing between auto tour signage and a bicycle and pedestrian specific wayfinding is not necessary, but may be desirable.

Figure 3-14: Wayfinding ("General Guide") Signage at Chincoteague NWR

Source: Barkley, Murray. Chincoteague National Wildlife Refuge.

Figure 3-15: Context-sensitive Intersection and trailhead map signage at Chincoteague NWR

Source: Barkley, Murray. Chincoteague National Wildlife Refuge.

Off-Refuge

While the refuge has no specific authority to place signs for nonmotorized users off-refuge, the public can benefit from a cohesive and integrated regional network of on-road and off-road signage. Working with adjacent landowners and municipalities, Oklahoma DOT, and regional coalitions, refuge staff could help spearhead the development of a memorandum of understanding among stakeholder groups on such things as design guidelines and placement. Such a partnership would strengthen funding opportunities and reduce the potential for signage confusion.

Staff-led Tours

Tours can introduce visitors to nonmotorized facilities available at the refuge. When properly designed and executed, tours can give the public a unique interpretive experience, while highlighting the benefits of nonmotorized travel. WMWR should consider bicycling tours as part of its interpretive program.

Case study

- Mississippi National River and Recreation Area's Bike with a Ranger Program – NPS offers three-hour interpretive bicycle tours for $8 per person ($5 for Friends group members). Kids under 10 ride free. Four routes are offered by reservation on different Saturdays in the summer. Route distances range between nine and 14 miles and cover a variety of natural and cultural resources. Offered since 2005, all rides are limited to 20 participants and loaner bikes are available from partner organizations.[26]

Bicycle Sharing/Rentals

The bicycle sharing/rental landscape in the United States has changed rapidly in recent years with the advent of automated bicycle kiosks and locking technologies in Europe in the mid-2000s and adopted in 2010. These systems—characterized by modular, solar-powered stations, touchscreen kiosks, and smartcard technology—tend to have high startup and operations costs.[27] Unlike traditional bicycle

[26] National Park Service – Mississippi National River & Recreation Area. Bike with a Ranger Program. http://www.nps.gov/miss/planyourvisit/bike.htm. Accessed June 3, 2013.

[27] DeMaio, Paul (2009). Bikesharing: History, Impacts, Models of Provision and Future. Journal of Public Transportation, Vol. 12 No. 4, 2009. http://nctr.usf.edu/jpt/pdf/JPT12-4DeMaio.pdf. Accessed June 3, 2013.

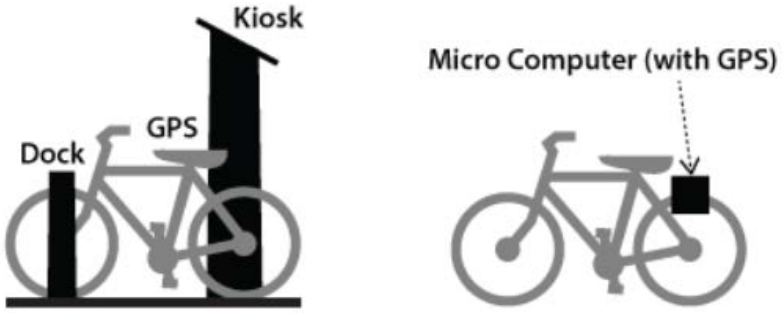
rentals, bicycle share systems have specialized or customized bicycles that lock into docks. These systems are in various stages of implementation in many large and small U.S. cities.

Background

Bicycle sharing tends to be viewed as an extension of public transit and is designed primarily for short-distance, utilitarian trips in urban areas. They are priced to reduce the personal cost of urban transportation and typically offer the first 30-60 minutes free for members. In the past, funding and operations for bicycle sharing systems came primarily from the public and non-profit sectors and were geared towards annual members. Increasingly, public entities are looking to the private sector to fund and operate bicycle sharing systems. These systems tend to have higher user fees and depend more on short term rentals and recreation-based trips.

Concurrent with the trend towards privatization of bicycle sharing, equipment vendors are experimenting with low-cost, smart lock-based systems that use traditional bicycles. These GPS-enabled systems take advantage of existing standard bicycle racks and can be rented from a smart phone or standalone kiosk (see Figure 3-16).

Figure 3-16: Technology Comparison: Kiosk and Smart lock-based Systems



Source: Inventropolis. *Bikeshare Disrupted?* http://inventropolis.com/bikeshare-disrupted/. Accessed May 20, 2013.

Table 3-4 compares the key distinguishing characteristics between kiosk-based and smart lock-based bicycle sharing systems and traditional bicycle rentals.

Table 3-4: Operating Characteristics of Kiosk and Smart lock-based Bicycle Sharing System Compared to Traditional Bicycle Rentals

	Bicycle Sharing		
Typical Characteristics	**Kiosk-based**	**Smart lock-based**	**Traditional Bicycle Rentals**
Facilities	Concentrated network of specialized stations	Dispersed network of formal/informal bicycle racks	Single, staffed location
Technology	Modular, solar-powered stations, GPS transponders	Modified traditional bicycles/locks	Traditional bicycles
Business Model/Funding	Public/Non-profit funding sources and operation, private sponsorships	Private	For-profit operation, private funding
Target Age	Adults	Adults	Adults and children
Capital Cost	High ~$1,000/bike $20-50,000/kiosk	Medium ~$1,000/bike	Low ~$300/bike
Annual Operating Cost	~$2,000/bike	Less than $1,000-$1,200/bike	Variable

Source: Toole Design Group and the Pedestrian and Bicycle Information Center (2012). *Bike Sharing in the United States: State of the Practice and Guide to Implementation.*

Personal communication: Derrick Moennick. Sandvault Group Global Solutions Corp. May 15, 2013.

Challenges for Bicycle Sharing on Public Lands

In a public lands context, the most notable integration of bicycle sharing systems to date has occurred in urban Park Service units in Minneapolis, San Antonio, and the District of Columbia, where park managers were able to build off the success of large kiosk-based systems. Other public lands units that offer bicycling options do so through traditional bicycle rental vendors. The relative lack of examples of bicycle sharing on public lands is likely due to the fact that these systems are still relatively new. Also, in recreational, rural, and small town settings, the feasibility of kiosk-based bicycle sharing is diminished by:[28]

- High capital and operations costs
- Lack of bicycle-friendly infrastructure
- Station placement constraints (technical, environmental, and historical resources)
- Hilly and mountainous terrain that dissuade bicycling
- Limited partnership opportunities in small/rural areas
- Distant destinations/attractions that present full/empty station problems

In light of these challenges, the refuge should consider the following when implementing a bicycle sharing system:

1. Review this resource guide and assess the implementation status of its infrastructure and program strategies.
2. Explore partnership opportunities with friends groups, gateway communities, and public health agencies and organizations for operations, marketing, and station placement.
3. Seek out a third party operator to run and market the system, minimizing liability.
4. Establish parking/station facilities in at least three locations to allow for one-way trips from multiple high-use sites.
5. Consider durable road, mountain, or hybrid bike models consistent with the distance and terrain visitor will most likely ride. Not all vendors can supply each.
6. Create a strong brand/logo that is highly visible, but echoes the agency's branding and mission. Bikes should be customized with distinct colors and branding, creating a unique look. A more rugged bike model might be desirable for use on un-paved refuge roads.
7. Work with partners or consider technological solutions to provide helmets to bicycle share users.
8. Provide options for children and people with disabilities.
9. Offer pricing strategies attractive for longer rides.
10. Consider low-cost bicycle share solutions, including smart lock-based systems and standalone kiosks.

Business Models – Operators and Vendors

Absent a cooperative agreement with a non-profit or government entity, the refuge would need to select an equipment vendor and operator/concessionaire through a competitive, open bidding process. Bicycle sharing equipment and operations are provided by several North American-based companies.

---

[28] Western Transportation Institute (2012). *Exploring Bicycle Options for Federal Lands: Bike Sharing, Rentals, and Employee Fleets.*

Some major equipment vendors include BIXI, Trek, and the Sandvault Group, among others. These groups have established partnerships with operators like Alta Bicycle Share, B-Cycle, and DecoBike respectively. Some equipment vendors adapt bicycles made by traditional bicycle manufacturers like Worksman, Kona, Rugged Cycles, and others. Table 3-5 provides a listing of identified North American-based private bicycle share operators followed by equipment vendors.

Table 3-5: North American-Based Private Bicycle Share Operators and Equipment Vendors

Company	Website	System/Equipment Type
Private Operators		
Alta Bicycle Share, Inc.	www.altabicycleshare.com	Kiosk-based
Bike and Roll	http://www.bikeandroll.com	Kiosk-based, Smart lock-based, Traditional Bicycle Rental
B-Cycle	www.bcycle.com	Kiosk-based
Bike Nation	www.bikenationusa.com	Kiosk-based
CycleHop	cyclehop.com	Kiosk-based and Smart lock-based
DecoBike	www.decobike.com	Kiosk-based
Equipment Vendors		
BIXI/Public Bicycle System Company (PBSC)	www.publicbikesystem.com	Kiosk-based stations and bikes
SandValult Group Global Solutions Corp.	www.decobike.com	Kiosk-based stations and bikes, Smart lock-based, standalone kiosks
Operators and Equipment Vendors		
Social Bicycles	socialbicycles.com	Smart lock-based bikes
viaCycle	www.viacycle.com	Smart lock-based bikes
Zagster	www.zagster.com	Smart lock-based bikes

Case Studies

- *Bright Angel Bicycle Rentals, Grand Canyon National Park*: 85 bicycle rental facility at South Rim Visitor Center, opened in March 2010 under a commercial use authorization. Visitors can purchase guided tours or embark on one of three suggested self-guided routes, each integrated

with the park's transit system. Prices for adults range from $12 for one hour to $40 for 24 hours. Longer term rentals and youth/child rentals are also available.[29]

- *Spokies, Oklahoma City*: eight kiosk, 95 bike system run by Oklahoma City Business Improvement (Downtown OKC, Inc.) in partnership with the Oklahoma City Office of Sustainability. One day membership ($5) can be purchased with a credit card at kiosks. One month ($20) and annual memberships ($75) are available online or by phone. Membership comes with unlimited 30-minute free rides and $2 each additional half hour (maximum: $75 per day).[30]

- *Tulsa Townies, Tulsa*: four kiosks, 75 bicycle system run by Saint Francis Health System along Tulsa's River Park Trail System. The program was initiated by the Warren Medical Research Foundation, a philanthropic organization. Anyone older than 18 with a credit card can rent a bike up to 24 hours free of charge. Riders are charged $100 if bikes are not returned within that time frame.[31]

Resources/Further Reading

- Toole Design Group and the Pedestrian and Bicycle Information Center (2012). *Bike Sharing in the United States: State of the Practice and Guide to Implementation.*

- Western Transportation Institute (2012). *Exploring Bicycle Options for Federal Lands: Bike Sharing, Rentals, and Employee Fleets.*

Events

Special events are an effective way to encourage people to walk or bicycle. Events help bring attention to bicycle and pedestrian issues, using fun group activities. Through partnerships, WMWR is host to three large annual events, including: the Race for Survival Marathon, Tour of the Wichitas, and Tour de Meers Bike Ride. Special incentives can also draw participants, such as temporarily closing roads to automobiles and having limited-time bicycling opportunities either at night on trails or on service roads usually off-limits to bicyclists.

[29] Bright Angel Bicycles website. http://bikegrandcanyon.com/, accessed May 22, 2013.
[30] Spokies – Oklahoma City's bike share program website. http://spokiesokc.com/, accessed May 22, 2013.
[31] Tulsa Townies. http://www.tulsa-townies.com/. Accessed May 22, 2013.

Enforcement

Effective enforcement requires establishing equal protection for all road users (motorists, pedestrians, and bicyclists) in addition to enforcing traditional traffic laws related to motorist speed and other moving violations. For motorists, law enforcement should focus on crosswalk and stop sign compliance, bicycle passing distance, and speeding in high pedestrian activity areas and crowded parking lots. For pedestrians and bicyclists, law enforcement should emphasize safe walking along roads, yielding to traffic when crossing at unmarked and mid-block locations, and resource-damaging activities like bicycling off trail.

Enforcement activities are particularly important on or near new facilities and in areas that may attract young or inexperienced bicyclists. Paired with targeted education activities, law enforcement can work to build positive relationship with bicyclists and pedestrians. In order to accomplish this, many public lands units have dispatched law enforcement rangers on bicycles or recruited volunteer trail ambassadors. Dispatching these individuals allows the unit to interact and connect with the public in ways not possible from an automobile and expands the presence of emergency assistance to more inaccessible areas.

When considering such programs, it is important to be aware of potential drawbacks. Law enforcement on bicycles will not be equipped to respond quickly to calls requiring long distance travel. While volunteers cannot technically enforce rules, they can educate the public, provide a visible presence, and contact law enforcement as necessary.

Case Studies

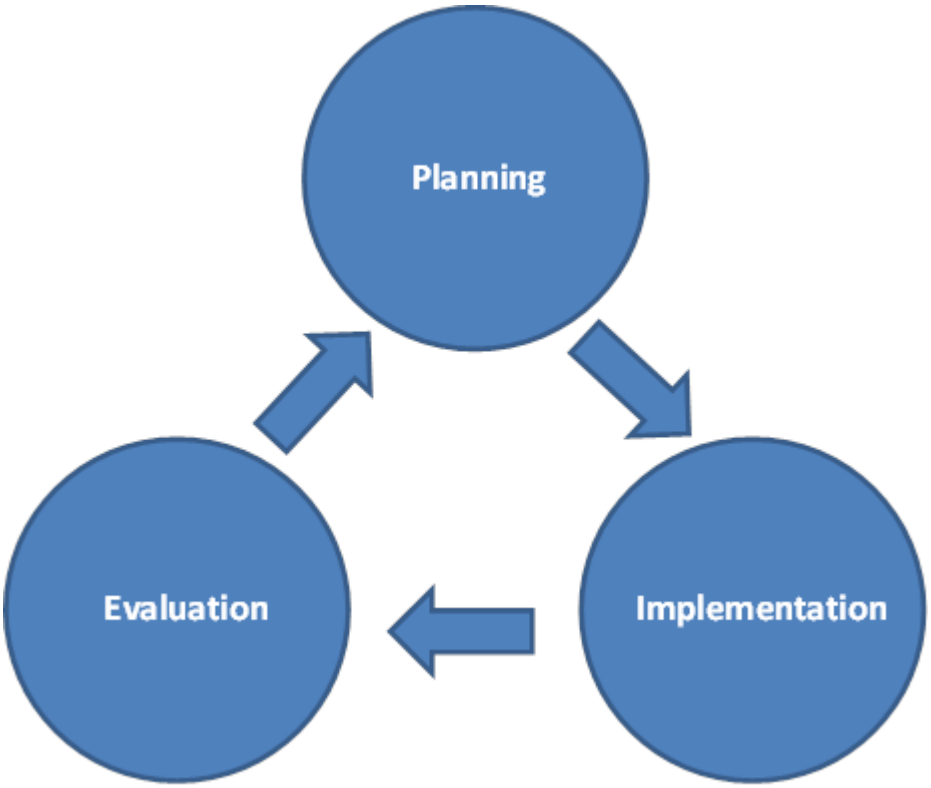
- *Grant Teton National Park Pathway Ambassador Program*: Since 2009, volunteer pathway ambassadors have traveled Grand Teton's multi-use trail system during peak visitation months providing the public with "rules of the road", administering first aid and medical assistance, and collecting visitor use data.[32]

[32] Grand Teton National Park (2012). Article: *Grand Teton Recruits for Volunteer pathway Ambassadors*. http://www.nps.gov/grte/parknews/volunteer-pathway-ambassadors.htm. Accessed May 22, 2013.

Evaluation, Planning, and Implementation

Continuous planning, implementation, and monitoring will be crucial to any effort by WMWR to accommodate bicycling and walking. Every nonmotorized strategy – engineering, encouragement, education, or enforcement – starts with sound planning. Planning provides the opportunity to define problems, develop strategies, program staff, engage the public, leverage partner expertise and resources, and prepare for funding opportunities. Implementation brings plans off paper and into real life. Evaluation and monitoring help assess the degree to which programs and projects are solving the problems that they were designed to correct and feed into future planning processes (see Figure 3-17).

Figure 3-17: Continual Process of Planning, Implementing, and Evaluation



Source: Volpe Center.

The CCP outlines not only a planning framework for nonmotorized transportation improvements but also calls for monitoring, evaluation, and adjustment beyond implementation. It is important that the refuge follow the adaptive management approach outlined in the CCP which aims to "make sure that progress is being made toward meeting goals. Monitoring also detects new problems, issues, or opportunities that should be addressed."[33]

Specifically, nonmotorized improvements should be evaluated based on their potential to increase group sizes, erosion, litter, impacts on law enforcement, and habitat and wildlife disturbance. Any

[33] CCP, pp. SUM-32

improvement should include a plan for trail maintenance, expanded 'Leave No Trace' education efforts, or other mitigation measures for public use activities.[34]

Additional refuge public use concerns relevant to nonmotorized transportation that the CCP outlines, which may also be evaluated, include:[35]

> **Partnerships**: As ecological and social pressure on the refuge grow (invasive species, climate change, urban sprawl, and increased visitation), the need for strong partnerships becomes more apparent. Partnerships at the local, State, and Federal level can raise the awareness of emerging issues and threats to the refuge and can build the necessary social, political, and economic support to address them.
>
> **Special uses**: A variety of commercial and non-commercial special uses have been allowed to occur on the refuge in the past without adequate documentation, evaluation, and administration. All public uses occurring on a national wildlife refuge must pass a determination of appropriate use, be evaluated for resource impacts in a Compatibility Determination, and be submitted for public review as required by NEPA. All special uses must be authorized and administered under an annual Special Use Permit.
>
> **Public use conflict**: Large groups of people have a negative impact on wildlife and lower the quality of the outdoor experience for other people. Zoning is needed to guide the long-term management of public facilities and to encourage a shift in human use patterns that reduces conflict between people and wildlife, as well as between various user groups.
>
> **Children in the outdoors**: A pervasive issue in our society today, and one of particular importance to the long-term health and survival of public lands, is the decline of children playing and recreating in the outdoors.
>
> **Condition of facilities**: All public use facilities on the refuge receive heavy use and require a significant investment of time and labor to maintain, repair, and upgrade. Both the use of the public facilities and the cost of maintaining them are expected to grow with increased visitation.
>
> The demand for public use facilities already exceeds capacity during weekends and on holidays. The limited size and ecologically isolated nature of the refuge necessitates that no more habitat be lost to development without very careful consideration.

Data and Performance Measures

Counts, surveys, and other data collection efforts form the basis of any monitoring effort. In conjunction with performance measures, these efforts provide key information needed to monitor change and progress towards a goal. Such efforts should focus on facility use, safety, and programing effectiveness and depend on data that is accessible, reliable, and accurate.

---

[34] CCP, pp. SUM-6

[35] CCP, pp. 3-98-99

Getting to Implementation

In order for nonmotorized transportation programs to be successful, the refuge should pursue proven strategies to fund and implement nonmotorized transportation programs and infrastructure. The strategies below are adapted from methods taken by municipalities with successful nonmotorized transportation programs.

Modify Planning Documents and Policy Decisions: Nonmotorized transportation is not just a subject for transportation planning documents. WMWR should incorporate bicycle and pedestrian considerations into all policy and planning documents including compatibility determinations and updates to plans covering facility management, public use, interpretation, law enforcement, safety, signage, and visitor services.

Finding Sustainable Funding: There is a perception that a lack of funding is a major barrier to investing in nonmotorized programs. The reality is that funding comes from many sources (see Appendix 3-A) and goes to grant applicants who stay one shovel-ready project ahead of the next funding opportunity. Preparing for the next grant opportunity includes assembling partnerships and coalitions and identifying matches to leverage outside dollars without the pressure of an impending deadline. WMWR management should identify one point person charged with keeping an up-to-date calendar of grant opportunities.

Pursue Easy Successes: Many projects take years to plan, fund, and implement. In the near term, bicyclists and pedestrians can benefit from quick, low-cost measures requiring only paint and signage. Larger projects require more extensive planning and environmental compliance, leveraging funds, and partnerships. WMWR should keep in mind "low-hanging fruit" projects like wayfinding, signed routes, bicycle parking, and maps.

Routine Accommodation: In large projects not specifically for nonmotorized transportation like road and parking area repaving or building construction, nonmotorized transportation can benefit from small add-ons like bicycle lanes, racks, and sidewalks. WMWR should identify projects in the Comprehensive Conservation Plan that could have a nonmotorized transportation component.

Engage and Support: Successful bicycle and pedestrian programs depend on communication, collaboration, and support both within and outside of an organization. Deep engagement is critical for communicating priorities and expectations, identifying partnerships and match opportunities, and leveraging the resources and expertise of outside groups. WMWR management should identify one point person to maintain continual communication with key contacts at Fort Sill, Fit Kids of Southwest Oklahoma, the Lawton Bicycle and Pedestrian Advisory Committee, and Medicine Park.

Conclusion

This resource guide is designed to aid WMWR in comprehensively promoting safe walking and bicycling opportunities for the visiting public. Refuge management and law enforcement, FWS engineers, and partner groups can further nonmotorized transportation to, within, and around WMWR by jointly pursuing a Five E approach that includes engineering, education, encouragement, enforcement, and evaluation, planning, and implementation activities. Appendix 3-B provides key resources and nonmotorized tools and organizations.

Appendix 3-A: Funding Programs

There are many Federal funding sources available for nonmotorized infrastructure and safety projects. For the refuge, these programs are administered by either FHWA's Central Federal Lands Highway Division or Oklahoma State government. Each program has specific eligibility requirements and program goals established in each Federal transportation reauthorization. Some require a non-Federal match, while others must have a local government or non-profit serve as the applicant. Table A-1 summarizes relevant funding programs, program purposes, match requirements, key contacts, application deadlines/cycles, and typical award amounts. Each program is grouped under headings describing the likelihood that the refuge projects could be programmed or awarded funds. Table A- 2 summarizes eligible project activities under each program.

Table A- 1: Key Federal Funding Programs for Bicycle and Pedestrian Infrastructure and Programs

Program	Funding Purpose	Match Requirement (Federal: Local)	Key Contact	Website	Funding Cycles *(Subject to change)*	Feasibility Considerations/Notes
High Chance of Success						
Federal Lands Access Program (FLAP)	State and local-owned and/or maintained transportation infrastructure projects that access Federal Lands (on or off unit)	80:20	Central Federal Lands Highway, ODOT	http://www.cflhd.gov/programs/flap/ok/index.cfm	Open June – August 2013, but programmed out multiple years	Highly competitive, $1.3 million available statewide for each year. FLTP can be used as a match.
Federal Lands Transportation Program (FLTP)	FLMA-owned transportation infrastructure projects	None	FWS Region 2	http://www.cflhd.gov/programs/fltp/index.cfm	Rolling	Limited funding; must be identified as a regional priority.
Recreational Trails Program (RTP)	Nonmotorized and motorized recreational trail projects and related facilities	80:20	Oklahoma Tourism & Recreation Department	http://www.oklatourism.gov/Grants/default.aspx	Applications available in August. Last business day in January.	$1.7 million available annually, $700,000 for nonmotorized trails (Federal request cannot exceed $160,000). Funds are highly competitive (in 2012, 33 applied and 10 were awarded).

Program	Funding Purpose	Match Requirement (Federal: Local)	Key Contact	Website	Funding Cycles *(Subject to change)*	Feasibility Considerations/Notes
Transportation Alternatives Program (TAP)	Nonmotorized facilities and safe routes to school projects	80:20	ODOT Transportation Enhancement Program	http://www.okladot.state.ok.us/projmgmt/enhance_prog/	General schedule: State Cycle opens: Mid-June Pre-application: October Final submission: January	Federal request cannot exceed $400,000. $3.7 million available per year statewide. Historically funds awarded on a 2-year cycle, 50 percent of projects receive funding. Funding averages $350,000-$400,000.
Medium Chance of Success						
Highway Safety Improvement Program (HSIP)	Safety improvement projects	90:10/None depending on project type	Oklahoma Highway Safety Office	http://ok.gov/ohso/	Occurs February	$35 million available. Data intensive grant application. Not traditionally used for bicycle and pedestrian projects in Oklahoma.
State and Community Traffic Safety Program (Section 402)	Education, enforcement, research programs that reduce crashes, deaths, injuries, and property damage on highways	None	Oklahoma Highway Safety Office	http://ok.gov/ohso/	Ends in July	WMWR not an eligible applicant. Only counties, municipalities, and local government are eligible to apply. In some cases non-profits are eligible.

Program	Funding Purpose	Match Requirement (Federal: Local)	Key Contact	Website	Funding Cycles *(Subject to change)*	Feasibility Considerations/Notes
Low Chance of Success/Not Currently Applicable						
Congestion Mitigation and Air Quality Improvement Program (CMAQ)*	Congestion relief and air quality improvement projects	80:20	N/A	N/A	N/A	WMWR is not currently located in an EPA designated nonattainment or maintenance area for air pollution. It is therefore not eligible.
Surface Transportation Program (STP)		80:20	ODOT Planning & Research Division	http://www.okladot.state.ok.us/p-r-div/	Continuous Statewide Transportation Planning Process	Large amount of money available ($163 million). Requires extensive and sustained coordination with ODOT.

Source: Program websites and contacts.

Table A- 2: Eligible Activities for Federal Bicycle and Pedestrian Funding Programs

	CMAQ	FLAP/FLTP*	HSIP	STP	402	TAP	RTP
Infrastructure							
Bicycle lanes on roadway	X	X	X	X		X	
Paved shoulders	X	X	X	X		X	
Signed bike route/Wayfinding	X	X		X		X	
Shared use path/trail	X	X	X	X		X	X
Spot Improvement Program	X		X	X		X	
Bicycle Racks on Buses	X	X		X		X	
Bicycle Parking	X	X		X		X	
Bicycle sharing stations	X	X		X		X	
Sidewalks/crosswalks, new or retrofit	X	X	X	X		X	
Non-Infrastructure							
Helmet promotion				X	X		
Maps	X			X	X	X	
Safety brochure/book	X			X	X		X
Training	X			X		X	

*FLAP funds cannot be spent on federal infrastructure

Source: Advocacy Advance. *Find It, Fund It Table*. http://www.advocacyadvance.org/site_images/content/Find_It_Fund_It_chart.pdf. Accessed May 24, 2013.

Appendix 3-B: Key Resources, Tools, and Organizations

Key Resources

- *Good Practices to Encourage Bicycling & Pedestrians on Federal Lands* (2011) by the Paul S. Sarbanes Transit in Parks Technical Assistance Center.

- *Guide to Promoting Bicycling on Federal Lands* (2008) by the Central Federal Lands Highway Division.

- *Non-Motorized User Safety: A Manual for Local Rural Road Owners* (2012) by the FHWA.

Tools

- Bicycle Countermeasure Selection System (BIKESAFE) – A website that helps identify solutions to bicycle safety issues. The website was designed for managers, engineers, and planners who are seeking more information about which countermeasure is appropriate for the issue they're seeking to fix.

- Pedestrian and Bicycle Crash Analysis Tool (PBCAT) – A software program to help track, summarize, and understand pedestrian and cyclist accidents. The program provides many improvements over manual methods of tracking such as spreadsheets or paper logs.

- Pedestrian and Bicycle Geographic Information System (GIS) Safety Analysis Tools – A suite of free plugins for ESRI ArcGIS software to identify safe and dangerous pedestrian and cyclist routes. Most useful when paired with a quality data source such as PBCAT.

- Pedestrian Safety Guide and Countermeasure Selection System (PEDSAFE) – A collection of online tools to help select pedestrian infrastructure and practices that can improve pedestrian safety. PEDSAFE is designed for use by managers, engineers, and planners who have identified potential pedestrian safety issues, and then guides them through the wide variety of countermeasures that would help alleviate that risk.

Organizations

- Advocacy Advance – A resource center for promoting nonmotorized transportation. The Alliance provides training, grants, and online information to help improve cycling and walking.

- Alliance for Biking and Walking – A national coalition of local and state advocacy groups dedicated to promoting nonmotorized transportation.

- America Bikes – A national coalition of local advocacy groups dedicated to promoting cycling-friendly communities. America Bikes performs lobbying and outreach activities and a wealth of online cycling resources.

- American Trails – A non-profit organization that provides planning, construction, design, and funding information and resources for all types of trails and greenways.

- America Walks – A national coalition of local advocacy groups dedicated to promoting walkable communities.

- Association of Pedestrian and Bicycle Professionals (APBP) – A non-profit group that represents the pedestrian and bicycle profession and its influence by facilitating the exchange of professional and technical knowledge, elevating practitioners' skills and defining the field.

- The League of American Bicyclists – One of the nation's oldest cycling advocacy groups, the League promotes cycling through lobbying, education, and events.

- National Recreation Trails – A resource for designated National Recreation Trails with promotion, technical assistance, networking, and access to funding. Supported by American Trails.

- Paul S. Sarbanes Transit in Park Technical Assistance Center (TRIPTAC) – A team of public and private transportation professionals, led by the Western Transportation Institute at Montana State University, that provides resources and technical assistance to federal land management agencies.
- Pedestrian and Bicycle Information Center (PBIC) – A national clearinghouse for information about health and safety, engineering, advocacy, education, enforcement, access, and mobility for pedestrians (including transit users) and bicyclists. PBIC also hosts the PBIC Image Library - a searchable collection of images relating to walking and bicycling.

- Rails-to-Trails Conservancy – An organization dedicated to converting unused railroad right of way into multiuse trails. The organization maintains a website with information helpful to individuals seeking general trail information, but maintains specific expertise in the conversion of little-used rights of way.

- Volpe Center Public Lands Team – A team of transportation professionals at the U.S. Department of Transportation that help federal land management agencies resolve complex transportation challenges as both the program and project levels.

4. Multi-Modal Network Alternatives Analysis

Wichita Mountains Wildlife Refuge
Comprehensive Alternative Transportation Plan

Table of Contents

Table of Figures

Table of Tables

Introduction and Purpose

The purpose of the Multi-Modal Network Alternatives Analysis is to identify a set of distinct nonmotorized investment alternatives for the Wichita Mountains Wildlife Refuge (WMWR) that fulfill the four goals of this Comprehensive Alternative Transportation Plan. This analysis will provide a framework for refuge staff to phase/implement nonmotorized transportation options and enhancements for the public within the context of WMWR's 2013 Comprehensive Conservation Plan (CCP). The alternatives define nonmotorized linkages between on- and off-refuge sites, primarily within the right-of-way of existing roads or along planned off-road routes. The project team developed a set of engineering and programming alternatives in consultation with refuge staff and then evaluated the degree to which each alternative fulfills the study goals.

The analysis considers projected use (new visitation to the refuge versus shifted visitation within the refuge), high-level resource impacts, impacts to parking and transportation, costs to implement and maintain, and connections to a potential future refuge transit system (explored in the Transit Assessment). It assumed the implementation of already funded projects, including the LETRA Trail. This analysis will not take the place of more thorough analyses of localized resource impacts of individual projects needed to fulfill requirements of the National Environmental Policy Act. Projects within the existing operational right-of-way of refuge roads will likely qualify as Categorical Exclusions.

Background

As noted in the Bicycle and Pedestrian Resource Guide, WMWR is one of the most visited and bicycled units in the National Wildlife Refuge System. At the same time, according to a recent U.S. Geological Survey study (outlined in the Transportation Assessment), 96 percent of WMWR visitors used private, motorized transportation on at least one leg of their visit to at least access the refuge. Thirty-four percent of surveyed refuge visitors reported hiking during their visit and four percent reported bicycling. Given the 1.53 million reported visitors to the refuge in 2012 (and accounting for the fact that approximately 50 percent of those visitors represent non-recreation trips), that translates to approximately 260,000 hikers and 30,000 bicyclists on the refuge a year. This visitation and usage will be altered and potentially buttressed by future infrastructure investments both on- and off-refuge.

On-Refuge Investments

WMWR has almost 30 miles of designated off-road trails, including almost eight miles of off-road trail open to bicycles (see Figure 4-3). Refuge hiking trails range in length from less than one-half mile to six miles, providing visitor experiences ranging from the fully accessible interpretive trail at Quanah Parker Lake to the 600-foot wilderness hike up Elk Mountain (see Appendix 4-A). The two most heavily used trails are the Elk Mountain and Charons Garden trail, which are both located in the rugged Charons Garden Wilderness Area. The refuge maintains automated counters at each trail entering the wilderness area to assess visitor impact (see Figure 4-1 and Figure 4-2).

Figure 4-1: Monthly Trail Counts, 2012

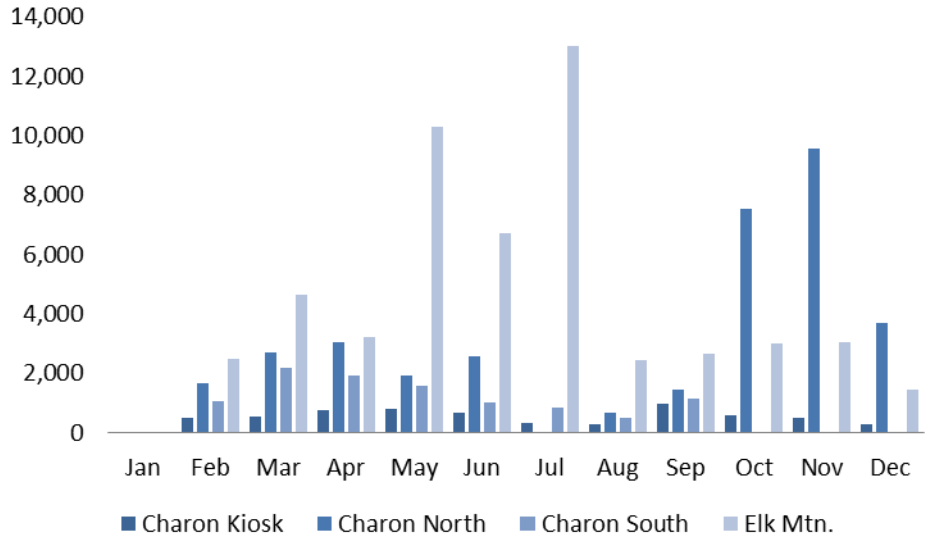
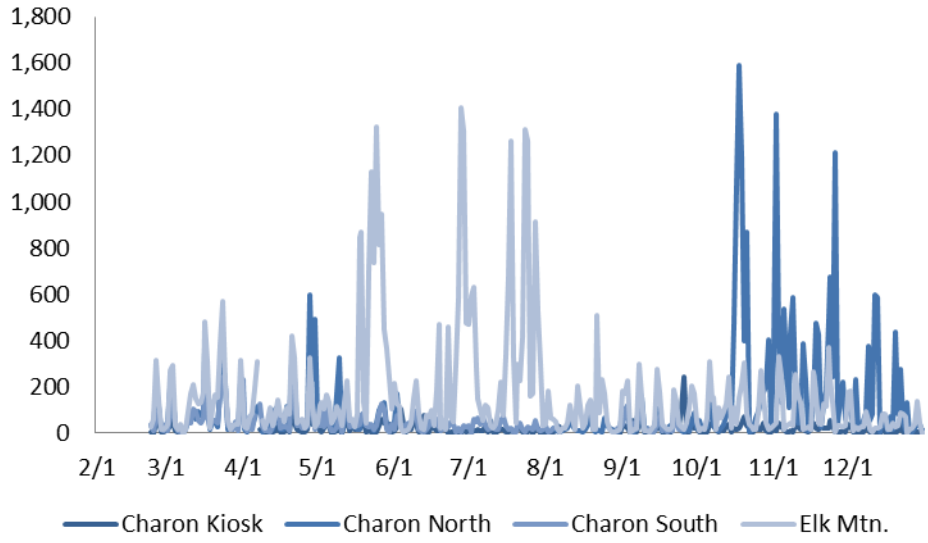


Figure 4-2: Daily Trail Counts, 2012



Bicyclists are permitted to use the 6.1 mile gravel service road behind Mt. Scott and the proposed trail along an abandoned roadway and reservoir dyke to the Army's Lake Elmer Thomas Recreation Area (LETRA). WMWR will fund the LETRA trail, which is planned to connect to the Medicine Park Aquarium and Natural Sciences Center (MPANSC),[36] with a $444,000 grant awarded by the Federal Transit

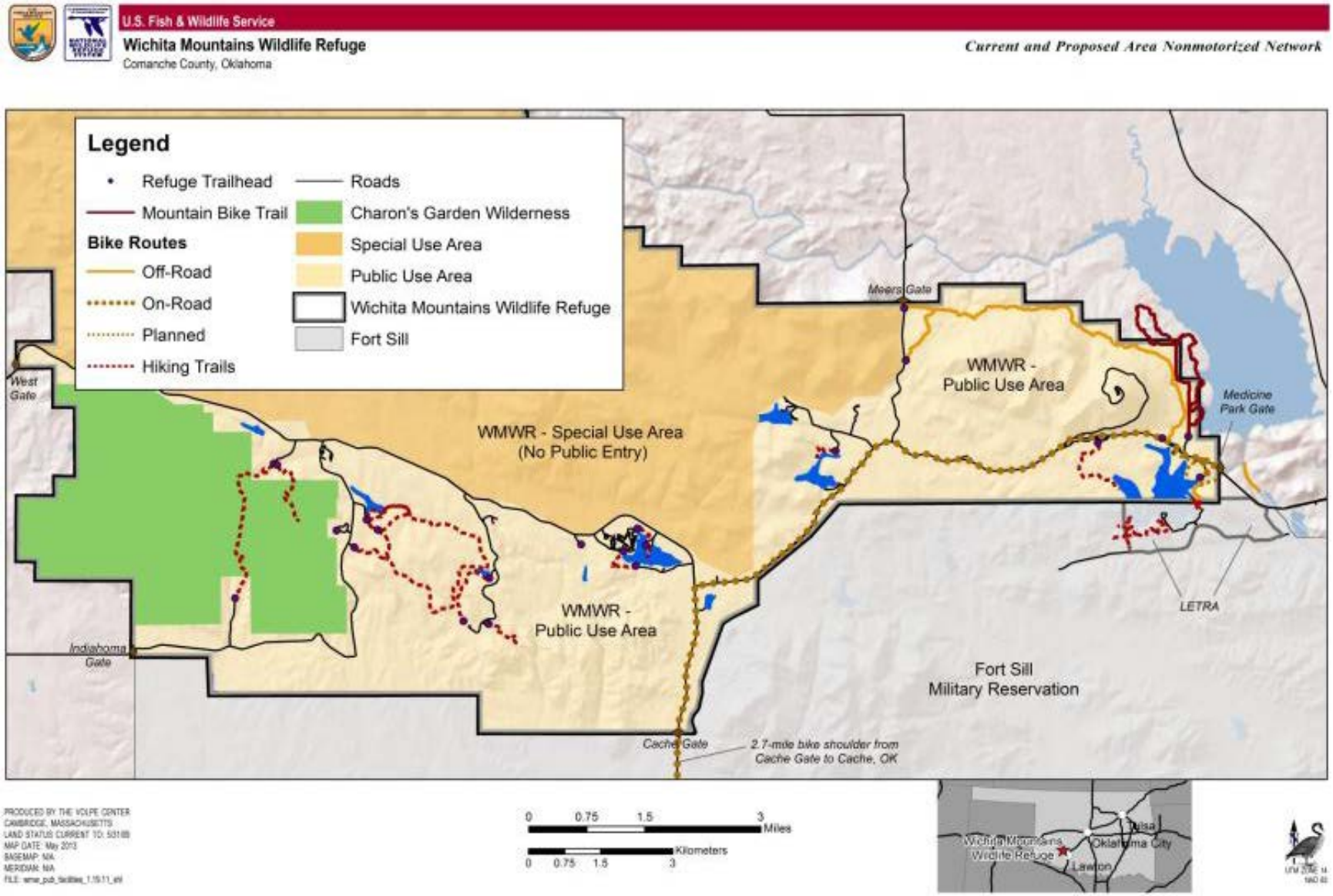
[36] A local nonprofit group continues to advance the development of the MPANSC just outside the Medicine Park gate. MPANSC recently developed a 25 year marketing plan and expects 125-150,000 visitors per year.

Administration. The LETRA trail will be paved for all or a portion of its 1.85-mile length (including two spur trails totaling 0.5 miles and a 0.37 mile segment of roadway open to motor vehicles).

Visitors also hike the Dog Run Hollow Trail System, which encompasses four distinct loops on the western side of the refuge and was designated a National Recreation Trail in 1981. The Narrows trail is located near the Dog Run Hollow Trail System and accesses several popular climbing walls. Two trails offer easy, family-friendly walks of one mile or less: the Little Baldy trail and the trail linking the Environmental Education Center and Doris Campground, which includes a short, accessible section at the Environmental Education Center.

The refuge does not currently designate any on-road bicycle facilities, such as bicycle lanes, buffered bicycle lanes, or signed routes; however, it does allow bicyclists to travel on all paved public roads in the unit. The Central Federal Lands Highway Division recently completed the 9.8-mile long addition of six- to eight- foot shoulders from Cache Gate to Medicine Park Gate along OK-49 and OK-15 through the refuge, which was, in part, constructed to accommodate bicyclists.

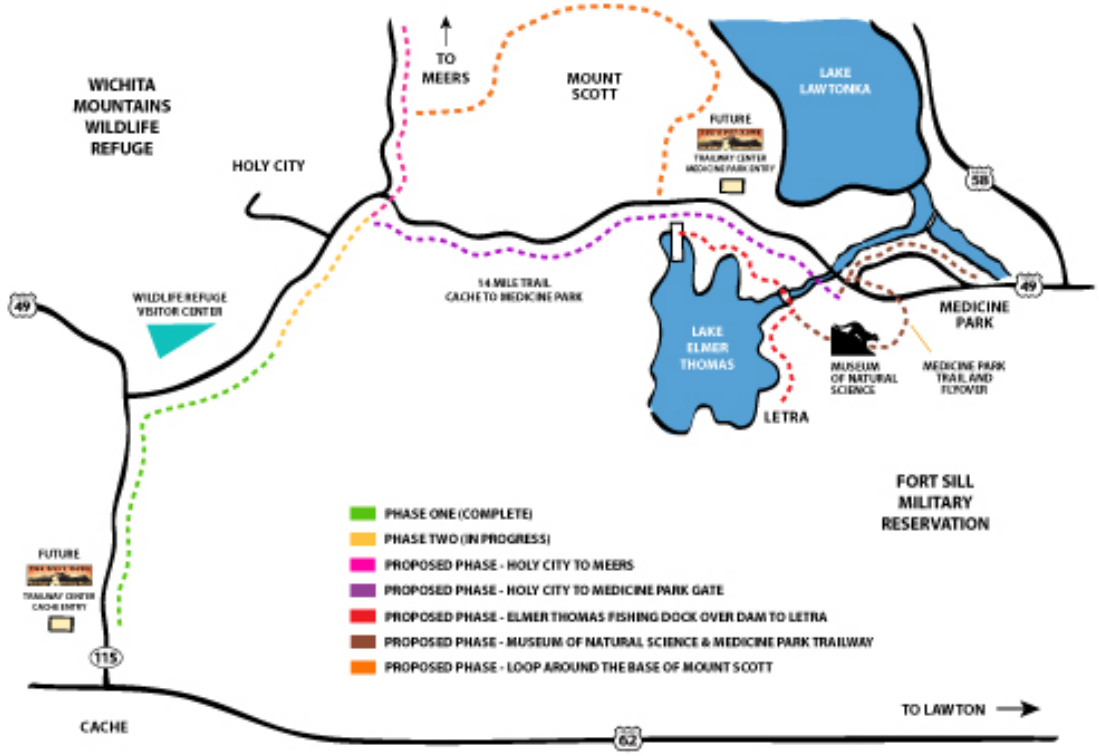
Figure 4-3: Current and Proposed On- and Near Refuge Nonmotorized Network



Off-Refuge Investments

Directly connecting to the on-refuge shoulder project are two off-refuge projects. One is a 2.8-mile long bicycle lane south from Cache Gate to Route 62 along OK-115 recently completed by Comanche County. The other is a road shoulder project recently programmed to potentially receive funding from Oklahoma's Federal Lands Access Program. The project would extend from Medicine Park Gate west along OK-49 to an existing shoulder that begins where the roadway intersects with OK-58. If funded, the 2.5-mile long project would further extend the Duty Rowe Fit Kids Fitness Trailway, a public health and active recreation initiative of the Oklahoma FitKids Coalition, completing a nearly 19-mile long continuous shoulder corridor from Cache, through WMWR, to Medicine Park, and Fort Sill's Apache Gate, all accessible by bicycle (see Figure 4-4).

Figure 4-4: Fit Kids Fitness Trailway

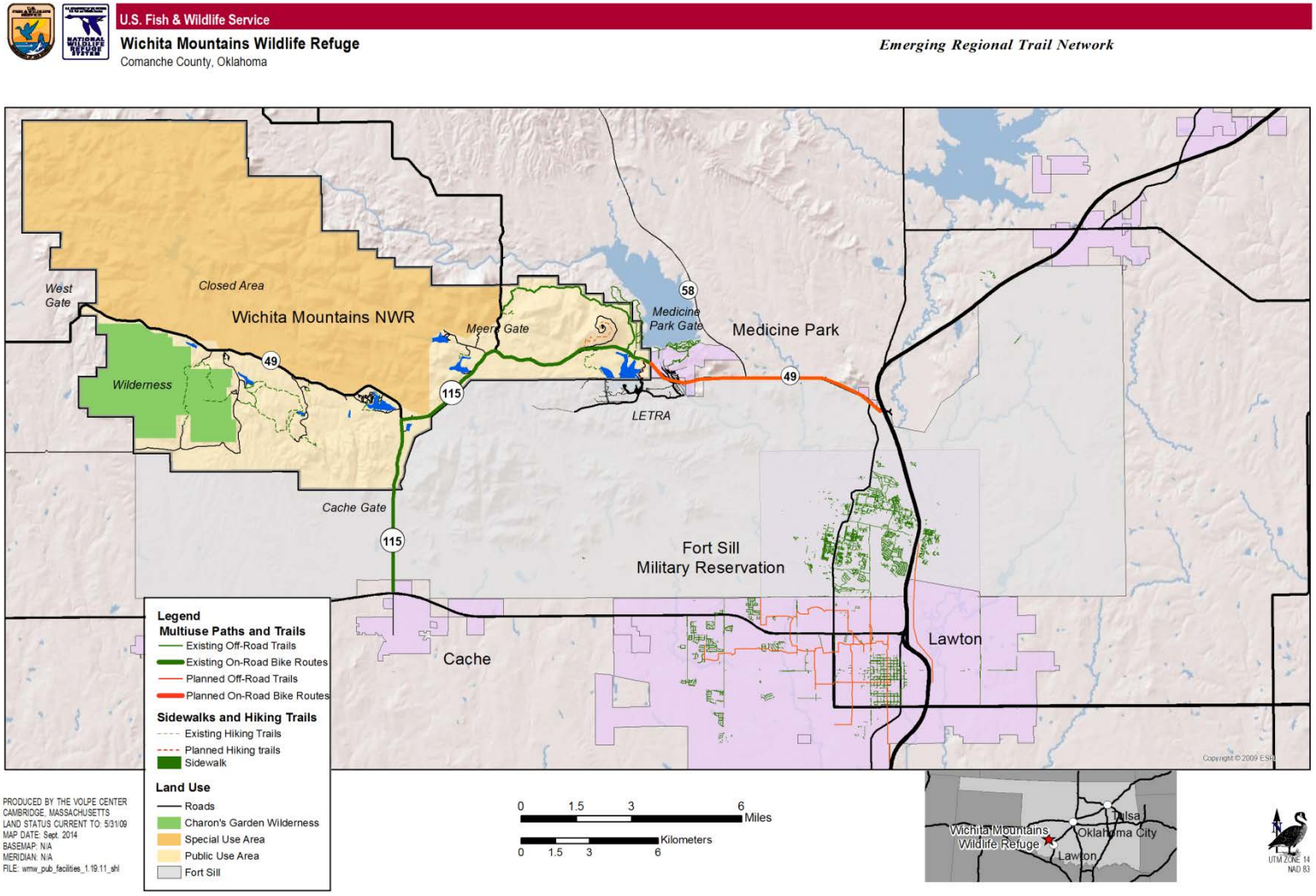


Source: Fit Kids Oklahoma. http://www.fitkidsofswok.org/fitkidsswokIthed.html.

The Lawton Metropolitan Planning Organization (LMPO) and Fort Sill are both in the process of improving pedestrian and bicycle facilities in the region. LMPO adopted the Lawton Metropolitan Pedestrian and Bicycle Plan in 2008 to guide nonmotorized infrastructure development over the next 25 years. The plan envisions 60 miles of on-street facilities and 24 miles of off-street multi-use trails to be constructed by 2030. The plan also envisions several intersection modifications and crosswalk improvements. ODOT awarded Lawton a $400,000 Transportation Enhancements grant to begin developing this bicycle system. Concurrently, Fort Sill recently began efforts to greatly enhance nonmotorized transportation on the base, including several new sidewalks.

Both LMPO and Fort Sill are in the first phases of implementing their plans (see Figure 4-5). These improvements, taken together, have the potential to increase usage of existing and planned on-refuge facilities, particularly among the bicycling public. These off-refuge improvements may also act to increase expectations that the visiting public has about pedestrian and bicycle accommodations when they arrive.

Figure 4-5: Map of Emerging Regional Nonmotorized Network



Alternatives

The study team developed three alternative packages of engineering interventions that could facilitate safe, nonmotorized transportation to and between refuge destinations. Alternatives range from limited interventions such as the addition of "share the road" signage, reconfiguring lane widths and adding road shoulder buffers, to larger projects like sidewalks and multi-use paths at key destinations on the eastern side of the refuge. Each alternative builds upon the previous one, increasing in effectiveness but also cost and, in some cases, potential resource impact from increased use in sensitive areas. The three distinct packages focus on different underlying methods to improve safety and encourage more nonmotorized visits. Each is paired with estimate costs:

- **Alternative A – Low (Estimated cost: $1,120):** Encourages all road users to travel with courtesy and share the road. This alternative focuses on informing roadway users that they should expect bicycles and other non-motorized users on or near refuge roads. In an effort to limit the proliferation of signs on the refuge, which have the potential to spoil the natural vistas, a series of informative signs (day and night speed limits, presence of animals, share the road with bicycles and pedestrians, etc.) would be placed at refuge entrances and key intersections, with a minimal number of signs on refuge roads. Alternative A includes several low-cost, non-infrastructure options such as improved visitor information and signage and coordinated planning across refuge management decisions.

- **Alternative B - Medium (Estimated cost: $189,703):** Demarcates bicycle lanes and creates more shoulder space, both within existing roadway right-of-way and along narrow roadway stretches. Lane narrowing, proposed in some areas, would help reduce traffic speeds, bringing them closer to posted speed limits and enhancing safety for all road users. A new shoulder (width unspecified and price not included) would be developed along narrow refuge roadways primarily for automobile safety, but with benefits to nonmotorized road users as well. These measures would provide added accommodation for pedestrians and inexperienced bicyclists, especially between Medicine Park Gate and Cache Gate. More experienced bicyclists would also benefit from improvements on other refuge roads to the west. These measures would be in addition to signage in Alternative A. Alternative B includes several medium-cost, non-infrastructure options such as a bicycle sharing pilot, installation of bicycle racks, a coordinated wayfinding system, partner/volunteer-led programs, and refuge participation in local bicycle/pedestrian advisory committees

- **Alternative C – High (Estimated: $549,703 – S967,941):** Further separates different modes. This alternative includes modern treatments which greatly improve nonmotorized transportation, but at higher costs. On the east side of the refuge, buffered bicycle lanes (instead of traditional bicycle lanes in Alternative B), which would help keep motorists and bicyclists at a safe distance while encouraging less experienced bicyclists to feel confident about their space on the road. Also, multi-use paths would be built to separate traffic in key corridors consistent with the 2013 WMWR CCP. Along corridors with designated bicycle facilities, drivers would be encouraged to pull over in designated areas to view wildlife. Like in Alternative A and B, signage would benefit bicyclists on the west side of the refuge. The cost of this alternative ranges significantly because the scope of the proposed multi-use trails is undetermined and no preliminary engineering has taken place. Alternative C includes several higher-cost, non-infrastructure options such as a full implementation of the bicycle sharing pilot, refuge-led special events focusing on children and families, partner-led share the road campaigns, and an annual nonmotorized monitoring report.

Engineering Elements

This section describes the site-specific engineering aspects for three alternative packages of multimodal improvements, paired with preliminary cost estimates. Engineering elements include physical permanent infrastructure, both on- and off-road. These options are discussed in a general refuge context in the bicycle and pedestrian resource guide, but specific engineering standards are detailed below based on guidelines from the Federal Lands Highway Project Development and Design Manual (PDDM)[37] and the Manual on Uniform Traffic Control Devices (MUTCD).[38] The recommendations for engineering options are presented with these general standards and proposed modifications when necessary to fit within the context of the refuge.

Table 4-1 details proposed infrastructure changes for each alternative by road segment. The three alternatives and their costs are generally cumulative from the previous alternative. The medium alternative (B) includes many treatments from the low alternative (A), and the high alternative (C) includes both, except for when a treatment is superseded by a more effective one. All alternatives include educational and regulatory signage. Depending on larger roadway investments (e.g., repaving or adding shoulders along Meers Road), some on-road projects can be staged on an opportunistic basis. Lower cost options could be pursued in the near-term.

[37] Project Development and Design Manual, Federal Lands Highway, http://flh.fhwa.dot.gov/resources/manuals/pddm/Chapter_09.pdf#9.3.17, Accessed September 6, 2013.

[38] Manual of Uniform Traffic Control Devices, http://mutcd.fhwa.dot.gov/htm/2009/part9/part9c.htm, Accessed September 6, 2013.

Table 4-1: Engineering Alternatives by Road Segment

	A - Low	B - Medium	C - High
Engineering – Highway 49			
Medicine Park Gate – Mount Scott Picnic Area west	• Share the road entrance sign • Bike route signs	• A, plus narrow travel lanes to 10’	• Narrow travel lanes to 10’ • 2’ buffered bicycle lane or bicycle lane in existing shoulder • Signage and managed vehicle pull-offs
Mount Scott Picnic Area west to Meers T intersection			
Meers T intersection – Visitor Center			
Visitor Center – Cache T	• Share the road signs at Cache T		• Narrow travel lanes to 10’ • 2’ buffered bicycle lane or bicycle lane in existing shoulder • Multi-use path between EE and Visitor Center
Cache T intersection – Environmental Education Center		• A, plus new shoulder for vehicular safety (width unspecified)	• B, plus multi-use path between EE and Visitor Center
Environmental Education Center – Indiahoma Road			• Same as B
Indiahoma Road – Caddo Lake			• B, plus natural surface hiking trail between Sunset and HQ
Caddo Lake to West Gate			• Same as B
Engineering – Highway 115			
Meers T intersection – Parallel Forest	• Share the road entrance sign • bike route signs	• A, plus new shoulder for vehicular safety (width unspecified)	• A, plus separated multi-use path for pedestrian/bicycle OR wide shoulder for bicycle/pedestrian accommodation
Parallel Forest – Meers Gate			
Cache T intersection – Cache Gate		• A, plus narrow travel lane to 10’	• Narrow travel lanes to 10’ • 2’ buffered bicycle lane or bicycle lane in existing shoulder

Engineering – Indiahoma Road			
Highway 49 – Refuge Headquarters	• Share the road entrance sign	• A, plus new shoulder for vehicular safety (width unspecified) • Signage for FWS residences (e.g. children at play, school bus)	• Same as B
Refuge Headquarters – Indiahoma Gate		• A, plus new shoulder for vehicular safety (width unspecified)	
Engineering – Lake Jed Johnson/ Holy City and Mt. Scott Access Roads and Parking Lots			
Highway 115 – Jed Johnson Tower Trail access road and parking area	• None	• New shoulder/widened road to accommodate transit vehicles • Bus turnaround and ADA sidewalk accommodations in the parking area	• Same as B
Jed Johnson Tower Trail access road – Rush Lake		• New shoulder for vehicular safety (width unspecified)	
Highway 49 - Mt. Scott summit access road and parking area	• None	• ADA accommodations within existing footprint of summit parking area	• Same as B

Engineering Standards

This section outlines specific engineering standards relevant to each alternative based on guidelines from the Federal Lands Highway PDDM and the FHWA MUTCD. Interventions explored include:

- Alternative A
  - Signage and bicycle route wayfinding
- Alternative B
  - Narrowed travel lanes
  - Bicycle lanes
- Alternative C
  - Buffered bicycle lanes
  - Sidewalks
  - Multi-use paths

Key Elements Included in Alternative A

Signage and Bicycle Route Wayfinding

For all alternatives, the refuge may install a series of highly visible retroreflective signs for motorists at the entry to the refuge. The information on these signs should include general roadway safety information, such as the day and night speed limits, notification of wildlife on the roadway, and the presence of bicycles and pedestrians on the road.

On the refuge, all alternatives include the addition of share-the-road signs (MUTCD sign W16-1P) that should be placed underneath bicycle signs (MUTCD sign W11-1) after each intersection. These signs could be coupled with speed limit signs to avoid sign clutter. The signs are a reminder for cyclists and motorists to travel with courtesy and serve as a warning for road users to be alert.

Where there are designated bicycle routes, a bicycle route sign (MUTCD sign D11-1,) should be placed after each intersection. These wayfinding signs would demarcate the safest route for cyclists between designated bicycle facilities. Figure 4-6 shows the MUTCD sign types appropriate for the refuge.

Figure 4-6: Sample signs for all alternatives

Key Elements Included in Alternative B

Narrowed Travel Lanes

Traffic calming refers to a variety of techniques used to reduce the design speed of a roadway to prevent chronic speeding, especially in areas with large amounts of pedestrian traffic. Many of the travel lanes on the refuge are twelve feet wide, a width suitable for speeds of 50 to 70 miles per hour, despite

the 45/35 mph day/night speed limits. Most urban traffic calming solutions would be out of place in a rural, recreational setting, but slightly narrowing vehicle lanes may help bring the design speed and actual speeds into closer alignment. The Highway Capacity Manual notes reducing the width of a twelve foot road to eleven feet drops average speeds by two miles per hour, while reducing from twelve feet to ten feet reduces speed by more than six miles per hour.[39]

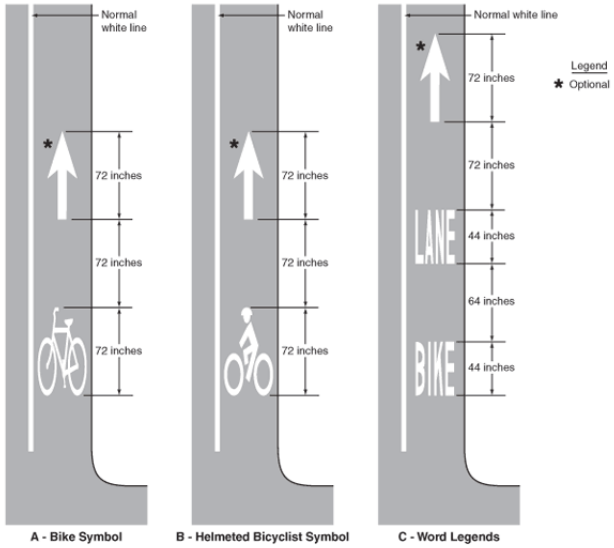
Bicycle Lanes

Chapter nine of the PDDM provides guidance for bicycle lanes on rural roads. As mentioned earlier, the PDDM states that lane and shoulder width combined should be at least 14 feet to safely accommodate a bicycle lane and recommends a desirable paved shoulder width of at least five feet for bicycles when average daily traffic is greater than 1,000 vehicles. On roads with speeds greater than 45 mph, desirable bicycle lanes should be at least six feet wide, but should generally not exceed six feet to discourage motor vehicle travel within the bicycle lane. The PDDM also states that a six-inch solid white line should be placed on the right edge of the motor vehicle travel lane to designate the bicycle lane, along with signs and bicycle lane pavement markings.

Figure 4-7 identifies different bicycle lane marking options that are consistent with the MUTCD. Figure 4-8 shows bicycle lane treatments at intersections with dedicated turn lanes. Marking spacing should be based on engineering judgment.

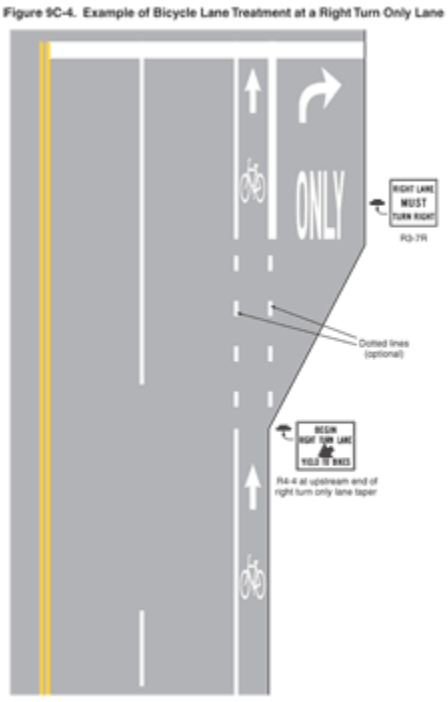
[39] Federal Highway Administration (2007). *Mitigation Strategies for Design Exceptions.* http://safety.fhwa.dot.gov/geometric/pubs/mitigationstrategies/chapter3/3_lanewidth.htm. Accessed May 24, 2013.

Figure 4-7: Bicycle Lane Marking Options



Source: MUTCD, http://mutcd.fhwa.dot.gov/htm/2009/part9/part9c.htm#figure9C03

Figure 4-8: Bicycle Lane at an Intersection



Source: MUTCD, http://mutcd.fhwa.dot.gov/htm/2009/part9/part9c.htm#figure9C03

Average daily vehicle traffic on refuge roads falls below PDDM criteria for a bicycle lane (greater than 1,000 ADT). If implemented, bicycle lanes on Highway 49 and Highway 115 between Medicine Park Gate and Cache Gate should follow PDDM guidelines regarding average vehicle operating speeds. While the speed limit on refuge roads is 45 mph or less, the operating speed of vehicles often exceeds the speed limit. Thus, bicycle lanes on the shoulder should be at least six feet wide unless the average vehicle operating speed can be reduced to below 45 mph.

The entire 9.8-mile long route between Medicine Park Gate and Cache Gate along Highway 49 and Highway 115 has a combined travel lane and shoulder width of 18 feet, which is sufficient for the addition of a bicycle lane in each direction. However, under current refuge policy, these shoulders are intended to accommodate dispersed and highly variable vehicle pullouts for wildlife viewing. Even with narrowed travel lanes, the shoulders are not wide enough to accommodate the suggested 11-foot width necessary for a parking area on roadways without curbs.[40] Therefore, without explicit vehicle pullouts, increased signage, and accompanying law enforcement activities, designated bicycle facilities along this route could add an element of ambiguity to the detriment of safety. The study team does not recommend the implementation of bicycle lanes without a concurrent effort to limit non-emergency automobile pull-offs.

Other refuge roads lack shoulders and have travel lanes which generally do not exceed a width of 10 feet. As such, these roads are insufficient for the inclusion of a bicycle lane without widening the roadway.

Key Elements Included in Alternative C

Buffered Bicycle Lanes

Wherever bicycle lanes are feasible (i.e., between Medicine Park Gate and Cache Gate), existing shoulders are wide enough to accommodate buffered bike lanes. A buffered bike lane places an additional distance of two feet between the vehicle and the bike lane. In the medium alternative, this additional distance would be marked with painted hash marks (rather than with physical barriers, as would often be used in urban contexts) (see Figure 4-9).

[40] Pedestrian and Bicycle Information Center. "Bike Lanes". http://www.bicyclinginfo.org/engineering/facilities-bikelanes.cfm.

Figure 4-9: Buffered Bicycle Lane

Source: Maus, Jonathan. Michigan DOT gives bikes 12-feet of space on state highway. http://bikeportland.org/2012/12/07/michigan-dot-gives-bikes-12-feet-of-space-on-state-highway-81013. Accessed June 4, 2013.

This marking underscores the separation of a bicycle lane while still allowing vehicles to pull over in emergencies. Shoulders on WMWR are intended to accommodate dispersed and highly variable vehicle pullouts for wildlife viewing As with traditional bicycle lanes, to avoid safety conflicts with parked motor vehicles, the study team does not recommend implementing buffered bicycle lanes without explicit vehicle pullouts, increased signage, and accompanying law enforcement activities

This option may be especially attractive on the eastern side of the refuge where the refuge would like to focus visitation and adjacent to planned multi-use trails likely to attract pedestrians and less experienced bicyclists.

Sidewalks

The American Association of State Highway and Transportation Official's (AASHTO) *Guide for the Planning, Design, and Operation of Pedestrian Facilities* recommends a width of at least five feet with an additional buffer space of two to four feet between the edge of the road and the edge of the sidewalk.[41] U.S. Access Board guidelines for outdoor developed areas should be adhered to for any major alteration.[42] A variety of surfaces are available and detailed in the Bicycle and Pedestrian Resource Guide. Low cost and low impact natural surfaces are appropriate if use is expected to be low.

Multi-use Trails

Multi-use trails provide the best separation between motorists and more vulnerable users. This separation is a particular draw for pedestrians and "Interested but Concerned" bicyclists who will not consider traveling on any facility not separated from automobile traffic. Visits to the refuge on a multiuse trails have a low environmental impact, especially when traveling from off-site, and provide a unique way for visitors to safely enjoy the sights of the refuge at a human pace.

---

[41] American Association of State Highway and Transportation Officials (AASHTO) (2012). *Guide for the Development of Bicycle facilities.*

[42] U.S. Access Board (2012). Guidelines for Outdoor Developed Areas. http://www.access-board.gov/guidelines-and-standards/recreation-facilities/outdoor-developed-areas. Accessed September 24, 2014.

Wider trails reduce conflicts between different user groups and accommodate segments of the population that are mobility impaired. These paths should be separated from roadways by a "significant terrain feature" such as a drainage ditch plus five feet of space. Where this is not possible, a much larger separation of space or crash barriers such as guardrails are an option.

Chapter 9 of the PDDM calls for eight-foot wide multi-use trail when targeting bicyclists as the main user group; paths expected to have large numbers of pedestrians and bicyclists should be 10 feet wide at a minimum with 12 feet as a target. Narrower, natural surface hiking trails are more appropriate in sensitive areas or when bicyclists are not an intended user group. For recreational trails, U.S. Access Board guidelines for outdoor developed areas should be considered and adhered to when feasible when determining trail width, surface type, and slope on Federal Lands. For transportation trails, the U.S. Access Board is currently developing stricter trail guidelines that will apply to multi-use paths.[43]

Encouragement, Education, Enforcement, and Evaluation/Planning/Implementation Activities

Each program alternative offers a range of initiatives to facilitate safe nonmotorized transportation to and between refuge sites. Like in the engineering interventions, three alternatives are proposed that could improve multimodal transportation on the refuge. These range from limited communication, enforcement, and planning activities, more involved bicycle sharing pilots and programs, volunteer trail ambassador programs, staff or volunteer led bicycle tours, and participation in local safety campaigns. Each alternative builds upon the previous one, increasing in potential impact but also in cost (see Table 4-2).

[43] U.S. Access Board. Rulemaking on Shared Use Paths. http://www.access-board.gov/guidelines-and-standards/streets-sidewalks/shared-use-paths/background. Accessed September 24, 2014.

Table 4-2: Encouragement, Education, Enforcement, and Evaluation/Planning/Implementation Alternatives

	A - Low	B - Medium	C - High
Encouragement	• Bicycle and Pedestrian Network Map • Trailhead maps and information displays • Continued accommodation of races	• A, plus Bicycle Sharing Pilot and bicycle racks at major destinations • Staff or volunteer led bicycle interpretive tours on multi-use trails with bicycle safety element • Trailhead maps and extensive, coordinated wayfinding on- and off-refuge	• B, but with full implementation of Bicycle Sharing System and bicycle racks • Refuge-led special event or coordinated annual partner-led event focusing on children and families
Education	• Key messaging for motorists, bicyclists, and pedestrians on Bicycle and Pedestrian Network Map	• A, plus assist and encourage partner-led bicycle/pedestrian safety programs in local public schools	• B, plus work with local partners on a 'share the road' campaign and disseminate materials on-refuge
Enforcement	• Existing enforcement program	• Moderately expanded enforcement program (See RSA) • Volunteer trail ambassador program	• Robust and continual enforcement program (See RSA) • Volunteer Trail Ambassador Program
Evaluation, Planning, and Implementation	• Staff grant schedule and delegation • Integrate bicycle and pedestrian considerations into other refuge planning documents	• A, plus staff participation in monthly Lawton Bicycle/Pedestrian Advisory Committee	• B, plus annual monitoring report

The Bicycle and Pedestrian Resource Guide provides information and case studies on each of the above activities. For discrete investments, like bicycle racks, bicycle sharing bicycles, trailhead maps, and wayfinding, anticipated costs are provided below as are recommendations for implementation. For the refuge area bicycle and pedestrian network map with key messaging for road users, the study team suggests WMWR use existing resources at its disposal. The staff funding/grant schedule is provided in Appendix 4-B of this report. For other activities, potential costs are highly variable and depend on a) how substantial the effort is in terms of refuge staff time, b) the scale of the initiative, and c) the degree of partner participation. For these activities, the study team believes the Bicycle and Pedestrian Resource Guide provides a good foundation for refuge staff to develop program activities with partners. Suggested partner groups for each effort are listed at the end of this section.

Bicycle Sharing

Based on information presented in the Bicycle and Pedestrian Resource Guide, if bicycle sharing is a management priority, the study team recommends that the refuge pursue a smart lock-based bicycle sharing system along with a partner group. Given the refuge's rural, recreational setting, smart lock-based systems have several advantages over kiosk-based systems common in more urban settings. These advantages include:

- Racks usable for all bicycle types, not just specialized bicycle sharing bicycles
- Lower capital and operating costs
- Fewer station placement constraints and less potential for visual impact
- Greater flexibility to choose terrain-appropriate bicycles, including mountain bikes
- Technology more conducive to a rent-and-return versus point-to-point business model

Given distances between sites and the likelihood of users needing to return to their point of origin, a rent-and-return model is suggested over the standard point-to-point bicycle share model. As such, the system's pricing structure (if fees are charged), should favor longer trips (two hours or more) compared to traditional bicycle sharing pricing structures (favoring 30-60 minute trips).

Bicycles, Racks, and Kiosks

In partnership with Fort Sill, MPANSC, and the town of Medicine Park, under the Medium (B) Alternative, the study team suggests the refuge purchase approximately 40 bicycles and install bicycle racks in seven locations using the inverted "U", "A", or post-and-loop rack types. Under the High (C) Alternative, the study team suggests 60 bicycles. Racks (each holding two bicycles) may be purchased individually and sited on a cement pad or purchased in groups and placed on level ground/hard surfaces. The former requires more installation costs and has greater potential resource impact. Therefore, where possible, the study team recommends racks be purchased in groups and placed on parking lots, roadways, or level ground with a gravel surface. More racks (each individual rack holds two bicycles) should be sited at locations with higher potential use. Based on likelihood of use, the study team recommends installation at the following sites (the number of recommended racks for each site is listed for the Alternative B):

- Jed Johnson Tower trailhead – 4 racks
- MPANSC – 8 racks
- Downtown Medicine Park – 20 racks across two sites
- LETRA – 14 racks
- LETRA trail spur – 4 racks
- Lake Elmer Thomas Pier (LETRA Trail trailhead) – 12 racks
- WMWR Visitor Center – 8 racks

Under the High Alternative (C), the study team recommends the purchase of an additional 30 racks with a proportional distribution in line with the above recommendations.

Smart lock-based bicycles cost approximately $1,100 each. Racks cost between $150 and $300 each (parks two bicycles). The refuge and its partners should aim to have each the total number of rack spaces where users are expected to originate from at least 50 percent full. This proportion helps avoid

oversubscribing racks with temporarily parked bicycles originating from other stations while also accommodating non-system bicycles.

Depending on equipment vendor chosen and technology purchased, users can check out a smart lock-based bicycle using either their cellular phone where available or a standalone kiosk (if available). Kiosks cost approximately $20,000 each. While standalone kiosks are not necessary, they do provide greater visibility for the system and an alternative to using a cellular phone if the user either does not have one or cannot get reception.

Operating Models

Bicycle purchases are not eligible under current Federal grant programs. WMWR and its partners could cover these expenses either under refuge's operating budget, revenues from user fees, and/or from a private/non-profit sources. The refuge is currently restricted by agency policy from operating and maintaining the system on its own due to liability concerns. The refuge could bid out operations under a concession contract or rely on a partner to manage the system under a cooperative agreement.

Even with user fees, the system is unlikely to be financially self-sustaining. Therefore, if the refuge were to engage a private concessionaire and the refuge and/or its partners would have to supplement operations regularly. The bicycle sharing system in Tulsa, Oklahoma, presents a good operating model that could be replicated in and around the refuge with minimal financial investment. The Tulsa Townies program, a 75 bicycle system, was purchased using philanthropic support from the public health community and is operated by the Saint Francis Health System. The service is available to users free of charge for up to 24 hours at a time.

Trailhead Maps and Wayfinding

With completion of the LETRA trail and concurrent with other investments and programming activities, there is likely to be a substantial increase in pedestrian, hiking, and bicycling activity on the eastern side of the refuge. This increased activity will necessitate new trailhead maps and wayfinding signage to clarify connections between facilities and further encourage nonmotorized travel. Under the Medium (B) and High (C) alternatives, the study team assumes the installation of eight maps at key trailheads and 20 wayfinding signs, including upgraded signage at select trailheads on the western side of the refuge. These efforts will ultimately have to be coordinated with WMWR's sign plan, which will be developed in 2015.

Potential partners

Table 4-3 provides a list of potential regional and local partners for each of the programming activities detailed above. The 2010 WMWR Alternative Transportation Study describes each partner group and provides a preliminary overview of opportunities for collaboration.

Table 4-3: Potential Area Partners for Encouragement, Education, Enforcement, and Evaluation/ Planning/ Implementation Activities

Activity	Potential Partner(s)
Annual monitoring report	Lawton Bicycle/Pedestrian Advisory Committee
Bicycle and Pedestrian Network Map with Key Messaging	Oklahoma FitKids
Bicycle Sharing	Oklahoma FitKids; Fort Sill's Family Morale, Welfare, and Recreation Program; private concessionaire
Bicycle Interpretive Tours on Multi-Use Trails	Refuge volunteers; Friends of the Wichitas
Events (Existing or Future)	Fort Sill (annual races); town of Meers (Tour De Meers); Friends of the Trail (Tour of the Wichitas)
Safety Programs in Local Schools	Local school districts
Share the Road Campaign	Oklahoma FitKids; Oklahoma Department of Transportation
Trail Ambassador Program	Refuge volunteers; Friends of the Wichitas
Trailhead Maps and Informational Displays	Oklahoma FitKids; Oklahoma Department of Transportation

Visitation and Mode Shift Estimates

There is very little research on or guidance about the degree to which nonmotorized travel decisions are impacted by specific infrastructure investments or programming activities, especially in a rural, public lands setting. While the overall impact is to increase nonmotorized travel and concurrently improve real and perceived safety, it is difficult to robustly compare the cost-effectiveness of any particular measure against any other measure. This difficulty holds true at the project level (e.g., completion of a multi-use trail) and the network level (in light of the overlapping impact of several projects).

All travel is derived from the need to get places. For WMWR, travel decisions are determined by where people live/are traveling from (origin), where they desire to go on the refuge (destination), and what options they have to get from their origin to destination and back again (mode choice). In a recreational context, once people arrive at their destination, they travel (drive, bicycle, walk, or take transit) to experience the site. Without substantial research to draw from, the study team approached travel projections for potential WMWR nonmotorized investments based on data and assumptions about specific origins and destinations (parking data, parking limitations and management, visitation projections). While these estimates do not precisely predict the future, they are useful in helping frame investment decisions in light of WMWR goals.

Visitation

Table 4-4 presents visitation increase and mode shift estimates and assumptions for travel to the refuge. Given new recreation amenities (especially the proposed Mt. Scott Summit Trail), the study team felt it was reasonable to anticipate a two to five percent increase in visitation (across all modes) over baseline projections by the year 2027. Given new nonmotorized infrastructure accessing the refuge (especially the LETRA trail), the study team anticipated a 0 to 0.05 percent increase in visitors arriving by foot and a one to two percent increase in the share of visitors arriving by bicycle. These ranges reflect potential refuge mode shifts given each alternative described above. Each assumes the completion of key recreational facilities, particularly the Mount Scott Summit Trail and LETRA trails.

Table 4-4: Projected Visitation Increases and Mode Shift from Nonmotorized/Recreational Investments at WMWR (Travel to the Refuge)

	2012	2027 (status quo)	2027 (with infrastructure and program investment)	Assumptions
People Entering the Refuge	1,533,915	1,832,598	1,848,725-1,872,91	2% - 5% visitation growth due to new recreational amenities
Total Visitors[44]	674,923	806,343	822,470-846,660	
Bicyclists[45]	8,774	10,482	18,917-27,940	1% - 2% mode shift to bicycles
Pedestrians	0	0	0-4,233	0% - 0.05% mode shift to walking

Based on data collected during the Transportation Assessment, the study team estimates that approximately 70 percent of WMWR site visits occur on the eastern part of the refuge, with approximately 50 percent of all site visits occurring just at Mt. Scott summit and the Visitor Center. The remaining 30 percent of site visits occur on the sensitive western side of the refuge (see Table 4-5).

[44] Based on the CATP traffic analysis and seasonal variation in visits, the study team estimates that 44% of people entering refuge gates are en route to refuge destinations. The study team used a 1.3% bicycle mode share based on 2004 estimate).

[45] Central Federal Lands highway Division (2008) reported a 1.3 percent bicycle mode share at WMWR in *Guide to Promoting Bicycling on Federal Lands*. http://katana.hsrc.unc.edu/cms/downloads/01_promoting_bicycling_entire_document.pdf. Accessed May 24, 2013.

Table 4-5: Modeled Site-Level Visitation, 2012

	Annual Visitors	Peak Season Visitors (March-June)	Visitors on 90% Day	% of All Site Visits
West				
Lost Lake	78,134	12,981	324	12%
Sunset Picnic	105,492	17,526	438	16%
Treasure Lake	10,129	1,683	42	2%
West Total:	**193,755**	**32,189**	**804**	**30%**
East				
Holy City	25,422	4,622	116	4%
Jed Johnson	5,084	845	21	1%
Lake Elmer Thomas	19,490	2,413	60	3%
Lawtonka Mountain Bike Trailhead	2,966	493	12	0%
Mt. Scott Summit	223,955	37,206	930	35%
Parallel Forest	4,661	774	19	1%
Prairie Dog Town	14,101	2,343	59	2%
Visitor Center	158,856	26,391	660	25%
East Total:	**454,534**	**75,087**	**1,876**	70%

Mode Shift

In consultation with WMWR staff, the study team sought to estimate the potential shifting of site visits within the refuge due to increased recreational opportunities on the east side of the refuge based on current and future activity types, regardless of increasing visitation. Assumptions are as follows:

- **High adventure**: 30-40% of Charons Garden Wilderness hikers shift to Mt. Scott summit
- **Casual hikers/walkers**: 20-30% shift of Dog Run Hollow Trail System hikers (accessing the trail from Lost Lake) shift to LETRA Trail, Jed Johnson Tower Trail, and Mt. Scott Nature Trail

Given these assumptions, the study team estimates that site visits to the western side of WMWR will decline in absolute terms (nearly 300 people on a peak day) and as a percentage of all refuge site visits (from 30% to 21%) (see Table 4-6).

Table 4-6: Projected Visitation Location Shifts from Nonmotorized/Recreational Investments at WMWR (Within the Refuge). 2027

	Visitors on 90% Day (2027) (Status Quo)	Visitors on 90% Day with Changes	Change	New Percentage of All Site Visits
West				
Lost Lake	373	279	-94	9%
Sunset Picnic	504	326	-178	11%
Treasure Lake	48	31	-17	1%
West Total:	**925**	**636**	**-289**	**21%**
East				0%
Holy City	133	133	-	4%
Jed Johnson	24	71	47	2%
Lake Elmer Thomas	69	116	47	4%
Lawtonka Mountain Bike Trailhead	14	14	-	0%
Mt. Scott	1,069	1,264	195	41%
Parallel Forest	22	22	-	1%
Prairie Dog Town	67	67	-	2%
Visitor Center	758	758	-	25%
East Total:	**2,158**	**2,447**	**(289)**	**79%**

Costs

Table 4-7 provides preliminary capital cost estimates for infrastructure investments and discrete encouragement, including bicycle racks, bicycle sharing bicycles, trailhead maps, and wayfinding signage. These estimates do not consider the infrastructure costs of roadway shoulder expansion or improvements at Mount Scott Summit and Jed Johnson Tower, as bicycle and pedestrian travel represents a minor impetus for these projects.

Table 4-7: Preliminary Capital Cost Estimates for Muti-Modal Network Alternatives

		Alternative A (Low)		Alternative B (Medium)		Alternative C (High)	
	Unit Cost	**Quantity**	**Cost**	**Quantity**	**Cost**	**Quantity**	**Cost**
Bike lane markings	$230	0	$0	28	$6,450	28	$6,450
Share the road signs	$160	7	$1,120	7	$1,120	7	$1,120
Lane marking striping (linear feet)	$0.20	0	$0	103,166	$20,633		$0
Buffer striping (linear feet)	$1.20	0	$0	0	$0	103,166	$247,598
Striping and Signage Subtotal			**$1,120**		**$28,203**		**$255,168**
Multi-use trails (linear feet)	$10-$95	0	$0	0	$0	4908	$46,500-$465,000
Multi-Use Trails Subtotal			**$0**		**$0**		**$46,500-$465,000**
Bicycle racks	$150	0	$0	70	$10,500	100	$15,000
Bicycle sharing bicycles	$1,100	0	$0	40	$44,000	60	$66,000
Bicycle sharing kiosks	$20,000	0	$0	4	$80,000	7	$140,000
Bicycling Encouragement Subtotal			**$0**		**$134,500**		**$221,000**
Trailhead maps	$1,500	0	$0	8	$12,000	8	$12,000
Wayfinding signage	$750	0	$0	20	$15,000	20	$15,000
Information and Wayfinding Subtotal			**$0**		**$27,000**		**$27,000**
		Total	**$1,120**		**$189,703**		**$549,645-967,901**

Source: See Table 3-3 for references.

Conclusions and Recommendations

In evaluating the multi-modal network alternatives above, the study team sought to answer how well each achieve the goals the four WMWR CATP goals. This evaluation (see Table 4-8) is based on the following questions:

1. *Habitat and Environmental Quality*: How well does each option improve environmental quality by a) encouraging visitor shift to less ecologically sensitive locations on the eastern side of WMWR and b) reducing reliance on private vehicles? All alternatives are consistent with the 2013 WMWR CCP. Options more likely to increase nonmotorized mode share, especially on the eastern side of the refuge score higher.

2. *Visitor Experience*: Does the network provide access to the destinations visitors want to visit? Options that educate the public through a wildlife-focused experience and increase the quality of life for visitors score higher.

3. *Public Use Facilities*: How well does this option administer safe, well-maintained, and energy-efficient facilities that allow the public and staff to enjoy and support the purpose of the refuge and the mission of the NWRS?

4. *Access*: How well does each option increase access to WMWR for all users, including underserved groups and the mobility impaired? Options that improve access for visitors from Lawton, Fort Sill, and/or the Comanche Complex, especially in conjunction with transit, score well in this category.

Table 4-8: Multi-modal Network Alternatives Evaluation

Transit Alternative	Goal 1: Habitat and Environmental Quality	Goal 2: Visitor Experience	Goal 3: Public Use Facilities	Goal 4: Access
Alternative A (Low)	*	*	*	**
Alternative B (Medium)	**	***	***	**
Alternative C (High)	****	****	**	***

According to the evaluation in Table 4-8, the alternative that best achieves the goals of the CATP is Alternative C. This alternative, with its designated bicycle facilities on the eastern side of the refuge, has the highest potential to shift “Interested but Concerned’ bicyclists out of their automobiles and onto the refuge. If built in conjunction with the LETRA trail, this facility has the potential to increase the number of visitors traveling to and between sites on the eastern side of the refuge by nonmotorized transportation. At the same time, Alternative C is the most expensive alternative. Even without the construction of the multi-use trail between the Visitor Center and the Environmental Education Center (which has limited potential for high usage by the general public), Alternative C is nearly three times more expensive than Alternative B. It also entails considerable challenges given WMWR’s current commitment to use the existing highway shoulder for temporary vehicle pulloffs and wildlife viewing.

Further designating this facility for nonmotorized users, without concurrent enforcement efforts and signage geared for motorists, could increase ambiguity and degrade safety.

Alternative B represents an appealing middle ground given feasibility challenges of Alternative C and the relatively minor investments (signage) envisioned under Alternative A. Furthermore, Alternative A could be implemented in the near term and the signage could be kept if Alternative B is implemented.

Appendix 4-A - Existing On- and Off-Refuge Multi-Modal Network

Table 4-9: Existing On-Refuge Trails

Trail Number	Trail Name	Mileage	Surface Type	Trail Type	Major Sites	Current Condition by Segment	Public Use Area	Notes
T103	Bison	5.84	Native	Hiking	French Lake	Good/ Ex/Ex	Medium	Loop Trail
T202	Burford Lake	0.43	Native	Hiking	Burford Lake	Poor/Ex	Medium	
T400	Cedar Planting	0.48	Native	Hiking	Parallel Forest	Ex/Ex	High	
T105	Charon's Garden	4.76	Native	Hiking	Charon's Garden Wilderness	1 Very Poor segment, 11 Excellent.	Low	.05 mile Section 2 is Very Poor
T200	Elk	0.32	Gravel	Hiking	Sunset Picnic Area	Excellent	Low	
T106	Elk Mountain	1.18	Native	Hiking	Sunset Picnic Area	Excellent	Low	
T201	Fawn Creek	0.85	Native	Hiking	Fawn Creek	Excellent	Low	
T301	Jed Johnson Tower	0.51	Native	Hiking	Jed Johnson Tower, Lk. Jed Johnson	Good	High	
T107	Kite	1.15	Native	Hiking	Lost Lake	Good/Ex	Medium	
T402	Lake Elmer Thomas Recreation Area (LETRA)	1.54	Asphalt, Concrete, Gravel, Native	Multi-Use	LETRA	Excellent	High	
T100	Little Baldy	1.13	Concrete, Native	Hiking	Doris Park Campground, Quannah Parker Lk.	Fair/Ex	Medium	
T104	Longhorn	0.51	Native	Hiking	Bison Trail	Excellent	Medium	
T101	Osage Lake	0.81	Native	Hiking	Osage Lake	Excellent	Medium	
T401	Mt. Scott	6.10	Gravel Admin Road	Multi-Use	LETRA to Parallel Forest	Not evaluated - Admin	High	
T403	Mt. Scott Picnic	1.41	Native	Hiking	LETRA, Mt. Scott Picnic	Excellent	High	
T102	Narrows	0.81	Native	Hiking	Boulder	Good/Excellent	Medium	
T300	Quanah Parker EE	0.43	Boardwalk, Gravel, Native	Hiking	Environmental Education Ctr.	Excellent	Medium	
T500	Quanah	0.21	Concrete	Nature	Environment	Ex.	Medium	Partially

	Parker Interpretive Trail			Trail	al Education Ctr.			Accessible

Source: FHWA CFLHD (2012). The Trail Inventory of Wichita Mountains NWR.

Table 4-10: Proposed On-Refuge Trails/Bikeway Improvement Projects

Project	Estimated Mileage	Proposed Surface Type	Trail Type	Major Sites	Public Use Area
Mt. Scott Summit Trail	2	Natural	Hiking	Mt. Scott Picnic Area to Mt. Scott summit	High
Visitor Center Interpretive Loop	0.15	Natural	Nature Trail	Visitor Center	High
Visitor Center to EE	0.9	Unspecified	Hiking/Interpretive	Visitor Center to Environmental Education Center	High/Medium
EE to Camp Doris	.75	Unspecified	Hiking/Interpretive	Environmental Education Center to Camp Doris	High/Medium
Meers	Undetermined	Unspecified	Undetermined – WMW exploring shoulder and multi-use trail alternatives	Holy City, Mt. Scott Trail, community of Meers	High
Jed Johnson Tower Reroute and Reconstruction	0.5+	Natural	Accessible hiking	Jed Johnson Tower, Lake Jed Johnson	High
LETRA Reconstruction	1.6	Asphalt or gravel	Mult-Use	LETRA	High

Source: Wichita Mountains Wildlife Refuge Comprehensive Conservation Plan and Environmental Assessment (2013)

Table 4-11: Existing and Proposed Off-Refuge Trails, Trail Renovations, and Bikeways

Trail Name	Estimated Mileage	Surface Type	Trail Type	Major Sites	Notes
Connection to Medicine Park Aquarium and Science Center	0.25	Asphalt or gravel	Multi-use	MPASC	Funding not identified for non-WMWR portion
Medicine Park Trail	0.27	Cement	Multi-use	Medicine Park	Proposals to extend trail to MPASC
Lawtonka/Medicine Park Mountain Biking Trails	~4	Natural surface	Mountain bike	Connects Mt. Scott Trail	Primarily a recreational loop
FitKids Trailway	14	Asphalt	Road shoulder	Medicine Park, WMWR, Cache	Partially complete; no formal bicycle designation (signage or striping) complete or planned

Appendix 4-B – Staff grant/funding schedule

The study team developed Table B-1 as a starting point for an ongoing document that WMWR staff can use to strategically plan and fund multi-modal projects. For reference, Table A-1 in the Bicycle and Pedestrian Resource Guide lists funding program names, match requirements, key program contact information/websites, funding cycles, and feasibility considerations. Table A-2 in the resource guide lists eligible activities under each program

Table B-1: Staff Grant/Funding Schedule and Suggested Projects

Month	Programs With Deadlines*	Suggested Eligible Projects to Submit**	Notes
January	Transportation Alternatives Program (TAP) – Includes Recreational Trails Program (RTP) and Safe Routes to School (SRTS)	• TAP: Bicycle Sharing Pilot, Visitor Center to Environmental Education Center Multi-use Trail, wayfinding and signage • RTP: Mt. Scott Summit Trail, Jed Johnson Tower Trail	
February	Highway Safety Improvement Program (HSIP)	• Lane narrowing and designated on-road bicycle facilities	
March			
April			
May			
June			
July	State and Community Traffic Safety Program (Section 402)	• Safety campaigns • Trail Ambassador Program	Local partner must be the applicant
August			
September			
October	TAP (pre-application due)		
November			
December			
Rolling Deadlines	• Federal Lands Transportation Program (FLTP) • Federal Lands Access Program (FLAP)	• Lane narrowing and designated on-road bicycle facilities • NEPA compliance to prepare projects for subsequent • Bicycle Sharing Pilot	FLAP projects may be on or off refuge land, but must ultimately be owned and operated by a local partner.

* Deadlines are subject to change.

**This indicates potential eligibility under these programs; however, there are specific requirements that must be met under each program and eligibility will be determined on a case-by-case basis. For state administered programs, Oklahoma agencies may prioritize certain eligibility categories over others.

5. Transit Assessment

Wichita Mountains Wildlife Refuge
Comprehensive Alternative Transportation Plan

Table of Contents

Table of Figures

Table of Tables

Introduction and Purpose

The purpose of the Transit Assessment is to identify potential feeder and circulator transit alternatives for the Wichita Mountains Wildlife Refuge (WMWR), asses the feasibility of each service, and evaluate them against the four goals of this Comprehensive Alternative Transportation Plan. The study team developed potential feeder routes based on the location of key nearby origins and destinations, financial constraints, existing regional transit service, and associated potential for partnerships. The team then developed a set of circulator alternatives in consultation with refuge staff in light of:

a) the ability of refuge sites to sustain more visitor access (resource suitability)

b) the ability of access roads and parking lots to accommodate transit vehicles (physical suitability) and

c) potential interest in use of the service to access sites (market demand)

Background

This section draws on key information from the 2010 WMWR Alternative Transportation Study regarding potential partners, including area transit partners and neighboring communities, and provides updates and additional detail, including data from this effort, when available.

Regional Origins and Destinations

Lawton

Lawton is the largest community in southwestern Oklahoma and the fifth-largest in Oklahoma overall. Lawton serves as a major service center for residents in the region's smaller communities, and adjacent Fort Sill attracts tens of thousands of visitors from across the country. Lawton is the region's tourist center with shopping centers, museums, casinos, and lodging.

Fort Sill

Fort Sill is home to over ten thousand residents and serves as the center of the area's fifty-thousand-strong military community. Fort Sill is the largest employer in the region and has grown under recent base realignments. As described in other sections of the report, the fort has a popular and well-developed recreation program including the Lake Elmer Thomas Recreation Area (LETRA). Although Fort Sill borders the refuge, most development on the base is close to Lawton and Interstate 44.

Comanche Complex

About eight thousand members of the Comanche Nation live throughout the Comanche Tribal Jurisdictional Area, which consists of Lawton and communities in several nearby counties. Although the members are dispersed, many tribal activities are centered on the Comanche Complex a mile north of the turnoff from Interstate 44 to WMWR. Recreational, social, healthcare, and government services are centered on the Complex along with some housing.

Medicine Park

Medicine Park is home to about four hundred people and is a regional tourism destination and a gateway to the refuge. Downtown Medicine Park along Lake Drive features a concentration of businesses, including a hotel, restaurants, and outfitters, and a walking path convenient from Highway 49. The proposed Medicine Park Aquarium and Natural Sciences Center on the southwest edge of town is also of interest to visitors and can serve as a formal gateway to the refuge. Many visitors to the refuge and to Lake Lawtonka start or end their trips with a visit to the town.

Area Transit Operators

Lawton Area Transit System

The nearest scheduled transit service is the Lawton Area Transit System (LATS), a public transit agency that runs five routes on weekdays and Saturdays between Lawton neighborhoods and its downtown. Each route converges on the Downtown Transit Center next to Lawton Old City Hall. LATS service is fairly extensive with a lengthy span of service and coverage throughout most of the city, but not nearby communities, such as Medicine Park, Marlow, and Duncan. See Appendix 5-A for a map of LATS transit coverage. Currently, LATS fares are $1.25 per ride for adults over 18 years in age, $0.75 for children between six and 17 years old, and free for children under six years old.

The Orange Line is the only LATS service with a regional focus, connecting Fort Sill to the city of Lawton. The Orange Line makes a large loop from downtown Lawton through the main living and working portions of the base along Sheridan Road. LATS is permitted into the base, but only after passing through a security checkpoint. Serving portions of the base outside the secured area, such as Key Gate immediately off of Interstate 44, avoids many of the operational complexities that would be caused by seeking security clearances. However, it provides less of a direct connection to the base's residential areas.

In coordination with Oklahoma FitKids, LATS provided an express bus to LETRA (the "LETRA Express") for area children to make up for pool closures in Lawton during the summer of 2011. The service operated every two hours from early July to mid-August on Fridays (11:15 AM-4:45 PM) and Saturdays (11:15 AM-6:00 PM) and carried a total of 200 passengers. LATS and FitKids discontinued the service after Lawton reopened city pools. LATS received positive feedback on this service from users. The service ran during July and August, which are months with relatively low visitation in WMWR.

Friends of the Wichitas

The Friends of the Wichitas is the refuge's official non-profit friends group, which provides fundraising and volunteer assistance to the refuge. As part of their work, the group runs guided bus tours approximately once per week with a variety of themes related to nature. The tours, operated since 2005, cost five dollars per person and include interpretation and programming. Destinations vary based on the theme of the trip, such as bird watching, historical sites, or astronomy. Several of the bus tours have the unique draw of being the only regular way for the public to access the closed northwestern portions of the refuge. The refuge owns the bus, which was recently replaced with a new bus using a $292,000 grant from the Paul S. Sarbanes Transit in Parks Program (see Figure 5-1).

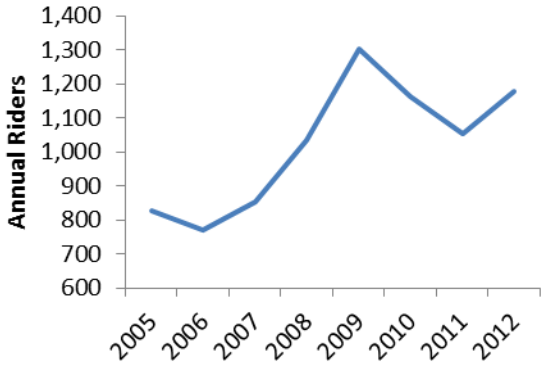
Figure 5-1: Recently Purchased WMWR Tour Bus

Source: Volpe Center

The bus tours served just under 1,200 riders in 2012, and ridership has trended upwards since the start of service in 2005 (see Figure 5-2). Fall is by far the service's most popular season due to the bugling elk tours in September (see Figure 5-3). July and August are the two least popular months historically, which caused the Friends to stop August service in 2013. Spring and winter see moderate demand in between the fall peak and the summer trough.

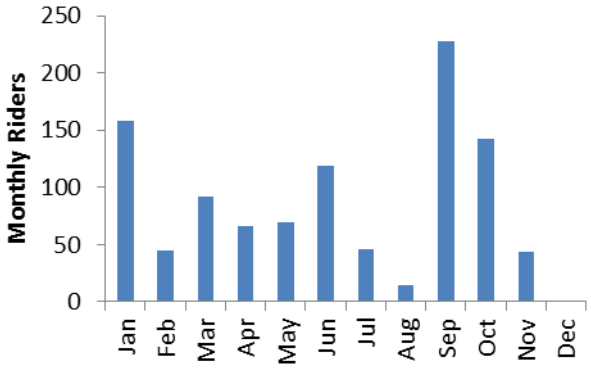
The different themes of the bus tours attract different markets, such as birdwatchers or families. All bus tours are intended for education and entertainment rather than transportation, and passengers rarely walk far from the bus. The bus tour itself is the destination, rather than a trailhead, viewpoint, or visitor center.

Figure 5-2: Annual Tour Usage, 2005-2012



Source: Wichita Mountains Wildlife Refuge

Figure 5-3: Average Monthly Tour Usage, 2005-2012



Source: Wichita Mountains Wildlife Refuge

Comanche Nation

The Comanche Nation operates transit service in the Comanche Tribal Jurisdictional Area. The Comanche fleet operates eight small buses that serve about 28,000 passengers per year. These buses can be used by tribal members for any purpose from commuting to recreation.

The Comanche Nation has not been involved with recent transportation planning on the refuge. The Nation has provided input in planning sessions in the past and could be interested in pursuing transit service, especially if engaged early in the planning process. Conceptually, a service could provide them with a scheduled transit connection, at least on weekends, between the Complex, Lawton, the Refuge, and Medicine Park.

Charter and Tour Buses

The refuge hosts between 80 and 100 charter and tour buses ranging from commercial tours to church groups to wildlife enthusiasts. Most of these trips are governed by FWS Special Use Permits, but provide a way for larger groups to visit the refuge with a minimal impact on traffic and the environment.

School Trips

School field trips are a popular activity on the refuge. Typically schools use school district buses and drivers. Refuge and Friends group staff provide interpretation once children arrive at the refuge. The Friends of the Wichitas provides small cash grants to help school districts defer the cost of traveling to the refuge. The Environmental Education Center is a popular destination for these groups, hosting 8,000 students per year.

Potential Transit Demand at WMWR

Regional environment for transit

The general prospectus for a transit system that would serve the refuge is mixed but promising. Operating expenses for transit are much lower than the national average – 2011 bus operating expenses were $123 per hour nationally, but LATS reported $65 per hour to the National Transit Database.[46] This relatively low cost of providing service means that lower fares can be charged to transit riders.

Transit systems serving public land units near cities with fairly high transit ridership benefit from a user base that is familiar with transit. As of the 2011 American Community Survey, about 1.5 percent of Lawton commuters use transit as their main commuting mode to work, compared with a national average of 5.0 percent.[47] Some Lawton residents use LATS on an infrequent basis, rather than for their daily commutes. However, user familiarity with transit is still low in Lawton compared to other metropolitan areas with higher shares of regular transit commuters.

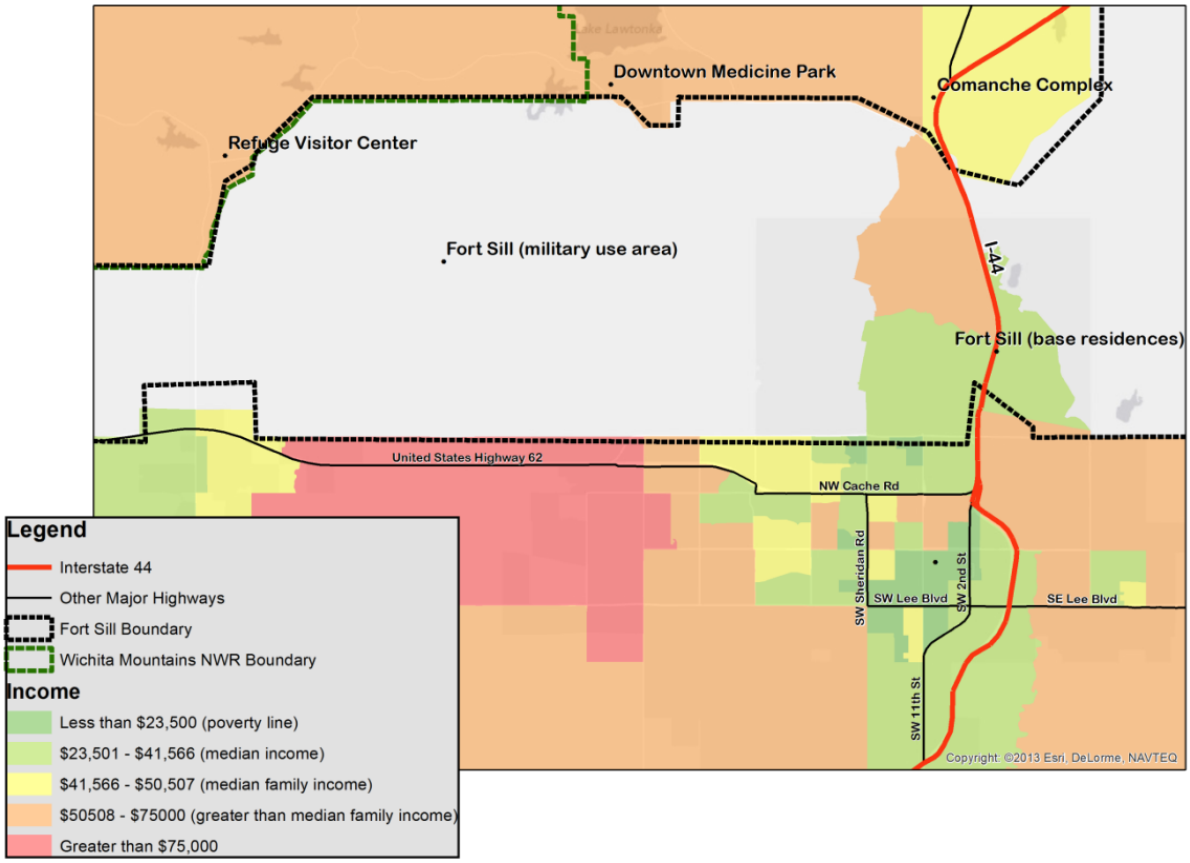
Figure 5-5 shows the locations of lower-income areas near WMWR, and Figure 5-6 shows the locations of households with lower car ownership – both populations that would benefit from transit access to WMWR.

---

[46] National Transit Database, http://www.ntdprogram.gov/ntdprogram/.

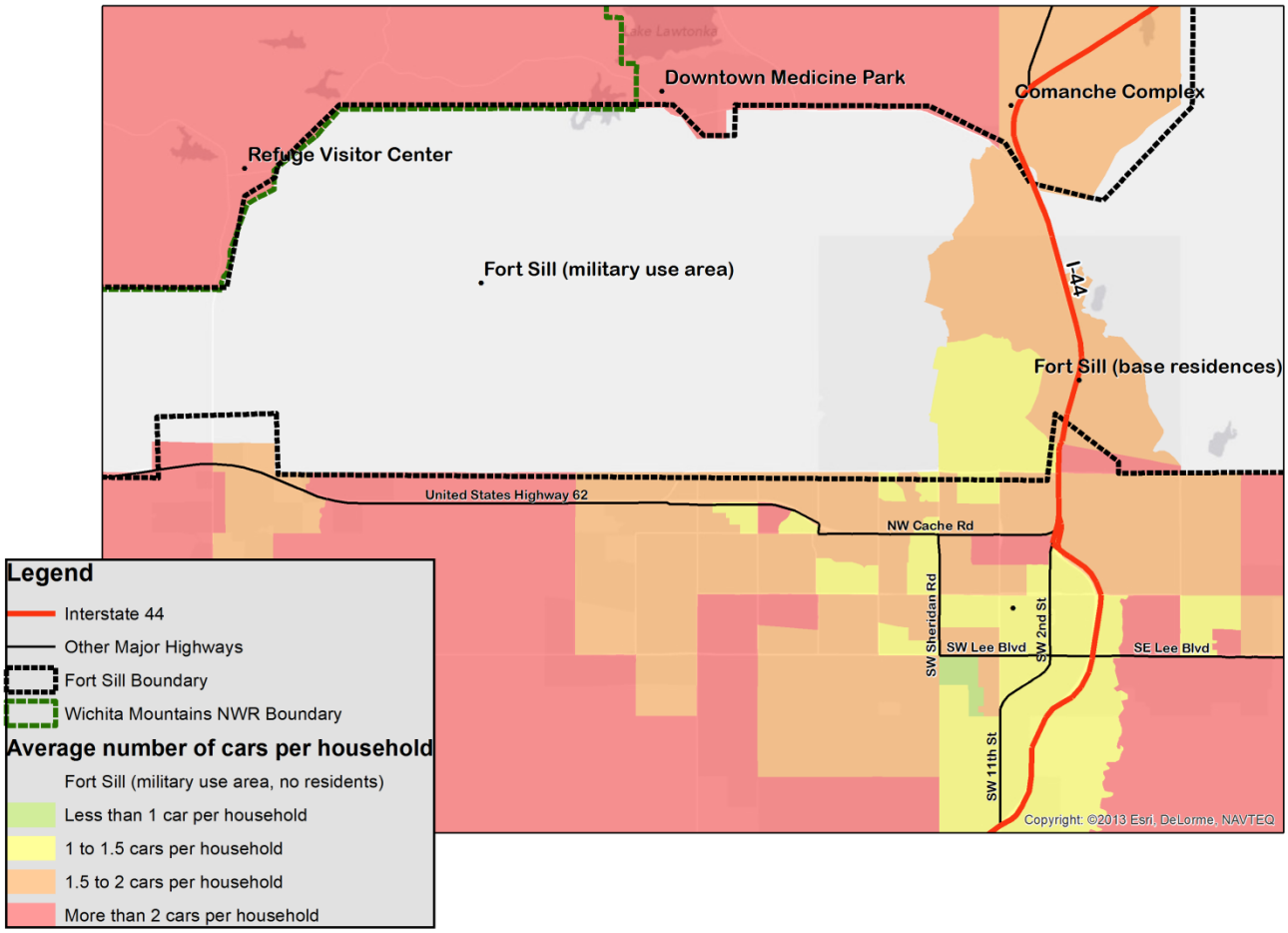
[47] U.S. Census Bureau, American Community Survey, https://www.census.gov/acs/www/.

Figure 5-4: Map of median household income by census tract near WMWR



Source data: 2010 U.S. Census, ESRI, DeLorme, NAVTEQ

Figure 5-5: Average number of cars per household for the area near WMWR



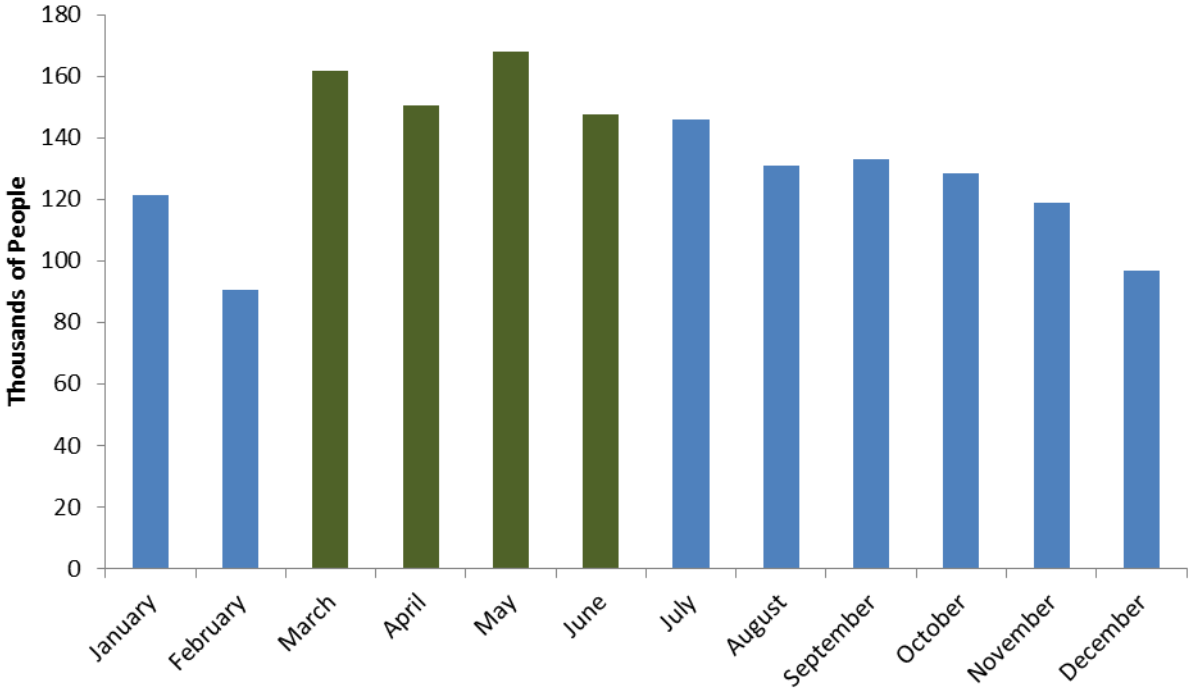
Source data: 2011 American Community Survey, ESRI, DeLorme, NAVTEQ

The refuge is popular as a day trip for local residents. Sixty percent of license plates observed during the study team's parking observations in October 2012 were Oklahoma plates, and anecdotal evidence suggests that many visitors are local, repeat visitors. A high ratio of locals to out-of-town tourists is a good environment for transit. Most tourists in Lawton bring their own or rental cars and would be less likely to use transit from Lawton. Transit to the refuge that serves hotel districts would be useful to travelers without cars.

Seasonal Demand

Visitation at the refuge peaks in the spring and early summer (highlighted in green in Figure 5-6). A new transit system could serve this peak season in order to maximize transit's potential to meet the goals of this study. Future service expansions could include service through the end of July or later.

Figure 5-6: Visitation by month in 2012

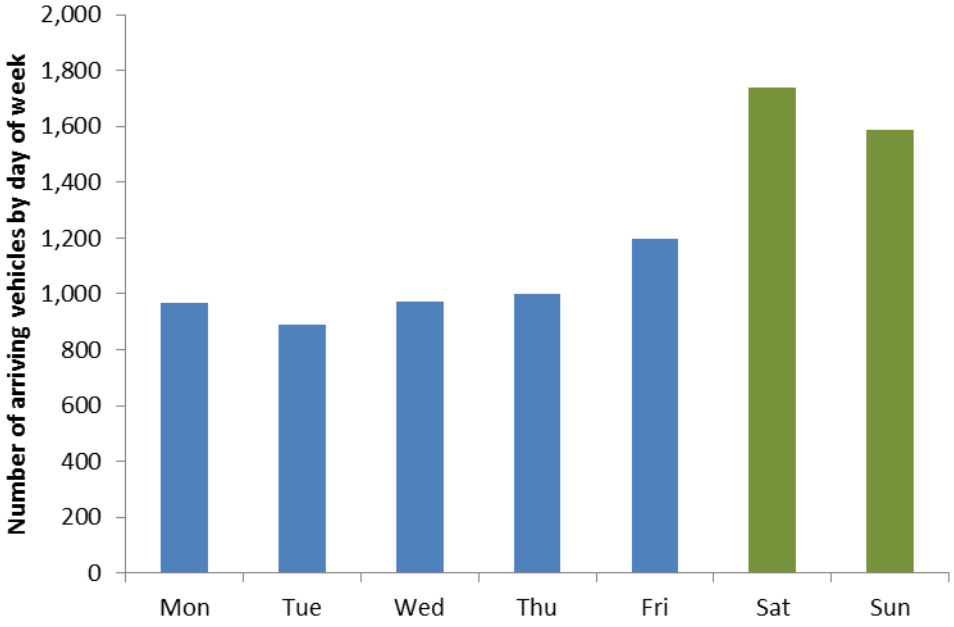


Source: Wichita Mountains Wildlife Refuge

Weekly Demand

WMWR sees visitation peak Saturdays and Sundays (green bars in Figure 5-7). Given that a higher proportion of weekday traffic is likely cut through traffic, the weekend increase, in terms of visitation to WMWR sites, is even more pronounced. (See the Traffic Analysis Study for a more detailed analysis of traffic counts.)

Figure 5-7: Arrivals by Day of Week in 2012

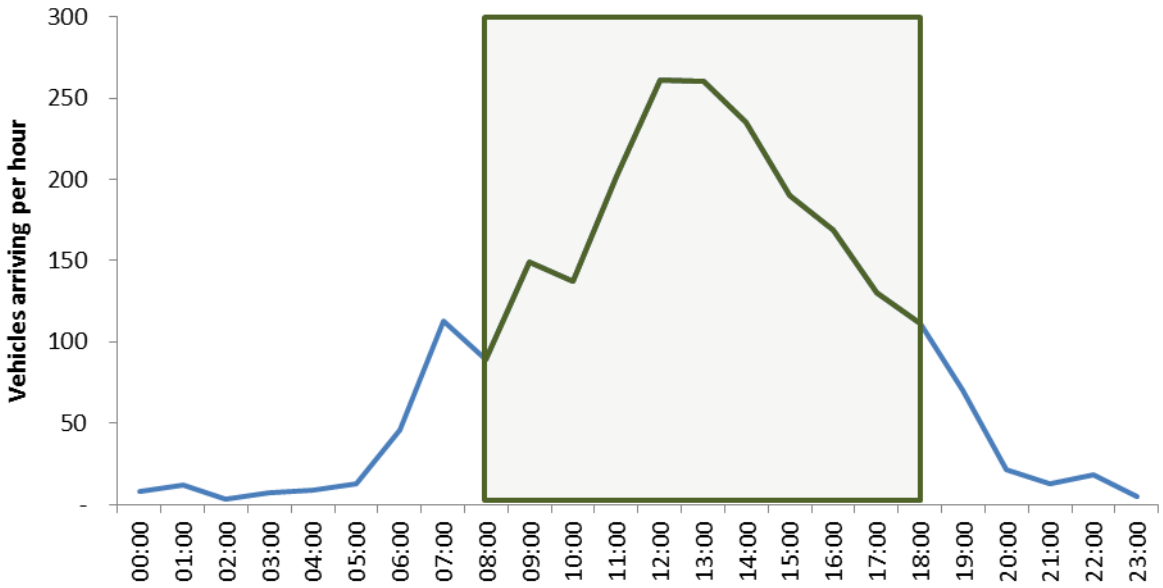


Source: Wichita Mountains Wildlife Refuge

Daily Demand

As seen in the chart below, people are passing through the refuge at all times. From about eight in the morning to six at night the refuge is busy with both visitors and pass-through traffic. The period of peak arrivals during weekends tends to be mid-day (highlighted in Figure 5-8). Parking data indicates that demand at trailheads and refuge destinations is earlier in the day compared to general traffic on the refuge.

Figure 5-8: Arrivals per hour, average of four April Saturdays in 2012



Destinations within Wichita Mountains Wildlife Refuge

Decisionmakers should choose transit destinations carefully, especially within an environmentally sensitive natural area. The study team evaluated each potential stop based on the following criteria, outlined in Table 5-1:

- **Resource Suitability: Can a destination handle more visitors?** From a resource management perspective, some sites are more suitable for large numbers of recreational visitors than others. Delivering a bus load of passengers to sites that developed to accommodate visitors or that have relatively few sensitive ecological resources is a fairly low impact to the natural resources the refuge was created to protect. On the other hand, providing the same service to sensitive destinations where visitation is currently limited by parking availability can cause harm to natural resources and could exceed wilderness area carrying capacities. The study team developed the rankings in Table 5-1 based on the refuge's Comprehensive Conservation Plan and discussions with refuge staff.[48]

[48] U.S. Fish and Wildlife Service, *Wichita Mountains Wildlife Refuge Comprehensive Conservation Plan and Environmental Assessment*, April 2013.

- **Physical Suitability: Can a bus or van access the trailhead and safely navigate through the parking lot?** Most of the parking lots and trailheads on the refuge have been engineered to a standard capable of fitting large vehicles. Buses are long, wide, and have wide turning radii that may be a challenge to safely maneuver in some areas, especially with a large number of pedestrians. Therefore, some destinations are unsuitable for a transit vehicle due to the access configuration or high levels of activity. However, some destinations could be made suitable for transit service through road or parking area retrofits.

- **Market Demand: Is it a place that transit riders want to go?** Market demand is critical when choosing a location for a bus stop. Serving locations that riders do not want to go will suppress ridership. If fares charged to riders are a major part of the service's funding portfolio, then the service may fail due to a lack of funding. Different users want to see different places. A person visiting their relatives at Fort Sill may be interesting in visiting a few of the top-tier easily accessible sites in an afternoon, such as Holy City and Mount Scott. An outdoors enthusiast living in Lawton and familiar with the refuge may want to visit some of the less popular trailheads on the refuge.

These criteria were applied to all major destinations on the refuge (see Table 5-1). Market demand ratings are based on observed parking volumes and average visit lengths in the Traffic Analysis Study.

Table 5-1: Transit Stop Suitability for WMWR Destination

Site	Resource Suitability	Physical Suitability	Market Demand
Lake Lawtonka	Medium	High	Low
Lake Elmer Thomas	Medium	High	Low (High is projected with completion of LETRA Trail)
Mount Scott Base	Medium	Low	Low (High is projected with completion of Mount Scott Summit Trail)
Mount Scott Summit	Medium	Medium	High
Holy City	High	High	High
Parallel Forest	Medium	Medium	Low
Rush Lake	High	High	Medium
Jed Johnson Tower	Medium	Low (higher with planned improvements)	Medium
Visitor Center	High	High	High
Lost Lake	Medium	Medium	High
Boulder Picnic	Medium	High	Low
Prairie Dog Town	Medium	High	Low
Sunset	Low	Medium	High
Treasure/Post Oak Lake	Low	Medium	High

Transit Demand Estimates

The project team used observations from the October 2012 parking lot counts and entrance gate counters to estimate demand for transit service at different sites throughout the refuge. Each year, approximately 107,000 visitors to the refuge will be arriving during this report's recommended transit service days and times. On the design day used during the parking and traffic analyses[49], about 2,681 visitors will be traveling to refuge destinations. Both figures exclude cut-through traffic, about 40% of the observed entrances at the refuge gates on weekends. This analysis excludes demand for very small sites, such as scattered trailheads where no data was collected during the parking study, and also excludes demand for sites outside the refuge.

Using the figures of 107,000 visitors per transit season and 2,681 visitors on design day, the project team modeled seasonal and daily transit demand on the refuge. If a hypothetical transit route provided good service to all destinations with data, it can be assumed to attract eight to twelve percent of the people already interested in traveling to that site. This draws from an analysis that found an average of ten to fifteen percent at several transit systems similar units.[50] The eight to twelve percent figure for WMWR is slightly lower than the national average, a factor that takes into account the low transit use in the Lawton area. This translates to between 214 and 370 riders who could be expected to use it on a busy spring Saturday as seen in Table 5-2 below.

Table 5-2: Estimated Design Day Transit Demand

Site	Daily Transit Demand (people)
Lost Lake	26 to 45
Mount Scott	74 to 128
Sunset Picnic Area	35 to 60
Treasure Lake	3 to 6
Refuge Visitor Center	53 to 91
Lake Elmer Thomas	5 to 8
Lake Jed Johnson	2 to 3
Lawtonka Mountain Bike Trailhead	1 to 2
Parallel Forest	2 to 3
Holy City	9 to 16
Prairie Dog Town	5 to 8

[49] The design day is a day that has more visitation than approximately 90 percent of all other days in a year and is used extensively in the Traffic Study portion of the Comprehensive Alternative Transportation Plan. The design day on the refuge represents a busy weekend in June or March, although not quite the peak days seen in April or during holidays.

[50] This analysis was performed by the Volpe Center in support of a transportation feasibility study for the Red Rocks Canyon National Recreation Area, a popular BLM destination near Las Vegas. The analysis used ridership reports from several transit services travelling to National Parks, Forests, Refuges, and BLM sites.

The 214 to 370 estimate for riders per day will be lower if not all sites are served by transit. These estimates are not meant to be precise predictions of ridership but an order of magnitude estimate for potential ridership. They are consistent with the low and medium ridership assumptions in the transit analysis below.

General Transit Service Considerations

When initially developing routes and assessing the feasibility of potential routes, the study team considered a number of factors that affect all types of transit service. This section presents each of these factors, along with associated challenges and opportunities. The study team thoroughly evaluated each factor in order to capitalize on the strengths of a potential system, while avoiding challenges and minimizing deficiencies:

Ridership: A paramount concern for any transportation service is whether there will be enough ridership to support and justify its provision. Very little data exists to demonstrate the need or potential demand for a shuttle to or within WMWR or nearby locations. The study team does have estimates of WMWR visitation overall, across specific popular sites, and throughout the year. Because of this lack of data, the study team assessed alternatives in terms of various factors that contribute to demand, in concert with considering the purpose of the service. With few comparable services to draw from, the study team assessed costs per passenger based on whether the prospective vehicle could attract 5, 10, or 15 passengers on an average trip. These figures demonstrate the important bearing that ridership has on costs and are consistent with site-level demand estimated.

Cost and Convenience: Potential transit demand to any destination is primarily a function of cost and convenience (time) of the service relative to other travel options. Both imply that the service must be easily accessible, that departure/arrival times are aligned with traveler's needs, and that the fare costs and travel times are reasonably comparable to transportation by automobile. In recreational settings, a shuttle service rarely matches the comfort, speed, or flexibility of a private car. However, a shuttle service may be more attractive if visitors are concerned about parking availability at the destinations they want to visit. Short headways, or the time between bus departures, will make a shuttle service more convenient.

Quality of Experience: Positive rider experience is essential to a transportation system's success. If the experience is pleasant, a rider may to some degree overlook increased costs or reduced convenience associated with a shuttle. Furthermore, transit service can enhance visitor experience through on-board interpretation activities. Quality of experience can become an attraction in and of itself, drawing visitors who are interested in a more immersive or educational experience.

Partnership Opportunities: Public lands agencies are generally ill-equipped to manage, operate, maintain, and promote transit service. Therefore, involving a range of partners is key to the feasibility and viability of transit service on public lands. Partners can build off of existing capacity and provide service, likely at lower cost than WMWR. In addition to increasing the suite of potential destinations, multiple partners make the service more resilient to fluctuations in

funding and service needs.

Multimodal Connections: Transit service functions best when thoughtfully tied to the multimodal transportation networks of an area or region. An ideal origin point for a transit service to WMWR would be linked to frequent transit to local neighborhoods, but would also be convenient to regional transit options.

Marketing and Branding: A strong advertising program is essential to a transportation system's viability. Often one of the most overlooked areas of a transportation project, a targeted, long-term marketing campaign lets people know that a service exists and informs travelers of transportation options they may not be aware of. A strong marketing campaign must include appropriate branding of the service, as well as a multi-faceted approach to disseminating traveler information such as maps, schedules, how-to-ride information, and trip planning.

Branding is an important part of establishing an identity for a shuttle system, not only for general exposure but also to bolster travel confidence among its riders. When a rider is using a transportation system, organization of information within that system is crucial to a rider's experience. Typically a rider wants to know where a shuttle goes, when it arrives and departs, and how long the trip will take. By developing accessible and consistent materials with regard to design and function, the rider becomes familiar with the signage and messaging, in turn making them more confident that they will arrive and return in a timely manner.

Physical Constraints: Depending on the vehicle type selected, certain areas may be inaccessible to the transit service. For instance, 40-passenger heavy duty buses may not be able to navigate steep or winding roads or turn around at many trailheads, while 30-passenger cutaways or 15-passenger vans tend to be more versatile. Smaller transit vehicles may therefore be more appropriate for WMWR. They would also be more cost effective and may be more appropriate for the anticipated ridership.

Transit Alternatives

In public lands settings like WMWR, transit systems typically serve two distinct purposes:

1. Access to the refuge (feeder route)
2. Mobility within the refuge (circulator route)

Providing transit access to WMWR means providing transit service from local population centers to the refuge. Such access services can be particularly valuable for populations that do not own a car, cannot afford a car, or would prefer not to drive because of cost, convenience, or personal preference. In the context of WMWR, the populations most likely to benefit from transit access to WMWR are low-income residents of local communities or residents of Fort Sill, many of whom do not have access to a car (see Figure 5-4 and Figure 5-5).

Providing transit mobility within WMWR means providing transit as a means for visitors to travel between recreational locations within the refuge. Such services can benefit people who take transit to the refuge, but they can also provide a way for visitors who drive to one location to park once and access other destinations without a vehicle.

Ideally, WMWR's transit system would serve both purposes of providing access to and mobility within the refuge, since these purposes are complementary. For example, a system that only provides access to WMWR will have very low ridership if visitors cannot use it to get to the part of the refuge they want to visit, while a system that only provides mobility within the refuge does not expand access to populations that do not have access to a car.

In the case of WMWR, a transit service providing mobility within the refuge has the potential to:

- reduce parking congestion;
- improve safety, particularly in congested parking lots; and
- in conjunction with planned new recreational amenities, such as the LETRA trail and the Mount Scott trail, encourage a shift in recreational use towards less sensitive natural environments in the eastern section of WMWR.

This section will analyze four primary alternatives for providing access to and/or within WMWR, including discrete options within them. These options are conceptual, and the routes, schedules, and cost estimates may change based on WMWR staff input or new information. The four primary approaches to transit at WMWR analyzed below are:

1. A feeder shuttle to WMWR;
2. A circulator shuttle within WMWR;
3. A combined approach with separate shuttle services providing access to WMWR and within WMWR; and
4. A hybrid approach that provides access to WMWR and to select locations within WMWR within the same shuttle route.

Transit Service Assumptions

Based on the study goals and an assessment of the existing demographic and transit conditions analyzed above, the study team made the following assumptions about a potential transit service for WMWR (Table 5-3).

Table 5-3: Transit Service Assumptions for WMWR

	Access Service To WMWR	Circulator Within WMWR	Single Route / Hybrid Service
Headways (Min.)	90 – 120 (depending on stops)	30	60
Key Origin/Destination	Downtown Lawton to Visitor Center	Visitor Center to Medicine Park Loop	Downtown Lawton to Visitor Center serving WMWR destinations
Operating Season	16 Weeks (March-June)		
Operating Days and Times	Saturday and Sunday(8:00 AM-6:00 PM)		
Transit Vehicle	Cutaway Bus with 15-30 passenger capacity (Some options assume multiple buses to maintain desired headways.)		
Key Transit Accommodation Considerations	N/A	Depending on route, potential need for improvements to Jed Johnson Tower trailhead	Depending on route, potential need for improvements to Jed Johnson Tower trailhead
Cost per Hour	$50-$80 per bus		
Ridership (at one time)	Estimates at 5, 10, and 15 people		

Ridership: There is very little data on how many visitors to WMWR would utilize transit for all or part of their trips. Because of the low transit ridership in the region, the study team assumes that fewer than one percent of trips to WMWR would use transit. However, transit usage within WMWR has greater ridership potential, especially if visitors perceive that parking scarcity would make transit preferable to driving between locations in WMWR. Based on the experience of other public lands units with voluntary circulation shuttles to provide access within their units, this report assumes that approximately eight to twelve percent of visitors would utilize this service in WMWR.

Headways: Headways, or the time span between bus departures from a given location along a route, are a key determinant of the service's convenience for visitors. Long headways (long waits between bus departures) can make a service unattractive to users. However, shorter headways may require more buses along a route, increasing costs of service. For this study, the team assumed different headways for different types of transit service. The team assumed 90- to 120-minute headways for feeder service to WMWR, because visitors can more easily plan when they will go to and from the refuge. By contrast, the study team assumed that a circulator service within WMWR should run with 30-minute headways to provide a convenient, attractive service for visitors. For the single route / hybrid service option, which would combine the access service and circulator service into one bus route, the study team assumed an intermediate headway time of 60 minutes.

Transit Service Model: The study team recommends that WMWR explore the possibility of developing a partnership with LATS or another local transit provider for a WMWR transit service. For the purposes of this transit analysis, the study team assumed that WMWR would partner with a transit service provider and pay for the service on an hourly basis. Therefore, the costs are calculated based on operation hours and the number of buses, rather than based on the purchase and life-cycle maintenance costs associated with owning a bus fleet.

It is also possible that WMWR could assist partners in applying for grant funding to cover the costs of purchasing new buses, to help partner increase the size of their fleet or recapitalize an existing fleet, providing the capital investment needed for the transit service. The partner could then provide transit service at a reduced hourly operating cost.

Operating Costs: LATS currently charges $50 per hour (approximately $500 per day) for bus charter services. However, LATS may not have the bus or staff capacity to provide the complexity of service that WMWR would require under a simple charter contract. LATS is also required to post all transit charter services to a competitive process to solicit bids from private transit companies. Private companies providing charter services in the area typically charge higher rates, with the busrates.com database reporting around $800 per day as of October 2013. However, there are currently no commercial charter operations based in Lawton proper, so any commercial charter must also pay for transit from Wichita Falls or Oklahoma City. Therefore, the study team assumed a range of operating costs between $50 and $80 per hour.

Operating Hours and Season: Based on the visitation data in Figure 5-6, Figure 5-7, and Figure 5-8, the study team recommends running services during the peak visitation months of March, April, May, and June, with buses running from 8:00 AM-6:00 AM on Saturdays and Sundays. A service during these peak visitation times will be most effective at reducing traffic and parking congestion and will be most likely to attract ridership.

Vehicle Type: Large transit buses, as seen in most cities, are expensive and inefficient at highway speeds. They also may be too large for some parts of the refuge and provide more capacity than will likely be filled. Smaller buses, including those built on truck chassis (cutaway or shuttle buses), seating 15-30 people with room for some standees, are a more appropriate size for the refuge and the expected use of the service. These buses cost about $125,000 to purchase new.

Common Transit Service Locations: The ideal pickup point for shuttle service to WMWR within Lawton would be near Old City Hall, which is the current transit center for LATS. The location is central and accessible from all of Lawton's bus routes. Ample parking is also available for refuge visitors who choose to take the shuttle, as are services such as restaurants for visitors at the start or end of their day at the refuge. This location was used as the origin point for the 2011 LETRA shuttle that ran on summer weekends.

Within the refuge, all of the access and circulation alternatives stop within the refuge at the Visitor Center. It is a major draw for visitors at the start of their trip to the refuge and it offers visitors the opportunity to learn about the refuge and its wildlife and speak with refuge staff to plan the rest of the day. Conceptually, visitors can then transfer onto the circulator bus.

Feeder Shuttle to WMWR

Unlike public lands units located in urban areas, there are very few people who are able to walk or bicycle comfortably to WMWR. That leaves transit as the main alternative transportation mode capable of regularly serving large numbers of refuge visitors. This section describes three alternative ways to connect the city of Lawton to the refuge using a bus, along with intermediary stops.

- **Option 1**: Basic Service from Lawton Old City Hall to the Refuge Visitor Center, with a stop in between at Medicine Park.
- **Option 2**: Option 1 but with an intermediary stop at either Fort Sill or the Comanche Complex, depending on partner interest and resources.
- **Option 3**: Option 1 with stops at both Fort Sill and the Comanche Complex.
- **Option 4**: Adds local stops within Lawton to serve visitors at the Central Mall, Downtown, and hotels near the interstate. This option can be added to any of the above three.

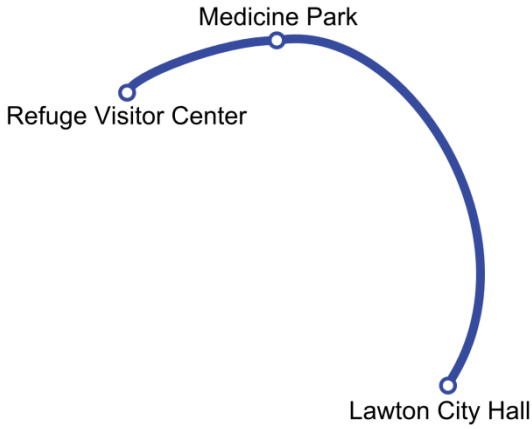
The following transit alternatives outline different options for connecting Lawton, the refuge, and destinations in between. Each successive alternative adds destinations, travel time, and potential riders and partner organizations.

Option 1: Lawton to Refuge Visitor Center via Medicine Park

Option 1 is a basic express bus linking Lawton and

Medicine Park to each other and then on to the refuge Visitor Center. Option 1 is the quickest and most direct route, bypassing potential stops and destinations along the way.

Figure 5-9: Schematic Route Map of Option 1



Route Description

A Lawton resident would drive, walk, bicycle, or take LATS to Lawton Old City Hall and board a waiting shuttle. After leaving Old City Hall, the bus then travels to Interstate 44 and exits at Highway 49, which it takes on towards Medicine Park, stopping downtown. It then travels onto the refuge where it

takes visitors to the refuge visitor center, and then reverses its journey. This route is estimated to take 83 minutes round-trip including stops and driver recovery time (see Figure 5-9). A single bus could travel this route every ninety minutes.

Estimated Operating Cost

Option 1 is the simplest and fastest option to connect the heart of the refuge to the heart of Lawton. It requires a single bus and can make seven round trips per day at an annual operating cost of $16,000-$25,600.

Other Considerations

The main drawback of Option 1 is the lack of service between Lawton and the Refuge, as the service would not serve any of the communities or potential partner groups along the route, with the exception of Medicine Park. As a result, the service has limited partnership opportunities.

Option 2: Lawton to Refuge Visitor Center via Medicine Park and Fort Sill or the Comanche Complex

The first variation on Option 1 above is to add another destination between Lawton and the Refuge. The two most promising destinations are Fort Sill and the Comanche Complex.

Option 2 is a scenario where a bus makes a stop at either Fort Sill or the Comanche Complex. Option 3 describes a bus route that stops at both.

Route Description

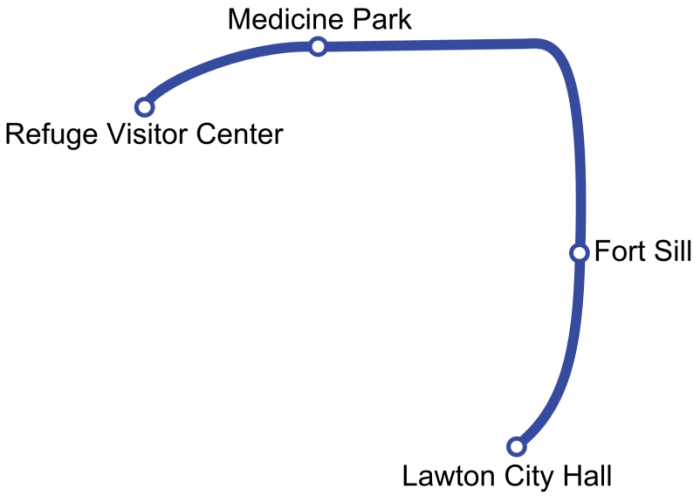
As in Option 1, the bus begins at Lawton Old City Hall and then proceeds to the interstate. Then, it either stops at Fort Sill or the Comanche Complex. After this stop it continues on to Medicine Park and then terminates at the refuge's Visitor Center.

Fort Sill Option

To serve Fort Sill the bus would exit the interstate, pick up passengers at the Key Gate, and then proceed on to Medicine Park and the refuge as seen in Figure 5-10. Serving the base continues the refuge's work with long-standing partners like the Fort and provides another recreation opportunity for military families. This route would take 94 minutes round-trip including driver recovery time and stops, meaning that a single bus could only run once every two hours.

The most convenient stop at Fort Sill is to take exit 41, then proceed to Key Gate East or West to pick up or drop off passengers, then return to the interstate. The gates are located immediately off the interstate exit, so serving the base would add about five minutes of travel time. Serving these gates avoids the security delays that the LATS Orange Line faces, where all bus passengers must present IDs to base security during times of increased security alerts.

Figure 5-10: Schematic Route Map of Option 2 (Stopping at Fort

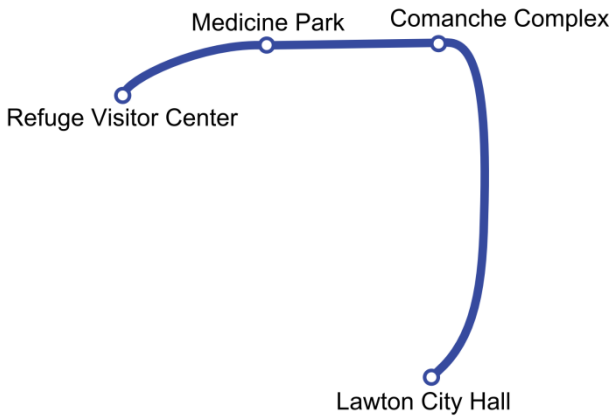


However, Key Gate is not immediately walkable from most of the housing on the base, which limits its convenience to base residents. Additionally, Fort Sill staff note that Key Gate is one of the busiest areas for vehicle traffic near the base, and that introducing pedestrians and u-turning buses to the area just outside the gates could pose a safety risk. Fort Sill staff recommend that transit service enter the base through Key Gate and use a safer location to pick up or drop off passengers and then turn around to enter the freeway. This would improve safety and increase ridership, but depending on the turnaround location and the security arrangements may add enough time to discourage other riders or make maintaining a 90 or 120 minute time between buses more difficult and expensive. If WMWR chooses to pursue a transit option that includes a stop at Fort Sill, the study team recommends investigating the feasibility of stopping within the Key Gate to alleviate these concerns.

Comanche Complex Option

The Comanche Complex is a center of the area's Comanche community and government and has some limited housing for tribal members. The complex is located about a mile north of the turnoff from the interstate to Medicine Park and would add about seven minutes to each bus trip. The route is shows in Figure 5-11. Several of the facilities along West Bingo Road in the complex have large parking lots accessible to buses. Serving tribal members would help the refuge achieve FWS goals of partnering with local communities. Similar to the Medicine Park service, a bus primarily intended to serve the refuge would also provide regional transit service from the Comanche Nation Complex to Medicine Park and Lawton on the weekends. This enhances its usefulness to area residents and may open up additional funding opportunities. Depending on where in the Comanche Complex the bus stops, the route could take up to 105 minutes round-trip, meaning a single bus could only travel once every two hours.

Figure 5-11: Schematic Route Map of Option 2 (Stopping at the Comanche Complex)



Operating Cost

Option 2 could be accomplished using one bus at a cost of $16,000-$25,600 per year. However, the additional stop adds enough time that the target headway of ninety minutes between buses cannot be met without reducing driver recovery time or time spent at stops. The headway with one bus must be increased to at least every hour and forty-five minutes, reducing convenience for visitors. Two buses reduces the headway to an hour between buses, but doubles the cost. This doubling in cost could most likely not be met with a doubling of funding or fare-paying riders.

Other Considerations

Whether Fort Sill or the Comanche Complex is served by Option 2 will come down mainly to a question of interest and resources. One or both destinations may note that their constituents would not be interested in a shuttle, or that they would not be able to help fund it. Conversely, one or both may say that they are very interested and would be able to offer funding. If both are interested, then Option 3 could be pursued.

Serving the additional stops will likely increase ridership by a small amount. Neither destination is as large as Lawton, but a well-coordinated marketing campaign to Fort Sill residents or Comanche tribal members could help to increase ridership. This can increase the financial sustainability of the bus service if the funding structure rests heavily on fares.

Option 3: Lawton to Refuge Visitor Center via Fort Sill, the Comanche Complex, and Medicine Park

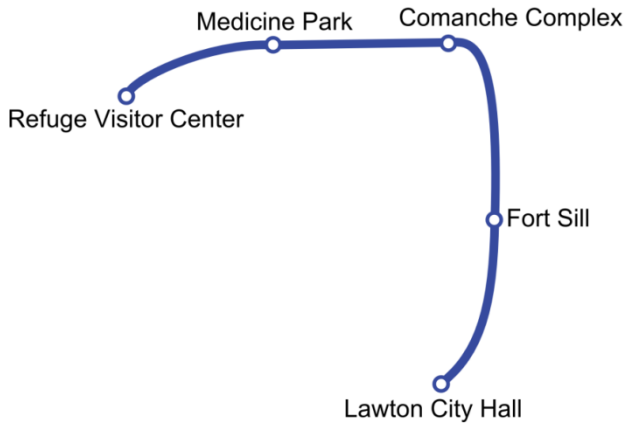
Route Description

Option 3 would begin at Lawton Old City Hall and then head for Interstate 44. It would exit and make the stop at Fort Sill's Key Gate as described in Option 2. Next, the bus would stop at the Comanche Center before proceeding to Medicine Park and then terminating at the refuge Visitor Center (see Figure 5-12). The round trip time on this route would be 111 minutes.

Operating Costs

Option 3 could be run using a single bus arriving every two hours for a cost of $15-$25,600 per year. This headway is less than desirable, and so two buses should be used to shorten headways to an hour. Two buses would double the cost to approximately $32,000-$51,200per year but would provide better service to refuge visitors.

Figure 5-12: Schematic Route Map of Option 3



Other Considerations

Serving both Fort Sill and the Comanche Complex provides the greatest coverage and builds the strongest coalition of partners. However, it increases the run time to nearly an hour each way. This provides a more inconvenient trip for Lawton passengers and increases the headway to about two hours unless a second bus is added. This second bus is the limiting factor to serving both destinations between the refuge and Lawton. Adding a second bus would double the daily cost and cost per season.

This alternative represents the maximum level of service and highest expense of the access route. It requires that Fort Sill and the Comanche Nation both be willing and committed partners, preferably also able to contribute funds to subsidize the increased cost incurred by serving their constituents. This service has the longest trip time, but riders benefit from a headway of one hour.

Option 4: Local Option

Figure 5-13: Local Stops in Lawton

Each of the alternatives described above could provide more extensive coverage in Lawton by making local stops, but at higher cost. The main alternatives detailed serve only Lawton Old City Hall, and then proceed directly to Interstate 44. Some or all of the local stops described below could be added onto any of the alternatives described above. As with a city bus route, stops can be skipped if there are no customers waiting for the bus and no riders are requesting a stop.

Route Description

Local stops at Old City Hall, the Central Mall, downtown Lawton, and the cluster of hotels near Exit 37 on the east edge of town would add several markets without changing the bus route significantly (see the diagram in Figure 5-13). The Central Mall is a major activity center in Lawton and features the downtown area's largest available parking lots. Downtown Lawton itself is also a large draw given its many local businesses. The last local stop in Lawton would be the cluster of seven hotels within a half mile around Exit 37. This would serve visitors to the town who want to visit the refuge and also provide them with a one-seat express ride from the hotel back into downtown Lawton.

Potential Partners

Local stops within Lawton could expand the number of potential partners. In addition to the City of Lawton and LATS, this option may be of interest to the Lawton Mall, the Chamber of Commerce, and the hotels, who may provide additional in-kind or financial assistance for the service.

Summary

If a transit service to WMWR made every local stop, it would add about fifteen minutes to the total one-way run time. More people would be able to easily access the bus, but the longer trip time would discourage riders traveling from the origin at Lawton Old City Hall. Some or all of these local stops could be considered as an add-on for any of the alternatives described above, as well as the "Combined" and "Single Route" alternatives described below. Alternative 1 could no longer run at a ninety minute headway with a single bus if it made local stops. Either the headways must be increased to two hours or a second bus would have to run.

Feeder Shuttle Conclusions and Recommendations

The alternative options to provide bus service to the refuge support FWS, Department of the Interior, and WMWR goals of reaching out to urban residents, especially those who are currently unable to visit refuges because they do not have access to transportation. Bus service also positions the refuge to serve growing demographics of people who choose not to own vehicles, and the refuge itself would benefit from fewer private vehicles on the road and in strained parking lots.

However, long-haul transit service is expensive. Each destination adds travel time and thus operating expenses, but also provides the promise of more paying customers and serving more constituents of organizations that could provide some funding. Each stop on a public lands shuttle can add up to five minutes of dwell time as passengers who may be unfamiliar with the service, load gear and bicycles into the vehicle, ask the driver questions, and pay a cash fare. A service with proper planning and efficient operations can keep these costs to a minimum, maximize revenue, and provide just the right amount of service. Table 5-4 summarizes the costs for each of the alternatives described above.

Table 5-4: Comparison of Feeder Route Options

Alternative	Travel Time (min)	Headway (min)	# Buses	Costs per Trip	Annual Costs	Cost per Pass-enger (5)	Cost per Pass-enger (10)	Cost per Pass-enger (15)
Option 1 - Lawton to Refuge	83	90	1	$75-120	$16,000-25,600	$15-24	$7.5-12	$5-8
Option 2 – Ft. Sill	94	120	1	$100-160	$16,000-25,600	$ 20-32	$10-16	$7-11
Option 2 - Comanche	105	120	1	$100-160	$16,000-25,600	$20-32	$10-16	$7-11
Option 3 - All stops	111	60	2	$100-160	$32,000-51,200	$20-32	$10-16	$7-11

Deciding between the three alternatives is a question of feasibility and interest from the intermediary destinations. Fort Sill and the Comanche Nation should be consulted on their level of interest and the interest they expect from their constituencies. Whether one or both of these destinations is a stop along the Lawton to Refuge shuttle depends on this interest and the potential resources of these partners. The question of local stops in Lawton should also be resolved based on total travel time and interest expressed by the City of Lawton and businesses along the route. The overall conclusion to this transit report evaluates the alternatives against each other given the study goals.

Mobility within WMWR

This section analyzes the following options for circulator service within WMWR:

- **Option 5:** Visitor Center to Medicine Park Loop with stops at the Mount Scott Trailhead, Lake Elmer Thomas, and the Medicine Park Aquarium and Natural Sciences Center (MPANSC)
- **Option 6:** Option 5 Loop with additional stops at Jed Johnson Tower and Holy City of the Wichitas
- **Option 6A:** Option 6 Loop + a stop on the summit of Mount Scott (in one direction only)
- **Option 7:** Western WMWR loop with stops at the Visitor Center, Quanah Lake, and Sunset (could be combined with options 5, 6, or 6A to extend circulator coverage to the western area of WMWR)

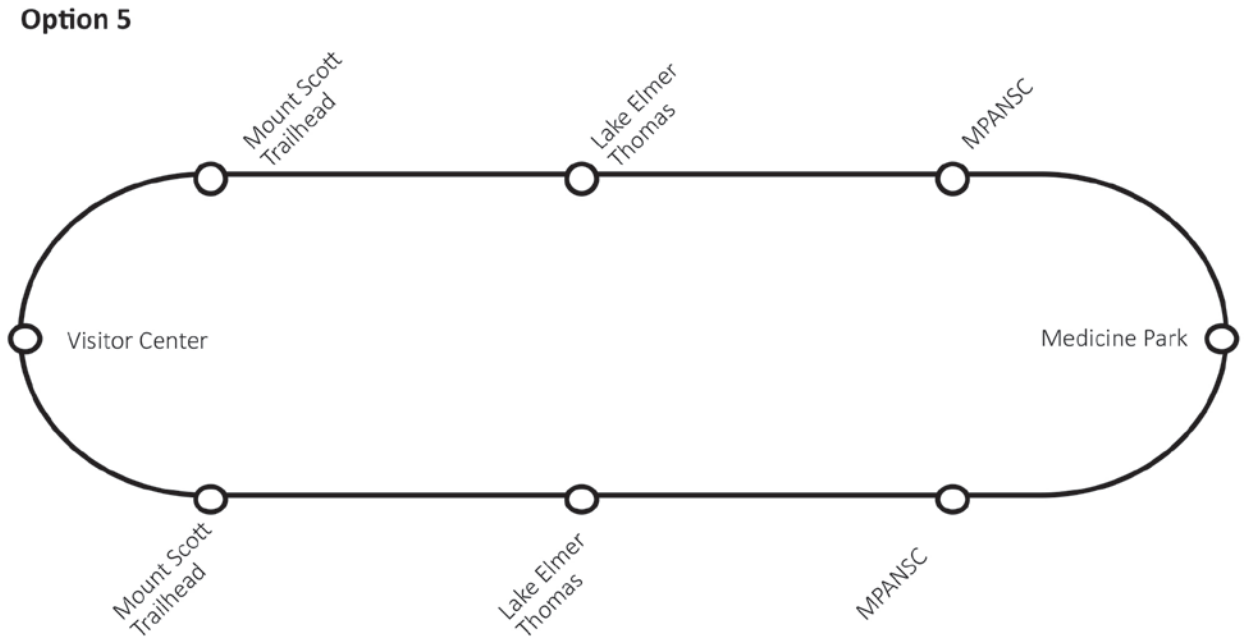
If paired with any of the feeder routes in the Access to WMWR section above, all of these options would connect with the feeder options at the Visitor Center and downtown Medicine Park, allowing users to transfer at either location. The study team recommends planning the circulator service to have a 30-minute headway, arriving and departing from destinations every half hour, to make the service convenient to refuge visitors. If the service is not considered to be convenient or reliable, then ridership will be low for a voluntary shuttle, as most visitors would choose to drive their vehicles between refuge sites, if available.

Option 5: Short Circulator Route from Visitor Center to Medicine Park with Stops at Mount Scott Trailhead, Lake Elmer Thomas, and Medicine Park Aquarium and Natural Sciences Center

Route Description

Option 5 (Figure 5-14) is the most limited circulator option analyzed in this report. The service is a loop that travels from the Visitor Center to the Mount Scott Trailhead to Lake Elmer Thomas to the MPANSC to downtown Medicine Park, then loops back, stopping at the same stops on the way back. This route provides the least amount of coverage of recreational destinations in WMWR while connecting with Medicine Park and MPANSC. This option allows for the potential of partnerships with the town of Medicine Park or with MPANSC. It allows visitors to drive to MPANSC or Medicine Park but access the refuge using the circulator service. This option would be the least expensive circulator option, and it would offer users the fastest circulation through WMWR, with a total running time per loop of 49 minutes including lay-over at the end of a circuit.

Figure 5-14: Route Map for Circulator Option 5



Estimated Operating Cost

To provide departures every 30 minutes, this option would require two buses. The annual operating costs would be approximately $32,000-$51,200 per year for Saturday and Sunday service.

Other Considerations

The schedule in Table 5-4 assumes that the new hiking trail to the summit of Mount Scott would begin at the parking lot at the base of Mount Scott road. This schedule could be adjusted to reflect the alternative proposed trailhead location at Quetone Overlook without substantially changing overall run time or operating costs.

Sample Schedule

Table 5-5: Sample schedule for Circulator Option 5

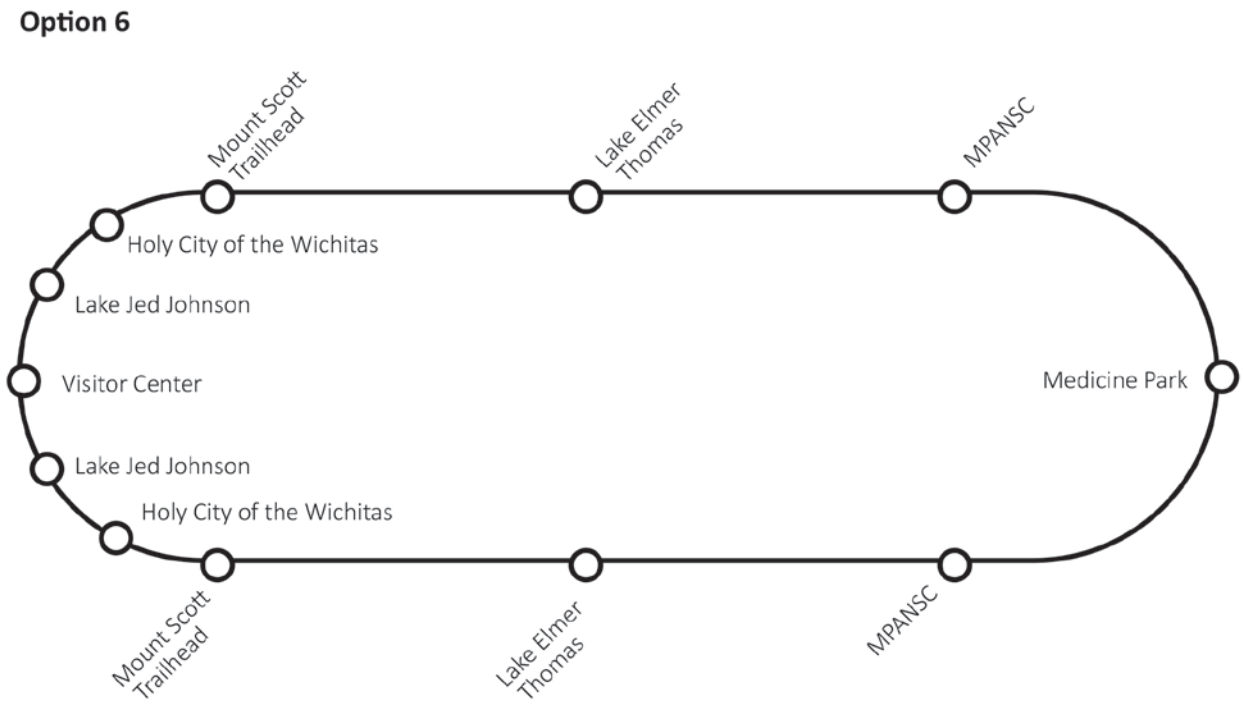
Bus #	Visitor Center	Mount Scott Trailhead	Lake Elmer Thomas	MPANSC	Medicine Park	MPANSC	Lake Elmer Thomas	Mount Scott Trailhead	Visitor Center
#1	8:00	8:08	8:12	8:16	8:22	8:28	8:32	8:36	8:47
#2	8:30	8:38	8:42	8:46	8:55	8:58	9:02	9:06	9:17
#1	9:00	9:08	9:12	9:16	9:25	9:28	9:32	9:26	9:47
#2	9:30	9:38	9:42	9:46	9:55	9:58	10:02	10:06	10:17
#1	Continues the same pattern throughout the day with departures every 30 minutes								
#2									
#1									
#2	16:30	16:38	16:42	16:46	16:55	16:58	17:02	17:06	17:17
#1	17:00	17:08	17:12	17:16	17:25	17:28	17:32	17:26	17:47
#2	17:30	17:38	17:42	17:46	17:55	18:58	18:02	18:06	18:17

Option 6: Option 5 Loop with additional stops at Jed Johnson Tower and Holy City of the Wichitas

Route Description

Option 6 (Figure 5-16) follows the same route at Option 5, but it adds two additional stops in WMWR: Jed Johnson Tower and Holy City of the Wichitas. This option would provide additional access to popular destinations in WMWR, and it would allow for potential partnerships with the Holy City of the Wichitas. However, it also adds time and expense to the circulator route. This loop would take approximately 85 minutes including lay-over time at the end of each circuit (see Table 5-5 for a sample schedule.)

Figure 5-15: Route Map for Circulator Option 6



Estimated Operating Cost

To provide departures every 30 minutes, this route would require three buses, which increases operating costs. The estimated annual operating cost for this route is $48,000-$76,800.

Other Considerations

Currently, the road to access Jed Johnson Tower is very narrow, raising concerns about its physical suitability for transit service. However, the cutaway buses assumed in this analysis are likely small enough to navigate this road. The road could be reconstructed to accommodate transit vehicles.

Sample Schedule

Table 5-6: Sample schedule for Circulator Option 6

Bus #	Visitor Center	Jed Johnson	Holy City	Mt. Scott Trailhead	Lake Elmer Thomas	Medicine Park Mus.	Medicine Park	Medicine Park Mus.	Lake Elmer Thomas	Mt. Scott Trailhead	Holy City	Jed Johnson	Visitor Center
#1	8:00	8:07	8:15	8:25	8:29	8:33	8:39	8:45	8:49	8:53	9:03	9:11	9:21
#2	8:30	8:37	8:45	8:55	8:59	9:03	9:09	9:15	9:19	9:23	9:33	9:41	9:51
#3	9:00	9:07	9:15	9:25	9:29	9:33	9:39	9:45	9:49	9:53	10:03	10:11	10:21
#1	9:30	9:37	9:45	9:55	9:59	10:03	10:09	10:15	10:19	10:23	10:33	10:41	10:51
#2	10:00	10:07	10:15	10:25	10:29	10:33	10:39	10:45	10:49	10:53	11:03	11:11	11:21
#3	10:30	10:37	10:45	10:55	10:59	11:03	11:09	11:15	11:19	11:23	11:33	11:41	11:51
#2	Continues the same pattern throughout the day with departures every 30 minutes												
#3													
#1													
#2	16:30	16:37	16:45	16:55	16:59	17:03	17:09	17:15	17:19	17:23	17:33	17:41	17:51
#3	17:00	17:07	17:15	17:25	17:29	17:33	17:39	17:45	17:49	17:53	18:03	18:11	18:21
#1	17:30	17:37	17:45	17:55	17:59	18:03	18:09	18:15	18:19	18:23	18:33	18:41	18:51

Option 6A: Option 6 Loop with additional stop at Mount Scott Summit

Route Description

Option 6A (Figure 5-17) follows the same route as Option 6, but it adds a trip to the summit of Mount Scott, a popular destination, in one direction of the loop. A trip to the summit provides logistical challenges, however. The trip up and down the mountain adds an additional 18 minutes to the circulator's run time. This trip could also be inconvenient for passengers who otherwise would not have wanted to ride the bus to the summit. For this reason, this report assumes that the route would only go to the summit in one direction of the loop; this would reduce the added time, but visitors who wanted to visit the summit could get off of the bus and catch a new bus every 30 minutes. The total running time per loop for this option would be 104 minutes including lay-over time at the end of each circuit (see Table 5-6 for a sample schedule).

Figure 5-16: Route Map for Circulator Option 6A

Estimated Operating Cost

To achieve departures every 30 minutes, Option 6A would require four buses on this route. The estimated annual operating cost would be $64,000-$102,400.

Sample Schedule

Table 5-7: Sample schedule for Option 6A

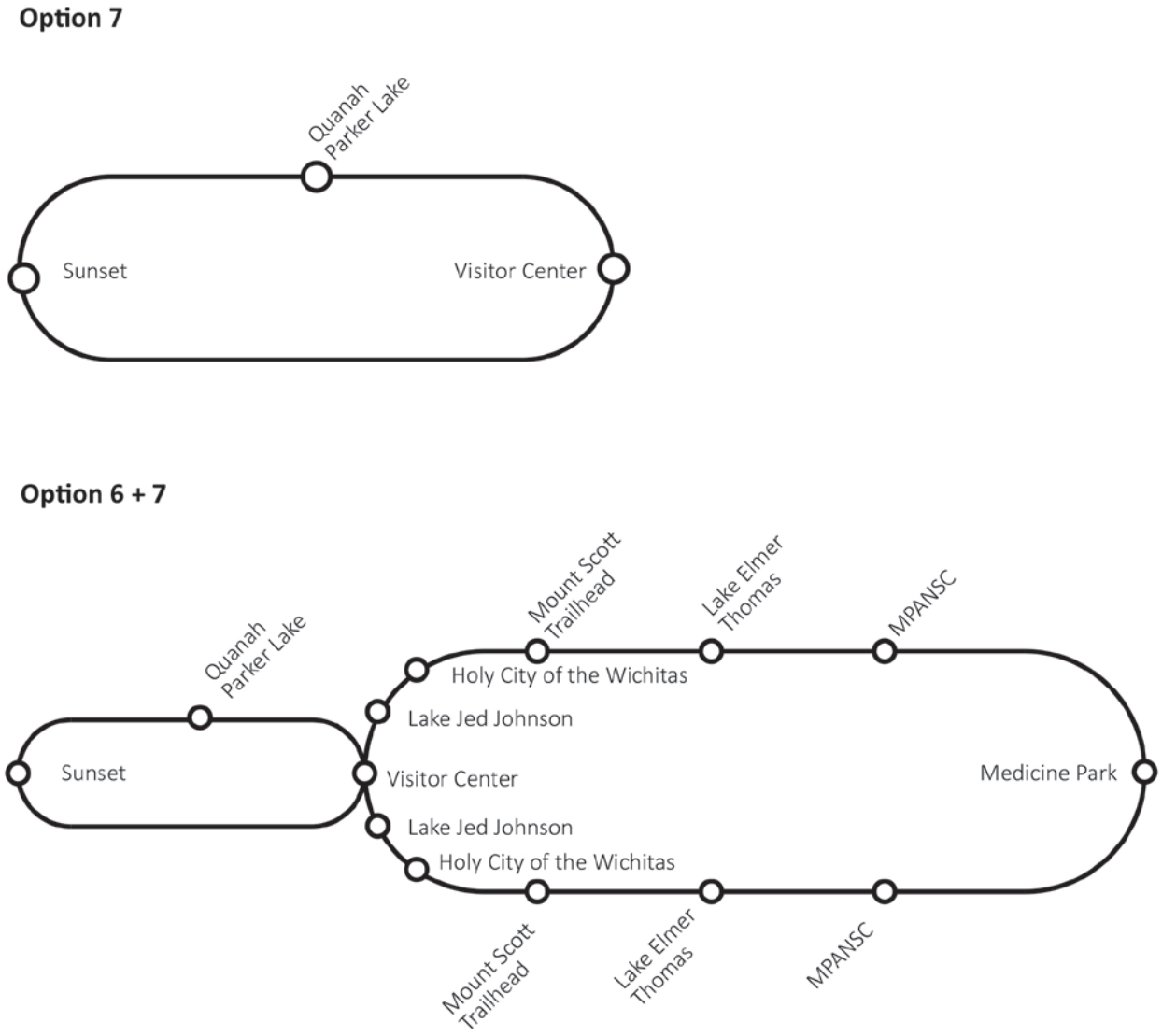
Bus #	Visitor Center	Jed Johnson	Holy City	Mt. Scott Trailhead	Lake Elmer Thomas	Medicine Park Mus.	Medicine Park	Medicine Park Mus.	Lake Elmer Thomas	Mt. Scott Trailhead	Sunmmit	Holy City	Jed Johnson	Visitor Center
#1	8:00	8:07	8:15	8:25	8:29	8:33	8:39	8:45	8:49	8:53	9:04	9:21	9:29	9:39
#2	8:30	8:37	8:45	8:55	8:59	9:03	9:09	9:15	9:19	9:23	9:34	9:51	9:59	10:09
#3	9:00	9:07	9:15	9:25	9:29	9:33	9:39	9:45	9:49	9:53	10:04	10:21	10:29	10:39
#4	9:30	9:37	9:45	9:55	9:59	10:03	10:09	10:15	10:19	10:23	10:34	10:51	10:59	11:09
#1	Continues the same pattern throughout the day with departures every 30 minutes													
#2														
#3														
#4	16:30	16:37	16:45	16:55	16:59	17:03	17:09	17:15	17:19	17:23	17:34	17:51	17:59	18:09
#1	17:00	17:07	17:15	17:25	17:29	17:33	17:39	17:45	17:49	17:53	18:04	18:21	18:29	18:39

Option 7: Western WMWR Coverage Loop with Stops at the Visitor Center, Quanah Lake, and Sunset

Route Description

Option 7 would provide transit service to the recreational destinations in western WMWR. It could be implemented in combination with Options 5, 6, or 6A to provide comprehensive transit coverage for WMWR. It is a short loop (see Figure 5-18 for route maps of Option 7 alone and in combination with Option 6). This route would provide convenient service from the Visitor Center to Quanah Parker Lake and Sunset. Total running time per circuit is 37 minutes (see Table 5-7 and Table 5-8 for sample schedules.)

Figure 5-17: Route Map for Circulator Option 7, the western coverage loop, alone (above) or added onto the stops in Option 6 (below)



Estimated Operating Cost

To achieve departures every 30 minutes, this route would require two buses, for an estimated operating cost of $32,000-$51,200 per year. One bus on this loop could achieve departures every 45 minutes and would then cost approximately $16,000-$25,600 per year.

However, if the stops in Option 7 were added to the loops described in Options 5 and 6A, the combined route would only require one additional bus because the additional time between circuit laps per bus in those options could be used to service those additional stops. Therefore, one loop that covered the stops in Options 5 and 7 would only require 3 buses and cost $48,000-$76,800 per year, and one loop that covered the stops in Options 6A and 7 would require 5 buses and cost $80,000-$128,000 per year. A combination of Options 6 and 7 would not realize this synergy, so adding these stops to Option 6 would require two additional buses for an overall cost of $80,000-$128,000 per year.

Other Considerations

The Western Coverage Loop would have the benefit of providing alternative methods to access western destinations like Sunset, which is currently the site of acute parking lot congestion. However, it would also enable additional access to ecologically sensitive areas of WMWR, including the Charon's Garden Wilderness, where visitor numbers are currently limited by parking availability. Expanding access to these sites may be contradictory to the WMWR CCP. Therefore, transit to this area may be inadvisable from a resource management perspective.

Sample Schedule

The sample schedule in Table 5-7 shows departures every 30 minutes.

Table 5-8: Sample schedule for Option 7 loop, 30-minute headways

Bus #	Visitor Center	Quanah Parker Lake	Sunset	Visitor Center
#1	8:00	8:05	8:18	8:32
#2	8:30	8:35	8:48	9:02
#1	Continues the same pattern throughout the day with departures every 30 minutes			
#2				
#1				
#2	17:00	17:05	17:18	17:32
#1	17:30	17:35	17:48	18:02

The sample schedule in Table 5-8 shows departures every 45 minutes.

Table 5-9: Sample schedule for Option 7 loop, 45-minute headways

Bus #	Visitor Center	Quanah Parker Lake	Sunset	Visitor Center
#1	8:00	8:05	8:18	8:32
#1	8:45	8:50	9:03	9:17
#1	Continues the same pattern throughout the day with departures every 45 minutes			
#1				
#1				
#1	17:00	17:05	17:18	17:32
#1	17:45	17:50	18:03	18:17

Discussion

As shown in Table 5-9, each option entails considerable differences in costs. Option 5 is the least expensive and would provide visitors with the fastest trip through WMWR. However, it does not provide access to some of WMWR's most popular destinations, including Holy City of the Wichitas, the Mount Scott summit, or popular hiking destinations on the western side of the refuge.

Options 6 and 6A increase access to the eastern WMWR destinations, but they require higher running times, which would necessitate additional buses to maintain departures every 30 minutes. Options 6 and 6A would increase costs by 50 percent and 100 percent, respectively.

Option 7 would expand service to western WMWR, which would have the potential to reduce parking congestion in popular destinations, such as Sunset. However, Option 7 would also raise environmental concerns as bringing more visitors to the western WMWR by transit risks exceeding the area's ecological carrying capacity.

Adding the western stops in Option 7 to Options 5 and 6A would add an additional $16,000 operating cost per year, whereas adding these stops to Option 6 would add an additional $32,000 per year. The difference in costs for adding Option 7 is due to the potential for synergy by using the extra time available at the end of each run for Options 5 and 6A. Option 6 does not have enough extra time to realize the same synergy between routes.

Table 5-10: Comparison of WMWR Circulator Transit Route Options

	Total Running Time (Min)	Number of Vehicles	Cost Per Trip	Annual Operating Costs	Cost per Passenger (5)	Cost per Passenger (10)	Cost per Passenger (15)
Option 5 – Loop: Visitor Center, Mount Scott Trailhead, Lake Elmer Thomas, MPANSC, Medicine Park	50	2	$50-$80	$32,000-$51,200	$10.00-$16.00	$5.00-$8.00	$3.33-$5.33
Option 6 – Option 5 + Jed Johnson Tower and Holy City of the Wichitas	85	3	$75-$120	$48,000-$76,800	$15.00-$24.00	$7.50-$12.00	$5.00-$8.00
Option 6A - (6 + Mount Scott Summit)	104	4	$100-$160	$64,000-$102,400	$20.00-$30.00	$10.00-$16.00	$6.67-$10.67
Option 7 as a separate loop	35	2	$50-$80	$32,000-$51,200	$10.00-$16.00	$5.00-$8.00	$3.33-$5.33
Option 5 + the stops in Option 7	86	3	$75-$120	$48,000-$76,800	$15.00-$24.00	$7.50-$12.00	$5.00-$8.00
Option 6 + the stops in Option 7	129	5	$125-$200	$80,000-$128,000	$25.00-$40.00	$12.50-$20.00	$8.33-13.33
Option 6A + the stops in Option 7	140	5	$125-$200	$80,000-$128,000	$25.00-$40.00	$12.50-$20.00	$8.33-13.33

Combined Alternative: Feeder Shuttle + Circulator

Route Description

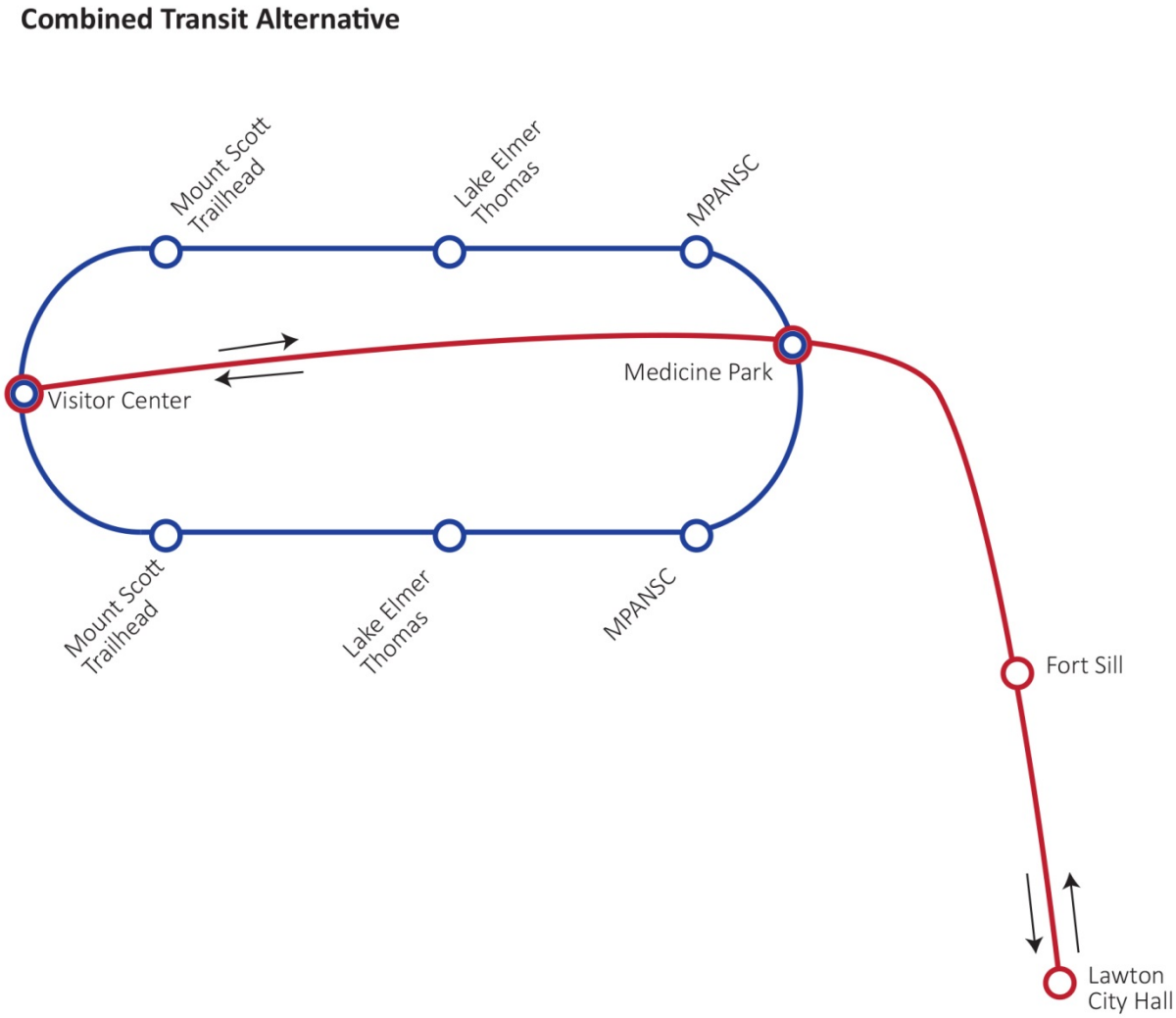
An alternative that pairs a shuttle that provides feeder access to WMWR with a separate circulator shuttle to provide access within WMWR is one way to achieve the goals of this study. With this approach, a shuttle running between Lawton and the WMWR Visitor Center (Options 1, 2, 3, or 4) every 90 or 120 minutes would be combined with a separate service that provides circulation within WMWR every 30 minutes (Options 5, 6, 6A, and/or 7). See Figure 5-19 for a schematic map of Access Option 2 combined with Circulator Option 5.

The advantage of separating these two services, rather than having one bus service cover all stops, is that they can run with different headways. A 90- or 120-minute headway for the feeder shuttle between Lawton and WMWR would save costs on a route that is expected to have a lower ridership due to the area's low transit ridership. Longer headways are also more acceptable on the shuttle to WMWR because visitors can plan their day around when to travel to WMWR.

The circulator shuttle, which is expected to be more heavily utilized, could then be designed to have a 30-minute headway to make it attractive for visitors who may drive to one destination in WMWR and take transit around the refuge. Longer headways on the circulator would make the shuttle service too inconvenient for visitors who may otherwise take it to travel between locations at WMWR; many visitors will not be willing to wait more than 30 minutes at a trailhead or parking lot to travel within the refuge.

A combined approach, running one shuttle between Lawton and WMWR every 90 or 120 minutes and another shuttle within the refuge every 30 minutes, could therefore achieve convenient service on the circulator shuttle while saving costs by minimizing the number of additional buses that would be required to achieve a 30-minute headway throughout the access and circulator routes if they were serviced by one bus loop. See Table 5-10 for cost estimates for the different potential combinations of access and circulator routes.

Figure 5-18: A schematic route map of the Combined Transit Alternative. In this map, Access Feeder Option 2 has been combined with Circulator Option 5.



Sample Schedule

Under this alternative, one shuttle service would run between Lawton and WMWR (Options 1-4), departing every 90 minutes. Another shuttle service would circulate within WMWR (Options 5-7), departing every 30 minutes. There would be two transfer points between the two shuttles: Medicine Park and the Visitor Center. See Table 5-11 for the estimated costs for the different combined transit alternatives.

Estimated Operating Costs

Table 5-11: Costs for Combined Transit Alternative, depending on the access and circulator options chosen

Access Shuttle Option	Circulator Option	Number of Vehicles (Access)	Number of Vehicles (Circulator)	Total Number of Vehicles	Annual Operating Cost (Access)	Annual Operating Cost (Circulator)	Total Operating Cost (Combined)
# 1	# 5	1	2	3	$16,000-$25,600	$32,000-$51,200	$48,000-$76,800
# 1	# 6	1	3	4	$16,000-$25,600	$48,000-$76,800	$64,000-$102,400
# 1	# 6A	1	4	5	$16,000-$25,600	$64,000-$102,400	$80,000-$128,000
# 1	# 6 + 7	1	5	6	$16,000-$25,600	$80,000-$128,000	$96,000-$153,600
# 2	# 5	1	2	4	$16,000-$25,600	$32,000-$51,200	$48,000-$76,800
# 2	# 6	1	3	4	$16,000-$25,600	$48,000-$76,800	$64,000-$102,400
# 2	# 6A	1	4	5	$16,000-$25,600	$64,000-$102,400	$80,000-$128,000
# 2	# 6 + 7	1	5	6	$16,000-$25,600	$80,000-$128,000	$96,000-$153,600
# 3	# 5	1	2	3	$32,000-$51,200	$32,000-$51,200	$64,000-$102,400
# 3	# 6	1	3	4	$32,000-$51,200	$48,000-$76,800	$80,000-$128,000
# 3	# 6A	1	4	5	$32,000-$51,200	$64,000-$102,400	$96,000-$153,600
# 3	# 6 + 7	1	5	6	$32,000-$51,200	$80,000-$128,000	$112,000-$179,200

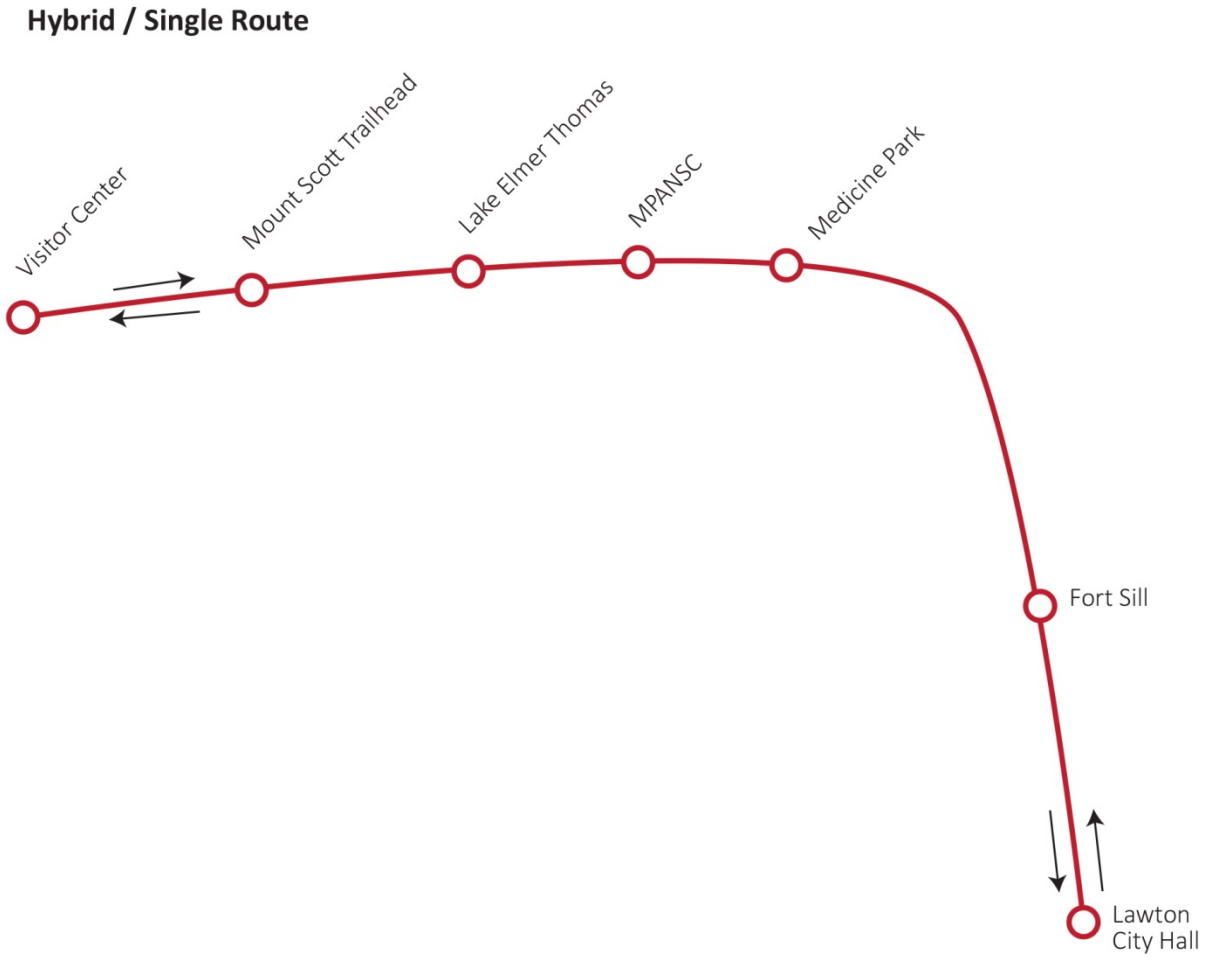
Hybrid / Single Route

Another approach that would achieve access to and mobility within WMWR is a hybrid approach in which the feeder shuttle from Lawton to WMWR and the circulator through WMWR would be achieved with a single route (Figure 5-20). The advantage of this approach would be that it would be simpler to run a single route than two separate bus routes and, depending on which stops it serves, could be less expensive. However, this option would either require a lower frequency of buses traveling between locations within WMWR or a substantial increase in costs to cover the route between Lawton and WMWR with the same frequency of service as the route within WMWR. For the purpose of this evaluation, the project team assumed a 60-minute headway, which is between the 90-minute headway for the access shuttle options and the 30-minute headway for the circulator shuttle options discussed above. At a 60-minute headway, the single route alternative would provide less convenient service within WMWR and may see lower ridership as a result; however, it would have more frequent service between Lawton and WMWR, increasing its convenience for trips to WMWR. See Table 5-12 for a sample schedule and Table 5-13 for estimated operating costs.

Route Description

An option for a Hybrid / Single Route with limited stops between Lawton and WMWR and within WMWR, analyzed here, would begin at Lawton Old City Hall and stop at Fort Sill, Medicine Park, MPANSC, Lake Elmer Thomas, the Mount Scott Trailhead, and the Visitor Center.

Figure 5-19: Route Map of the Hybrid / Single Route Option, serving stops between Lawton and WMWR and within WMWR in one bus route.



Sample Schedule

Table 5-12: Sample Schedule for Hybrid / Single Route Alternative

Bus #	Lawton City Hall	Fort Sill (Hwy 44)	Medicine Park	MPANSC	Lake Elmer Thomas	Mount Scott Trail	Visitor Center	Mount Scott Trail	Lake Elmer Thomas	MPANSC	Medicine Park	Fort Sill (Hwy 44)	Lawton City Hall
#1	8:00	8:20	8:42	8:48	8:52	8:56	9:07	9:18	9:22	9:26	9:32	9:52	10:14
#2	9:00	9:20	9:42	9:48	9:52	9:56	10:07	10:18	10:22	10:26	10:32	10:52	11:14
#3	10:00	10:20	10:42	10:48	10:52	10:56	11:07	11:18	11:22	11:26	11:32	11:52	12:14
#1	Continues the same pattern throughout the day with departures every 60 minutes												
#2													
#3													
#1	15:00	15:20	15:42	15:48	15:52	15:56	16:07	16:18	16:22	16:26	16:32	16:52	17:14
#2	16:00	16:20	16:42	16:48	16:52	16:56	17:07	17:18	17:22	17:26	17:32	17:52	18:14
#3	17:00	17:20	17:42	17:48	17:52	17:56	18:07	18:18	18:22	18:26	18:32	18:52	19:14

Operating Costs

Table 5-13: Estimated Operating Costs for Hybrid / Single Route Alternative

	Total Running Time (Min)	Number of Vehicles	Cost Per Trip	Annual Operating Costs	Cost per Passenger (5)	Cost per Passenger (10)	Cost per Passenger (15)
Limited Hybrid / Single Route	138	3	3	$75-$120	$48,000-$76,800	$15.00-$24.00	$7.50-$12.00

Conclusions and Recommendations

One critical factor in evaluating the transit alternatives analyzed above is how well they achieve the four goals of this study. The study team's evaluation of how well the transit alternatives meet these goals (Table 5-13) was based on the following questions:

1. *Habitat and Environmental Quality*: How well does each option improve environmental quality by a) encouraging visitor shift to less ecologically sensitive locations and b) reducing reliance on private vehicles? Options that include western coverage score poorly in this category because they threaten to increase strain on sensitive environmental resources.

2. *Visitor Experience*: How convenient is the transit service? Does it provide access to the destinations visitors want to visit? Options with short headways and that cover popular destinations score well in this category.

3. *Public Use Facilities*: How well does this option help WMWR administer safe, well-maintained, and energy-efficient facilities? Options that reduce congestion and promote public safety score well in this category, while those options that may introduce transit into areas that are not physically suitable score poorly. Options that score well in this category should also provide the appropriate amount of facilities for public use and avoid over-building facilities. Options that would lead to the over-supply of transit, and thus empty buses circulating the refuge, would score poorly on this criterion.

4. *Access*: How well does each option increase access to WMWR for mobility-impaired and transportation-disadvantaged groups? Options that provide access from Lawton, Fort Sill, and/or the Comanche Complex score well in this category.

Evaluation of Transit Alternatives

Table 5-13 evaluates how well each transit option in this report meets the goals of the CATP. The scoring is on a scale of one to four stars, with one being poor and four being excellent. Dashes indicate that the option does not meet the goal or may even contradict it.

Table 5-14: Evaluation of how well the transit alternatives fit the CATP goals

Transit Alternative	Goal 1: Habitat and Environmental Quality	Goal 2: Visitor Experience	Goal 3: Public Use Facilities	Goal 4: Access
Access Shuttle Option 1	**	*	*	**
Access Shuttle Option 2	**	*	*	***
Access Shuttle Option 3	**	*	*	***
Circulator Option 5	***	**	****	*
Circulator Option 6	****	***	***	*
Circulator Option 6A	**	****	**	*
Circulator + Western Coverage Option 5-6A + 7	--	****	****	*
Circulator Option 7 (western coverage loop alone)	--	**	***	*
Combined Service (Access Shuttle + Circulator that does not include western coverage)	****	****	***	****
Hybrid / Single Route	***	**	****	****

According to the ratings in Table 5-13, the alternative that best achieves these goals is the Combined Service Alternative, which combines a feeder shuttle service from Lawton to WMWR (Options 1-4) with a separate circulator service (Options 5-6A). The alternatives that include western coverage (Option 7) score high on Goals 2 and 4, since they provide service to an area that is very popular (Sunset) and offer the best potential for relieving parking lot congestion. However, they score the worst on Goal 1 because they provide increased access to the Charon's Garden Wilderness Area. Because habitat and environmental conservation are crucial to the Fish and Wildlife Service's mission, the study team does not recommend any transit alternative that includes transit service to Sunset.

The Combined Service Alternative best meets the CATP goals, but it is also the most expensive because it incurs the costs of both the feeder service and the circulator service (see Table 5-10). The Hybrid / Single Route Option, which provides access to WMWR and within WMWR in one hybrid route provides less convenient service within the refuge but is more cost-effective, because it requires fewer buses (see Table 5-12).

Another option to meet most of the CATP goals effectively within a more limited budget is to focus on providing only the circulator service (Options 5-6A). Providing a circulator service alone, without providing access into WMWR, would not achieve the goal of expanding access for local residents without access to cars. However, the circulator route has the potential to help WMWR achieve its other goals of reducing traffic and parking congestion by providing a way for visitors to park in one location on the refuge and travel around the refuge using transit.

Depending on how many riders use this service, this could help reduce the number of cars traveling between points in the refuge and relieve pressure on parking lots that are at or above capacity. Providing convenient transit service to new recreational amenities on the eastern side of the refuge may also encourage a shift in visitors towards recreational destinations that are less ecologically sensitive, which would be easier to visit than the Charon Gardens Wilderness Area. Focusing on a circulator route alone could be a good way to begin transit service with limited funds. WMWR could then expand service to include a feeder service if there is sufficient demand and financial support.

During this study's stakeholder outreach, LATS identified opportunities to pursue funding to operate a feeder route that would provide weekend service between Lawton, Fort Sill, and WMWR. This service could complement their goals to expand Lawton area transit service and to provide greater mobility for Fort Sill residents. Therefore, a hybrid route that provides feeder service to the refuge with limited stops in Eastern WMWR may be the option that best meets the goals of the CATP and may be feasible with partner support. One potential scenario would be for LATS to extend Orange Line service from Fort Sill to WMWR in partnership with the refuge, although this study does not specifically analyze the feasibility or costs of that option. Although WMWR must ultimately determine route choice based on refuge staff's goals for transit, the study team believes the hybrid feeder option is the most promising service option based on this analysis and stakeholder outreach.

Implementation Recommendations

The study group recommends that WMWR should approach transit service through a phased approach. WMWR could begin providing a limited service that would allow them to gauge market demand for transit before permanently implanting or expanding service. Gaining a better understanding of transit demand would help WMWR staff plan an appropriate level of transit service, and having evidence of demand for transit to and/or within WMWR will help WMWR develop a case for attracting additional funding or new partners.

Refuge staff should consider beginning with a pilot service for two years, after which period they can evaluate the demand for transit service at the refuge and the effectiveness of the service provided. Ridership data should be carefully collected throughout the pilot phase to inform this evaluation. Between the first and second years, staff could alter the service based on initial feedback or questions about optimal routes or schedules. At the end of the two years, the data should be analyzed to determine if the service should be expanded, altered, or discontinued. Through this approach, WMWR

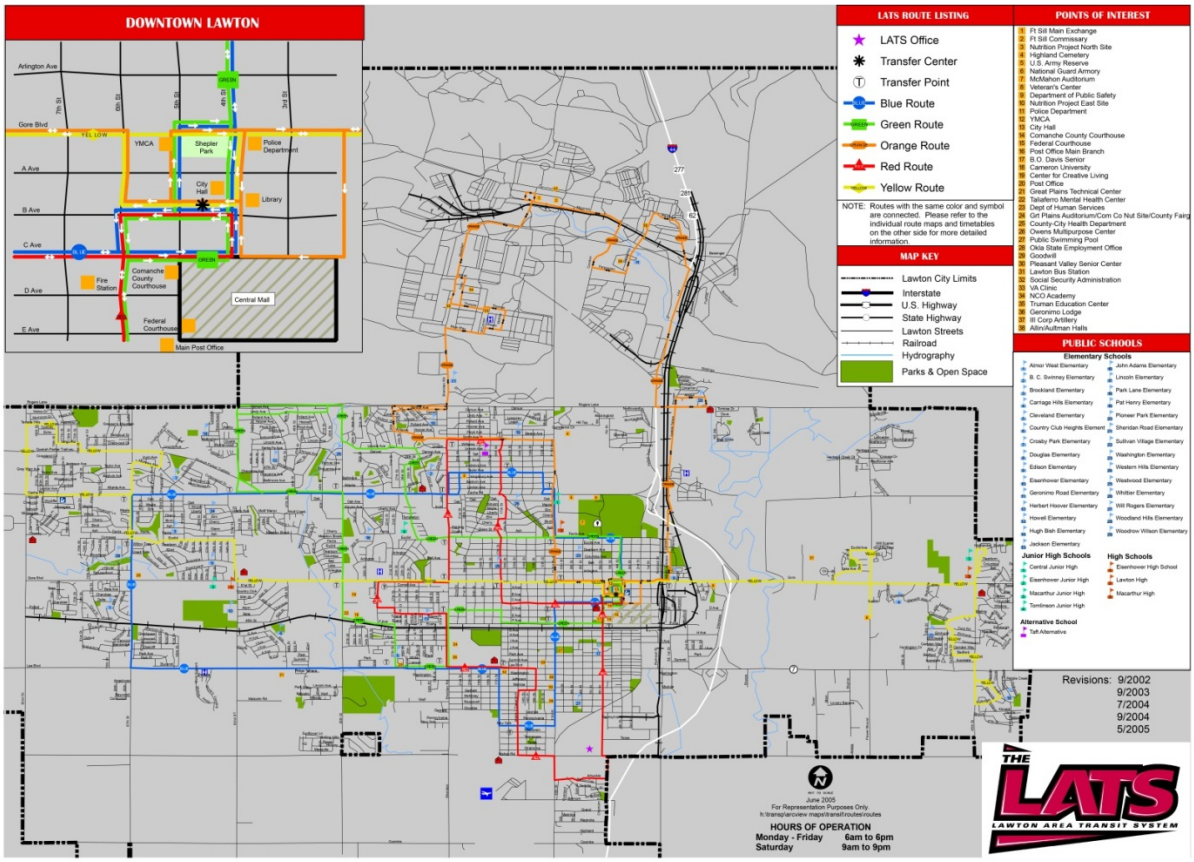
could start with a less ambitious transit system and expand service if there is demonstrated demand and additional resources become available.

Potential Resources for Implementation

LATS currently accesses Federal Transit Administration funds for operations and capital expenses and may be able to access additional funds to achieve a service expansion to WMWR. A transit system providing access to WMWR could also be eligible for Federal Highway Administration Funds funds under the Federal Lands Access Program (FLAP), which funds non-federal transportation facilities that provide access to, are adjacent to, or are located within Federal lands. FLAP provides funds for public roads, transit systems, and other transportation facilities, with an emphasis on high-use recreation sites and economic generators. To be eligible for FLAP funds, transportation facilities must be owned by or under long-term maintenance agreements with local, state, or tribal governments. Funds are awarded through a competitive application process managed by the Federal Highway Administration on a state-by-state basis. In the case of a WMWR transit system, the City of Lawton could apply for funds to pay for the acquisition of buses, with the U.S. Fish and Wildlife Service as a project sponsor. The acquisition of buses could be a capital contribution towards the transit service. These funding sources may make a transit service to WMWR more financially feasible.

Appendix 5-A: LATS Bus Routes

Figure 5-20: LATS Bus Routes and Hours of Operation, Revised 2005



Source: LATS, http://www.ridelats.com/

6. Summary of Recommendations

Table 6-1 arrays the proposed time-sequenced strategies against the original goals and objectives of this study. Many of the strategies help the refuge meet more than one of its goals.

Table 6-1: CATP Goals and Strategies

Strategy	Goal 1: Habitat and Environmental Quality		Goal 2: Visitor Experience			Goal 3: Public Use Facilities			Goal 4: Access	
	Obj. A	***Obj. B***	***Obj. A***	***Obj. B***	***Obj. C***	***Obj. A***	***Obj. B***	***Obj. C***	***Obj. A***	***Obj. B***
Short Term (1-3 Years)										
Implement low cost bicycle signage and striping improvements on roadways		X	X			X		X	X	
Offer special use permits to private tour operators on the eastern side of the refuge	X	X							X	
Complete the LETRA Trail and Jed Johnson Tower Trail accessibility improvements	X		X		X	X	X			X
Publish live parking information	X			X				X		
Update refuge website and maps	X			X		X				
Develop and install wayfinding and trailhead signage	X	X	X	X	X	X				
Develop biological resource thresholds to inform parking management	X					X				
Medium Term (4-10 Years)										
Initiate a 2 year transit pilot project	X	X				X			X	X
Design and build the Mt. Scott Summit Trail	X		X							
Implement transit accommodations at and approaching the Jed Johnson Tower Trailhead	X		X			X	X		X	X
Pursue partnerships to develop a bicycle share pilot between refuge, Medicine Park, and LETRA	X	X	X	X					X	
Long Term (11-15 Years)										
Complete the Environmental Education Center to Visitor Center trail	X	X	X			X	X	X	X	X
Implement sustained seasonal transit system depending on pilot	X	X				X			X	X

U.S. Department of Transportation
John A. Volpe National Transportation Systems Center
55 Broadway
Cambridge, MA 02142-1093

617-494-2000
www.volpe.dot.gov

DOT-VNTSC-FWS-14-01