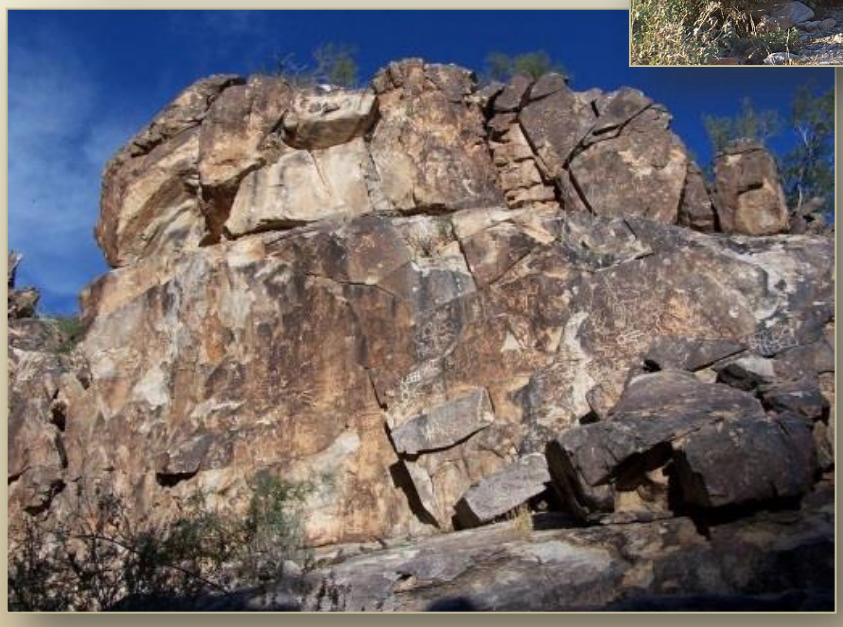
White Tank Mountain Regional Park

Master Plan Update
2014-2034



Maricopa County
Parks and Recreation

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White Tank Regional Park Master Plan Update (2014-2034)

Recommended by:

MARICOPA COUNTY PARKS AND RECREATION DEPARTMENT

R.J. Cardin

Director, Maricopa County Parks and Recreation Department

2/4/2014

[Date]

MARICOPA COUNTY BOARD OF SUPERVISORS

FEB 24 2014

Denny Barney, Chairman Date

Attest

FEB 24 2014

Clerk of the Board Date

Approved as to Form:

2/6/14

Attorney for Maricopa County Date

Maricopa County
Parks and Recreation

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United States Department of the Interior

BUREAU OF LAND MANAGEMENT
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MARICOPA COUNTY PARKS & RECREATION DEPARTMENT

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R. J. Cardin, Director
Maricopa County
Parks and Recreation Department
234 N. Central Avenue, Suite 6400
Phoenix, AZ 85004

Dear Mr. Cardin:

This is in response to a request from Leigh E. Johnson, of your staff, to review and comment on the White Tank Mountain Regional Park Master Plan Update (2014-2034) on lands patented to Maricopa County (02-2002-0003, 02-72-0048, 02-67-0030, 02-69-0047, 02-67-0031) under the Recreation and Public Purposes (R&PP) Act of 1926.

The Bureau of Land Management (BLM) has reviewed the Master Plan Update and determined that the proposed improvements are consistent with the Recreation and Public Purposes Act and the patents listed above. It is our understanding that your Department intends on presenting this Master Plan Update to the Board of Supervisors later in February for final approval. Once approved by the Board, please notify this office and the appropriate files will be noted with the Master Plan Update.

If you have any questions, please contact Jim Andersen at (623) 580-5570.

Sincerely,

D. Remington Hawes

Rem Hawes
Field Manager

cc: Leigh E. Johnson

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Acknowledgements
This master plan update was a collaborative process that involved the guidance and expertise of many. The Maricopa County Parks and Recreation Department would like to thank the Planning Team who committed their time to monthly meetings and document review; likewise to the Stakeholder Advisory Group who took time out of their personal lives to provide their invaluable input.

Planning Team
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Michele Kogl, Planning and Development Manager
Allen Ockenfels, Trails Development Manager
Fareed Abou-Haidar, GIS Technician
Leigh Johnson, Park Planner

Stakeholder Advisory Group
Jamil Coury
Linda Gilgosch
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This Master Plan update was also made possible by the contributions and guidance of the following:

- Maricopa County Board of Supervisors
  - Denny Barney, District 1
  - Steve Chucri, District 2
  - Andy Kunasek, District 3
  - Clint L. Hickman, District 4
  - Mary Rose Wilcox, District 5
- Maricopa County Parks and Recreation Commission
  - Jack Stapley, District 2
  - Anne Lynch, District 3
  - Dr. Robert Branch, District 4
  - Carlton Yoshioka , Member-at-Large
  - Rod Jarvis, Member-at-Large
- Maricopa County Parks and Recreation Department staff
- Maricopa County Sheriff's Office, Mountain Patrol Division
- Bill "Doc" Talboys, Interpretive Ranger, MCPRD (retired)
- Shelly Rasmussen, Interpretive Ranger, MCPRD (retired)
- Public meeting participants

The Department would also like to thank its agency partners at the City of Surprise, City of Buckeye, Arizona Game and Fish Department, and the Bureau of Land Management - Phoenix District Office for their input and guidance.

The Maricopa County Parks and Recreation Department would also like to thank the tireless efforts of the park staff and volunteers, without whom the park could not operate.

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Glossary of Terms and Abbreviations

Term	Definition
ADA	American's with Disabilities Act
ADOT	Arizona Department of Transportation
ADWR	Arizona Department of Water Resources
AMA	Active Management Area
APS	Arizona Public Service Company
ASU	Arizona State University
ARS	Arizona Revised Statutes
AZGFD	Arizona Game and Fish Department
AZGS	Arizona Geological Survey
ASLD	Arizona State Land Department
BH-RMP	Bradshaw-Harquahala Record of Decision and Approved Resource Management Plan
BOS	Board of Supervisors
BLM	Bureau of Land Management
CIP	Capital improvement plan
County	Maricopa County
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ET	Evapotranspiration
FTE	Fulltime Equivalent (employee)
FY	Fiscal Year
GIS	Geographic Information System
GPS	Geographic Positioning System
HDMS	Heritage Data Management System
HUC	Hydraulic Unit Code
I-	Interstate (number)
IGA	Intergovernmental Agreement
LEED	Leadership in Energy & Environmental Design
LMP	Lightscape Management Plan
MAG	Maricopa Association of Governments
MCDOT	Maricopa County Department of Transportation
MCLD	Maricopa County Library District
MCPRD (or Department)	Maricopa County Parks and Recreation Department
MCSO	Maricopa County Sherriff's Office
MOU	Memorandum of Understanding
MPA	Municipal Planning Area
n.d.	No date
NOx	Nitrogen Oxide
OHV	Off-Highway Vehicle
PM	Particulate Matter
RAE	Recreation Activity Evaluation
R&PP	Recreation and Public Purposes Act

Term	Definition
RTP	Regional Transportation Plan
RV	Recreational Vehicle
SAG	Stakeholder Advisory Group
SERI	Species of Economic and Recreational Importance
SGCN	Species of Greatest Conservation Need
SHPO	State Historic Preservation Office
SR-	State Route (number)
SWAP	State Wildlife Action Plan
USFWS	U.S. Fish and Wildlife Service
VOC	Volatile Organic Compounds
VRM	Visual Resource Management
WTIA	White Tanks Improvement Association

Date of Master Plan amendments or updates:

Date	Activity
1964	Master Development Plan (original)
2014	Master Plan update

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Table of Contents

List of Appendices (under separate cover)

List of Maps, Figures, and Tables

Maps

Figures

Tables *Page*

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CHAPTER 1 – INTRODUCTION

This chapter introduces the concept of a regional park and the planning activities that accompany it. It also provides a general overview of the project, the vision, mission, and theme(s) of the park.

The regional park fills a void between city and state or national parks. Regional parks are located outside the metropolitan area (although with rapid development, this is becoming less and less the case) but within reasonable driving distance to the population for which it was planned and attempts to maintain a buffer from urban encroachment.

A regional park is defined as a natural, unspoiled area providing its visitors an escape from city trappings, with enough space and facilities for day and overnight use. A regional park provides passive activities (e.g. hiking, walking, horseback riding, picnicking, camping, nature study and sightseeing) that allow its visitors to unwind and immerse themselves in nature. A regional park may have unique topography and scenery or hold special historical or archaeological interest. A regional park provides a blend of unspoiled nature, wilderness preserve and refuge, and open space, offering its visitor(s) a sense of remoteness.

Its development, phased in over time, is geared toward facilities that encourage enjoyment of the natural environment while still providing some comforts of home. All development is carefully patterned and designed to conform to the landscape, avoiding a crowded feeling, and typically includes a nature center, picnic tables and shelters, campsites, a trail system, and adequate support facilities (parking, restrooms, concessions, etc.).

Therefore the regional park system serves to preserve the mountains, canyons, native vegetation and wildlife in their natural state while also encouraging the enjoyment of these natural resources by providing well planned and appropriate facilities. White Tank Mountain Regional Park, one of ten regional parks or conservation areas, offers the opportunity to camp or picnic, to hike or explore, and satisfies our primitive instincts and restores our sense of well-being.

1.1 Project Background

The White Tank Mountain Regional Park entered the Maricopa County park system in 1961 and its master plan was written in 1964. Many components of the master plan have never come into fruition while at the same time public use has often dictated when and where development has occurred. This update to the master plan is to bring those disparities back into alignment and to steer future development of the park. This plan is based on a 20-year outlook and should be referred to on a regular basis and updated if needed. This plan is meant to be flexible while also providing long-term direction to the Park Supervisor, senior management, the public, and other interested parties while continuing to protect the park's resources both natural and built.

White Tank Mountain Regional Park is a component of the Maricopa County regional park system and is to date the largest at 29,572 acres and features rugged mountain terrain, gentle foothills, and open valley views. The system includes ten parks or conservation areas that comprise over 120,000 acres and encircle the Phoenix metropolitan area. The park system provides recreational and educational opportunities for residents and visitors alike.

1.2 Vision, Mission, and Theme

This plan is meant to align with the vision and mission of the Maricopa County Parks and Recreation Department (MCPRD or Department). The parks unique combination of wilderness and cultural interests automatically provides a basic direction for the park's planning and development and is subsequently reflected in the parks operational and marketing themes.

1.2.1 Vision and Mission

This plan aligns with the vision and mission set forth by the Department. The vision and mission are:

"Our vision is to connect people with nature through regional parks, trails and programs, inspire an appreciation for the Sonoran Desert and natural open spaces, and create life-long positive memories."

"Our mission, through responsible stewardship, is to provide the highest quality parks, trails, programs, services and experiences that energize visitors and create life-long users and advocates."

1.2.2 Themes

The 1964 White Tank Mountain Regional Park Master Development Plan acknowledges that while all parks try to provide many of the same basic features, no park can be all things to all people and that each park has its own unique qualities. In addition, it noted that the park possesses a unique combination of wilderness characteristics and archeological interests that should guide development and management of the park. That principle remains unchanged today. Recreation is an obvious component to the park and with its unique natural and cultural resources it is ripe for educational opportunities as well. MCPRD has established an operational theme and a marketing theme to reflect this character of the park.

Operational Theme

The White Tank Mountain Regional Park Master Plan update is aligned with the Maricopa County Parks and Recreation 2009 Strategic System Master Plan that recommends keeping the park as a "preservation, conservation, and education" based park. As such, its priority mandates have been identified in Table 1-1:

Table 1-1: Themes and Mandates

Maricopa County Park	**White Tank Regional Park**
Operational Theme	**Preservation, Conservation and Education Park**
Priority Mandates	
1 – Preserve the natural setting and environmental aspects of the park by heavily restricted use and limited public access.	
2 – Devote resources to the repair and replacement of existing infrastructure.	
3 – Pursue limited development to enhance the quality and diversity of recreational opportunities.	
4 – Acquire additional property to create a buffer from encroaching external development.	

Source: Maricopa County Parks and Recreation Strategic System Master Plan, June 2009, page 203.

Until a new department-wide strategic plan is implemented that changes these priority mandates, any proposed park improvement project (i.e. capital development or programmatic change) should support one or more of these mandates.

Marketing Theme

Complimentary to its operational theme, each park also carries a marketing theme. Shortly after the 2009 Strategic System Master Plan was adopted, each park selected a "theme" that best represents the park's spirit or essence. The themes were vetted through feedback via community focus groups and park staff meetings. As a result, the primary themes identified for White Tank Mountain Regional Park were "*petroglyphs and Native American history*" with the tag line of "*where education and nature meet*". This placed an emphasis on the wilderness experience and was carried forward in the MCPRD Marketing Plan.[1]

Although the park has many amenities to offer from mountain biking to camping, with the impressive natural and cultural assets of the park, there are ample opportunities to promote this theme by providing additional educational programs as well interpretive opportunities. Any proposed programming should also keep these themes at the forefront.

[1] Themes are further outlined in MCPRD Connecting People with Nature Marketing Plan (12/6/11 revision), page 44.

CHAPTER 2 - MASTER PLAN PROCESS

This chapter provides the purpose of the master plan and reviews the master plan update process, including the public participation program, planning issues, and a recreation activity evaluation conducted during the project. This is the first master plan update the Department has undertaken and it shall be used as a template for future park master plan updates.

The planning process for this project involved numerous tasks and relied on input from the planning team and other key Department staff members, a stakeholder advisory group, and the general public over the course of 18 months. Some tasks were completed simultaneously but entailed gathering or analyzing different sets of information. Each task was tracked on a timeline to provide direction to the planning team.

2.1 Purpose of the Master Plan

The purpose of this plan is to update the 1964 Master Development Plan to reflect current use of the park as well as to identify and address community needs and concerns, characterize and evaluate environmental resource information, and identify other potential recreational opportunities suitable for inclusion in the park.

The ultimate purpose of developing a park master plan is to outline the long-range vision for the park as well as to guide development priorities that will provide for both the public's enjoyment and the protection of the park's resources. The master plan provides a conceptual planning framework for establishing those priorities. It will also assist the park with upholding the standards for a "Quality County Park System" per the 2009 Strategic System Master Plan.

2.2 Previous Planning Efforts

This is the first major update to the original master plan for the park. Several plans played an important role in shaping this master plan. Specifically, the 2009 Strategic System Plan guides the decision-making for future development and management of the park system; it also provides recommendations on how the park system might improve itself. The Connecting People with Nature Marketing Plan took additional steps to identify the predominate feature of each park and promote a "theme" for each as well as a timeline for implementation of that theme. The annual business plan will outline short-term projects and goals to further enhance or maintain park resources.

This plan consulted the following list of plans and documents:

- Master Development Plan, White Tank Mountains Regional Park, Maricopa County Parks and Recreation Commission (August 1964),
- Maricopa County Regional Park System Plan, Volumes 1 and 2 (1965),
- Maricopa County 2020 Eye to the Future, White Tanks Grand Avenue Area Plan (December 6, 2000),
- Maricopa County 2020 Eye to the Future, October 1997 (Revised August 2002),
- Trail System Plan, White Tank Mountains Regional Park, Maricopa County Parks and Recreation Department (2002),
- Integrated Contingency Plan, Spill Prevention, Control and Countermeasure Plan; Storm Water Pollution Prevention Plan (n.d.),

- Maricopa County 2020 Eye to the Future, Olive Avenue Scenic Corridor Design Guidelines (March 2006),
- MCPRD Strategic System Master Plan (June 2009),
- MCPRD Connecting People with Nature Marketing Plan (December 6, 2011 revision), and
- White Tank Business Plan, Maricopa County Parks and Recreation Department (May 2012).

2.3 Plan Amendments or Updates

This plan should be reviewed annually by park staff to insure their knowledge of and adherence to this plan and to evaluate implementation progress. At a minimum, this plan should be revised and updated every 20 years to take the changing needs of the County and the community into consideration.

If any major and/or sudden changes take place prior to the 20 year mark, it may also be time to update this plan. Major amendments to this plan may require public notification and as such, all potential changes should be reported to executive management and planning staff for consideration. Major amendments may include changes to the Management Zone; adjacent land use changes or development; acts of nature that dramatically alter the park; any other action that would permanently affect the land; and/or an occurrence that is not within the scope of the master plan.

Minor amendments or updates to the plan should be made as needed and do not require public participation or formal approval. This includes updating demographic and other statistical information; updates to appendices such as insertion or removal of annual reports (such as business plan, marketing plan, etc.); new or updated resource information; and/or to correct grammatical or formatting issues. Minor amendments or updates should also be reported to executive management and planning staff for consideration.

2.4 Agency Participation Program

2.4.1 Department Participation

The master plan update was developed internally by Department planning staff, park staff, and senior level management. Department staff worked individually and met as a group throughout the planning process in order to define the scope of the master plan, review project information, consult the public, and develop and analyze draft park improvement projects, and to finalize the master plan update.

2.4.2 Parks and Recreation Commission

Department planning staff provided periodic updates or presentations to the Parks and Recreation Commission and invited them to provide feedback. These meetings were open for the public to attend and make comments; however, no members of the public provided feedback during these meetings. Presentations or updates were given on the following dates:

- November 13, 2012,
- April 9, 2013,
- November 12, 2013, and
- January 21, 2014.

The Commission provided its approval recommendation on January 21, 2014. Their support is acknowledged on the signature page in the front of this document.

2.4.3 Board of Supervisors

This plan was presented to the Board of Supervisors (BOS) on February 26, 2014 for their approval**.** The public is invited to attend BOS meetings. The BOS approved this plan as acknowledged on the signature page in the front of this document.

2.4.4 Agency Participation

Department planning staff engaged its agency partners such as City of Surprise, Town of Buckeye, Arizona Game and Fish Department (AZGFD), Maricopa County Sherriff's Office (MCSO), and Maricopa County Department of Transportation (MCDOT) in one-on-one meetings as well as by follow-up phone calls or emails. The Department also invited each agency (and others throughout the metro area[1]) to attend public open house meetings and to provide comments. One-on-one meetings were held:

- City of Surprise:
  - November 19, 2012, at Surprise City Hall,
  - July 16, 2013, at Surprise City Hall,
  - November 5, 2013 at Surprise City Hall (presentation to City Council),
- Town of Buckeye:
  - November 29, 2012, at Buckeye Town Hall,
  - July 10, 2013, at Buckeye Town Hall,
- AZGFD:
  - December 20, 2012, at Department office,
  - August 14, 2013, at Department office,
- MCSO:
  - June 26, 2013, at Department office, and
- MCDOT:
  - June 27, 2013, and
  - November 8, 2013, at MCDOT office.

The majority of park land was acquired by the Department via the Recreation and Public Purposes Act (R&PP) and must remain consistent with R&PP requirements and land patents. As a result, the Department consulted with the BLM and received its written approval of this plan and is found in the front of this document.

Planning staff sought input from Arizona State Land Department and had several telephone discussions and email exchanges with their representative, after which their comments were incorporated into the final plan update. Planning staff also sought input from potentially interested Native American communities regarding this master plan update. Consultation letters were mailed to the following communities: Ft. McDowell Yavapai Nation, Gila River Indian Community, and Salt River Pima-Maricopa Indian Community. No responses were received. This is discussed in detail in Chapter 3.7.4.

2.5 Public Participation Program

A public participation program was designed by planning staff in order to inform the public of the planning process, to identify recreational needs, and to solicit as much public and stakeholder feedback as feasible. The various components included:

[1] DMB Associates (the Verrado community HOA representative); City of Phoenix; Pueblo Grande Museum; Heard Museum; City of Litchfield Park; Sun City West; City of Goodyear; Arizona State Land Department; City of Peoria; White Tank Riding Stables; Bureau of Land Management; Maricopa County Library District; APS.

2.5.1 Arizona State University (ASU) Park Visitor Study

ASU periodically performs visitor use surveys on behalf of the Department. Visitors are asked questions by an interviewer during an in-park survey. Visitors are also asked to participate in a longer take-home survey and provide more detailed responses to questions. Survey responses for the year 2012-2013 were taken into consideration when developing park improvement projects.

2.5.2 Stakeholder Advisory Group (SAG)

A major component of the public participation program was the formation of a Stakeholders Advisory Group (SAG). The purpose of the SAG was to establish a small group representing a range of opinions in a forum small enough to allow for education of the participants, detailed discussion of issues, and informal dialogue. Members were selected based on their knowledge of the park, capability to commit time required throughout the project, and willingness to be impartial. The group was comprised of four avid park users with varying recreational interests, with planning staff and the Park Supervisor serving as facilitators. The group's comments and concerns were integrated into the planning process and assisted in the development of the recommended park improvement projects.

The SAG met four times between March and August 2013 at White Tank Mountain Regional Park Nature Center; a list of participants is included in Appendix A.

- March 8, 2013 (9:00-11:00am),
- April 19, 2013 (9:00-11:00am),
- June 28, 2013 (9:00-11:00am), and
- August 16, 2013 (9:00-11:00am).

Comments received during these meetings reflected a general sense of happiness with the park and its performance although the group did provide its insight on potential upgrades to the park. Briefly, those comments included:

- Develop modest facilities on the west side of park (small visitor center, trailhead, trails),
- Expand the horse staging area to better accommodate large trailers; include a restroom and a covered picnic area,
- For visitors who camp with horses, provide a corral (or space to set up one's own corral) in a camping area,
- Install a restroom at the competitive track,
- Need additional access points (from Greenway, Bell, or to the north and west),
- Need additional trail connections (Willow to Mesquite to Goat Camp trail),
- Offer additional trail options (ADA or family trails, GPS trail markers),
- No shooting range, water park, OHV use, mini-golf, major roads or invasive development,
- No need for thousands of picnic or camping sites as stated in 1964 master plan, and
- Earlier summer hours; later evening hours.

2.5.3 Public Open House Meetings

The public was notified of the planning process and their feedback was sought through two public meetings and surveys or comment cards. Additional comments were captured through the park website, email, and by park staff members' discussions with citizens. More information on the public participation process can be found in Appendix B.

Surveys and/or feedback forms were provided at each public meeting to gather the public's opinion. Each meeting was followed by a 30-day open comment period to collect the needs and preferences of those who were unable to attend the meeting(s) in person. Also during these 30-day periods, poster boards were left on display at the park's nature center with comment forms available for the community to review and provide additional feedback.

The first public meeting was held March 27, 2013 (6:00-8:00pm) at the White Tank Nature Center where 10 people signed in and three comment cards received. Thirty-five additional responses were received during the open comment period. Comments received during this time expressed their general happiness with the park and its performance (however, many comments were deemed outside of the scope of this master plan). Hikers represented the largest share of respondents. Briefly, some comments included:

- A general desire for additional trail options,
- Partner with other agencies for additional trailheads/trails,
- Maintain wildlife connections,
- Acquire buffer parcels,
- Protect natural and cultural resources,
- Develop north and/or west side of park,
- Prefer the natural feel of the park,
- Additional campsites,
- No tram or lake, and
- Pursue partnerships.

The second public meeting was held September 7, 2013 (10:30am-12:30pm) at the White Tank Nature Center where 25 people signed in and eight comment cards received. Twenty-eight additional responses were received during the open comment period. Comments received during this time expressed their general approval with the park improvement projects as presented (however, a few additional comments were deemed outside of the scope of this master plan). Bicyclists represented the largest share of respondents. Briefly, comments included:

- Acquire additional lands to buffer the park,
- Develop and promote a "dark sky" preserve,
- Need additional play areas for children,
- Good general plan and involvement procedure,
- Do not over-improve. Keep it as nature built it,
- Need a coffee shop/café,
- New trail connections,
- Expanded camping is great,
- No ATV's or such in this park,
- Cabins are a good idea,
- Upgrades to competitive track are good,
- Expand trails for mountain bikers,
- Allow rock climbing/rappelling,
- Maintain a tent camping only area, and
- Include a north entrance/trailhead.

Figure 2-1: Public Open House Meeting (September 2013)

2.5.4 Project Website

Information was posted on the park website to keep the public and other interested parties apprised of the planning process. The public was also invited to provide comments through the park website at http://www.maricopa.gov/parks/white_tank/wtproject.aspx, by sending an email or letter to planning staff, or by completing an online survey or questionnaire during each 30-day comment period.

2.5.5 Media Coverage

A general press release was issued at least 30 calendar days prior to each public open house meeting and made available on the County website and Department website. Facebook[2] was also utilized to inform the community of public open house meetings. Press releases are contained in Appendix B. Additionally, these news outlets published (or posted online) the press release:

- Maricopa County Office of Communications, http://www.maricopa.gov/Communications/CountyNews.aspx ,
- Arizona Boating and Watersports, Western Outdoor Times, http://azbw.com/Maricopa_Arizona_County_Parks_Updates.php,
- Verrado Home Owners Community, http://www.verrado.net/, and
- West Valley View, http://content.yudu.com/Library/A2cr9v/WestValleyViewVol28I/resources/index.htm?referrerUrl=http%3A%2F%2Fwww.westvalleyview.com%2F .

2.6 Planning Issues

Tight budgets and staffing are the top planning issues. Budgets and staffing will impact all areas of the park and are always of concern. The budget will dictate the number of staff employed at the park and the number of park improvement projects that can be successfully completed.

Notwithstanding that, the remaining planning issues identified during scoping for the project were identified by the Planning Team and can be grouped into five major categories: develop new facilities; maintain/rehabilitate existing facilities; education/interpretation; administrative; and resource protection. The park improvement recommendations, as detailed in Chapter 6, will address these concerns while supporting the parks priority mandates and themes.

2.7 Recreation Activity Evaluation (RAE)

A Recreation Activity Evaluation (RAE), Table 2-1, was prepared to identify various recreation opportunities appropriate for consideration in the park. In the RAE, potential park uses were compared against environmental resource, management, and operational criteria. Throughout the process, the vision statement, operational theme (preservation, conservation, and education) and its four priority mandates were used to guide development and evaluation of the alternatives.

[2] White Tank Facebook page: https://www.facebook.com/WhiteTankPark

Table 2-1: Recreation Activity Evaluation (RAE)

Type	Activity	Complies with MCPRD Policy	Supports Park's Theme(s)	Supports one or more Park Priority Mandate	Public Interest L	M	H	Public Opposition L	M	H	Regional Availability L	M	H	Potential Site Disturbance L	M	H	Infrastructure Requirement L	M	H	Operations & Maintenance L	M	H	Potential Revenue L	M	H	Considered for WT Master Plan
Camping	Family: upgrade/expand	Y	Y	Y																						YES
Camping	Back country	Y	Y	Y																						YES
Camping	Youth: expand	Y	Y	Y																						YES
Camping	Group: upgrade restroom	Y	Y	Y																						YES
Camping	Willow: renovations	Y	Y	Y																						YES
Camping	Area 1: convert to RV camping	Y	Y	Y																						YES
Camping	With horses	Y	Y	Y																						YES*
Trails	Motorized: OHV	N	N	N																						NO
Trails	New connections (multiple locations)	Y	Y	Y																						YES
Trails	To towers	Y	N	N																						NO
Trails	Competitive track (beginner level)	Y	Y	Y																						YES
Trails	Bike park elements	Y	Y	Y																						YES
Trails	Wildlife Trail to barrier-free	Y	Y	Y																						YES
Trails	Competitive track connection to Ironwood	Y	Y	Y																						YES
Picnic	Day Use: shaded picnic	Y	Y	Y																						YES
Picnic	Waterfall: renovations	Y	Y	Y																						YES
Picnic	Area 4: renovations	Y	Y	Y																						YES
Picnic	Area 7: renovations	Y	Y	Y																						YES
Interp/Education	Area 3: convert to kids education area	Y	Y	Y																						YES

Interp/Education	Kiosks/Panels	Y	Y	Y	YES
Interp/Education	Butterfly garden	Y	Y	Y	YES
Interp/Education	Tortoise enclosure	Y	Y	Y	YES
Shooting	Hunting	Y	Y	Y	YES*
Shooting	Archery	Y	Y	Y	YES*
Facilities	Development (north)	Y	Y	Y	YES
Facilities	Maintenance Compound improvements	Y	N	Y	YES
	Area 4: (north) relocate landscape materials	Y	Y	Y	YES
Facilities	Playground updates at 3 sites	Y	Y	Y	YES
Facilities	Cabins	Y	Y	Y	YES
Facilities	Roads (bike lane, improvments)	Y	N	Y	YES
Facilities	Coffee cart/shop	Y	N	Y	YES
Facilities	Expand parking (in key areas)	Y	N	Y	YES
Facilities	Horse staging area: renovations	Y	Y	Y	YES
Facilities	Mini-golf	N	N	N	NO
Facilities	Water park	N	N	N	NO
Facilities	Restroom(s)	Y	N	Y	YES
Other	Zip lines	Y	Par	Par	NO
Other	Rock climbing/repelling	Y	Par	Par	NO
Other	Lake	N	N	N	NO
Other	Tram	N	N	N	NO
Other	Extended hours	Y	Par	Par	NO
Comments	** Limited to designated area only.*				

CHAPTER 3 – RESOURCE ANALYSIS

The resource analysis for the master plan includes natural, human, and cultural resources that could be affected by any additional development and operation of the park. Inventory of park resources occurred from September 2012 through June 2013. Data collection included reviewing previous reports and documents pertaining to the park and resources in the area, aerial photo interpretation, GIS analysis, agency contacts, and field investigations.

The park consists of 29,571.59 acres, of which approximately 517 are developed. This amounts to less than 2% of the total acreage that is developed. The 2009 Strategic System Plan[1] provides a guideline to keep developed areas to 10% or less of the total land area (smaller parks that are contiguous to another protected open space may exceed 10%).

A photo monitoring program has been established for the park. Using a digital camera and GIS will allow park staff to return to the same points each year to check for signs of change in its visual, cultural or natural resources. This is detailed further in Appendix C.

3.1 General Project Setting

At nearly 30,000 acres, White Tank Mountain Regional Park is the largest regional park in Maricopa County to date. The park is located west of the Phoenix metropolitan area and serves as the westernmost edge of the Salt River Valley. Most of the park is made up of the rugged and beautiful White Tank Mountains, the range that separates the Phoenix Basin from the Hassayampa Plain, with elevations ranging from 1,270 to 4,083 feet above sea level. Infrequent heavy rains cause flash floodwaters to plunge through the canyons and pour onto the plain. These torrential flows, pouring down chutes and dropping off ledges, have scoured out a series of depressions, or tanks, in the white granite rock below. Many tanks still exist in the mountains; however the White Tank that is the source of the name of the mountains was destroyed during a storm sometime between 1898 and 1902. This very large tank was an important source of water in the early years of Arizona Territorial history. The White Tank was said to have held water all year and appears in journals and maps as early at 1863.[2]

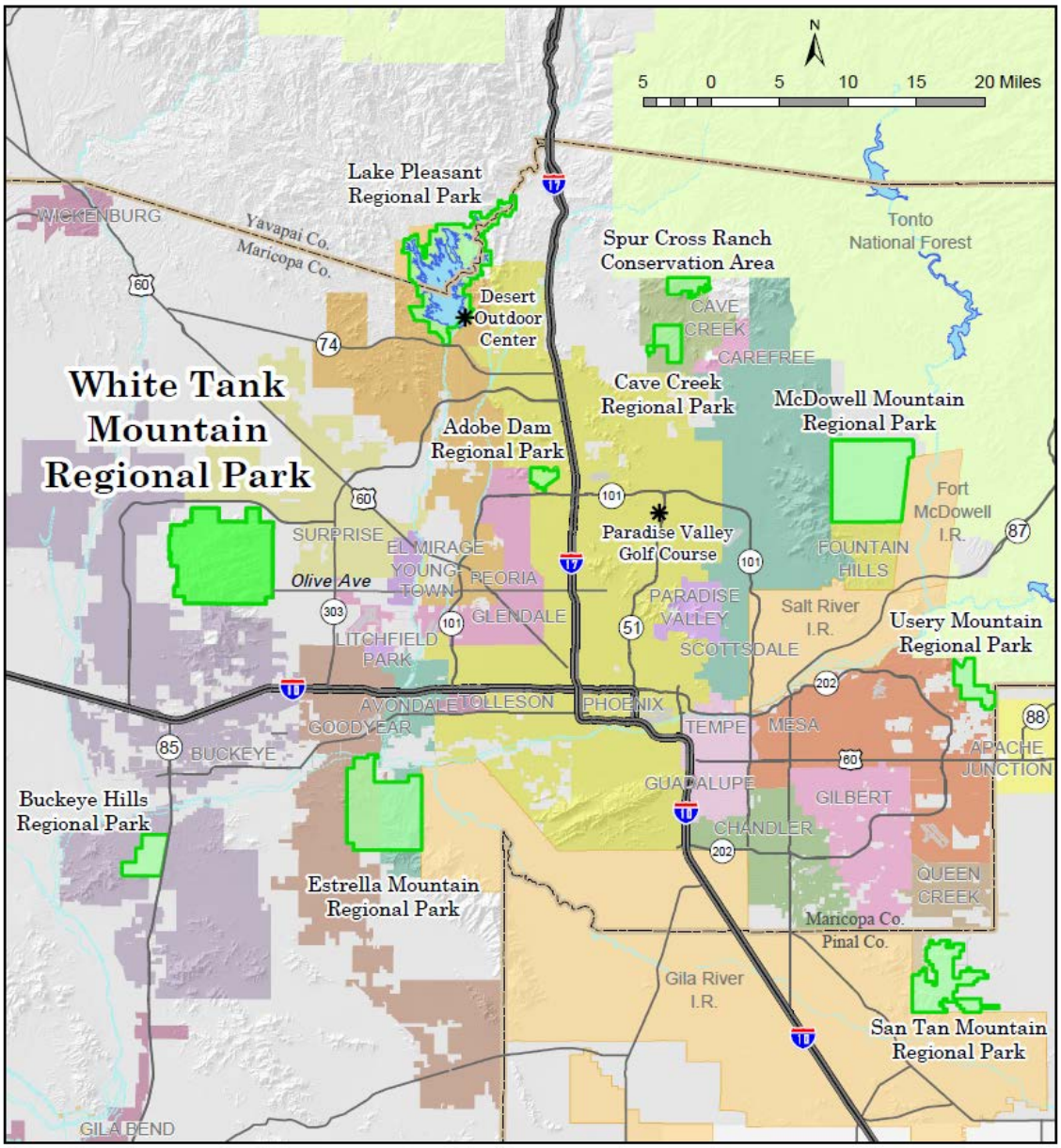
The park's physical location is 20304 W. White Tank Mountain Road, Waddell, AZ 85355. The park may be contacted by telephone 623-935-2505 or fax 623-535-4291 or via email at whitetankpark@mail.maricopa.gov. Map 3-1 shows the location of White Tank Mountain Regional Park in proximity to the greater metropolitan area and other Maricopa County Regional Parks. Current park operating hours[3] are:

Park Hours
Sun-Thu: 6:00am – 8:00pm
Fri-Sat: 6:00am – 10:00pm
365 days a year

Nature Center Hours
Mon-Sun: 8:00am – 4:00pm

Administrative Office Hours
Mon-Fri: 8:00am – 4:00pm

[1] Maricopa County Parks and Recreation, 2009 Strategic System Master Plan, p105.
[2] Arizona Place Names, Byrd H. Granger, University of Arizona Press, Tucson, 1960 and History of Waddell, Arizona, posted by Karen Krause , http://waddellhistory.wordpress.com/2013/04/23/how-the-white-tank-mountains-got-their-name/, as accessed October 30, 2013.
[3] Source: park website as of February 22, 2013.



Map 3-1: Park and Metro-area

3.2 Special Designations

3.2.1 Recreation Resources

Maricopa Trail makes its connection to the park with Mule Deer Trail. The trail is part of a regional trail plan that will link all Maricopa County Regional Parks and provide connections with metropolitan areas, municipal trails, communities, and neighborhoods with regional non-motorized multi-modal corridors. Maricopa Trail will also protect open space corridors and natural and cultural resources from development along its route.

3.2.2 Cultural Resources

There are several important petroglyph areas within the park and are worth safeguarding and are monitored by the Arizona Site Steward program. Along the Waterfall Canyon Trail at "Petroglyph Plaza" is a large collection of petroglyphs on display. Black Rock Loop Trail circles through a Hohokam village site, though the pit houses and trash mounds are hidden to all but the trained eye of an archaeologist. Known sites are monitored by Arizona Site Stewards, an Arizona State Parks program. The park is routinely surveyed for pre-historic and historically significant cultural resources prior to the construction of new trails or other projects. To date, over 2,900 acres have been surveyed.

3.2.3 Natural Resources

The park is abundant with natural resources and steps have been put into place to protect some of the more vulnerable, of which include:

Pond

The park entered into a Safe Harbor Agreement (March 2008) between the Arizona Game and Fish Department (AZGFD) and U.S. Fish and Wildlife Service (USFWS) for Gila topminnow (*Poeciliopsis occidentalis*), Yaqui topminnow (*Poeciliopsis sonoriensis*), desert pupfish (*Cyprinodon macularius macularius*), and Quitobaquito pupfish (*Cyprinodon eremus*)[4] – although they may not all be stocked at the same time.

Figure 3-1: Nature Pond

In 2011, after two years of planning and construction, the park opened a nature pond and a 40-foot working replica of a historic windmill to showcase the Gila topminnow (*Poeciliopsis occidentalis*) and desert pupfish (*Cyprinodon macularius macularius*) - made possible by a Natural Heritage Grant from AZGFD and with an agreement with the USFWS. The original windmill was used by early 1900's cattlemen to pump water from its deep well. This area is designated for wildlife viewing only; horses are not permitted to walk through or drink from the pond. Bulrush, a noxious species, tends to overgrow and is removed from the pond as needed.

Wildlife Linkages

AZGFD has extensively researched and recorded critical wildlife linkage areas along the north and west park boundary. These linkages allow wildlife, such as mule deer, to migrate from the Belmont Mountains and from the Vulture Mountains to the White Tank Mountains. Wildlife linkage is discussed in Section 3.6.2 Wildlife Linkages.

Hunting

The park allows hunting of mule deer and some small game during specified hunting seasons as regulated by AZGFD. It is illegal and a revocable offense to shoot a firearm within a quarter-mile of any developed picnic area, developed campground, shooting range, occupied building, boat ramp, or golf course or other recreational area developed for public use; or to shoot from, on, or across a roadway; or

[4] Under the authority of Section 10(a)(1)(A) of the Endangered Species Act of 1973, as amended, 16 U.S.C. 15389(a)(1)(A). This agreement establishes a population and permits incidental taking of the specified species.

to trespass on private property. A trail is not considered a developed area. Hunting is discussed further in 3.9.3 Hunting.

Non-Attainment Areas[5]

Maricopa County's Air Quality Department is tasked with protecting the public from airborne particulate matter and with complying with federal, state, and local air quality regulations. Nearly the entire Phoenix metropolitan area falls within the non-attainment area. These designations remain in effect until the Environmental Protection Agency (EPA) determines otherwise:

Particulate Matter

Inhalable coarse particulate matter[6] is sized at either 2.5 (PM2.5) or 10 (PM10) micrometers in diameter and is defined by the Environmental Protection Agency (EPA). Except its westernmost edge, the park is within the PM10 Non-attainment Area and subject to dust-control measures. PM10 includes dust, soot, and other tiny bits of solid materials that are released into and move around in the air (either from natural or anthropogenic sources). County inspection reports are kept on file in the park office.

Ozone

The park is also included within the 8-hour Ozone Nonattainment Area boundaries. At ground level, ozone aids in creating smog and is formed by the reaction of VOCs[7] (for example, photochemical smog) and NOx[8] (a reaction of nitrogen and oxygen gases in the air, particularly from motor vehicles) in the presence of heat and sunlight.

Fire Bans

At times it is necessary to implement a ban on all fires (such as campfires, fire pits, and charcoal grills) throughout the entire park in order to ensure public safety and protect park resources. A typical fire ban may be in effect from May 1 through September 30 each year. A violation of this park rule, Rule 113[9], may result in a citation and park eviction. Gas and propane use is usually acceptable in designated areas, except during extreme fire bans. Lifting the fire ban is dependent on the amount of monsoon rain the park receives and is announced by the Department.

A burn permit is not needed from Maricopa County's Air Quality Department for the following activities:[10]

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[5] Maricopa County Air Quality Department, Planning Area Maps, http://www.maricopa.gov/aq/divisions/planning_analysis/PlanningAreaMaps.aspx as accessed July 18, 2013.

[6] EPA, Particulate Matter (PM 10) Information, http://www.epa.gov/airquality/greenbk/pindex.html as accessed August 27, 2012.

[7] Volatile organic compounds (VOCs) are organic chemicals that have a high vapor pressure at ordinary, room-temperature conditions. Their high vapor pressure results from a low boiling point, which causes large numbers of molecules to evaporate or sublimate from the liquid or solid form of the compound and enter the surrounding air.

[8] NO_x is a generic term for mono-nitrogen oxides NO and NO_2 (nitric oxide and nitrogen dioxide). They are produced from the reaction of nitrogen and oxygen gases in the air during combustion, especially at high temperatures. In areas of high motor vehicle traffic, such as in large cities, the amount of nitrogen oxides emitted into the atmosphere as air pollution can be significant.

[9] Maricopa County Parks and Recreation, Park Rules, Adopted August 13, 2003 by Maricopa County Board of Supervisors. http://www.maricopa.gov/parks/PDF/ParkRules.pdf as accessed May 2, 2012.

[10] Maricopa County Air Quality Department, REGULATION III - CONTROL OF AIR CONTAMINANTS, RULE 314 OPEN OUTDOOR FIRES AND INDOOR FIREPLACES AT COMMERCIAL AND INSTITUTIONAL ESTABLISHMENTS

- Cooking for immediate human consumption (Regulation III, Rule 314, Section 303.1.a)
- Warmth for human beings (Regulation III, Rule 314, 303.3a, unless under a fire ban)
- Recreational purposes where the burning material is clean, dry wood or charcoal (Regulation III, Rule 314, 303.3b, unless under a fire ban)

However, it should be noted that while a permit may not be needed for these activities, they may be prohibited while under a fire ban.

3.3 Physiography and Climate

This section reviews the physiographic properties of the park and describes typical climatic conditions and other natural surroundings.

3.3.1 Physiography

White Tank Mountain Regional Park is within the Basin and Range province of the Southwest United States. An abrupt change in elevation, alternating between narrow faulted mountain chains and flat arid valleys or basins, is typical here. The development of the province is the result of crustal extension that began in the Early Miocene era. As these blocks titled, sediments from erosion filled the valleys between them, creating the basins.

The park is within the Sonoran Desert, the dominate feature of Basin and Range. The Sonoran Desert covers about 120,000 square miles of the Southwest United States, extending into Mexico. This desert region is the hottest desert in the United States although winter temperatures can sometimes reach freezing. Winter storms and summer monsoons provide much needed water to the rich and diverse desert life. The winter storms, when they produce enough precipitation, result in an abundant spring flowering season.

As a free-standing mountain range, the White Tank Mountain range extends approximately 13 miles in a north-south direction and is about 50% contained within park boundaries. The elevation ranges from about 1,315 feet on the east side of the park to 4,083 feet at Barry Goldwater Peak, the highest point within the park. White Tank serves as the western-most boundary of the Salt River Valley, the valley which encompasses the Phoenix metropolitan area.

3.3.2 Climate

The warmest months are June through September when temperatures can reach over 100°F and park activity slows down. Cooler months, January through March and November through December, provide visitors with an opportunity to enjoy the scenic beauty without the heat.

Table 3-1: Average Temperature and Precipitation

Month	Avg. High	Avg. Low	Avg. Precip.
January	67.0 °F	37.0 °F	0.96 in
February	72.0 °F	41.0 °F	1.13 in
March	77.0 °F	45.0 °F	1.10 in
April	86.0 °F	51.0 °F	0.30 in

http://www.maricopa.gov/aq/divisions/planning_analysis/rules/docs/314-1207.pdf as accessed December 26, 2012.

May	95.0 °F	59.0 °F	0.12 in
June	105.0 °F	68.0 °F	0.05 in
July	108.0 °F	75.0 °F	0.71 in
August	106.0 °F	74.0 °F	0.95 in
September	101.0 °F	67.0 °F	0.93 in
October	90.0 °F	55.0 °F	0.71 in
November	76.0 °F	43.0 °F	0.69 in
December	67.0 °F	37.0 °F	0.97 in
Source: The Weather Channel, http://weather.yahoo.com/united-states/arizona/white-tank-mountain-regional-park-23504538/, as accessed March 29, 2012.			

However, as elevation increases, temperature decreases and humidity rises. The 2,720 foot elevation differential with the park sometimes causes a lowering of heat index[11] in summer months as one climbs up from the valley floor. Similarly, heat related discomfort may be reduced by the prevailing westerly winds and thermal air movement in the canyons and upper reaches of the mountain. Higher elevations combined with nearly constant air movement may result in an increase in summer use of the park due to a more comfortable temperature as compared to other parks lower in the Valley. Park visitors are advised to use caution when hiking in extreme temperatures.

The National Weather Service provides information regarding heat index calculations and educational information at:

- http://www.nws.noaa.gov/om/heat/index.shtml

Monsoon thunderstorms are also experienced throughout the Phoenix metropolitan area (due to wind shifts and daytime heating[12]) generally in the months of July through September and may produce heavy rain or humidity. Occasional wind or dust storms may be experienced as well.

3.4 Water Resources

The water resources section describes surface and groundwater resources within the park.

3.4.1 Surface Water Hydrology

There are no perennial or intermittent streams in the area but there are a number of natural, ephemeral washes throughout the park.

Table 3-2: Drainage Areas of Major Washes	
Location of Wash at Park Boundary	**Drainage Area Within Park in Square Miles**
Section 6, T3N-R3W	2.2
Section 5, T3N-R3W	2.7
Section 7, T3N-R2W	5.6
Section 18, T3N-R2W	4.2
Section 19, T3N-R2W	2.6

[11] NOAA, *Heat Wave: A Major Summer Killer*, http://www.noaawatch.gov/themes/heat.php and NOAA's National Weather Service, Office of Climate, Water, and Weather Services, *Heat: A Major Killer*, http://www.nws.noaa.gov/om/heat/index.shtml as accessed April 3, 2012.

[12] ASU, School of Geographical Sciences & Urban Planning, Basics of the Arizona Monsoon & Desert Meteorology, http://geoplan.asu.edu/aztc/monsoon.html as accessed April 3, 2012.

Section 30, T3N-R2W	5.1
Section 31, T3N-R2W	2.3
Section 31, T3N-R3W	1.5
Section 32, T3N-R3W	1.8

Source: Maricopa County Regional Park System Plan, Volume 2, page 18, 1965.

Annual rainfall is scant and largely limited to the winter and summer seasons. Light winter rains bring forth grasses and forage plants, and green up the cacti and ocotillo; when plentiful, wildflowers are abundant. Summer rain, largely the product of thunderstorms, is frequently torrential and although run-off accounts for only 10% of total precipitation, it is exceedingly fast due to steepness of slope and prevalence of surface rock.

Figure 3-2: Summer monsoon flash flood across a park roadway.

Flash floodwaters, carrying large amounts of rock debris, plunge through the canyons and pour out upon the plain where they lose their momentum, deposit their burden of sand and silt and soak into the ground. These torrential flows, pouring down chutes and dropping off ledges, have scoured out a series of depressions, or "tanks", in the white granite rock below. The Flood Control District monitors precipitation and provides flood alerts through the following monitoring stations:

Table 3-3: Flood Alert System

Station ID	Station Name	Station Type	Install Date	Responsibility
5300	Sun Valley Pkwy at Northern Ave.	Precip/Stage	8/2/2005	FCD Maricopa Co
5415	White Tank FRS 3	Precip/Stage	3/12/1986	FCD Maricopa Co
5425	Ford Canyon Wash	Precip/Stage	2/5/2002	FCD Maricopa Co
5430	White Tank Peak	Repeater/Precip	4/1/1981	FCD Maricopa Co
5440	McMicken Dam South	Precip	2/13/2002	FCD Maricopa Co

Note: shaded stations are within park boundaries; other stations are nearby.

3.4.2 Groundwater Resources

As does most of Maricopa County, White Tank Mountain Regional Park resides in the Phoenix Active Management Area (AMA)[13] groundwater basin; these are areas that rely heavily on mined groundwater and require additional withdrawal rate management. The basin is drained by five major rivers; the Salt, Gila, Verde, Agua Fria, and Hassayampa Rivers. White Tank Mountain Regional Park is within the Agua Fria (HUC 15070102) and Hassayampa River (HUC 15070103)[14] hydrologic units, subsections of the AMA.

[13] Arizona Department of Water Resources, http://www.azwater.gov/ as accessed September 26, 2012.
[14] EPA, MyWATERS Mapper.
http://watersgeo.epa.gov/mwm/?layer=LEGACY_WBD&feature=15070102&extraLayers=null

According to a study of water development[15] possibilities, the granite and granitic gneiss which prevails throughout the White Tank Mountains is not generally a water-bearing material, although there are several springs within the park. Springs fed by underflow beneath dry drainage courses break out at fault lines in the bedrock and add to surface water collected in the tanks. Springs may also be found in areas where the rock material is decomposed enough to store limited supplies of water.

Table 3-4: Springs	
Location	**Source**
Section 23, T3N-R3W	Willow Spring
Section 23, T3N-R3W	Mesquite Spring
Section 26, T3N-R3W	Dripping Spring
Section 35, T3N-R3W	Spring (no name)
Source: Maricopa County Regional Park System Plan, Volume 2, page 16, 1965.	

There is one active well in the park, marked by a working historic replica windmill, that supplies water to a small constructed pond; however, water is supplemented when the water table is down to keep the pond full.

3.5 Earth Resources

The park is located within the Basin and Range Province of the Desert Southwest, as is much of Arizona. Basin and Range is a result of tectonic forces and volcanism over millions of years.[16] Unlike the typical northwest-southeast orientation of Basin and Range, the White Tank Mountains are oriented at a northeast-southwest angle,[17] indicative of a much older geological event (called metamorphic core complex[18]) than other ranges found throughout the province.

3.5.1 Geology

The rock types found are mostly Precambrian granite, gneiss, schist, and other related rock types. For a full list of types and detailed description of locations of occurrence, as compiled by Arizona Geological Survey[19] Map Services, see Appendix D.

White Tank Mountain Regional Park is well known for its petroglyphs, renderings left behind on rock by ancient peoples. The rocks are covered by a paper-thin coating of dark “desert varnish” or patina[20] on

[15] Master Development Plan, White Tank Mountain Regional Park, Maricopa County Parks and Recreation Commission, August 1964, quoting report by Heinrich J. Thiele, *Preliminary Groundwater Development Study, White Tank Mountains Regional Park, Maricopa County, Arizona*, 1692.
[16] The Geologic Origin of the Sonoran Desert, Robert Scarborough http://www.desertmuseum.org/books/nhsd_geologic_origin.php as accessed April 18, 2012.
[17] Chronic, Halka. Roadside Geology of Arizona. Missoula, Montana: Mountain Press Publishing Company, 1983, page 33.
[18] Metamorphic Core Complexes, complied by V.L. Rystrom, http://www.colorado.edu/GeolSci/Resources/WUSTectonics/CoreComplex/5700.html and http://www.colorado.edu/GeolSci/Resources/WUSTectonics/CoreComplex/Arizona.html as accessed April 18, 2012.
[19] The Arizona Geological Survey, AZGS Map Services Geologic Map of Arizona, http://www.azgs.az.gov/services_azgeomap.shtml as accessed March 5, 2012.

exposed rocks and boulders. This varnish is what allowed native peoples to leave their petroglyph messages behind.

3.5.2 Land Subsidence and Earth Fissures

Arizona Department of Water Resources (ADWR) is the state agency responsible for identifying and monitoring active land subsidence areas around the state. The West Valley land subsidence feature is located in the Western Phoenix Metropolitan Area in Maricopa County and lays closest to the park. This land subsidence feature is just outside of the eastern park boundary and includes the cities of Sun City, Sun City West, Surprise, Peoria, and Glendale. The feature shows zero to one centimeter and/or one to two centimeters of change between the study period of May 8, 2010 and April 22, 2013.

Effective September 21, 2006, Arizona Revised Statute § 27-152.01(3) requires the Arizona Geological Survey (AZGS) to complete comprehensive mapping of earth fissures throughout Arizona and providing earth fissure map data to the State Land Department to be made available online with other GIS map layers for the public to use in building their own customized maps. Maricopa County was mapped[21] and no fissures are currently known within the park itself. However, the closest study area is the "Luke" area (http://www.azgs.az.gov/Earth%20Fissures/Luke2-09.pdf) and some fissures were noted there.

3.5.3 Soils[22] and Erosion Potential

Soils are made up of decomposed White Tank Mountains: granite, gneiss, schist, andesite, rhyolite, basalt. The major soil types found in the park are coarse loam and gravelly loam. The soils immediately surrounding the White Tank Mountains have a low to moderate shrink/swell potential[23] - see Appendix E for a soils map. Due to the steep and rugged slope (15% or greater) of the mountains, erosion potential is high in these areas, resulting in talus and alluvium deposits below (and is what slowly fills the "basins" within a Basin and Range system). During an extreme flash flood event, these materials can be transported to lower lying areas below.

3.6 Biological Resources

The State of Arizona has over 900 animal species and a diversity of landscapes. Maricopa County is located in the central portion of the Sonoran Desert and is home to a variety of plants and animals. The wildlife and vegetation commonly seen in the park is typical of a Sonoran Desertscrub environment.

Fire is not historically common to a Sonoran Desertscrub environment, although with intrusion of human influence, it is more of a risk today. For example, in July and August of 1993 a fire sparked by a metal blade hitting the rocks during road construction to the towers (known as the Bug Fire[24]) burned 3,000 acres with the White Tank Mountains, including acreage inside the park.

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[20] Desert Soils, Joseph R. McAuliffe, http://www.desertmuseum.org/books/nhsd_desert_soils.php as accessed April 18, 2012.
[21] The Arizona Geological Survey, Arizona's Earth Fissure Center, http://www.azgs.az.gov/Earth%20Fissures/MaricopaCounty1-10%20(DM-EF-17)_sm.pdf as accessed March 5, 2012.
[22] USDA Natural Resources Conservation Service, Soils website, http://soils.usda.gov/ as accessed April 18, 2012.
[23] The Arizona Geological Survey, Arizona's Geologic Hazard Center, http://www.azgs.az.gov/hazards_problemsoils.shtml as accessed March 5, 2012.
[24] History of Waddell, Arizona, posted by Karen Krause, http://waddellhistory.wordpress.com/2012/11/02/the-bug-fire-the-story-of-a-fire-started-by-a-caterpillar/ as accessed September 20, 2013.

The Arizona Upland Subdivision vegetation occurs on slopes and broken ground (green areas on map 3-2) while desert pavement is typical of the Lower Colorado River subdivision (red areas on map 3-2); high temperatures and little precipitation are common elements to each.

Map 3-2: Biotic Communities, (Source: Arizona Game and Fish Department, HabiMap™)

3.6.1 Wildlife[25]

Most low desert mountain ranges in central Arizona share a predictable fauna, a rich assortment of common and less abundant species of reptiles, amphibians, mammals and birds. Many of these species have broad distributions across much of the state. However, some these central Arizona mountain ranges with higher elevations, have species that are not found in the more abundant lower elevation ranges. Additionally, from a biogeographical standpoint, many of these ranges are literally where east meets west and species from the low arid western deserts overlap with species from the wetter uplands in a narrow band running north to south more or less through the center of the state. In a like manner, the desert valley bottom habitats surrounding these ranges support an abundance of species not found in the mountain ranges, but equally unique and important to the biological integrity and ecology of the region.

Common Reptiles and Amphibians

Several central Arizona mountain ranges, including the White Tanks, act as a reptilian fault line where western species such as desert tortoise (*Gopherus agassizii,* Sonoran population), speckled rattlesnake

[25] This section was developed with significant input and assistance from D. Warnecke, Habitat Specialist III, Arizona Game and Fish Department.

(*Crotalus mitchellii*), Great Basin collared lizard (*Crotaphytus bicinctores*), and desert rosy boa (*Charina trivirgata*), reach their eastern distributional limits; species such as tiger rattlesnake (*Crotalus tigris*) and eastern collared lizard (*Crotaphytus collaris*) reach their western distributional limits; and Sonoran desert toad (*Bufo alvarius*) and desert iguana (*Dipsosaurus dorsalis*) reach their northern limits.

Examples of species adapted to sandy washes and relatively open gravelly areas include the zebra-tailed lizard (*Callisaurus draconoides*), greater earless lizard (*Cophosaurus texanus*), desert iguana (*Dipsosaurus dorsalis*), desert horned lizard (*Phrynosoma platyrhinos*), tiger whiptail (*Aspidoscelis tigris*), variable sandsnake (*Chilomeniscus stramineus*), and sidewinder (*Crotalus cerastes*).

Examples of species adapted to the bajadas, or rocky and steep terrain, and/or brushier vegetation include the desert tortoise (*Gopherus agassizii*, Sonoran Population), Gila monster (*Heloderma suspectum*), desert spiny lizard (*Sceloporus magister*), regal horned lizard (*Phrynosoma solare*), common chuckwalla (*Sauromalus ater*), Western patch-nosed snake (*Salvadora hexalepis*), and tiger rattlesnake (*Crotalis tigris*).

Some species spend a majority of their time underground emerging either to feed or breed such as the Gila monster; or the case of the Western threadsnake (*Leptotyphlops humilis*) remains underground to feed on larval insects such as ants or termites.

Some of the most wide spread species throughout the park area include the common kingsnake (*Lampropeltis getula*), long-nosed snake (*Rhinocheilus lecontei*), diamondback rattlesnake (*Crotalus atrox*), and several toads including the red-spotted toad (*Bufo punctatus*), Woodhouse's toad (*Bufo woodhousii*), and Great Plains toad (*Bufo cognatus*). Several toads reach their northern most distributions in the planning area including the Sonoran Desert toad (*Bufo alvarius*) and Couch's spadefoot toad (*Scaphiopus couchii*).

Common Birds

Within the HabiMap™, an online planning tool, the Arizona Breeding Bird Atlas query function identifies reproductively active birds within the park's planning area. The more common Sonoran Desertscrub species with confirmed breeding activity are: Anna's hummingbird, ash-throated flycatcher, Bendire's thrasher, black-tailed gnatcatcher, loggerhead shrike, and others.

For example, there are many resident and migratory bird species that inhabit the park. A few of the most common and visible diurnal (active during the day) species include the Gila woodpecker, cactus wren, roadrunner, verdin, Gambel's quail, mourning dove, and turkey vulture. The great horned owl (*Bubo virginianus*) and Western screech owl (*Otus kennicottii*) are nocturnal raptors (active at dusk/dawn and during the night); and the red-tailed hawk *(Buteo jamaicensis)* and American kestrel (*Falco sparverius*) are common diurnal raptors.

Figure 3-3: Javelina and deer

Common Mammals

With the exception of the desert bighorn sheep, the diversity of large and medium sized mammalian fauna

of the White Tanks remains diverse, despite increasing urban development and habitat loss around the mountains. Mule deer, an important prey species for mountain lion, inhabit the steep slopes of the mountains as well as the surrounding bajadas. Coyote, javelina, raccoons, and skunks are common and abundant. The nocturnal and more secretive kit fox lives in the creosote valley bottoms west of the mountains and the ringtail inhabits the canyons and
rocky cliffs of the mountains. Numerous small mammals occur in this region, many of which are active nocturnally, including several species of pocket mice, Merriam's and desert kangaroo rats, and white-throated woodrats. A few of the more visible during the day include the desert cottontail, rock squirrel, round-tailed ground squirrel, and Harris' antelope squirrel.

Bat surveys in the area are limited, but several species have been documented in the western portions of Maricopa County including: western pipistrelle (*Pipistrellus Hesperus*), big brown bat (*Eptesicus fuscus*), big free-tailed bat (Nyctinomops macrotis), cave myotis bat (*Myotis velifer*), California leaf-nosed bat (*Macrotus californicus*), Greater Western mastiff bat (*Eumops perotis californicus*), Hoary bat (*Lasiurus cinereus*) and pallid bat (*Antrozous pallidus*). A few additional Species of Greatest Conservation Need (SGCN) bat species that have historic, present and potential distributions within the planning area include Pale Townsend's big-eared bat, Western red bat, Western yellow bat, Arizona myotis and Yuma myotis, pocketed free-tailed bat, and Mexican free-tailed bat. The California leaf-nosed bat roosts in mines within the foothills of the White Tank Mountains. AGFD research indicates that this species forages within close proximity to the roost sites by gleaning insects from natural desert and wash vegetation and uses the area for "lekking" (aggregations of males competing for female attention), a reproductive activity.

3.6.2 Wildlife Linkages[26]

The White Tank Mountain range is considered to be a wildland block; meaning it is a relatively large contiguous natural area capable of supporting a diverse array of wildlife into the foreseeable future. Currently, these mountains are connected to undeveloped river valleys and mountain ranges to the west and north; with very few roads, urbanization or other barriers. Wildlife linkages (often called corridors) are areas of land used by wildlife to move between or within habitat blocks in order to acquire resources necessary for survival: food, water, protective cover, and mates. AZGFD has researched wildlife movement and modeled critical wildlife linkage areas that extend from the north and west park boundaries to adjacent wildlands, in anticipation of future urban development (Map 3-3). AZGFD recommends preservation of upland habitats across various elevations, from valley bottom to mountain tops, and wash corridors in order to best ensure goals associated with wildlife linkages (corridors) may be achieved in the future. It is believed that these linkages would allow wildlife such as mule deer to migrate between the park, Hassayampa River corridor, Belmont Mountains (to the west) and from the Vulture Mountains (to the north). Based on AZGFD recommendations, the City of Surprise is incorporating these linkage corridors into their 2035 General Plan and into their Village 3 planning efforts, areas that abut the northern park boundary; the Department strives to do the same.

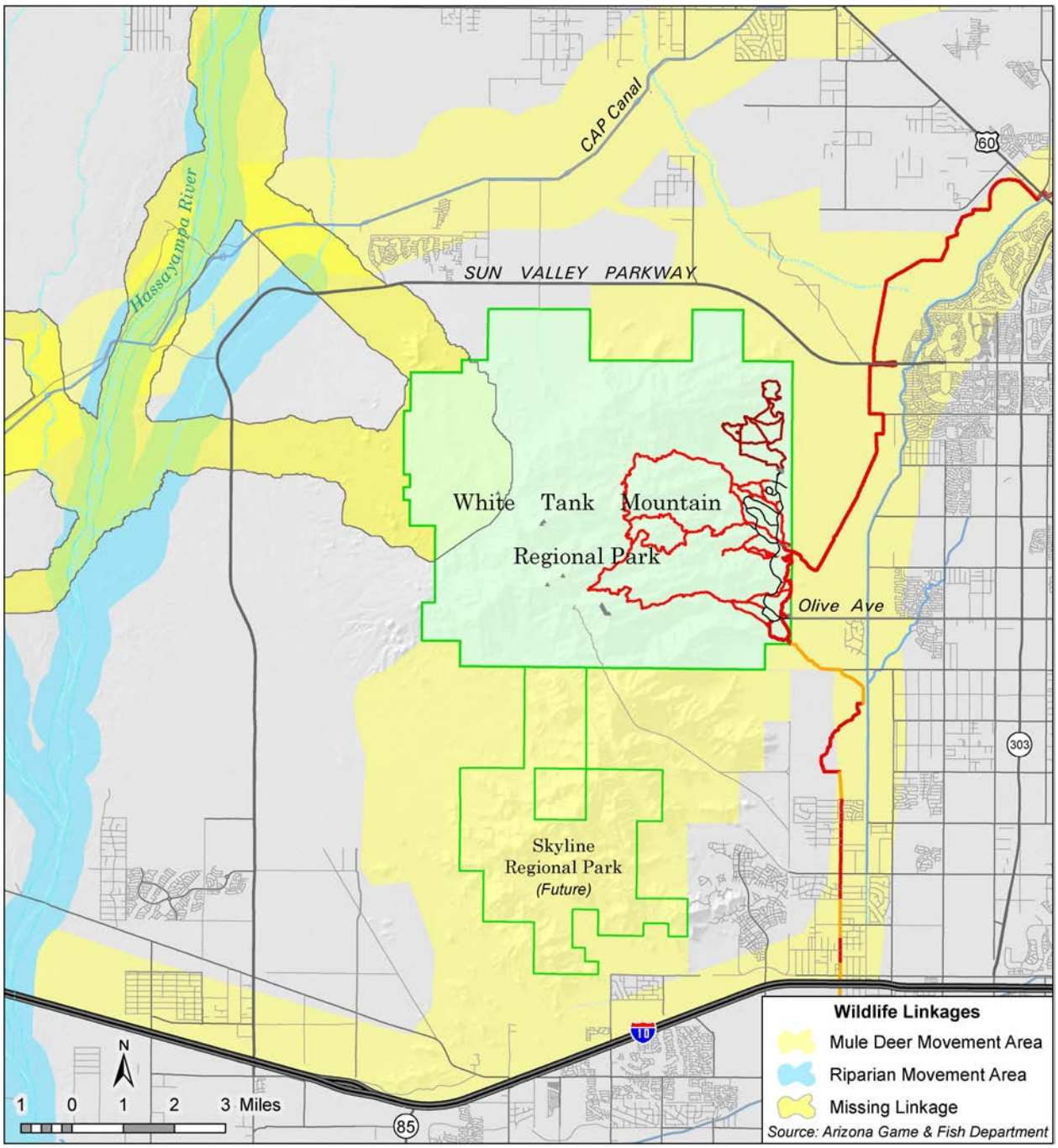
Among AZGFD's recommendations is to avoid siting development along the narrowest section of a linkage and to provide wildlife with a one kilometer wide minimum berth to accommodate their migration or movement patterns. In developed areas, it should be noted that for approximately 300 feet

[26] Arizona Game and Fish Department. Wildlife and Habitat Connectivity, http://www.azgfd.gov/w_c/connectivity.shtml as accessed December 31, 2012 and in-person meeting December 20, 2012 with Dana Warnecke, Habitat Specialist III, Arizona Game and Fish Department and follow-up consultation.

surrounding a developed feature, wildlife will show sensitivities to noise, light, and other disturbances and may change their behavior patterns.

What is projected to happen in 20 years and beyond?
If development occurs around the park as is currently projected, the park may become an "island" and the various species now found within it may be cut off from migration routes and habitats and resources they have relied on in the past for survival and reproduction. AZGFD reports in its *Wildlife Friendly Guidelines*, "[a]s connectivity between wildland blocks is lost, isolation deprives species of their daily, seasonal, and lifetime needs. Loss of connectivity deprives animals of resources, reduces gene flow, and prevents animals from re-colonizing areas where extirpations have occurred, and ultimately prevents animals from contributing to ecosystem functions such as pollination, seed dispersal, control of prey numbers, and resistance to invasive species. Maintaining biodiversity and ecosystem functions requires habitat connectivity. Connectivity can be established through dedicated corridors of undisturbed lands or other forms of open spaces (parks/preserves/monuments) that support wildlife and allow wildlife to move between (permeable) wildland blocks. Disturbed areas (agriculture, flood control areas, low density residential areas) can also support wildlife and may act as corridors, especially if the disturbance is managed so as to minimize impacts to wildlife."[27]

[27] Arizona Game and Fish Department. Wildlife Friendly Guidelines (Feb. 2009), Page 5, http://www.azgfd.gov/pdfs/w_c/WildlifeFriendlyDevelopment.pdf as accessed December 31, 2012.



Map 3-3: Wildlife Linkages, Arizona Game and Fish Department

3.6.3 Special Status Wildlife

The Federal Register (Register) currently has forty-six federally Threatened or Endangered[28] animal species listed under the Endangered Species Act within the State of Arizona. The Register is updated daily and species may be added or dropped and should be checked regularly to ensure compliance. See Appendix F for a listing of these animals that occur within Maricopa County. The park should review this

[28] U.S. Fish and Wildlife Service, Species Report, http://ecos.fws.gov/tess_public/pub/stateListingIndividual.jsp?state=AZ&status=listed as accessed April 12, 2012.

list periodically. Of those listed, the following may be found or the park may contain habitat that supports the species:

- Desert pupfish (*Cyprinodon macularius*) - Endangered
- Gila topminnow (*Poeciliopsis occidentalis*) – Endangered
- Desert tortoise (*Gopherus agassizii,* Sonoran population) - Threatened and Similarity of Appearance (Threatened)

The park entered into a Safe Harbor Agreement (March 2008) between AZGFD and U.S. Fish and Wildlife Service (USFWS) for Gila topminnow (*Poeciliopsis occidentalis*), Yaqui topminnow (*Poeciliopsis sonoriensis*), desert pupfish (*Cyprinodon macularius*), and Quitobaquito pupfish (*Cyprinodon eremus*).[29] Although AZGFD may periodically stock these fish, not all are currently found within the park's nature pond.

Figure 3-4: Desert pupfish. Photo credit, John Rinne, USFWS[30]

3.6.4 Natural Heritage Program – Heritage Data Management System (HDMS)

Additionally, AZGFD tracks animals of state concern through its Natural Heritage Program.[31] Of those listed, the following may be found within the park or habitat may exist to support the species:

- California leaf-nosed bat (*Macrotus californicus*)
- Cave myotis (*Myotis velifer*)
- Great Basin collared lizard (*Crotaphytus bicinctores*)
- Lowland leopard frog (*Rana yavapaiensis*)

3.6.5 Species of Greatest Conservation Need (SGCN)

The State of Arizona has identified certain species with a great need for conservation actions in its Wildlife Action Plan (SWAP) and those are indicative of the diversity and health of the State's wildlife. The list includes species that are currently listed as threatened or endangered under the Endangered Species Act (ESA) as well as many others with significant vulnerability such as low and declining populations. Overall, it is AZGFD's intent to highlight the needs of these species, as well as Special Status Species, in an effort to "keep common species common" and maintain as much of Arizona's biodiversity

[29] Per under the authority of the Endangered Species Act, Section 10(a)(1)(A) of the Endangered Species Act of 1973, as amended, 16 U.S.C. 15389(a)(1)(A). This agreement establishes a population and permits incidental taking of the specified species.

[30] U.S. Fish and Wildlife Service, Image Library, Fish, John Rinne, http://www.fws.gov/southwest/es/arizona/images/SpeciesImages/desert_pupfish_Rinne.jpg as accessed December 31, 2012.

[31] Arizona Game and Fish Department, Natural Heritage Program, http://www.azgfd.gov/w_c/edits/species_concern.shtml as accessed April 12, 2012.

as possible in light of development pressures and habitat loss. These species within the park planning area include: Abert's Towhee (*Melozone aberti*), Arizona myotis (*Myotis occultus*), Arizona pocket mouse (*Perognathus amplus*), bald eagle (*Haliaeetus leucocephalus*), California leaf-nosed bat (*Macrotus californicus*), Gila monster (*Heloderma suspectum*), Gila woodpecker (*Melanerpes uropygialis*), Sonoran desert tortoise (*Gopherus agassizii,* Sonoran Population), Western burrowing owl (*Athene cunicularia hypugaea*), and others.

3.6.6 Other Types of Animals

Occasionally, park staff finds other types of animals within the park; usually domestic pets that have been abandoned or lost inside the park. When discovered, these animals are turned over to the appropriate agency for their care and potential re-homing. These animals include:

- Dogs,
- Turtles, and
- Lizards.

3.6.7 Vegetation

Vegetation is scarce on the upper slopes of the mountain and hillside plant growth is limited to grasses, perennial shrubs, cacti, and stunted palo verde. Trees, including mesquite, willow, and ironwood are generally confined to canyon bottoms where there is more moisture and soil. A flora inventory completed in 1973[32] showed nearly 300 species and variations occurring within the park; the inventory and a searchable database are available on the Southwest Environmental Information Network website. The following plants are commonly found in the park:

- Palo verde (small leaf)
- Ironwood trees
- Hedgehog cactus
- Prickly-pear cactus
- Saguaro cactus
- Pincushion cactus
- Barrel cactus
- Lupine
- Poppy
- Fairy duster
- Brittlebush
- Creosote
- Christmas cactus
- Mesquite
- Cat claw
- Elephant tree
- Stag-horn cholla
- Buckhorn cholla

[32] Keil, D. J. 1973. Vegetation and Flora of the White Tank Mountains Regional Park, Maricopa County, Arizona. Journal of the Arizona-Nevada Academy of Science 8: 35-48. http://swbiodiversity.org/seinet/checklists/checklist.php?cl=5 as accessed September 4, 2013.

Figure 3-5: Vegetation: cholla, saguaro cacti, brittlebush

Noxious Weeds List

Disturbed areas within the park, especially near campsites, parking lots, and along trails are ripe ground for noxious weeds to take root. The most common noxious weed within the park is buffelgrass (*Pennisetum ciliare* (L.)) and may be found along the Waterfall Trail, areas along Willow Road, and the main park road. Red brome (*Bromus rubens* L.) is also found within the park, but to a lesser degree. Bulrush is also found in the pond and is removed as needed. See Appendix G for description of these weeds.

Figure 3-6: Buffelgrass. Photo credit: Larry Allain, USDA-NRCS

3.6.8 Special Status Vegetation

The Federal Register currently has seventeen federally Threatened or Endangered[33] plant species listed under the Endangered Species Act within the State of Arizona. The Register is updated daily and species may be added or dropped. The park should review this list periodically.

[33] U.S. Fish and Wildlife Service, Species Report, http://ecos.fws.gov/tess_public/pub/stateListingIndividual.jsp?state=AZ&status=listed as accessed April 12, 2012.

Additionally, AZGFD tracks plants of state concern through its Natural Heritage Program.[34] See Appendix F for a listing of these plants that occur within Maricopa County and how other agencies rank them. Of those listed, the following may be found within the park or habitat exists that may support the species:

- Saguaro cactus (*Carnegiea* gigantea),
- Arid tansyaster (*Machaeranthera arida*),
- Lobed fleabane (*Erigeron lobatus*), and
- Melonleaf nightshade (*Solanum heterodoxum*).

3.7 Cultural Resources and Native American Consultation

Most of the archaeological sites in the area are concentrated around the White Tanks themselves. Some tanks probably held water year-round, drawing people to the region. Petroglyphs on rocks indicate that Indians were more than transients. Pottery sherds along the Agua Fria and Hassayampa Rivers signify the presence of villages and a good possibility that an Indian trail connected the streams with White Tank long before Europeans came into the area. The discovery of possible agricultural terraces and check dams indicates that farming may have been practiced in the various canyons of the White Tank Mountains by utilizing seasonal runoff and rain water.

Ruggedness of terrain and scarcity of water restricted the prehistoric archaeological sites to large canyons that lead out of the mountains on the east, north and probably west. In these canyons, of the eleven confirmed sites in the park, there are seven villages, varying from one to seventy-five acres in area, a rock shelter in the face of a steep cliff overlooking the white tanks, and several sherd areas. Several of the villages appear to have been occupied for long periods by sizeable populations, while the sherd areas may represent temporary camps of hunters and gatherers.

Pottery found in the park include Gila Butte Red-on-buff, Santa Cruz Red-on-buff, Sacaton Red-on-buff, and Gila Plain. Stone mortars and metates used for grinding corn, seeds, and beans; green river rocks used as hammerstones; and obsidian imported from other areas have also been found. Lithic material (or chipped stone) found in some of the sites suggest that stone tools were manufactured here.

3.7.1 Pre-History of Area

It's thought that Western Archaic People[35] inhabited or seasonally hunted and gathered in the White Tank Mountains from as early as 300 A.D. These people may have left their stories and ideas on the rocks in a graphical form called petroglyphs.

Surveys conducted by the Arizona State Museum in January 1963 disclosed the presence of eleven archaeological sites within the park. The archaeological sites inside the park indicate that Hohokam Native Americans[36] lived in the park from about 500 to 1100 A.D. The peak of Hohokam civilization was around 1250 (with the center of their civilization around what is now the Phoenix Airport area). By 1450, evidence of the Hohokam halts. The Hohokam left their stories and ideas on the rocks in the form of petroglyphs. Within the park these petroglyphs can best be seen on the Waterfall Trail.

[34] Arizona Game and Fish Department, Natural Heritage Program, http://www.azgfd.gov/w_c/edits/species_concern.shtml as accessed April 12, 2012.
[35] Circa 5500 B.C. to A.D. 400.
[36] The word Hohokam means those who have vanished.

The White Tanks were apparently abandoned by the Hohokam about 1100 A.D. There is no further indication of human occupation until the historic period of Western Yavapai control who lived, hunted and gathered in the park about 200 years ago. They also left petroglyphs on the rocks, examples of which can be seen on the Black Rock Loop Trail.

About the Petroglyphs

Ancient Arizonans pecked hundreds of figures and symbols on the rock faces of the White Tank Mountains. Some may approach 5,000 years old having withstood sun, rain, and vandals for centuries; while others have been lost to nature or vandals. The largest group of rock art panels is along the Waterfall Canyon Trail at "Petroglyph Plaza." These sites are routinely monitored by the Arizona Site Steward program.

Figure 3-7: Petroglyph panel (August 2010)

A rock drawing was serious business to its maker. While no one can say precisely what most petroglyphs mean, we know they had important functions in the lives of their makers. They were not simply stone-age graffiti. The symbols recorded events and marked locations. Some served as trail markers and maps; others may have represented religious concepts.

Park rules require that visitors do not try to make "tombstone rubbings" of the petroglyphs; it does not work and will erode the dark areas, making the petroglyph dimmer. Park staff recommends that visitors view and photograph these figures and symbols of history without touching the petroglyphs as skin oils will damage them.

3.7.2 History of Area

Legend and lore abound within the park. Among those tales include the origin of stone corrals on Goat Camp Trail and Mesquite Trail that are thought to have been made by Basque (from the Basque region of Spain) goat and sheep herders who lived in the White Tank mountain range from the late 1800s into the early 1900s. Other tales include the use of an old mine to hide a bootlegger's still during prohibition and the rugged mountains serving as a hideout for bank robbers and horse thieves.[37]

The White Tank Mountains were named for one particular tank located in the northeast end of the mountain range - a large tank that held water year round. The "White Tank" of the "White Tank Mountains" predates Phoenix and is referred to in journals as early at 1863 while the mountains or the tank appear on maps as early as 1865. The original tank was destroyed sometime between 1898 and 1902 and its original location is not known. [38]

Before the railroad from Phoenix to Prescott was completed in 1895, the White Tank Wagon Road served as a freight route until 1863. The road followed a string of wells and waterholes across miles of dry desert between Maricopa Wells (south of the Gila River), to Wickenburg, and north to the Prescott area. This road passed along the eastern slope of the mountains and through the northeast corner of the mountain range.[39]

Ranching/Herding

A small masonry dam made from river rocks and crude cement can be found on the back side of the Ford Trail in the Ford Canyon Wash. The dam is filled in with sand on the up-stream side. It is about forty feet wide and only about four feet tall on the down-stream side. It is believed that this dam was made either by the Basque goat and sheep herders (late 1800s to early 1900s) or by cattlemen in the early 1900s. Atop the old dam, there is a concrete brick with what appears to be a brand “-PP”. Park staff discovered that it was a brand used by G & EE Bacon of Globe up until 1920 before disappearing from the brand registry (Figure 3-8).

Figure 3-8: Brand

There is a line shack with a small stone corral up on the Willow Trail by Willow Springs. It appears that at a later date someone added a galvanized trough and barbwire corral. The stone corral and line shack are believed to be from the early 1900s. The added trough and barbwire may have been from cattlemen.[40] Concrete tanks were also built at Dripping Springs but the springs were later buried by a cave-in and are now dry.

On Waterfall Trail there is a large galvanized water storage tank, perhaps placed there by the cattle industry in the early 1900s, up to 1934. In the area where the waterfall flows, there is evidence of a small dam and large metal buckles. These supported a pipe or trough that carried water over to the galvanized tank. Periodically, large irons pipes, the remainder of the gravity water transport system are uncovered in the Waterfall Canyon Wash area. In fact, a number of small earth tanks were set up in

[37] Personal communication from Karen Krause, October 30, 2013.
[38] Personal communication from Karen Krause, October 30, 2013.
[39] Personal communication from Karen Krause, October 30, 2013.
[40] Park lore says that the cattle industry used parts of White Tank Regional Park property up to the year 1934.

strategic locations in the upper range, but none proved capable of storing water for long due to their small size and soil composition.

In the existing Horse Staging Area of the park, there are remains of a turn of the century (last century) well. In the late 1800s and early 1900s, water was drawn up about 700 feet by a windmill pump system. The windmill was destroyed in the 1930s but since the well was still good, the windmill was replaced and now draws water into a nature pond in the Horse Staging area. (The windmill replacement was made possible by a Heritage Fund Grant.)

Mining Claims and Mineral Rights

Although the rock types are not generally indicative of mining potential, there is evidence throughout the park of an attempt at mining (1800s through about 1950). Although the documentation is scant, there were over 100 mining claims[41] filed (with most of the larger claims located south of the park's boundaries) and remnant prospect holes are still found throughout the park.

According to the records there was no evidence that minerals or metals of significant value were found or mined in the White Tank mountain range. Despite a local newspaper touting the White Tank Mountains as being on the verge of becoming the next great mining district, the mineral wealth was never enough to warrant large scale mining operations.[42] When small amounts of copper were taken away for assay and identification (circa 1960s), it showed virtually no commercial potential. Likewise, no records exist indicating that a mining corporation had any interest in the White Tank Mountains, although one miner, Bert Ford, had some success and sold his mines to a company that sold mining shares.[43]

There may have been various attempts to find silver or gold; however, a number of the prospect holes found in Section 3 show small amounts of copper oxides (malachite and chrysocolla). On the extreme northern end of the mountain, in the NW ¼ of Section 3, T3N, R3W, is a tunnel that is thought to have been made by a miner determined to follow a vagrant vein. This claim was either never recorded or it was not properly described as being in the White Tanks. Additionally, on the U.S. Geological Survey map N1-12-7, there is a copper mine marked on "Point of Mountain" (the extreme northeast corner of the White Tanks) yet records in the Arizona Department of Mineral Resources are void of any proof of a mine or mineral production in the area.[44] In the center of Section 6 in the northeast corner of the park, white granite or granitic gneiss was quarried at one time, presumably for use in decorative masonry or landscaping. [45]

3.7.3 Findings

A cultural resources records review was initiated to document the extent of previous archaeological survey within the park and the number of previously recorded archaeological and historical sites that have been identified by those surveys. These studies were undertaken in support of a variety of projects such as fence line construction, hiking trail construction, and grazing/range improvements. The surveys

[41] Personal communication from Karen Krause, October 30, 2013.
[42] Personal communication from Karen Krause, October 30, 2013.
[43] Personal communication from Karen Krause, October 30, 2013.
[44] Maricopa County Regional Park System Plan, Volume 2, page 11, 1965.
[45] Master Development Plan, White Tank Mountains Regional Park, Maricopa County Parks and Recreation Commission, page 12, August 1964 quoting report by R.C. Townsend, Consulting Geologist, *Preliminary Geology of the Maricopa County Regional Park System*, 1964.

aggregate to a total of approximately 2,904 acres, or about 10% of the park's total 29,571.59 acres. No new field surveys were undertaken for this plan update.

However, a cultural resource management program should be established to track and monitor known sites. A cultural resource survey and State Historic Preservation Office (SHPO) consultation is recommended prior to any new construction or trail project. During future master plan updates, consultation with representatives of Native American Communities claiming cultural affiliation to the area should be coordinated through MCPRD headquarters staff in order for the Community to assist in assessing the cultural significance of or actions needed to protect any significant resources.

3.7.4 Native American Consultations

Planning staff sought input from potentially interested Native American communities regarding this master plan update. Consultation letters, dated April 4, 2013, concerning the first phase of the project were mailed to the following communities: Ft. McDowell Yavapai Nation, Gila River Indian Community, and Salt River Pima-Maricopa Indian Community; no responses were received. Planning staff sent follow-up letters (dated August 23, 2013) to the same communities for input concerning the final phase of the master plan update; again, no responses were received.

3.8 Visual Resources

Important views for public enjoyment, trail development and vegetation management are identified in this section. Management actions to classify and retain selected views from key observation viewpoints should be taken into consideration with any new development within the park. The park follows general guidance provided by the Department's mission statement, management zoning definitions, and BLM visual resource management classes to protect its scenic views.

3.8.3 Agency Visual Resource Management Classes

The Bradshaw-Harquahala Record of Decision and Approved Resource Management Plan (April 22, 2010) (BH-RMP), a BLM document, has designated areas within park boundaries as "Class II" and areas just outside park boundaries as "Class IV".

BH-RMP VRM Class Definitions

VRM Class II: The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.

VRM Class IV: The objective of this class is to provide for management activities that require major modifications of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer's attention. Every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

3.8.4 Sensitive Views

Maricopa County has developed scenic overlays along several corridors. These overlays provide for differentiated development guidelines as specified in the Maricopa County Zoning Ordinance and are intended to protect the scenic quality along these designated routes. The following plans are meant to assist in protecting the viewshed of the White Tanks area:

- Olive Ave Scenic Corridor Plan, and
- McMicken Scenic Corridor Plan.

Residential Views

Currently, the closest resident is slightly over one mile away from the entrance of the park on Olive Avenue. The predominant view within that one mile span is open desert with prominent displays of saguaro cactus.

Recreation Views

Barry Goldwater Peak is among the highest peaks, and is highly visible from various parts of the developed area of the park and from many stretches of trails. It has a concentration of communication towers that can be seen from various places throughout the park. There are a several other towers scattered on other peaks throughout the park.

The flatlands of the park, where most park development currently is located, are highly visible from many of the trails, especially the lower portions of Goat Camp, Mesquite Canyon, and Ford Canyon Trails, since those trails are elevated.

The saddle along the main park road north of Group Picnic Area 3 (Quartz Grove) and the Mule Deer Trail where it crosses the small mountain east of Group Picnic Area 4 (Black Rock Rest) provides panoramic views of the cactus-studded bajada to the south. The road saddle, which is currently an undeveloped pullout, is the only place where visitors can see such a view if they are not hikers or riders.

Backcountry trails include several prominent spots where visitors are likely to stop and admire the views. These include:

- The ridge above Goat Camp (just past milepost GC-3).
- The ridge around Goat Camp milepost GC-6, where the view opens up to both the east and west.
- Ford Canyon – Mesquite Canyon – Goat Camp trail junction.
- The saddle at Ford Canyon milepost FD-6, which provides the first extensive views to the south for those coming up from Ford Canyon.
- The old dam on Ford Canyon Trail.
- The boulder-strewn inner gorge of Ford Canyon.
- The narrow, rocky ledge just below Ford Canyon milepost FD-4.
- The saddle on Willow Canyon Trail, above Mesquite Canyon Trail where uphill climbers will get their first view of rugged Willow Canyon.
- The switchbacks of Mesquite Canyon Trail up to the saddle at Mesquite Canyon milepost MQ-2.

Transportation Views

Views to the west from the top ridges extend to the flatlands outside the park, across state trust lands, towards the Sun Valley Parkway. The first mile or so from the park boundary includes prominent, scenic

outcrops. From Sun Valley Parkway at approximately North 211th Avenue, the park is within view by a quarter mile at its closest point. Other transportation planning documents serve to protect these views:

- White Tanks-Grand Avenue Area Plan (December 2000),
- Olive Ave Scenic Corridor Plan, and
- McMicken Scenic Corridor Plan.

3.9 Recreation Resources

As a result of the abundant natural and cultural resources, the park offers visitors a number of recreational and educational opportunities:

- Camping (RV, tent, group),
- Picnic,
- Trails (hiking, equestrian, mountain bike),
- Playgrounds,
- Volleyball court,
- Wildlife viewing ,
- Nature photography, and
- Hunting.

3.9.1 Off-Highway Vehicles (OHV)

OHV use is not an approved recreational activity within the park or on its trails and therefore is not detailed further in this plan. As of the date of publication of this plan, OHV use within park boundaries may violate park rule R-107 regarding motor vehicle and bicycle use. OHV use may be permitted by Department staff for maintenance or emergencies or by authorized first responders for emergency or rescue purposes only.

3.9.2 Interpretation and Environmental Education

Interpretive rangers at the park lead hundreds of visitors on a variety of educational hikes throughout the year that incorporate the local geology and cultural artifacts to tell the story of the park. Interpretive signage, such as along Waterfall Trail, is used to educate park visitors and draw their attention to natural or cultural features that might have been missed otherwise. The park provides other programs such as:

- Guided nature hikes,
- Guided fitness walks ,
- Youth-oriented events, and
- Star gazing.

Additionally, the park has a 100-seat amphitheater just behind the library building where interpretive rangers can present educational lectures or special event hosts can perform.

Figure 3-9: Interpretive signage along Waterfall Trail

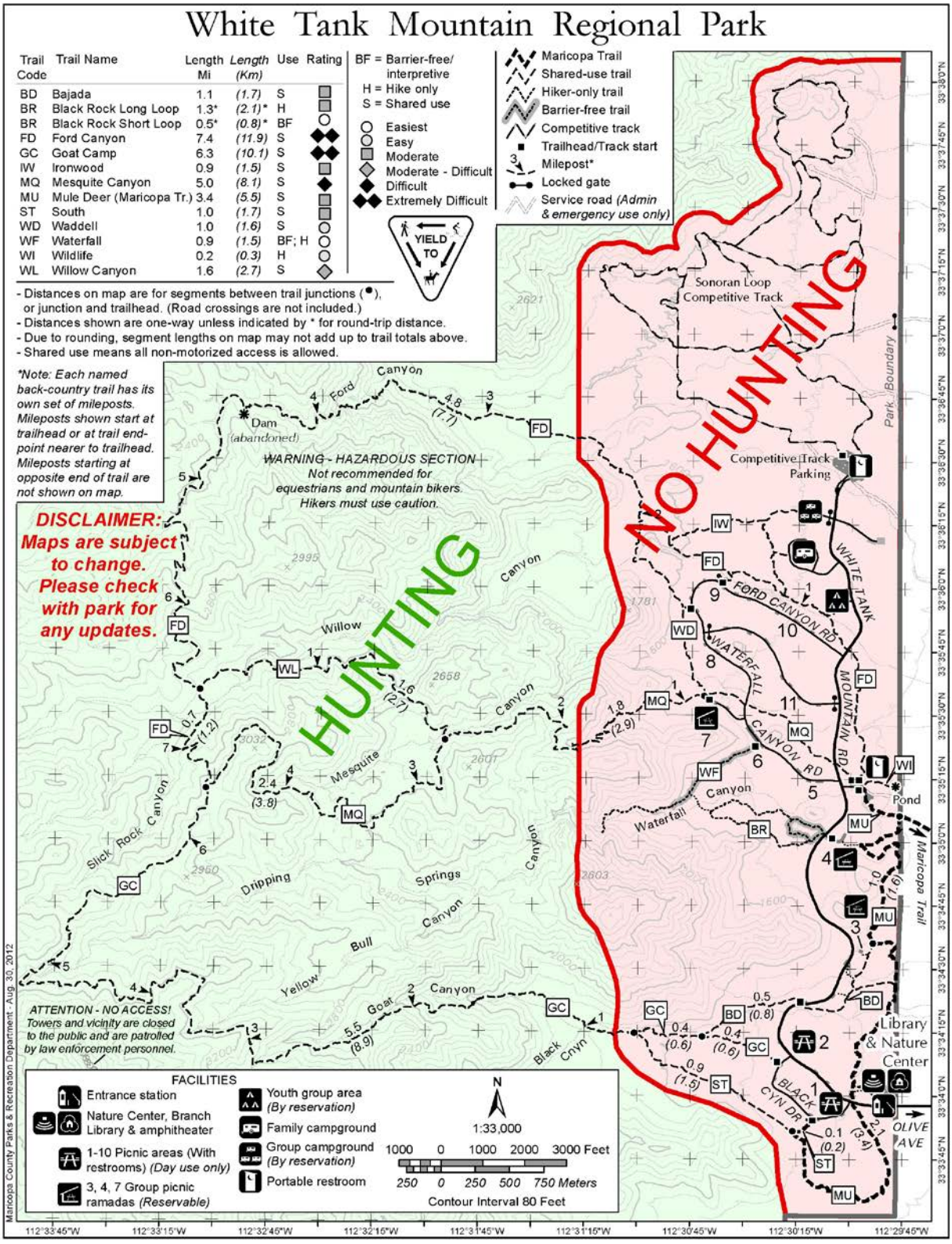
3.9.3 Hunting[46]

The park allows hunting of deer (mule, white-tailed), javelina, mountain lion, some small game, reptiles, and amphibians during specified hunting seasons as regulated by AZGFD. The park currently falls within Region 6, Game Unit 42 of the AZGFD Game Management Unit Map.

A valid hunting license is required and each hunter should state his/her intention to hunt at the park entrance station or with the Park Supervisor (or his/her designee) and pay any applicable park fees. All hunters must comply with the most current copy of Arizona Revised Statutes, Arizona Game and Fish Commission rules and regulations, and Park rules.

It is illegal and a revocable offense to shoot a firearm or bow and arrow within a quarter of a mile of any developed picnic area, developed campground, shooting range, occupied building, boat ramp, or golf course or other recreational area developed for public use; or to shoot from, on, or across a roadway; or to trespass on private property. A trail is not considered a developed area.

[46] This section was developed through the assistance of D. Warnecke, Habitat Specialist III, Arizona Game and Fish Department and other Arizona Game and Fish Department staff members.



Map 3-4: Hunting Map (subject to change)

Species of Economic and Recreational Importance (SERI)

AZGFD considers the park of high value to a number of species. AZGFD has noted that mule deer populations within the park have declined[47] in recent years due to drought and other variable disturbance factors. However, populations are currently rebounding and will continue to do so if the area receives sufficient rainfalls. Historically, the White Tank Mountains are within the known distribution of Desert Bighorn sheep statewide (R. E. Lee, 1993).[48] Sheep were last documented in the White Tank Mountains by an AZGFD Wildlife Manager in 1978 (AZGFD[49]). There are no imminent plans by AZGFD to translocate sheep to this area to reestablish a huntable population; however the possibility remains a viable population management strategy for the future. The primary species of economic and recreational importance for the White Tank Mountains, as shown by HabiMap™[50] SERI data, include:

- Mule deer
- Desert bighorn sheep
- Gambel's quail
- White-winged dove
- Mourning dove
- Javelina
- Cottontail rabbit
- Black-tailed jackrabbit
- Mountain lion

Statewide, anglers and hunters spend $958 million, creating an economic impact of $1.34 billion to the state of Arizona. This spending supports over 17,000 jobs, provides residents with $314 million in salary and wages and generates more than $58 million in state tax revenue.[51]

According to AZGFD, fishing and hunting within Maricopa County accounts for $409.1 million (or 43% of the statewide total) in expenditures (or $515 million using an economic impact multiplier effect). Salary and wages of the 5,382 outdoor industry professionals is about $103 million and provides $21.1 million in state tax revenue.[52]

Participation

Hunting is not a large recreational component of the park. The 2012-2013 ASU Park Visitor Study reported no visitors engaged in hunting during the survey period (down from 2.8% from the 2007-2008 Park Visitor Study).[53] Although the Visitor Study did not record any hunters during this time, hunters are required to check in with the park office and 192 did so during the January 2013 hunting season. Differences between these statistics make annual comparisons difficult.

[47] Arizona Game and Fish Department, Game Management Unit 42, http://www.azgfd.gov/h_f/hunting_units_42.shtml

[48] AZGFD staff member, D. Darveau reports that bighorns were referenced within an AZGFD publication, as being located within the White Tanks, as part of a known distribution within the State *The Desert Bighorn Sheep In Arizona* – AZGFD, 1993. Published by Research Branch, edited by Raymond E. Lee.

[49] AZGFD staff member D. Warnecke and M. Stewart reports: Sheep did occur in the White Tanks and were last documented there by AGFD Wildlife Manager Tom Rickel (*spelling*) in 1978.

[50] Arizona Game and Fish Department, HabiMap™, http://www.habimap.org/

[51] Arizona Game and Fish Department, Economic Impact, http://www.azgfd.gov/w_c/survey_results.shtml as accessed December 24, 2012.

[52] Arizona Game and Fish Department, The Economic Importance of Fishing and Hunting, http://www.azgfd.gov/pdfs/w_c/FISHING_HUNTING%20Report.pdf, page 30-31, as accessed December 24, 2012.

[53] 2007-2008 ASU Park Visitor Study, 17.4% of respondents believe hunting is an appropriate activity within the park.

Table 3-5: Hunters Present in Park				
ASU Visitor Use Survey			**Park Records**	
Year	**Participation Rate**[1]		**Year**	**No.**[2]
2012-2013	0.0%		2013	192
2007-2008	2.8%		2012	146
2005-2006	1.7%		2011	235
2002-2003	0.4%			
1999-2000	0.0%			

Sources:
1. ASU Park Visitor Study for listed year.
2. Actual hunters checking in with park office during January of listed year. Source: personal communication from R. Schell, Park Supervisor, July 16, 2013.

When surveyed during the 2007-2008 Visitor Study, 17.4%, system-wide, agreed that hunting was an appropriate activity for county parks. This question was not asked in the 2012-2013 visitor study.

3.10 Land Use

3.10.1 Ownership & Jurisdiction

Ownership

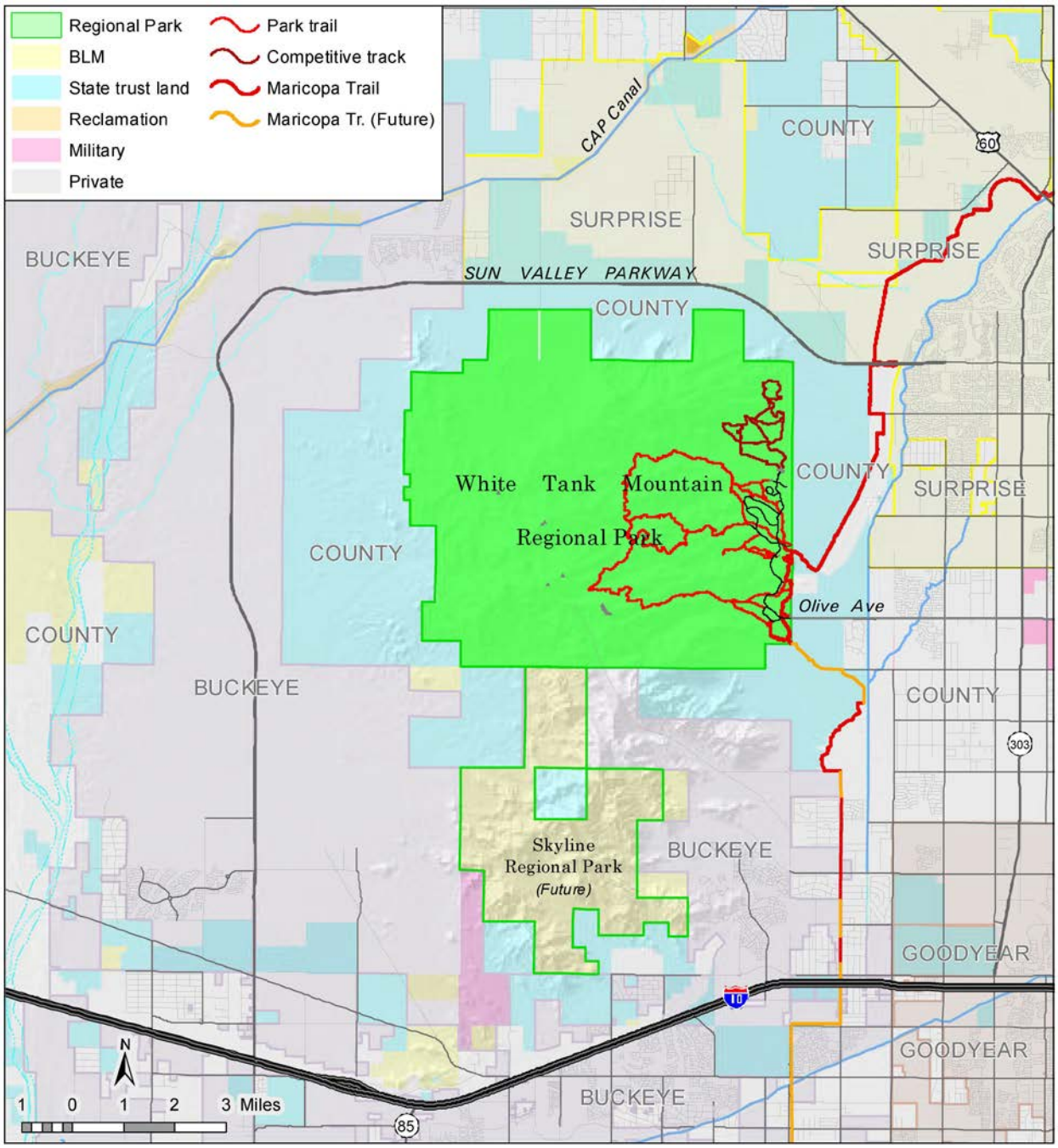
The bulk of the property now managed by Maricopa County Parks and Recreation Department was acquired through the Recreation and Public Purposes Act[54] (R&PP) process in 1966, 1968, and 1972. The R&PP is administered by the Bureau of Land Management (BLM) and authorizes the sale or lease of public lands for recreational or public purposes. All uses of the land must comply with the R&PP Act[55] and the patents as issued. The park has not acquired any additional lands since 2002. The Department holds these areas as patents:

Table 3-6: R&PP Land Patents		
Patent	**Date**	**Acres**
USA Patent # 02-67-0030	Dec. 1966	487.55
USA Patent # 02-67-0031	Dec. 1966	165.13
USA Patent # 02-69-0047	Dec. 1968	640.83
USA Patent # 02-73-0030	Oct. 1972	25,038.09
USA Patent # 02-2002-003		2,880.00
Total patented acres:		29,211.60
Total park acres:		**29,571.59**

An easement was granted by the Caterpillar Tractor Company to MCPRD in June 1979. This area was a former proving ground for Caterpillar heavy equipment. The remaining acres are owned by the County

[54] As revised August 1996. Recreation and Public Purposes Act (68 Statute 173; 43 United States Code 869 et. seq.) as a complete revision of the Recreation Act of 1926 (44 Stat. 741). This law is administered by the Bureau of Land Management (BLM).
[55] BLM, Recreation and Public Purposes Act, http://www.blm.gov/wo/st/en/prog/more/lands/recreation_and_public.html as accessed February 28, 2013.

and when combined, account for the total 29,571.59 park acres. Appendix H details land parcels and other park assets.



Map 3-5: Surrounding Land Ownership

Jurisdiction

White Tank Mountain Regional Park is located within the following jurisdictions:

Table 3-7: Jurisdictions	
Political Unit	**District**
Legislative	4
Congressional	2
Maricopa County Board of Supervisors	4
Maricopa County Parks Commission	4
School Districts	
Wickenburg Unified School District	
Saddle Mountain Unified School District	
Dysart Unified School District	
Law Enforcement	
Maricopa County Sheriff's Office	

An intergovernmental agreement (IGA) with Maricopa County Library District sets the terms of use for the newly constructed Nature Center and Library and is kept on file in Department records. As a LEED Certified building, it also helps fulfill the County's Green Government Plan goal labeled PR4 for land use.[56]

Towers

Atop seven high points in the mountain range are microwave stations and air navigational beacons installed during World War II. The first beacons were battery-operated and all construction materials and equipment were transported up the mountain by pack train. Power lines were later installed, one of which traverses the east end of the park to a beacon on the ridge behind Point-of-Mountain.

This area and access road are governed by the White Tanks Improvement Association (WTIA) and is a membership of the primary users of the tower area, including Maricopa County,[57] to provide a cooperative forum for disputes and use, fund maintenance land labor, and to provide recommendations to the BLM, the State of Arizona, and Maricopa County regarding use and occupancy of the tower area. There is no public access allowed on the road that leads to the towers.

The BLM receives and reviews applications for new communications towers on the peaks of White Tank Mountains. Applications must comply with the Bradshaw-Harquahala Record of Decision and Approved Resource Management Plan (April 2010), White Tank Mountains Programmatic Environmental Assessment EAR AZ-020-8-83 (dated August 27, 1976), and White Tanks Communication Site Plan (dated August 12, 2005).

3.10.2 Existing Land Use and Zoning

Existing Use

Land use surrounding the park to the north, south, and west is largely agricultural or vacant in nature and is held in trust and managed by Arizona State Land Department (ASLD) whose mission is to maximize revenue for Trust beneficiaries through sales and leasing of state land. There is one section owned by BLM to the south that has been awarded to the Town of Buckeye via the R&PP process in 2010. The Town intends to develop the 8,675 acres into a regional park featuring trails, picnic areas,

[56] Green Government, http://www.maricopa.gov/GreenGovernment/pdf/GGP%20Landuse%20Measures.pdf as accessed September 10, 2012.
[57] Maricopa County is represented by the Office of Enterprise Technology for WTIA membership.

camping sites, etc. The Town intends to open the park in 2015 with access off of Watson Road, 2 miles north of I-10. Another one-half section is also owned by BLM at the southwest corner of the park.

On the east side of the park there are residential areas. A horse riding stable, White Tanks Riding Stables[58] is also located just outside of the park's east entrance and provides guided horseback rides through the park. The stable is an independent concessionaire and is allowed access to the park via a Commercial Management Concession Agreement (CMCA).

Zoning

The area within park boundaries is zoned RU-43 or RU-190 by Maricopa County. The unincorporated areas parcels immediately outside of park boundaries are also zoned RU-43 or RU-190**.**

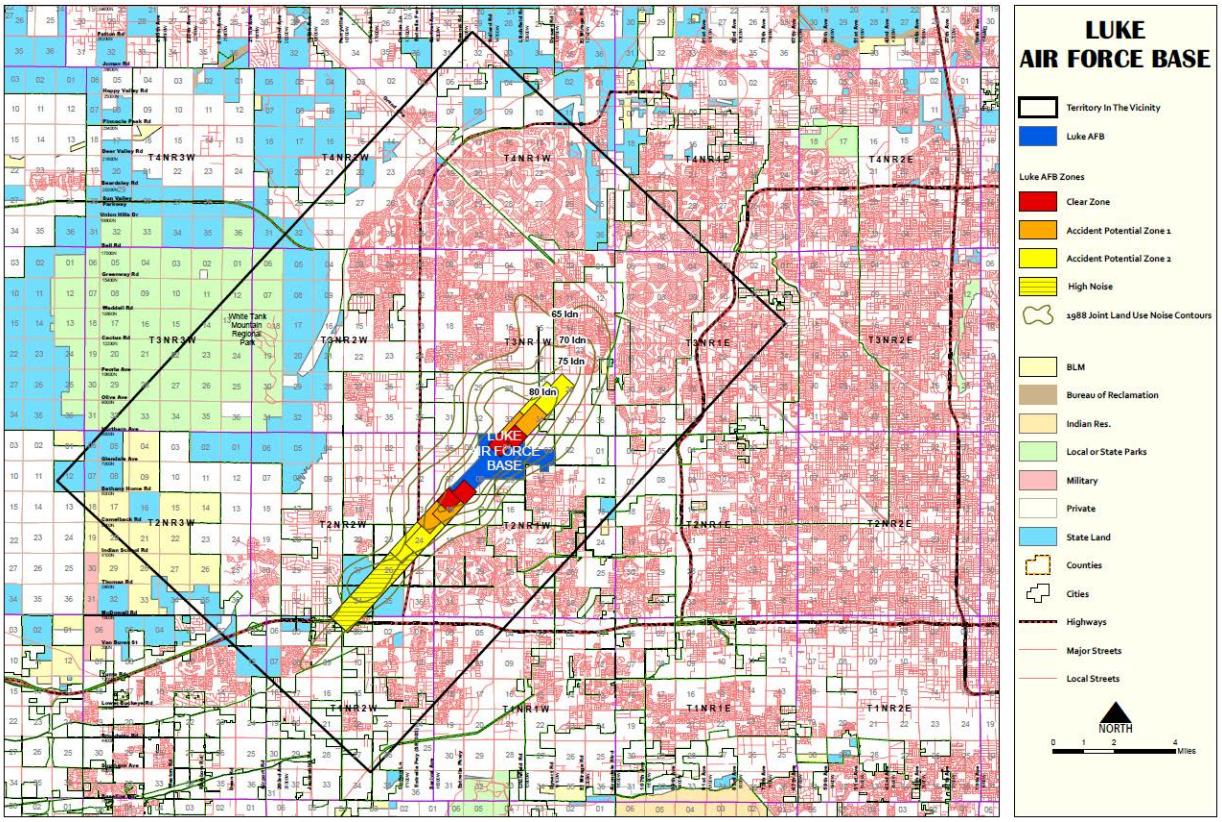
- RU-43 defined as: one acre per dwelling unit[59] - protects farm and agricultural uses and permits recreational and institutional uses.
- RU-190 defined as: 190,000 square feet per dwelling unit[60] - protects farm and agricultural uses and permits recreational and institutional uses.

Other areas outside of park boundaries are currently under ASLD's jurisdiction and are vacant. However, areas west of the park fall within the Town of Buckeye's[61] planning area and are largely zoned for planned communities. The City of Surprise[62] has approved the Village 3 plans for its areas adjacent to the park's northern boundary (zoned rural residential and open space). These areas are discussed further in the "Future Land Use" section below.

Luke Air Force Base

The park is also within the Luke Air Force Base[63] vicinity and sometimes experiences aircraft fly-over's. The Luke website describes itself as being the largest and only active-duty F-16 training base in the world with over 135 F-16s assigned, conducting over 24,500 operations or over flights in its local airspace annually. Luke Air Force Base flight operations are typically from 7:00 a.m. to 11:30 p.m. Monday through Friday, but may also fly outside of this window, to include weekends, depending on mission requirements.

[58] White Tanks Riding Stables, http://www.whitetanksriding.com/ as accessed September 26, 2012.
[59] Maricopa County Zoning Ordinance, Chapter 5 Rural Zoning Districts, Chapter 5, Pages 13-15 of 15. http://www.maricopa.gov/planning/Resources/Ordinances/pdf/reform_ordinance/mczo1.pdf as accessed April 12, 2012.
[60] Maricopa County Zoning Ordinance, Chapter 5 Rural Zoning Districts, Chapter 5, Pages 1-11 of 15. http://www.maricopa.gov/planning/Resources/Ordinances/pdf/reform_ordinance/mczo1.pdf as accessed April 12, 2012.
[61] Refer to Town of Buckeye for updated information, http://www.buckeyeaz.gov/index.aspx?NID=1127
[62] Refer to City of Surprise for updated information, http://www.surpriseaz.gov/index.aspx?NID=317
[63] Luke Air Force Base website, http://www.luke.af.mil/library/factsheets/factsheet_print.asp?fsID=6401 as accessed July 23, 2013.



Map 3-6: Luke AFB Noise Contours[64]

3.10.3 Future Land Use

Much of the land surrounding the park is held in trust by ASLD and could be sold or leased at market value for development purposes. Other jurisdictions have planning documents in place to facilitate development in the White Tank area.

Maricopa County (unincorporated areas) and Private Property

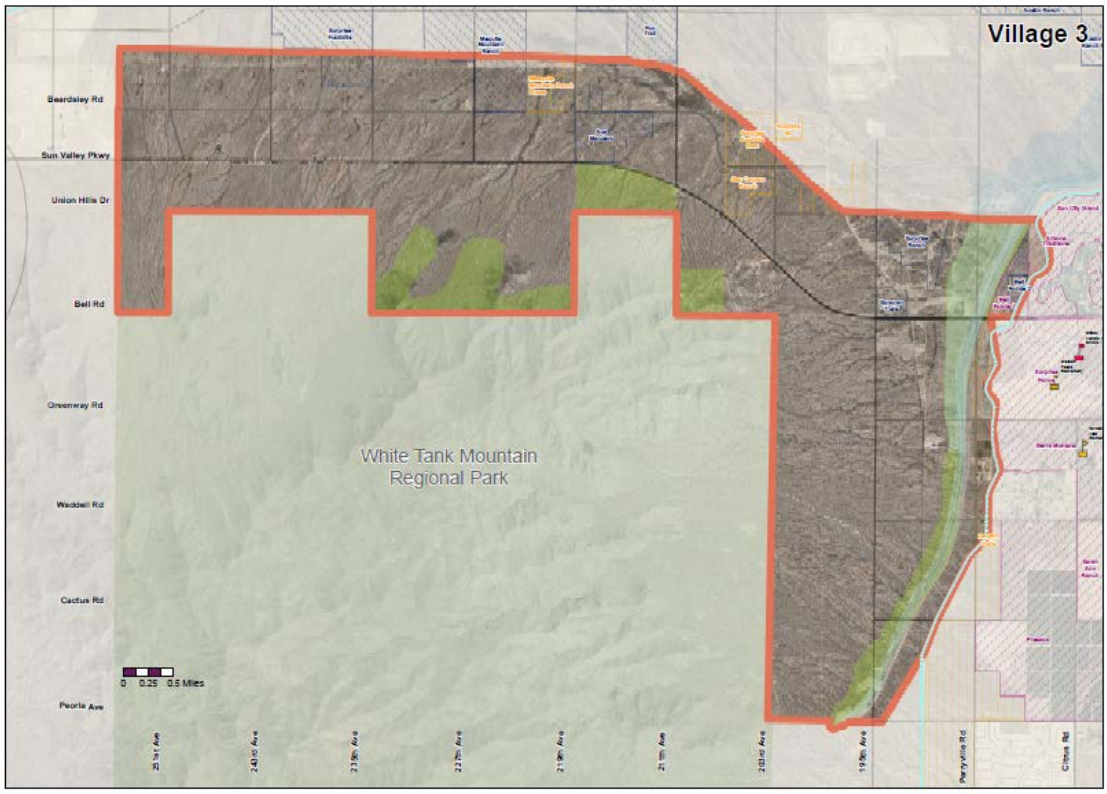
Privately owned parcel(s) just outside of park's eastern boundary and within the unincorporated County are currently zoned RU-43 and RU-190 which limits housing density to protect the agricultural or rural character of the area; however this is subject to change pending any new zoning applications.

City of Surprise

The City of Surprise began updating its General Plan in 2012. When surveyed, Surprise citizens responded that safety, cleanliness, and recreation were the most important community characteristics.[65] A component of the General Plan, is "village" planning and subsequently Village 3[66] planning is complete and has been approved. The park shares its north and northeast boundaries with Village 3 and this should be taken into consideration when planning future facilities within the park. The City has worked with AZGFD to include wildlife linkages into the Village 3 plans. The Village 3 plans

[64] Map source: Luke Air Force Base website, http://www.luke.af.mil/library/factsheets/factsheet_print.asp?fsID=6401 as accessed July 23, 2013.
[65] City of Surprise, Surprise General Plan Update, www.surpriseaz.gov/generalplan as accessed December 26, 2012.
[66] City of Surprise, Village 3, http://www.surpriseaz.gov/index.aspx?nid=2242 as accessed December 26, 2012.

advocate providing open space, preserving desert ecosystems, habitat linkages, and it also includes a potential a resort or resort-like development near the park's northern border.



Map 3-7: Village 3 Plan, City of Surprise, Arizona

Likewise, there are three major planned developments on the east side of the park: Zanjero Trails, Cortessa, and White Tank Foothills; these projects may add up to 13,000 residential units and approximately 35,000 people to the area.[67]

Town of Buckeye

There are opportunities for the Town of Buckeye to develop residential and commercial areas, roads, and other infrastructure to the west of the park. Another development, Verrado, may include up to 9,000 dwelling units. Also, within the Town of Buckeye's planning area, Festival Ranch will include up to 24,000 dwelling units. Further west of the park, the proposed or planned developments Belmont, Douglas Ranch, Trillium, Sun Valley, Tartesso, and Sun Valley Villages I and II may add up to 171,000 dwelling units in addition to commercial development. The Town's 2007 General Plan lists several policies that will require coordination with MCPRD and the park itself:

> Goal 9.0. Manage Open Space and Recreation [68]

[67] Olive Ave Scenic Corridor Plan, Page 15-16; and map page 17, https://www.maricopa.gov/planning/Resources/Plans/docs/pdf/Olive_Avenue_Scenic_Corridor_Design_Guidelines.pdf as accessed December 3, 2012.

[68] Town of Buckeye, 2007 General Plan, page 2-8 through 2-10, http://www.buckeyeaz.gov/DocumentCenter/View/142 as accessed December 3, 2012.

Policy 9.12: Develop direct trail access throughout the Town, to the Maricopa County White Tank Mountains Regional Park, and to parks south of I-10.

Policy 9.16: Coordinate with the Bureau of Land Management, Flood Control District of Maricopa County, Maricopa County Parks and Recreation Department, Arizona State Land Department, Arizona Game and Fish Department, and other agencies to identify sites for open space or recreational amenities that could be mutually beneficial.

Policy 9.19: Prohibit new land uses or developments that eliminate connections to the Town of Buckeye's trail plan and linkages to the Maricopa County Parks and Recreation Department's regional trail system.

Policy 9.21: Maximize land use compatibility with the Sonoran National Monument and White Tanks Regional Park to enhance community recreational opportunities.

Policy 9.22: Make Buckeye the recreational gateway to the National Monument and the White Tanks. Develop a coordinated strategy with the Bureau of Land Management and Maricopa County Parks and Recreation Department for tourist traffic, portals, and trailheads to these important Sonoran Desert environments.

The Town is in an early planning stage to develop their version of a regional park facility south of the White Tank Mountain Regional Park known as Skyline Regional Park (map 3-8). In November 2010, the Town and the Bureau of Land Management signed a 25-year lease as part of the R&PP act. A master plan was created, which was adopted by the Town on September 4, 2012. The park is currently under design and should be open to the public in 2015.

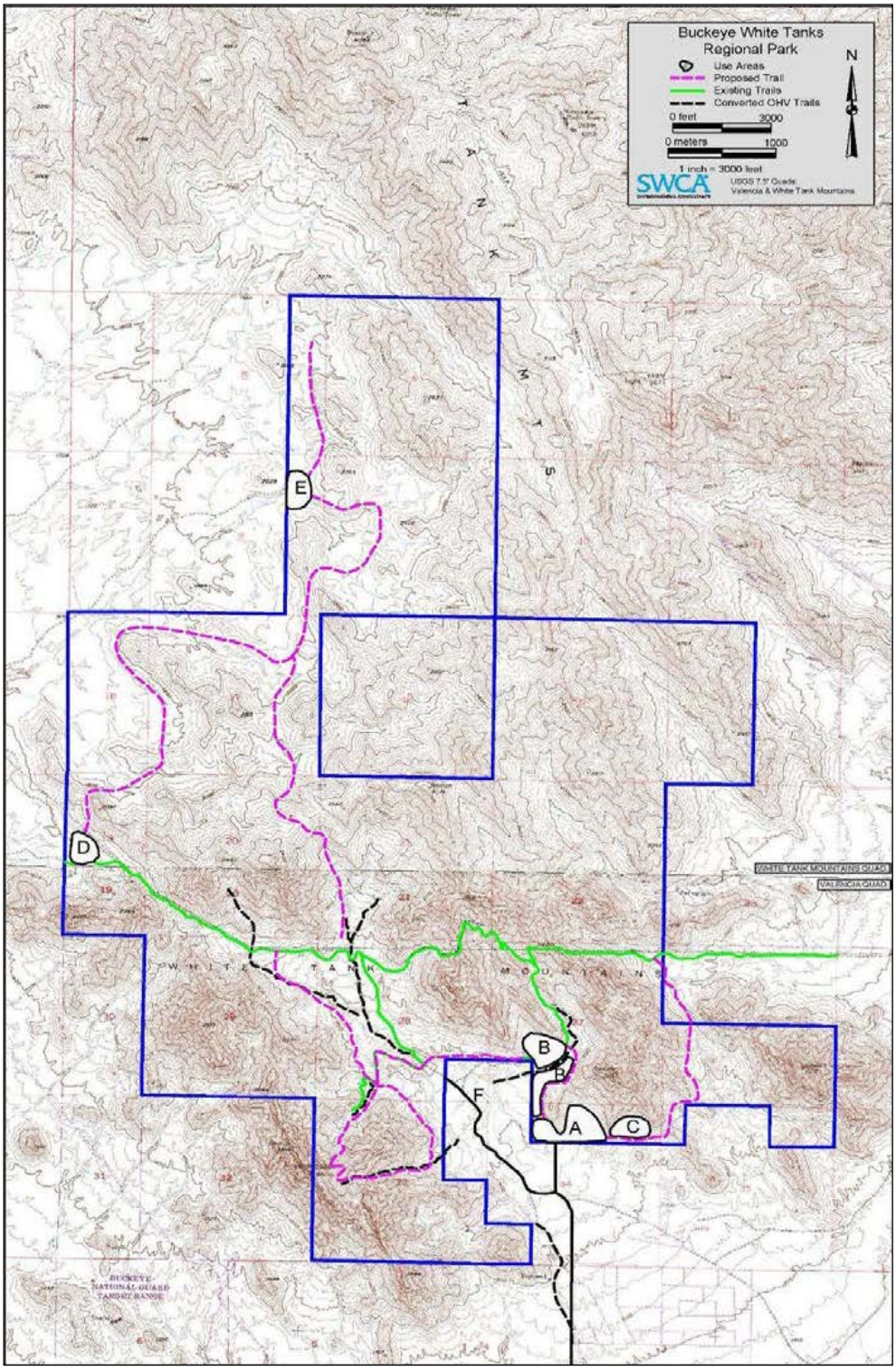
Bureau of Land Management (BLM)

The BLM began a scoping and EIS (environmental impact statement) process in 2010 to determine the best sites for renewable energy development in the State of Arizona as a part of The Restoration Design Energy Project (RDEP), funded by the American Recovery and Reinvestment Act of 2009. The draft EIS was released to the public on February 17, 2012 for comments. Two potential sites on BLM lands west and southwest of White Tank Mountain Regional Park may affect views within the park if these development projects are realized.[69]

- Belmont Proposed Disposal (site #3, page 84, see footnote 55) – west of park.
- Foothills Proposed Disposal (site #21, page 120, see footnote 55) – southwest of park.

As of March 2012, the BLM is also considering a communications tower application[70] that proposes a new tower near or among the existing towers. This new tower, if constructed, will have additional visual impacts within the park and on some sections of trails. The Department has submitted its comments regarding this application to the BLM in April 2012; no further updates are available at the time of this printing.

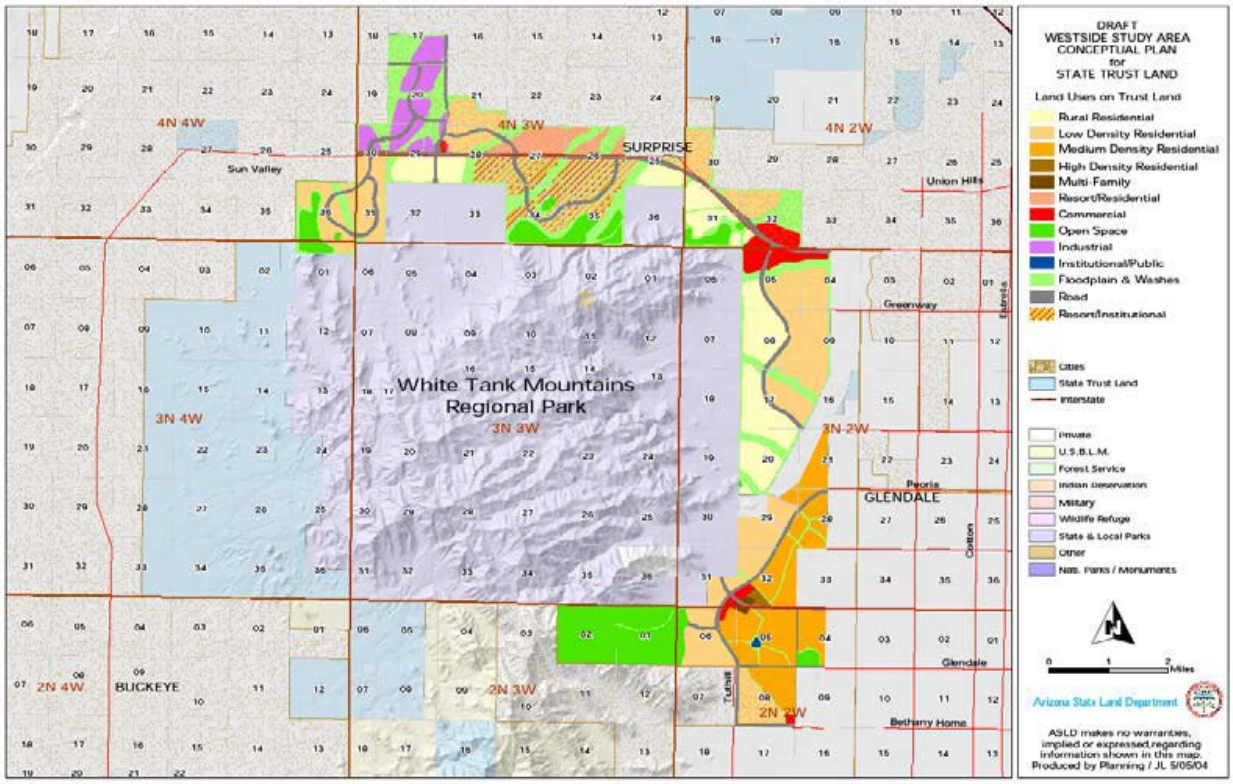
[69] BLM, Restoration Design Energy Project, Draft Environmental Impact Statement, Appendix C: Arizona Restoration Design Energy Project, Solar and Wind Energy Assessment of Nominated Sites, February 2012, http://www.blm.gov/az/st/en/prog/energy/arra_solar.html as accessed April 18, 2012.
[70] Reference application numbers 2800 (P010), AZA-35918 for GovNET, Inc.



Map 3-8: Skyline Regional Park (Skyline Regional Park Master Plan, p28)[1]

Arizona State Land Department (ASLD)

The Westside Study Area Conceptual Plan for Arizona State Trust Land (May 5, 2004) shows areas neighboring the park that are planned for development including low to medium density residential and commercial near the parks eastern corners. It is important to note that Map 3-9 is a draft version of a conceptual plan and was never adopted and therefore is subject to change.



Map 3-9: ASLD Westside Study Area Conceptual Plan (draft)

3.10.4 Access / Transportation

Existing Roads

Several major roadways encircle the White Tank Mountain range:

- Loop 303 (east side of park) – a 39-mile freeway stretching from Interstate 10 in Goodyear to Interstate 17 in Phoenix; frequent road closures are expected for construction activities anticipated through 2014.
- Sun Valley Parkway (north and west sides of park) – between Beardsley Canal and I-10, the parkway is about 28 miles long, curving around the White Tank Mountain range and into Bell Road at an east-west alignment.
- Interstate 10 (south side of mountain range) - a major transcontinental highway, running east from the California border and through the central core of the Valley before it meets Interstate 17, eventually turning south to Tucson.

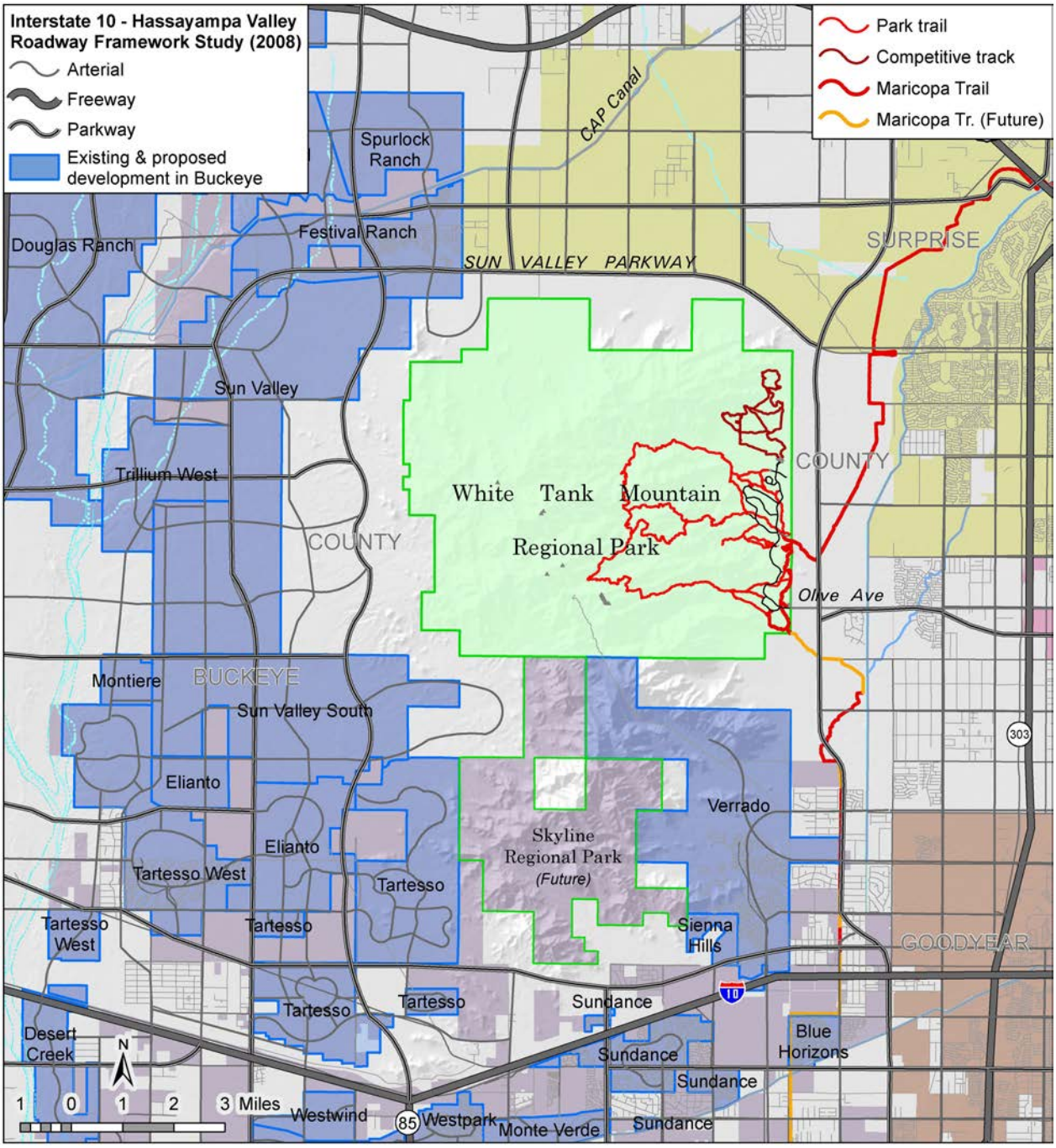
Olive Avenue, on the east side of park, serves as the park's main entrance point and is recognized as a scenic transportation corridor. Although old dirt roads or trails may exist into the park, Olive Avenue provides the only authorized access into the park.

Future Road Expansions

MCDOT and its consultant(s) are actively examining transportation needs and conducting feasibility studies on the following parkway proposals in the west valley:

- Turner Parkway (a north-south alignment): the preferred alignment spans about 32 miles from SR-74 to I-10.
- Deer Valley Parkway (an east-west alignment): the preferred alignment spans about 11 miles and is generally centered on the Deer Valley Road section line, and extends from the planned future Wild Rose Parkway (approximate 243rd Avenue alignment) to US-60.
- Jackrabbit Trail Parkway (a north-south alignment): the preferred alignment is about 12 miles long and connects to I-10 along Perryville Road, curves west to Indian School Road and continues north Bethany Home Road along the Beardsley Canal. Then it curves west to the 199th Avenue alignment, travels along the west side of McMicken Dam and joins the 191st Avenue alignment at its intersection with Bell Road.
- Wild Rose Parkway (a north-south alignment): the preferred alignment is about 11 miles long, beginning at Sun Valley Parkway extending north along the 243rd Avenue section line to just north of Pinnacle Peak Road to where it transitions northwest to the 251st Avenue section line, continuing to the Joy Ranch Road alignment, then curving to the northeast to meet US-60 at a perpendicular angle. This plan also recommends maintaining the viewshed of the White Tank Mountains.
- Greenway Parkway: the study area is approximately nine miles in length and two miles wide, is generally centered on the Greenway Road section line, and stretches from one mile west of the planned future Hassayampa Freeway alignment (approximately 339th Avenue alignment) to one mile east of the planned future Turner Parkway (approximately 279th Avenue alignment).
- Wintersburg Parkway (a north-south and east-west alignment): the study area stretches approximately 22 miles from Salome Highway to the proposed Turner Parkway.
- Hassayampa Freeway (a north-south alignment): the study area is approximately 41.2 miles and extends from the north study boundary to the Gila River. This may also be incorporated into the I-11 development.

Arizona Department of Transportation (ADOT) (in cooperation with Nevada Department of Transportation and its consultants) began a study in October 2012 to determine feasibility of Interstate 11 (I-11), a multi-modal corridor connecting the Phoenix area to the Las Vegas, Nevada area. As of this publication date, draft alternatives are being developed.



Map 3-10: Existing and Future Roadways

All of these roadway expansion projects (and others as they are identified) should be tracked by the Department and the park itself so that park management pressures or impacts can be addressed. The Interstate 10 – Hassayampa Valley Roadway Framework Study, a MAG document, provides more detail regarding these roadways.

3.11 Drive-time Analysis

As part of the 2009 Strategic System Master Plan, PRO's Consulting[71] (PRO's) examined drive times from the park entrance outward on roadways traveling at designated minute increments. PRO's used 2000 Census Tract estimates for 2007 populations, simplified into density categories:

- Urban (2.0 people per acre or more; 0.5 acres per person or less),
- Exurban (0.5 people to 2.0 per acre; 0.5 to 2.0 acres per person), and
- Rural (less than 0.5 people per acre; 2.0 acres per person or more).

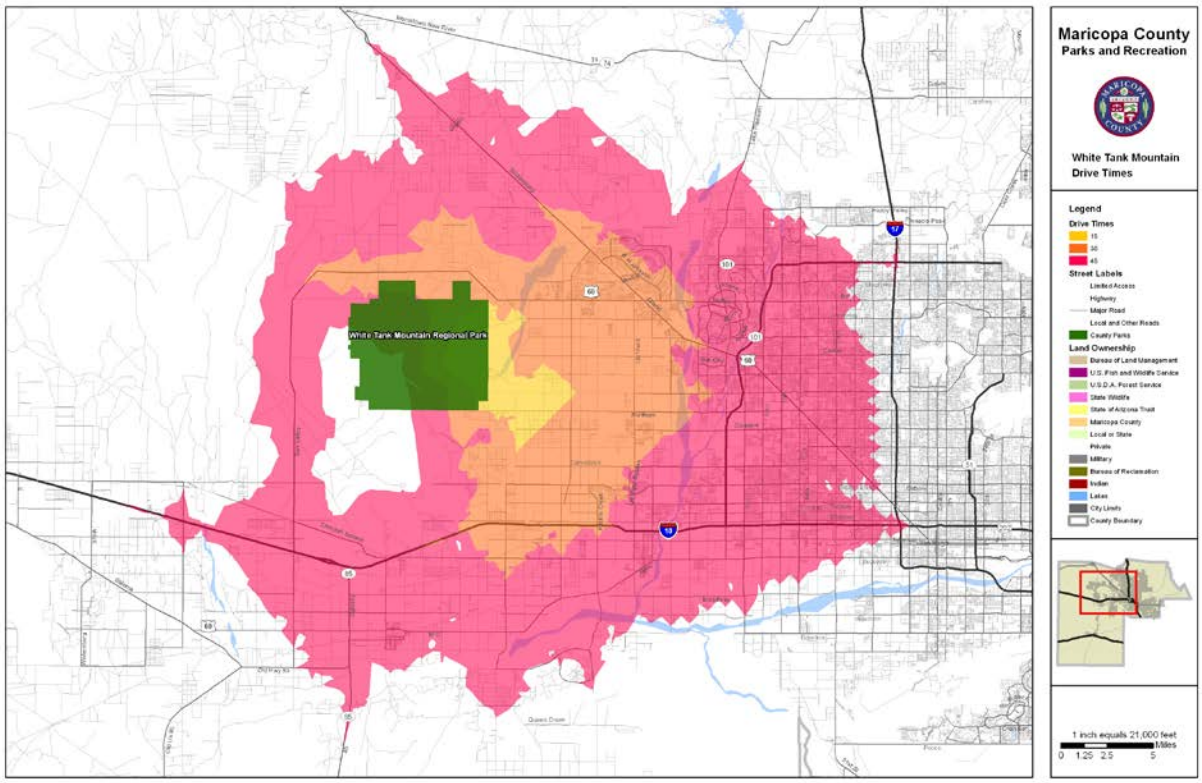
They then derived proportional population estimates for each drive time and weighted against the drive time acreages to establish average correlated people per acre and the inverted ration of acres per person. This effort to measure population against acres available is to demonstrate the need and pressure each County park will be under for the future and how to plan to meet that need in updated master plans and to serve all age groups despite pressure on the park's per person per acre ratio.

Table 3-8: Drive Time/Acres Analysis for White Tank Mountain Regional Park

Total Population by Time Segment (minutes)			
Year	**15**	**30**	**45**
2007*	2,029	160,851	1,133,810
2017	2,782	267,256	1,593,287
Acres by Time Segment (minutes)			
26,337	16,704	118,889	391,878

Source: 2009 Strategic System Master Plan, PRO's Consulting, page 25.
*2000 Census Tract estimates for year 2007.

[71] 2009 Strategic System Master Plan, PROs Consulting. Page 45-47.



Map 3-11: Drive time analysis. 2009 Strategic System Master Plan, PROs Consulting, page 58.

3.12 Facilities and Infrastructure

3.12.1 Entrance Station

The main entrance, with a contact station, is located off of Olive Avenue on the east side of the park and is the park's primary entrance. Other access into the park is by uncontrolled pedestrian or equestrian trail access.

3.12.2 Regional Library, Nature Center, Amphitheater (combined facility)

All three facilities may be accessed near the park entrance gate at Olive Avenue. The 29,000 square foot library, when opened, was the first Leadership in Energy and Environmental Design (LEED) Platinum library in Arizona, and only one of four in the United States. The BLM reviewed these plans and concluded this facility was in compliance with the existing master plan and approved its construction on July 7, 2009 (BLM reference number AZAR-017958).

Maricopa County Library District operates the library and welcomed over 87,000 customers in fiscal year 2013 (table 3-9). The library has a collection capacity of 35,000 items and provides specialty rooms like quiet study and children's story time rooms. The Friends of White Tank Library operate a used bookstore just inside the building entrance.

Table 3-9: Library Visitation & Programs (Fiscal Year 2013)	
	Attendance
Customer count (visits)	87,464
Total circulation	246,794
Kid's programs (170 programs)	5,051
Adult programs (97 programs)	1,700
Source: personal communication from J. Govern, Branch Development Administer, MCLD, September 4, 2013.	

Attached to the library is the 5,000 square foot Nature Center that houses a reptile exhibit, an area to purchase retail items and park souvenirs, along with an outdoor patio with a great mountain view. The Nature Center also has a classroom that can accommodate up to 20 tables or 50 chairs. The amphitheater, just a short walk from the Nature Center, can seat 100 people and is lighted for evening use.

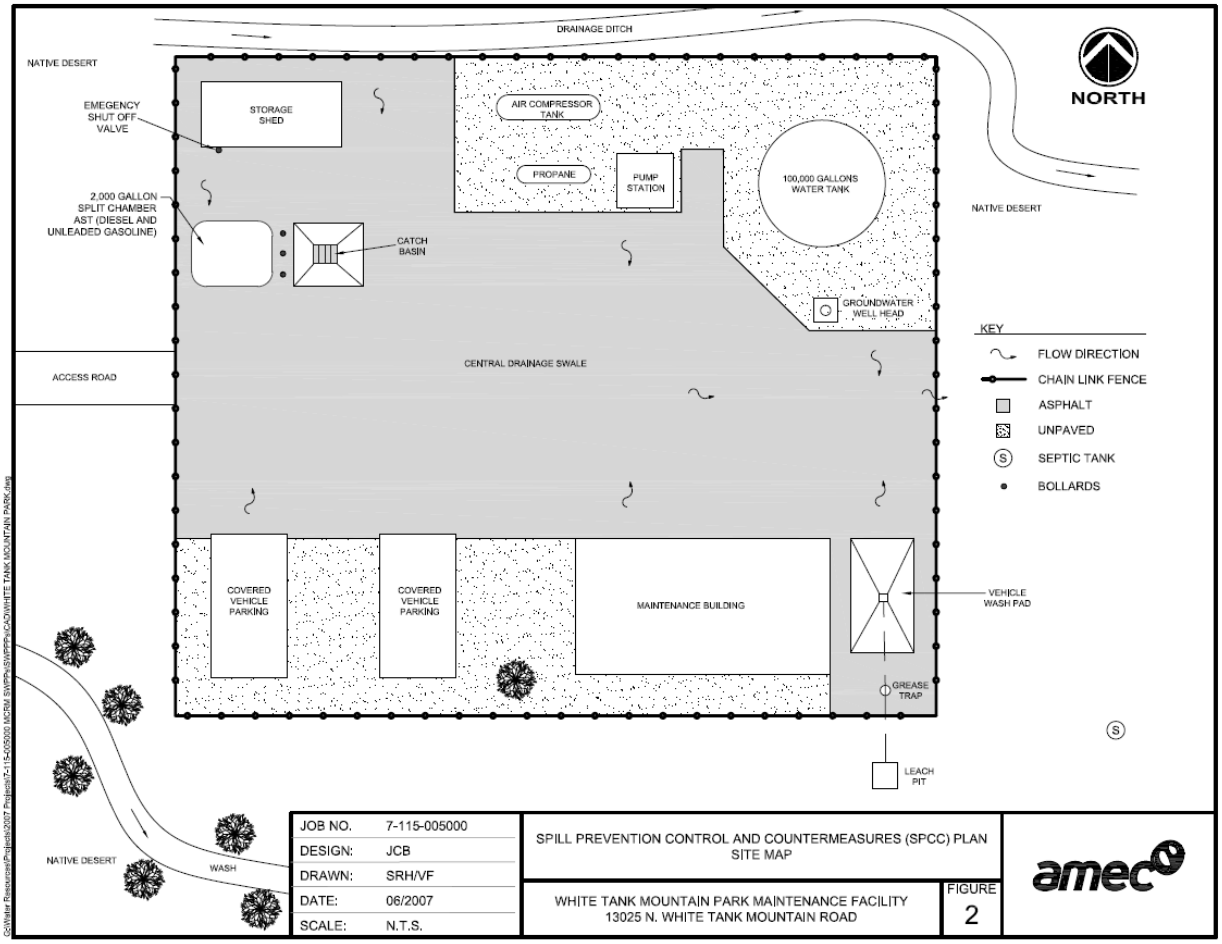
Figure 3-10: Amphitheater

3.12.3 Maintenance Compound

Once inside the park, Open Sky Way, to the east, provides access to the maintenance compound. The Spill Prevention Control and Countermeasures Plan (August 2007) prepared by AMEC Earth & Environmental, Inc. describes the area in detail:

"The maintenance compound encompasses a fenced area of 0.64 acres and includes a maintenance building on the southeastern portion of the site. The northeast portion of the site contains the parks water supply system, consisting of a groundwater extraction well, a 100,000-gallon above-ground water tank reservoir, water supply pumps and controls, and an above-ground air compressor tank. A temporary storage shed is located on the northwest corner of the facility and it is used to store traffic cones, barricades, detergents, and other cleaning supplies. Two mobile home/RV spaces are located on the southwestern corner of the facility. These spaces are reserved for the Park Hosts. All of these features are shown in Figure 2.

Immediately north of the entrance gate, on the western portion of the site, is a 2,000-gallon split-chambered gasoline/diesel AST used to fuel County vehicles. A 1,000-gallon propane AST and dispensing system are located on the north-central portion of the site. A vehicle wash pad is located at the southeastern corner of the site. The surface of the compound is asphalt-paved and gently slopes to the east. The perimeter of the site is protected by a 6-foot high chain-link fence."



Map 3-12: SPCC Plan Site Map (maintenance facility), Figure 2

For maintenance, inspection, and spill control measures for this area, refer to the most recent Spill Prevention Control & Countermeasures (SPCC) Plan.

3.12.4 Picnic Areas

White Tank Mountain Regional Park offers 231 picnic tables with grills, 35 of which have a small cover, within its picnic areas (including Willow). Three group areas, with 11 ramadas total are available for large groups and may be reserved for a fee in four-hour increments. If not marked as reserved, they are available on a first-come, first-served basis. All picnic sites are considered day-use only; all have restrooms.

Table 3-10: Picnic Areas		
Area	**Name**	**Description**
Area 1	Petroglyph Point	Located off Black Canyon Road. Contains 35 tables and a restroom. Provides access to South Trail and Goat Camp Trailheads.
Area 2	Bajada Crossing	Contains 13 tables and a restroom. Bajada Trail crosses here.
Area 3 (group)	Quartz Grove (a) Gneiss Ramada (b) Granite Ramada	Two, four-table ramadas, three large barbeque grills, an activity court, a fire ring, restroom facilities, and parking for approximately 20 vehicles.
Area 4 (group)	Black Rock Rest (a) Agate Ramada (b) Basalt Ramada (c) Cobble Ramada (d) Desert Varnish Ramada (e) Esplanade Ramada (f) Fool's Gold Ramada	Located across the Black Rock Loop Trailhead, this area also provides access to Mule Deer Trail. Six, four-table ramadas, seven grills, three activity courts, three fire rings, a playground, and restroom facilities.
Area 5	Metate Meeting	Contains 16 tables and a restroom.
Area 6	Waterfall Flats	Two 2-table ramadas (non-rentals) and 14 tables. Also features the Waterfall Trailhead, restroom, and playground.
Area 7 (group)	Laramide Lookout (a) Jasper Ramada (b) Olivine Ramada (c) Gypsum Ramada	Located at the Waddell/Mesquite Trailhead. It also offers a stage with four benches; three two-table ramadas; six grills; one fire ring; and restroom facilities.
Area 8	Hohokam Hideaway	27 tables and restroom. Provides access to Waddell Trailhead.
Area 9	Dry Wash Draw	22 tables and restroom. Provides access to Ford Canyon Trailhead.
Area 10	Tinaja Tables	20 tables and restroom.

Figure 3-11: Picnic Area 4-D (Desert Varnish Ramada)

3.12.5 Campgrounds

The 1964 Master Plan delegated no special areas for the exclusive use of camper vehicles (travel trailers, tent trailers, pickup campers, microbuses, etc.) nor did it intend to provide utility hookups for camp vehicles. This plan update acknowledges the importance of providing campers access to a range of camping types from basic tent to developed RV camping. Campground amenities include:

- Developed: includes electrical/water hookups, dump station, restrooms, picnic tables, and grills.
- Semi-Developed: includes restrooms, picnic tables, and grills.

- Primitive: Not available.
- RV Host Site: Includes shade, electrical/water hookups, dump station, restrooms, picnic tables, and grills. (These sites are reserved for camp hosts, but may occasionally be available to rent.)

Campsites are still not considered exclusive to one type of camping; however the various campgrounds provide various amenities to accommodate differing camping types. All sites in the campgrounds may be reserved online. All campground restrooms offer flush toilets and showers.

Youth Group (Area 12) - for scout groups and other youth groups under the age of 18 years (up to 100 people). Groups must be adult-supervised. The group area offers 12 sites that accommodate one or two tents per site, one small grill at each site, a group fire ring, five picnic tables at the fire ring, and restroom facilities.

Figure 3-12: Youth Campground

Family Campground (Area 13) - to improve the camper's experience, the 40 sites received water and electrical hookups in 2013 and a dump station will be constructed in 2014 near the entry to this campground. This campground will be considered "developed" camping and will also include a picnic table, barbecue grill, a fire ring, and plenty of room for camping at each site.

Group Campground (Area 14) - two large ramadas with four picnic tables each, two large barbecue grills, one large fire ring, restrooms with showers, lights/electrical outlets, and parking for approximately 50 RVs.

Backcountry Camping - overnight backpacking, with a permit, is allowed. This is for "low impact" camping, i.e. no fires and pack out what is packed in.

Other camping areas - Willow (Area 11) and the Competitive Track Parking Area are occasionally used to provide alternative or overflow camping space when needed.

3.12.6 Playgrounds

The park has a total of three playgrounds (currently located at Family Campground, Picnic Area 4, and Picnic Area 6). Each is inspected regularly by park staff for obvious signs of disrepair. Additionally, each playground is inspected annually by a certified playground inspector (via an IGA with the City of Phoenix

or by Department staff) to ensure each playground complies with current safety and ADA standards. Inspection reports are kept on file at the park's administrative office.

3.12.7 Horse Staging Area

White Tank Mountain Road to Wildlife Way provides access to several trails and a horse staging area. This area features a trailhead area for Mesquite Canyon, Ford Canyon, Mule Deer, and Wildlife Trails (horses may access all trails from here). The area also has four tables, one of which is covered; hitching rails; and a watering hole. This area also provides trail access to the pond via Wildlife Trail.

Figure 3-13: Horse staging area

3.12.8 Roads and Parking

All paved and named roads are constructed and maintained by Maricopa County Department of Transportation (MCDOT) and conform to its standards for park roadway systems. Unnamed roads are maintained by the park's maintenance staff or the MCPRD trades crew.

Paved and unpaved parking areas are likewise constructed and maintained the park maintenance staff or the Departments trades crew, but will often times hire MCDOT to provide these services.

Table 3-11: Roads and Parking				
Roads	**Miles**		**Parking**	**Vehicles**
Paved	7.0		Designated	735
Unpaved	4.0		Undesignated	350

Capacity

Physical capacity at the park is limited by the number of parking spaces. There are 1,085 designated and undesignated parking spaces. Using the park average of 2.92[72] people per vehicle, this would put peak capacity at about 3,168 visitors at any one time based on available parking alone. Further study is needed to determine the environmental and social capacity of the park.

[72] 2012-2013 ASU Park Visitor Study Final Report, Table 1.20A, page 34.

3.12.9 Water and Sewer

The park utilizes its own well for running water. Other restrooms within the park utilize evapotranspiration (ET) beds for waste filtration and are not dependent on a utility service provider. These areas are built and maintained by Maricopa County Parks and Recreation Department.

3.12.10 Electrical

White Tank Mountain Regional Park receives electricity from Arizona Public Service Company (APS). In June 2012, the park entered into an non-exclusive right, privilege, and easement in, upon, over, under, through and across White Tank Mountain Regional Park for the purpose of installing, operating and maintaining electrical lines for the transmission and distribution of electricity in the park campgrounds with APS.

3.12.11 Asset Inventory

Many park facilities were built in 1973 and are beginning to show their age. By assigning each building type an estimated lifespan, park management can better plan budgets for the years when major repairs or replacements are estimated to occur. Having such large numbers of buildings within the same age bracket could indicate that their expected usefulness, or lifecycle, expires at the same time. Management should be ready to make decisions at that time that may include extensive renovation or total replacement. Appendix H contains a building and land inventory.

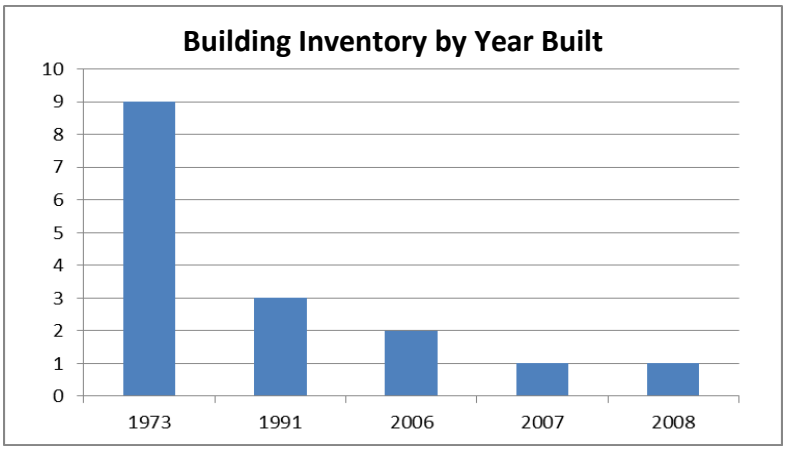


Figure 3-14: Building Inventory by Year Built

The most visible park assets are the entrance station and monument sign (both constructed in 2007). Assuming a 50-year useful lifespan for these two structures, it can be estimated that the entrance station will need replacement or extensive renovation by 2057 and the monument sign by 2032. Of the 17 buildings on the facilities inventory, 14 are restrooms. Seven of those restroom facilities were built in 1973 and may be expected to be replaced by 2023. *Note: This is outside of annual maintenance and general upkeep measures.*

3.13 Socioeconomics

Nearly 60% of the state's residents live in Maricopa County. This section compares population characteristics in more detail at the state, county, and park levels.

3.13.1 Population Characteristics

The 2010 Census reveals that the State of Arizona has 6,392,017 people (a 24.6% increase from the 2000 census[73]) with 3,817,117 residing in Maricopa County. Women slightly outnumber men in the state and county; and women also outnumber men as visitors to the park. There were 443,971 households with people under the age of 18[74] years. County-wide, the median age was 34.6 years compared to 43.43 for the park.

Table 3-12: Population and Park Visitor Characteristics

Population by Sex/Age	State of Arizona[1]	Maricopa County[1]	White Tank MRP (2007-2008)[2] Visitors	White Tank MRP (2012-2013)[3] Visitors
Total Population	6,392,017	3,817,117	203,852	144,395
Male	3,175,823 (49.6%)	1,888,465 (49.5%)	112,322 (55.1%)	66,854 (46.3%)
Female	3,216,194 (50.0%)	1,928,652 (50.5%)	91,529 (44.9%)	77,540 (53.7%)
Under 18	1,629,014	1,007,861	*n/a*	*n/a*
18 & over	4,763,003	2,809,256	*n/a*	*n/a*
20 - 24	442,584	266,872	*n/a*	*n/a*
25 - 34	856,693	541,126	*n/a*	*n/a*
35 - 49	1,249,516	786,104	46,478 (22.8%)	37,253 (25.8%)
50 - 64	1,141,752	640,768	37,182 (18.24%)	27,723 (19.2%)
65 & over	881,831	462,641	31,393 (15.4%)	12,417 (8.6%)
Median Age	35.9	34.6	47.7	43.43

[1] Source: http://2010.census.gov/2010census/popmap/ipmtext.php?fl=04
[2] ASU Park Visitor Study and visitation for 2007-2008.
[3] ASU Park Visitor Study and visitation for 2012-2013.
Note: totals may not equal 100% due to rounding.
n/a = data not available for direct comparison

The most noticeable differences in race or ethnicity during the 2012-2013 ASU Park Visitor Study were among the following: 81.8% of park visitors self-identified as white (down slightly from 82.8% in 2007-2008); 3.4% as African American (a slight increase from 2.0% in 2007-2008); and 1.5% as American Indian (an increase from 0.0% in 2007-2008).[75]

[73] As result of the population increase, Arizona gained one member to the House of Representatives, bringing the number to nine for the state.
[74] 2010 US Census Bureau, http://2010.census.gov/2010census/popmap/ipmtext.php?fl=04 as accessed March 14, 2012.
[75] 2012-2013 ASU Park Visitor Study Final Report, Question 17, page 306.

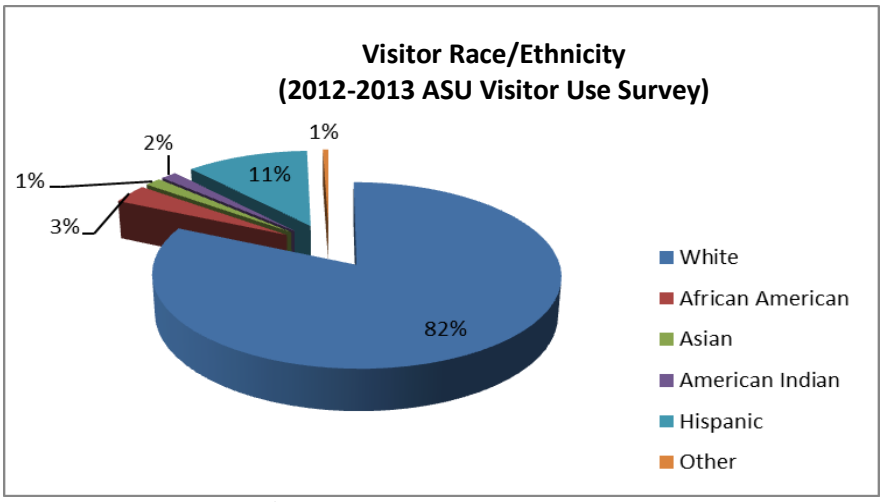


Figure 3-15: Visitor Race/Ethnicity

3.13.2 Census Tracts

The 2010 Census tracts that immediately surround and include the park (Tracts 506.05 and 405.16) have a total population estimate of 8,684 persons.

3.13.3 Population Forecast

In the Regional Transportation Plan 2010 Update, Maricopa Association of Governments (MAG) has forecasted that by 2030 Maricopa County will double in population over the year 2000 base population resulting in an anticipated total of 6.1 million people. This means that the region will experience a growth of approximately one million people during each decade (MAG, RTP 2010 Update, page 3-3). Furthermore, over the 25-year period of 2005-2030, seven Municipal Planning Areas (MPA) are projected to grow by more than 100,000 persons, including the Phoenix, Buckeye, Surprise, Goodyear, Gilbert, Peoria, and Chandler (MAG, RTP 2010 Update, page 3-5) – requiring the park to pay close attention to growth in the western part of the metro-area. Those MPA's closest to the park are shown in Table 3-13.

Table 3-13: Total Resident Population (July 1, 2005 and Projections July 1, 2010 to July 1, 2030)

	Total Resident Population 2005	Total Resident Population 2010	Total Resident Population 2020	Total Resident Population 2030
Avondale	70,160	83,856	105,989	123,265
Buckeye	32,735	74,906	218,591	419,146
Glendale	257,891	279,807	315,055	322,062
Litchfield Park	6,787	8,587	10,305	10,510
Phoenix	1,510,177	1,695,549	1,990,450	2,201,843
Surprise	93,356	146,890	268,359	401,458
All MPA's	3,681,025	4,216,499	5,230,300	6,135,000

Source: MAG, RTP, Table 3-2 (modified), page 3-4, http://www.azmag.gov/Documents/RTP_2010-Annual-Report_Final_v17.pdf as accessed August 8, 2013.

3.13.4 Employment, Income, and Educational Attainment

The State of Arizona had an unemployment rate of 9.0% in December 2011 according to the Bureau of Labor and Statistics.[76] U.S. Census data also shows that 28.3% of Maricopa County residents have attained a bachelors degree or higher; over 2% higher than the state. Likewise, the median household income was $50,410 which is over $3,600 above the statewide median.

Table 3-14: Employment and Education

Population	State of Arizona[1]	Maricopa County[1]	White Tank MRP (2007-2008)[2]	White Tank MRP (2012-2013)[3]
Employed	*n/a*	57.2%	44.3%	57.5%
Median household income	$46,789	$50,410	21.8% of park visitors between $45,000 to $60,000	17.5% of park visitors between $45,000 to $60,000
Bachelor's degree or higher	25.9%	28.3%	75.3%	93.6%

[1] Source: http://2010.census.gov/2010census/popmap/ipmtext.php?fl=04
[2] ASU Park Visitor Study, 2007-2008, page 248, Questions 24, 25, and 26.
[3] ASU Park Visitor Study, 2012-2023, page 316, Questions 29, 30, and 31.

3.13.5 Housing Value

The median value of an owned home (does not include value of homes that are being rented) was $180,800[77] for the County, a value just over $11,000 higher than the statewide median.

Table 3-15: Median Housing Value

	State of Arizona	Maricopa County
Median value of owned home	$168,800	$180,800

Source: http://2010.census.gov/2010census/popmap/ipmtext.php?fl=04

3.13.6 Obesity

Maricopa County had an obesity rate 20.9%[78] in 2007, ranking it as the fourth lowest obesity rate for a county within the state; however, the State of Arizona itself ranked 24th in the nation for obesity in the year 2007.

3.14 Visitation and Tourism Trends

The State of Arizona attracted 36.9 million domestic and international overnight visitors, equal to roughly 101,000 visitors per day in 2010.[79] Of those, 9.7 million overnight visitors were Arizona residents, representing 26% of the market.[80]

[76] U.S. Bureau of Labor Statistics. http://www.bls.gov/eag/eag.az.htm as accessed March 14, 2012.
[77] U.S. Census Bureau, http://2010.census.gov/2010census/popmap/ipmtext.php?fl=04 as accessed March 14, 2012.
[78] Arizona Department of Health Services, *Obesity in Arizona: Prevalence, Hospital Care Utilization, Mortality,* Page 6, Figure 4, Average Annual Prevalence of Obesity by County of Residence, Arizona, 2001-2007. http://www.azdhs.gov/plan/brfs/other%20reports/2007%20Obesity%20Report%20Final.pdf
[79] Arizona Office of Tourism, *Arizona 2010 Tourism Facts* brochure, Page 3, http://www.azot.gov/research-and-statistics/annual.

3.14.1 Residency[81]

Almost 86% of park visitors are residents of Arizona with most coming from the metropolitan area driving an average of 19.07 miles[82] to arrive at the park. Just over 14% of the park's visitors were from out of state or out of country. The top five metro-area locations include:

- Surprise 16.6%
- Phoenix 11.6%
- Sun City 8.5%
- Glendale 8.0%
- Litchfield Park 7.0%

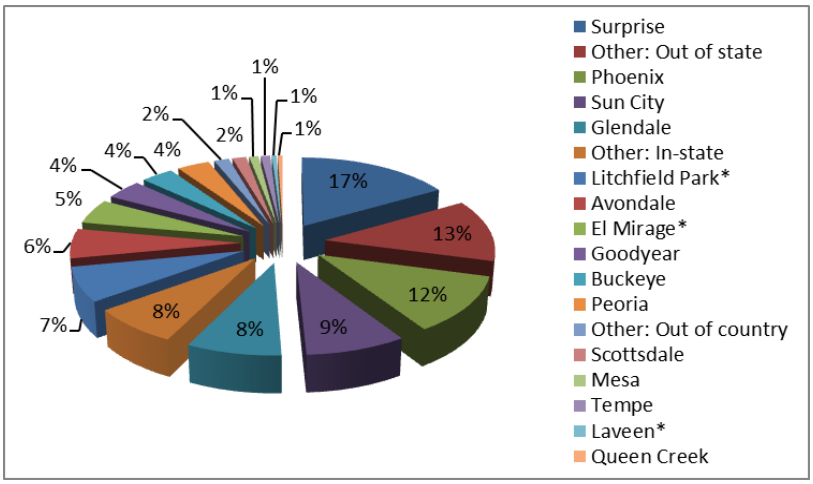


Figure 3-16: Visitor residency (*new cities denoted with asterisk)

3.14.2 Park Visitation

During fiscal year 2012-2013 the park welcomed 144,395 visitors to the park. Park visitation has fluctuated over the previous ten fiscal years with a high in FY08-09 a low in FY03-04 with 182,257 as the ten year average.

[80] Arizona Office of Tourism, *Arizona 2010 Tourism Facts* brochure, Page 3, http://www.azot.gov/research-and-statistics/annual.
[81] 2012-2013 ASU Park Visitor Study Final Report, page 32, table 1.18.
[82] 2012-2013 ASU Park Visitor Study Final Report, Question 5, page 305.

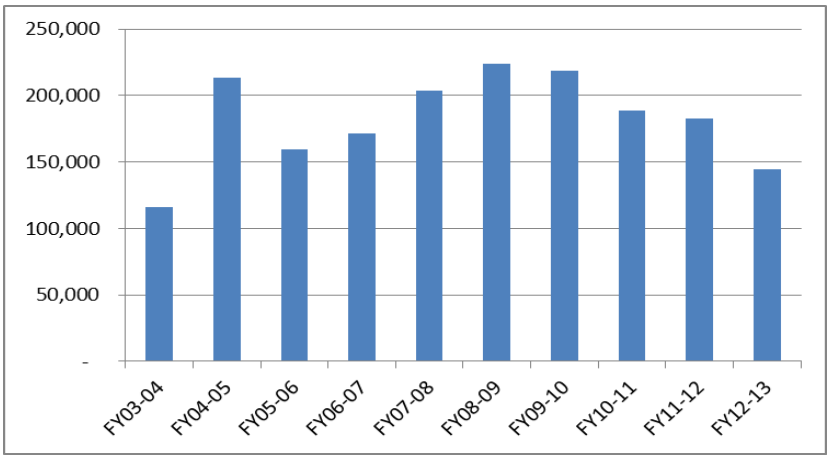


Figure 3-17: Visitation by fiscal year

Visitation can fluctuate for a variety of reasons: Spring Break, Easter, and mild temperatures usually result in March or April being the busiest months. Easter is generally the busiest day of the year when all or most picnic areas are fully rented. However, in 2012, there were a higher number of ramada rentals the Saturday *before* Easter than in previous years. Years with plentiful rain also increase spring visitation as people flock to the park to view the waterfalls and wildflowers. The months with the lowest visitation are July or August when temperatures soar.

Notes: The introduction of a new Point of Sale system did not accurately count about 18,000 passes; in addition, the Nature Center and Library hosted its grand opening and allowed free entry. These two events may help explain slightly lower visitation numbers in FY10-11.

The Family Campground was closed during parts of FY2012-2013 and FY2013-2014 for electrical upgrades and perhaps played a role in lower visitation numbers during these times. The Horse Staging Area was likewise closed for construction in FY2012-2013; parking accommodations were relocated to the Group Camp Area.

Forecasting future visitation carries with it its own uncertainties, however preliminary trend analysis indicates a positive upward tendency in future visitation (as shown by dark blue lines in Figure 3-17).

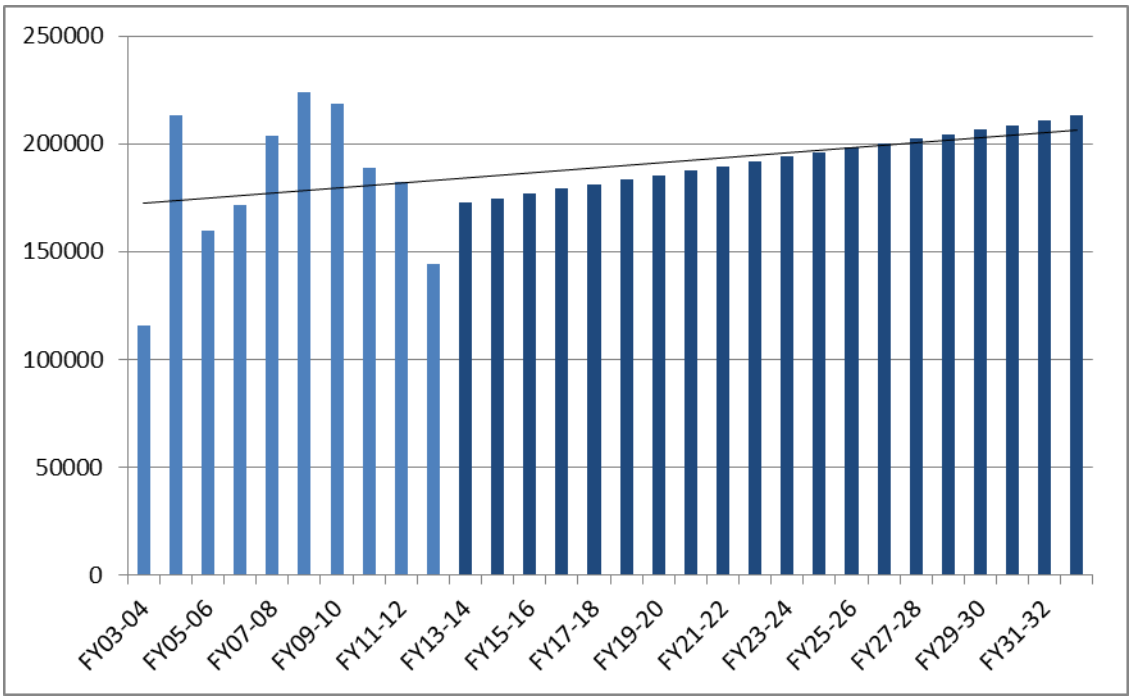


Figure 3-18: Actual (blue) and forecasted (dark blue) visitation per fiscal year

3.15 Park Use

3.15.1 Use[83, 84]

About 98% of visitors were in the park for a "day use" activity, spending 2.48 hours inside the park. This is down from 3.06 hours reported in the 2007-2008 visitor use survey. Of the 2% that spent the night inside the park, they stayed for an average of 3.20 nights (up from 2.54 nights in 2007-2008 but down from previous years).

3.15.2 Primary Activity[85]

Park visitors engage in a range of activities during their visit (trail hiking, picnicking, photography, mountain biking, nature study, and more); however one activity is usually considered the primary activity, or what the visitor specifically came to the park to do. The top five primary activities in 2012-2013 were:

- Trail hiking (76.6%)
- Picnicking (10.2%)
- Mountain biking (3.9%)
- Running/jogging (3.4%)
- Walking for pleasure (1.5%)

[83] 2012-2013 ASU Park Visitor Study Final Report, Question 4, page 305.
[84] 2012-2013 ASU Park Visitor Study Final Report, Question 1, page 305.
[85] 2012-2013 ASU Park Visitor Study Final Report, Table 1.9A, page 23.

3.15.3 Return Visits

Seventy-four percent of those surveyed were return visitors, visiting the park 16 times on average in the previous twelve months[86] (up from 6.2 visits in 2007-2008). When asked what prompts visitors to return to the park, trail-related responses were most common; other written responses included:[87]

- Close to home
- Location
- Clean, well-kept

Return visits based on activity, reveals that hikers made over 17 return visits in the previous twelve months and mountain bikers made over 28 return visits; runners/joggers returned eight times; and walkers returned over five times. Picnickers made over four return visits to the park.[88]

3.15.4 Reasons for Use[89]

Top five reasons visitors come to the park:

- Observe the scenic beauty
- Enjoy physical exercise
- Enjoy the sounds and smells of nature
- Have an inexpensive recreational experience
- Get away from everyday responsibilities

3.15.5 Satisfaction

When asked about their level of satisfaction with the park, 58.7% of those surveyed were extremely satisfied and 39.1% were very satisfied with the park; 2.2% were fairly satisfied. No visitors expressed dissatisfaction with the park.[90]

3.15.6 Attachment to Park

Park visitors often form strong attachments to their favorite park or locations within a park and half of the parks visitors agree that they are, indeed, very attached to this park. Nearly 72% agreed that the park means a lot to them; over 56% agreed that this park offers the best settings and facilities for the activities that they enjoy most.[91] Favorite parts of the park included many trail-related responses, specifically mentioning Waterfall, Mesquite, Willow Canyon, Ford, Goat Camp trails, and the Competitive Track[92] by name.

3.15.7 Visitor Spending[93]

Visitors reported spending $72.81 (up from $65.33 in 2007-2008) per group during their visit to the park. This is significantly lower than the system-wide average of $157.63 per visit.

[86] 2012-2013 ASU Park Visitor Study Final Report, Question 1, page 305.
[87] 2012-2013 ASU Park Visitor Study Final Report, Question 7b, page 322.
[88] 2012-2013 ASU Park Visitor Study Final Report, Table 3.4 page 88.
[89] 2012-2013 ASU Park Visitor Study Final Report, Question 6, page 308.
[90] 2012-2013 ASU Park Visitor Study Final Report, Question 1, page 307.
[91] 2012-2013 ASU Park Visitor Study Final Report, Question 7, page 309.
[92] 2012-2013 ASU Park Visitor Study Final Report, Question 7c, page 323.
[93] 2012-2013 ASU Park Visitor Study Final Report, Question 8, page 310 and Table 2.9, page 59.

3.15.8 Park Facilities

Park visitors were surveyed about which facilities are most important to them. In the 2012-2013 survey, park roads, parking availability, restrooms, and trail mileage signs were almost unanimously the most important features at the park. (The least important facilities were: equestrian facilities, competitive tracks, playgrounds, and showers.)[94]

When visitors were surveyed about what facilities they would be likely to use, if provided: visitor/information center, wildlife viewing areas or blinds, shaded picnic areas, restaurants/snack bars, outdoor exercise/circuit course. (The facilities that they would not use or don't know if they would use were: conference facility; competitive tracks, OHV areas, sports fields/facilities, and RV or trailer hook-ups.)[95]

3.16 Local Recreation, Needs, and Opportunities

White Tank Mountain Regional Park has a unique opportunity to offer visitors RV and tent camping, a competitive track, equestrian and hiking trails, wildlife viewing, picnicking, hunting, and other opportunities as approved park activities. The park also offers educational and interpretive events on a regular basis. Many of these activities cannot be found elsewhere in the community, giving White Tank Mountain Regional Park an opportunity to fill those needs. Other recreational opportunities near White Tank Mountain Regional Park can be found in the following table:

[94] 2012-2013 ASU Park Visitor Study Final Report, Question 4, page 307. Note: campground closures played a role in fewer campers staying in the park and likely fewer campers being surveyed and expressing a camper's perspective.

[95] 2012-2013 ASU Park Visitor Study Final Report, Question 9, page 310. Note: campground closures played a role in fewer campers staying in the park and likely fewer campers being surveyed and expressing a camper's perspective.

Table 3-16: Local Recreational Opportunities			
Facility	**Distance from Park**	**Acres / Miles of trails**	**Recreational Opportunity**
City of Litchfield Park, AZ park facilities	13.5 miles	Various facilities available	Swimming, soccer, basketball, etc.
City of El Mirage, AZ park facilities	13.5 miles	18 acres plus various facilities available	Baseball, basketball, fitness, playground, water park, retail, dog park, picnic, etc.
Town of Youngtown, AZ park facilities	13.5 miles	Various park locations available	Fishing, walking, picnic.
City of Surprise, AZ park facilities	15.0 miles	Various facilities available	Tennis, swimming, playground, library, soccer, picnic, pickleball, etc.
Estrella Mountain Regional Park	19.5 miles	19,840 acres / 33 miles	Hiking, rodeo arena, golf, picnic, camping, biking, baseball.
Town of Buckeye, AZ park facilities	26.5 miles	Various facilities available	Aquatics, sports, playground, picnic sites, dog park.
Additional recreational opportunities: *Undeveloped Campgrounds: Camping is allowed on Bureau of Land Management lands throughout the area. Camping on State Land requires a permit from the State Land Department.*			

3.17 Park Administration and Special Functions

3.17.1 Staffing

Currently, the park has a staff of five full-time employees. This includes the park supervisor, one administrative assistant, one interpretive ranger, and two park maintenance workers. The park does not currently have any part-time employees. See Appendix I for a park organizational chart.

A park supervisor plans, organizes, coordinates and is responsible for all operations of the park while protecting park resources. This position supervises all aspects of work and performance of subordinates to facilitate productivity and efficiency. The park supervisor also constantly coordinates activities for maximum revenue and most efficient utilization of facilities including outdoor education and wellness programs for park users. This position is responsible for marketing efforts to promote the park, operating within the budget and providing detail for formulation of budget as related to grants, capital improvement projects and park projects.

An administrative assistant performs clerical duties in support of park operations to include but not limited to: proper cash handling during fee collection, preparing daily deposits, reconciliation, revenue recording and reporting, administrative reporting and support, processing camping and ramada reservations, souvenir program oversight, and customer service via the phone, mail and email.

An interpretive ranger plans, organizes, promotes, conducts, and evaluates outdoor recreation and environmental educational programs to include maintaining and demonstrations of live animal and plant displays. This position provides customer service by assisting and providing information and park interpretation to park visitors, the general public, County departments, other agencies, volunteers, and community groups. Responsibilities also include accurate reporting of program attendance, fee collection and reconciliation, and occasional response to emergency situations.

A park maintenance worker performs general facilities management to include but not limited to: cleaning and maintaining restrooms, trash collection, painting interiors and external structures, graffiti removal, minor plumbing and electrical repairs, fence repair, trail maintenance and signage, desert landscaping maintenance, and customer service to park visitors.

3.17.2 Volunteers

The park utilized 56 volunteers in FY12-13 who provided over 15,800 hours of service such as camp hosts, entrance station attendants, nature center hosts, among other roles. The Independent Sector estimates that the value of volunteer time in Arizona is $20.08 per hour.[96] This translates to volunteers at White Tank Mountain Regional Park providing $318,905.54 worth of services or the equivalent of 7.63 full-time[97] employees, providing an enormous economic value to the park.

Table 3-17: Volunteer Hours by Fiscal Year

	2011-2012		2012-2013	
Volunteer Type	**Volunteers**	**Hours**	**Volunteers**	**Hours**
Park Hosts	24	14,026.0	28	11,511.75
Community Volunteers	28	4,379.5	28	4,370.0
Total	52	18,405.5	56	15,881.75

A park host will assist the park supervisor and serve as an ambassador to park visitors by providing information and promoting resource protection and recreational opportunities through visitor education. Each host works a minimum of 20 hours per week and includes those responsibilities agreed upon between the host and Park Supervisor as a written agreement. Duties may include fee collection, light maintenance work, clerical tasks, and special projects. The hosts receive free camping and use of park facilities while they are serving as host.

Community volunteers may provide administrative, trails, education, special event, or maintenance assistance. Episodic volunteers give their time for a special project, rather than volunteering on an on-going basis. See the Volunteer Manual, Making a Difference and webpage[98] for more details on volunteer roles and responsibilities.

Episodic volunteers may assist in short-term, special projects: for example, a Boy Scout troop may perform a light building project or park cleanup in order to earn a badge or patch. Hands on Greater Phoenix volunteers performed trail maintenance on several occasions along the Black Rock Loop during fiscal year 2012-2013, providing valuable assistance to the park.

3.17.3 Partnerships

White Tank Park has identified several partners or other organizations with a mutual interest in the park's operation and success. Table 3-18 specifies existing and potential partners and their roles in the operation and improvement of the park.

[96] Independent Sector, dollar value by state for year 2011, http://www.independentsector.org/volunteer_time as accessed July 1, 2013.
[97] FTE = total volunteer hours divided by 2,080 hours (2,080 = 40 hours week * 52 weeks).
[98] Website and Volunteer Manual available here: http://www.maricopa.gov/parks/volunteer.aspx

Table 3-18: Partners	
Partner	**Potential or existing role**
Maricopa County Agencies	Parks Commission: Lobby and advocate for Park causes. Maricopa County Library District (MCLD): Share MC Library and Nature Center facilities, program cooperation, utilities and facility maintenance. Maricopa County Sheriff's Office: Regularly patrols park, trails and boundaries. MCDOT: Road maintenance.
State Agencies	Arizona Office of Tourism: Cooperative work on attracting tourism, especially "Watchable Wildlife" tourists. Arizona Game and Fish Department: Variety of wildlife issues, advice and enforcement. Arizona State Land Department: Protection of adjoining property and access issues.
Federal Agencies	BLM: Land exchange/purchase. Cooperative work to serve public recreational needs.
Local cities/towns	City of Surprise / Town of Buckeye: Work with landowners and other agencies to connect White Tank Park trails with other trail systems. Cooperative facilities. Cooperative programs (example Western Heritage Tour Trail for tourist attraction). City of Phoenix: Playground inspections.
Friends of White Tank Park	Perform fundraising for specific projects. Lobby elected officials on critical issues and funding. Voice and advocate for the park.
Site Steward Program (and SHPO)	Volunteers regularly patrol and check on archaeological sites in park.
Equestrian, RV, Special Interests	Work with individual groups and park staff on special interest desires when possible.

3.18 Public Safety

The park relies on Maricopa County Sherriff's Office (MCSO) for law enforcement and public safety. MCSO may be contacted by using the following phone numbers:

- 602-876-1011 for non-emergency needs;
- 911 for emergencies.

MCSO keeps track of all contacts and reports it makes. Note that inconsistencies with the data may exist based upon where the call was located; i.e. if it was actually outside the park boundary but responding units did not correct that location with dispatch.

Table 3-19: MCSO Statistics						
White Tank Mountain Regional Park						
	2008	**2009**	**2010**	**2011**	**2012**	**2013**[1]
Contacts (all)[2]	190	117	97	116	107	62
Burglary from vehicle	7	5	0	1	9	10

Search & Rescue Operation	4	5	5	4	9	5
Game & Fish Violation	6	0	1	0	0	0
County Parks Violation	27	11	6	3	2	1
Entry Use Violation (R104)	3	0	1	0	0	0
Vehicle & Bicycle Violation (R107)	3	0	1	1	0	0
Fire Violation (R113)	0	0	0	1	0	0
Trails Violation (R118)	1	0	0	0	0	0

Notes:
1. January 1 through April 14, 2013 only.
2. Totals excluding "Patrol/Vacation Watch" category.

Source: personal communication from MCSO Sgt. Fred McCann 4/17/13.

Park staff and its volunteers also provide park visitors with safety messages and summon assistance when needed. Park visitors are expected to know and comply with all park rules.

Figure 3-19: MCSO and Rural Metro on call

3.18.1 Fire and Fire Bans

Park Rule R-113 outlines acceptable use of fire and grills. MCPRD implements fire bans during the warm summer months to help prevent destructive fires. The bans are lifted as soon as the prevailing weather conditions permit. Some limited use of grills may be permitted unless under an extreme fire ban.

3.19 Finances

3.19.1 Park Budget

The park budget consists of components shown below such as park revenue, park expenditures, and park donations. Park staff is responsible for revenue generation and staying within the budget formulated by the Department's finance team. The dashboards exhibited below reflect year to year trends. More detailed budget and financial information may be reviewed in the park business plan.

3.19.2 Park Revenue

Park revenue comes from many sources but primarily from visitor entrance fees, camping and picnic reservations, souvenir sales, etc. Other funding sources may come from grants or other partnerships, but those funds are generally earmarked for specific projects or purposes. Revenue is generally increasing each year due to improved or additional facilities as well as from improved marketing. Weather has the biggest impact on park revenue; for example, rainy weather causes the waterfall to flow and flowers to bloom, which in turn draws many visitors to the park. Conversely, excessively hot summer days results in decreased park visitation.

FY2010 did well fiscally (as a result of the new nature center and a good wildflower and waterfall year), but FY2012 surpassed it as the best year since FY2009 (figure 3-20). Despite campground closures and construction on SR-303, FY2013 maintained strong statistics.

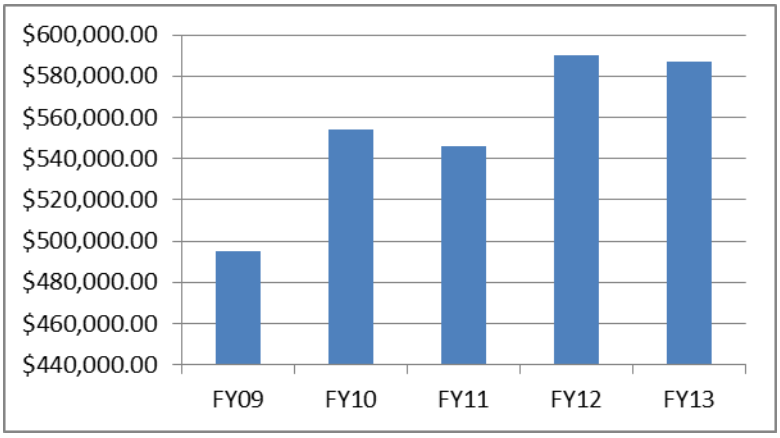


Figure 3-20: Revenue per Fiscal Year

Figure 3-21 demonstrates the monthly breakdown of the fiscal years, noticing that summer months have improved, as well has December. March remains the overall best month when visitation is generally at its peak.

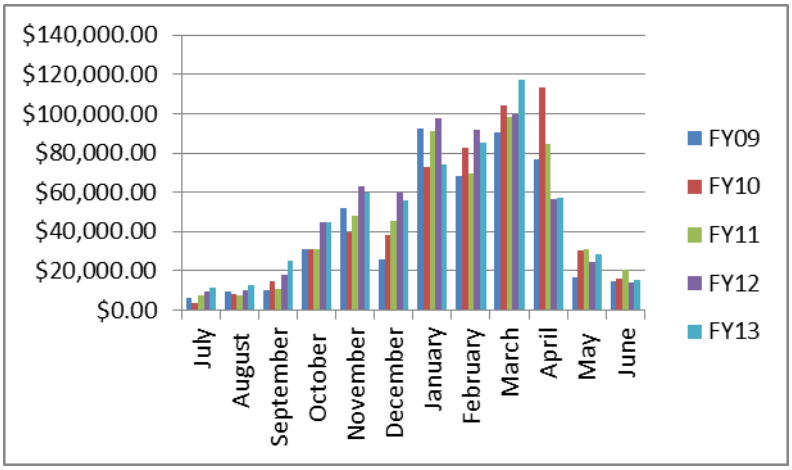


Figure 3-21: Revenue by Month

One of the biggest revenue increases appears in the souvenir fund. The park experienced a 178% increase from FY2010 to FY2011 (figure 3-22). This increase is attributed to the new Nature Center and Library facility that was completed in October 2010.

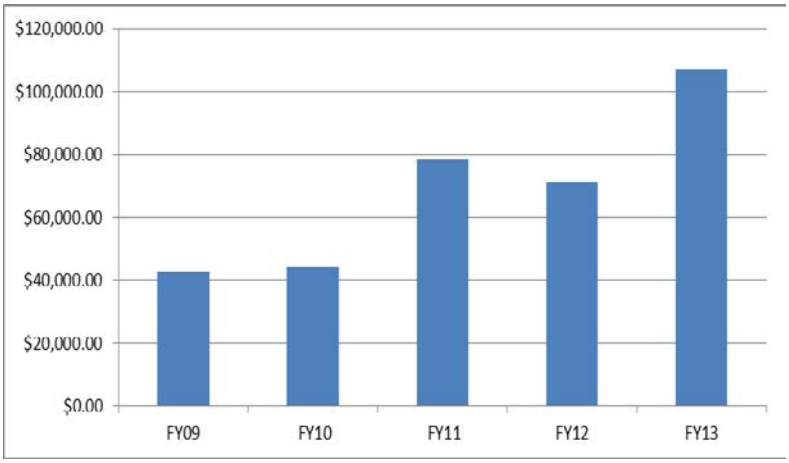


Figure 3-22: Souvenir Fund

Camping reflects a decrease in revenue due to campground closures and SR-303 construction in FY2013 (figure 3-23).

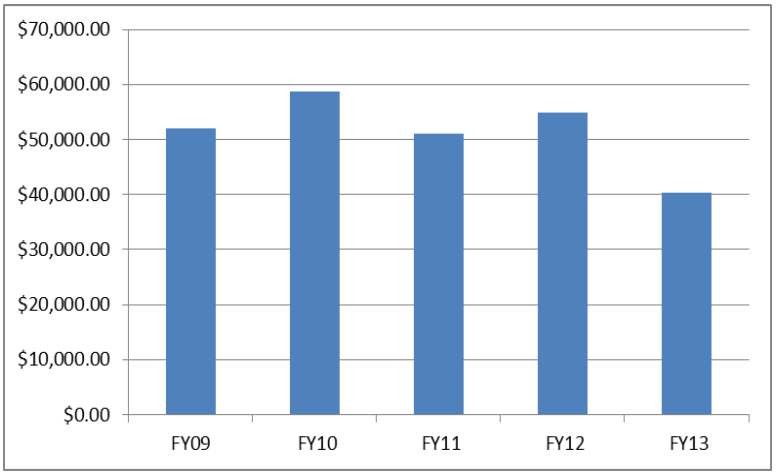


Figure 3-23: Camping per Fiscal Year (campground closures and SR-303 construction in FY13)

Facility rentals are remaining fairly strong (figure 3-24). The park sees many return visitors renting facilities each year.

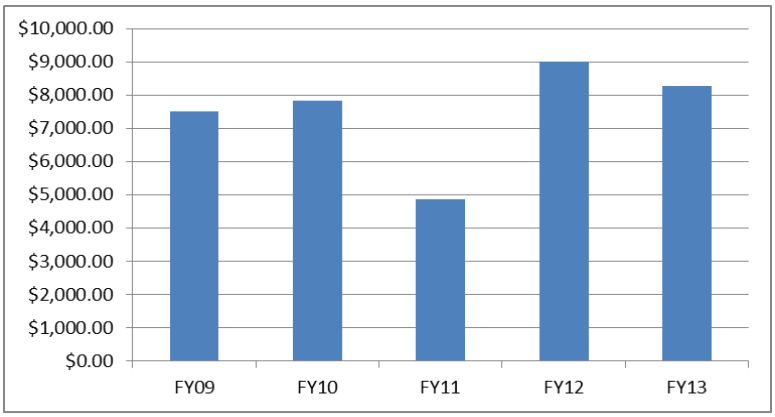


Figure 3-24: Facility Rental

Annual pass sales show an overall upward trend from year to year (figure 3-25) and is expected to increase. Park visitors have expressed their satisfaction with the annual pass program.

Figure 3-25: Annual Passes

Despite campground facility additions and road construction, vehicle entries are remaining fairly steady (figure 3-26).

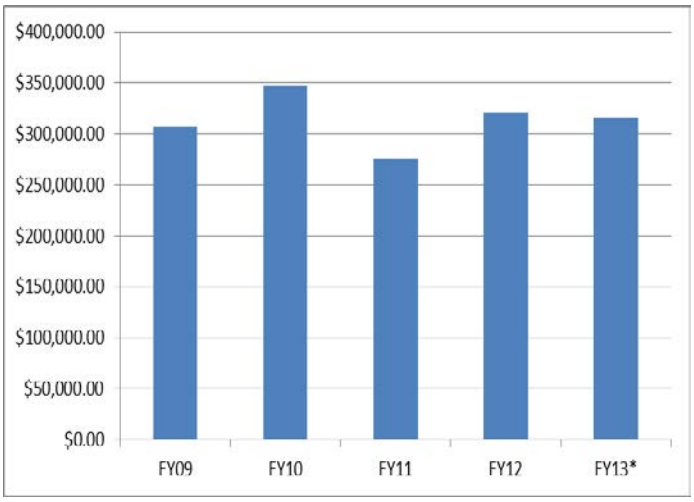


Figure 3-26: Vehicle Entries (campground closures and SR-303 construction in FY13)

3.19.3 Expenditures

Park expenditures cover everything from park staff wages and benefits, maintenance, as well as general office supplies and vehicle fueling. Although facilities have increased, staff remains the same. The park covers the extra need with additional hosts and volunteers.

Table 3-20: Summary of Annual Expenditures*

Expense type	FY 2010	FY 2011	FY 2012	FY 2013 (estimated)
Personal Services (wages and benefits)	235,724	251,786	247,367	249,865
General Supplies	17,310	20,660	21,238	25,374
Fuel	11,273	13,486	15,056	12,246
Other supplies	8,323	3,412	0	0
Utilities	42,601	48,257	47,186	30,481
Other costs (postage, education & training, repairs & maintenance, other services)	21,910	11,068	20,841	18,524
Building and Improvements	0	0	3,129	0
TOTAL EXPENSES	337,141	348,669	354,817	336,490
*Funding sources: 100 General Fund, 241 Park Enhancement Fund.				

3.19.4 Donations

Donations to the Park are accepted pursuant to ARS §11-941, paragraph A and are used for designated items such as memorial benches, ramadas, brochures, critter care, or general use. Between 2006 and 2009, the park received just over $29,000 in donations for these purposes (figure 3-27).

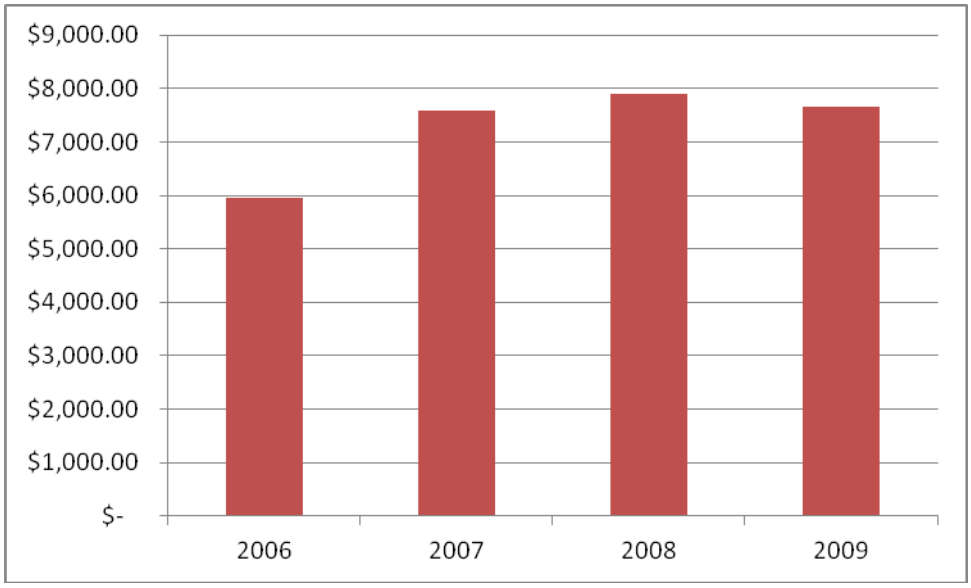


Figure 3-27: Donations per Fiscal Year

CHAPTER 4 – TRAILS

The trails chapter details the existing trails within the park. The trail system is a vital component of the park and provides park visitors with diverse recreational experiences from educational interpretive trails to rugged mountain hikes. The 1964 Master Development Plan called for over 36 miles of trails with an estimated need of well over 250 miles; today that need is not anticipated and the park maintains a more sustainable trail system. The 1964 plan did not make any special provision for bicycling, instead reserving trails for hiking or equestrian use only. This plan update acknowledges the importance of providing mountain bikers access to trails and has designated all trails as shared use (except where signed otherwise).

The Trails Management Manual provides further detail on Policies, Standards, and Guidelines for Planning, Design, Construction, and Maintenance of the Trails and Tracks System in Maricopa County Parks. In areas where this plan update is silent, the Trails Management Manual prevails.

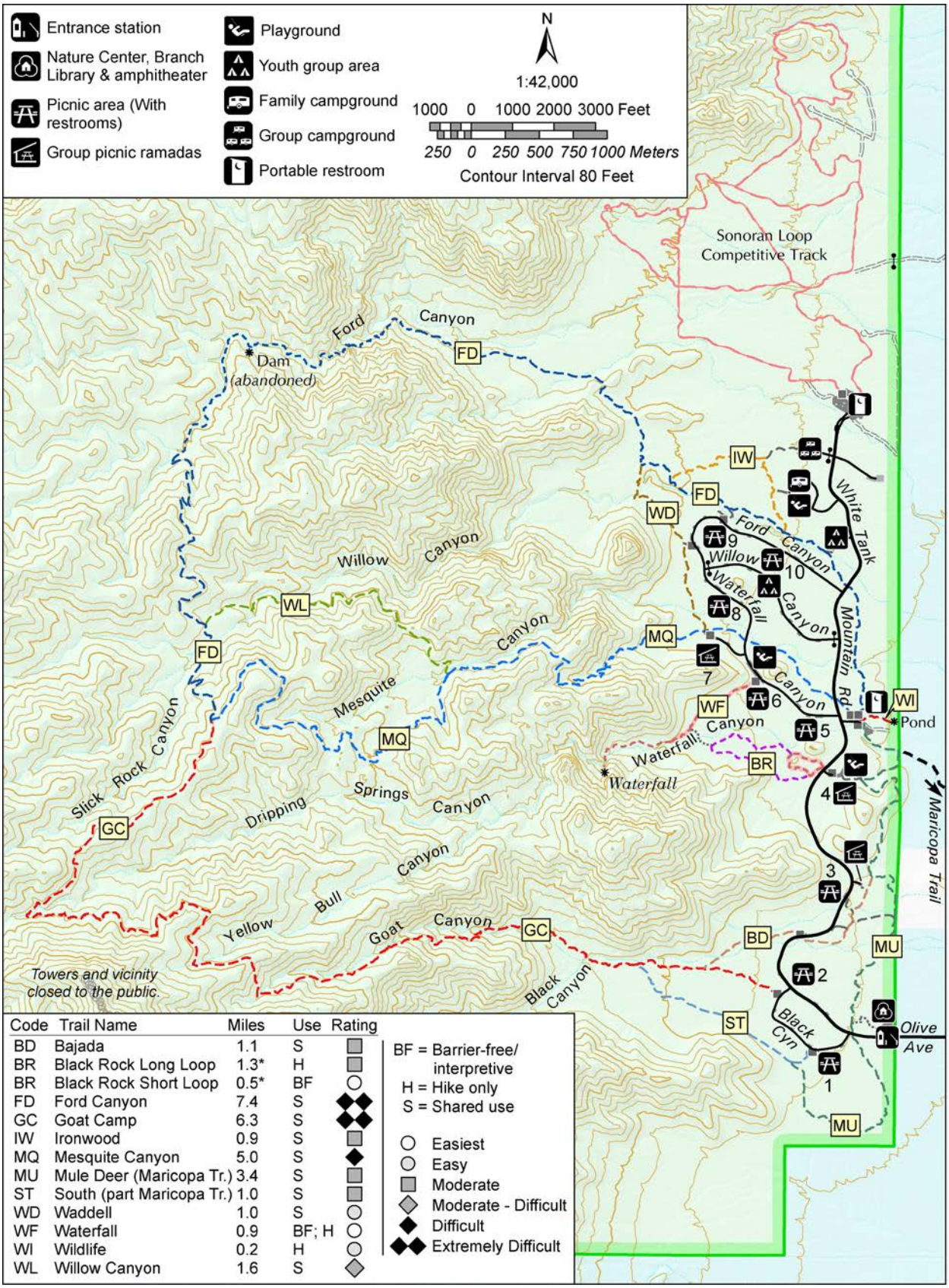
The White Tank Mountain Regional Park Trail System Plan (Appendix J) was adopted in December 2002. The Trail System Plan describes the desired future condition of the trail system, including trail access points and service road access, and prescribes actions to achieve the planned condition. This master plan update will provide conceptual trail recommendations (Chapter 6) based on public feedback received during the open public comment phases; it will then delegate the specific trail alignment planning to the park's Trail System Plan. Additional trails or deletions to the trail system may require an amendment to the Trail System Plan; the trail development planner/manager is tasked with making that determination and implementing the amendment process, if required. All trail alignments must be incorporated into the Trail System Plan prior to construction and are not considered authorized trails until that time regardless of their mention in the Master Plan update. In areas where this Master Plan update is silent, the Trail System Plan prevails.

Figure 4-1: Waterfall Trail

4.1 Existing Trails

White Tank Mountain Regional Park offers approximately 31 miles of shared-use trails, ranging in length from 0.9 mile to 7.9 miles (Map 4-1). Trails are rated from easy to strenuous and include the only double-diamond rated trails in the County's park system (Table 4-3 below). Day hikes provide breathtaking views of the mountains and panoramas of the valley below. Horseback and mountain bike riders are welcomed, although caution is stressed as some of the trails may be extremely difficult.

In addition, there are 2.5 miles of pedestrian-only trails. These include two short trails that are hard-surfaced and barrier-free. Waterfall Trail is barrier-free to Petroglyph Plaza, about 0.4 miles from the parking lot (and has since been extended a bit further along the trail). The short loop of Black Rock Trail, which is about 0.5 mile long, begins at Ramada Area 4 and is also barrier-free.



Code	Trail Name	Miles	Use	Rating
BD	Bajada	1.1	S	▢
BR	Black Rock Long Loop	1.3*	H	▢
BR	Black Rock Short Loop	0.5*	BF	○
FD	Ford Canyon	7.4	S	◆◆
GC	Goat Camp	6.3	S	◆◆
IW	Ironwood	0.9	S	▢
MQ	Mesquite Canyon	5.0	S	◆
MU	Mule Deer (Maricopa Tr.)	3.4	S	▢
ST	South (part Maricopa Tr.)	1.0	S	▢
WD	Waddell	1.0	S	○
WF	Waterfall	0.9	BF; H	○
WI	Wildlife	0.2	H	○
WL	Willow Canyon	1.6	S	◇

BF = Barrier-free/ interpretive
H = Hike only
S = Shared use

○ Easiest
○ Easy
▢ Moderate
◇ Moderate - Difficult
◆ Difficult
◆◆ Extremely Difficult

Map 4-1: Existing Trails

4.1.1 Competitive Track

The park offers an approximately 10-mile Competitive Track in addition to its trails. The Competitive Track is designed to provide challenging, strenuous, and high-speed outdoor recreation for individuals, groups, and organized events. The competitive track is designed multiple-use for cross-country runners and joggers, fast bicyclists and racers, and trotting/galloping equestrians and endurance riders. The track may be closed to general use while organized events are taking place. Large events, like the Cactus Cha-Cha, often bring over 400 participants to the event. Other mountain bike events or races may bring 50 to 350 participants to the park. The track also has an oversized parking area where 25 to 30 cars may be seen on an average springtime Saturday. (The parking area may also be used as overflow camping when needed.)

Table 4-1: Competitive Track Events and Participants

Fiscal Year	Events	Participants
2010-11	5	1,039
2011-12	3	735
2012-13	4	875
2013-14 (pre-scheduled as of 7/24/13)	1	200-300

4.1.2 Maricopa Trail

The Maricopa Trail has a connection north of the park entrance at Mule Deer Trail and extends well into the park. This segment is 3.4 miles in length and is a shared-use trail (hiking, biking, and equestrian). The hike offers excellent open views that extend in all directions, especially east towards the city. The trail is part of a regional trail plan that will link all Maricopa County Regional Parks and will provide connections to metropolitan areas, municipal trails, communities, and neighborhoods with regional non-motorized multi-modal corridors. It will provide challenging, longer trails for competitive hikers and mountain bikers seeking back-country experiences outside the urbanized park systems. There are two RV host sites available near the pond and windmill (or equestrian parking lot) for Maricopa Trail volunteer hosts.

Table 4-2: Designated Trails

Name	Miles	Kilometers	Notes	Rating*	Management Classification
Bajada	1.1	1.7	Shared use		Primary
Black Rock Long Loop	1.3	2.1	Hike only		Primary
Black Rock Short Loop	0.5	0.8	Hike only/barrier-free/interpretive		Barrier-free / Interpretive
Ford Canyon	7.4	11.9	Shared use		Primary
Goat Camp	6.3	10.1	Shared use		Primary
Ironwood	0.9	1.5	Shared use		Primary
Mesquite Canyon	5.0	8.1	Shared use		Primary
Mule Deer (Maricopa Trail)	3.4	5.5	Shared use		Primary
South	1.0	1.7	Shared use		Primary
Waddell	1.0	1.6	Shared use		Primary
Waterfall	0.9	1.5	Hike only/first 0.5 barrier-		Barrier-free /

			free		Interpretive
Wildlife	0.2	0.3	Shared use		Primary
Willow Canyon	1.6	2.7	Shared use		Secondary
Competitive Track	***Total tread length***				
Sonoran Loop Competitive Track	9.3	15.0	Shared use		Competitive Track
*Rating symbols are defined in Table 4-3 below or online at http://www.maricopa.gov/parks/trailrating.aspx					

Figure 4-2: Mule Deer Trail (Maricopa Trail), looking southwest.

4.2 Trail Use

All trails are shared-use unless otherwise designated. All trail users are encouraged to practice proper trail etiquette. Park Rule R-118 requires hikers, equestrians, and bicycle riders to remain on designated trails and shortcutting by any type of trail user is prohibited. Trail education and, if necessary, law enforcement will be used to attain compliance. Signs will be posted and barriers constructed at obliterated paths, roads, and undesignated washes if use is continued after closure.

The 2012-2013 ASU Park Visitor Study shows that nearly 77% of all park visitors' primary activity is trail hiking,[1] hiking an average of 3.24 miles[2] on that visit. When singled out by activity, other trail uses include:

- Mountain biking: 8.63 miles,
- Running/jogging: 7.40 miles, and
- Walking for pleasure: 1.23 miles.

Visitors who came primarily to camp or picnic also report using trails:

[1] 2012-2013 ASU Park Visitor Study Final Report, page 23.
[2] 2012-2013 ASU Park Visitor Study Final Report, page 26.

- RV camping: 2.00 miles,
- Tent camping: 2.50 miles, and
- Picnicking: 3.03 miles.

4.3 Trail Rating

In 2012, a partnership of area park agencies developed a trail rating guide to assist trail users in assessing what trails are best suited for their abilities. During the hotter months when the temperatures and/or humidity are high, trails are rated at least one level higher.

Table 4-3: Trail Rating Guide

Rating Symbol	Brief Definition	Surface	Grade	Obstacles/Steps
Easiest	Paved Accessible Trail	Paved or hard and smooth		None
Easy	Mostly smooth and wide	Dirt with occasional unevenness		2" or less, rocks and ruts
Moderate	Mostly smooth, variable width	Dirt with occasional unevenness		<8" rocks and ruts, loose material
Moderate difficult	Mostly uneven surfaces	Dirt and rock		<12" rocks and ruts, loose material
Difficult	Long rocky segments with possible drops and exposure	Dirt and loose rock with continual unevenness		12" or taller, loose rocks, exposure to drops
Extremely difficult	Long rocky segments with possible drops and exposure	Dirt and loose rock with continual unevenness		12" or taller, loose rocks, exposure to drops and excessive heat >90F

CHAPTER 5 - Management Zoning

The foundation for the management zones is found in the Maricopa County Parks and Recreation Department 2009 Strategic System Master Plan, page 105-116, June 2009 and is presented again here. It should also be noted that the Strategic System Master Plan also recommends that the size of all developed areas should be limited to 10% of the overall park size; however, smaller parks that are adjacent to other protected open space may exceed that 10% recommendation. Today, the park has about 1.8% of its total acres developed.

Table 5-1: Management Zone and Acreage	
Zone	**Percent of Total Park Acres**
Development	1.8% (517.01 acres)
Trail	0.6% (191.02 acres)
Semi-Primitive	18.8% (5,572.33 acres)
Primitive	72.3% (21,349.89 acres)
Perimeter Buffer	6.5% (1,910.41 acres)
Non-Management Zone	0% (0.0 acres)
Source: 2009 Strategic System Master Plan, page 116	

5.1 Methodology for Determining Management Zones

The current management zoning descriptions and maps used for White Tank Mountain Regional Park are taken directly from the Maricopa County Parks and Recreation Department Strategic System Master Plan, June 2009 (pages 105-116), as prepared by consultant Pros Consulting, LLC. The zones were determined based on existing use and location of developed features. These management zones are meant to provide some flexibility. If/when development occurs on the north or west side of the park, the development zone in those areas will require review and possibly changed.

Future revisions of these zones should include, in more detail, descriptions of the desired experience. For example, one zone may provide the visitor with a sense of wilderness and remoteness, challenging their outdoor skills. This zone would thus require a low level of management and a high level of resource protection and may be labeled as “primitive” and should reflect the desired future conditions of the park rather than existing use or conditions.

5.2 Description of Management Zones

The following chart describes the zones that are areas of land-based management only and are designed to be a working document so that some flexibility of the classification of each is allowed.

Table 5-2: Park Management Zones		
Zone (Management Level)	**Description**	**Includes, but not limited to:**
Development (Highest)	Includes areas which require the highest level of management. These areas contain the largest level of park activity by visitors. When possible, this zone should not exceed 10% of overall park size. Smaller parks that are contiguous to	Roads Golf courses Archery/shooting range Model airplane Sports fields Aquatic complex Restroom facilities Picnic areas and ramadas

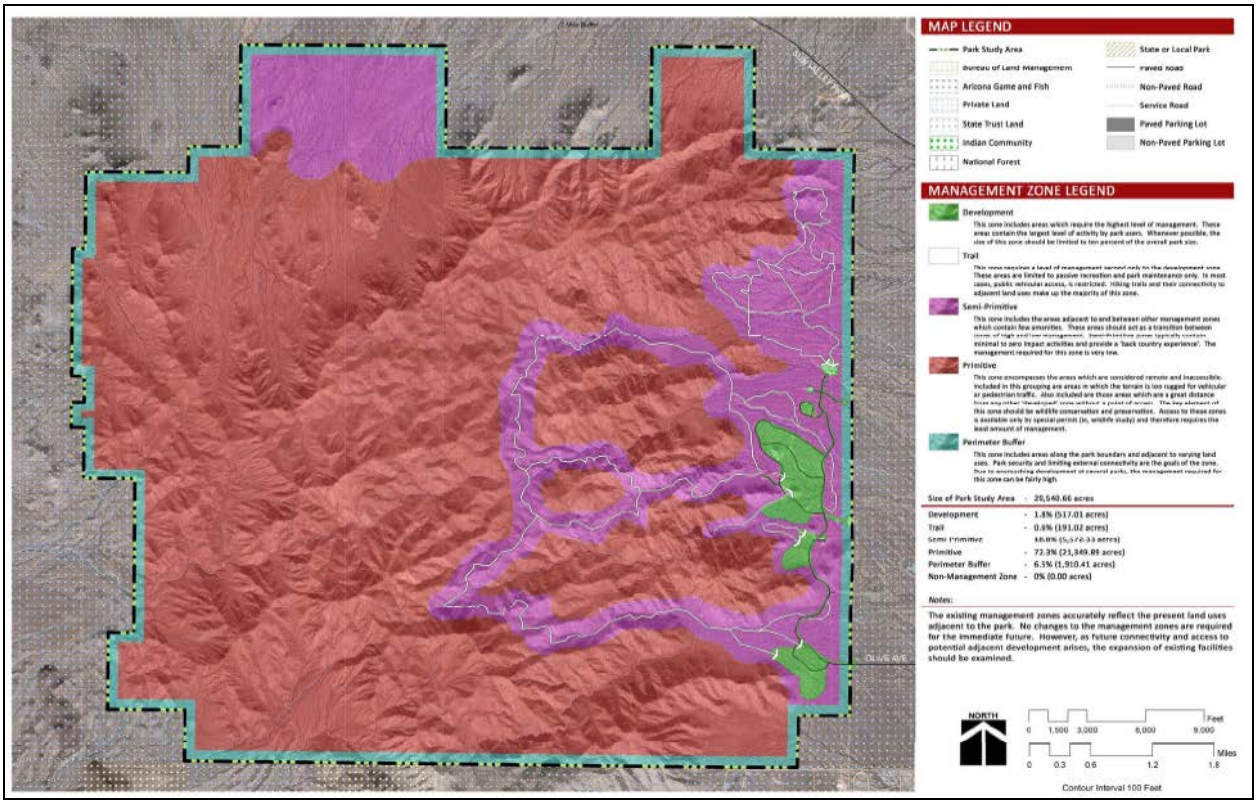
	other protected open space may exceed 10%.	Camp sites Equestrian facilities Entrance stations Visitor centers Trailheads Parking lots Boat launch areas Amphitheaters Group areas Staging areas Park offices
Trail (High)	This zone requires a level of management second only to development zones. These areas are limited to passive recreation and park maintenance only. In most cases, public vehicular access is restricted. Hiking trails and their connectivity to adjacent land uses makes up the majority of this zone.	Park access gates Shared-use trails Barrier-free trails Hiker-only trails Regional system trails Competitive tracks Service roads Public roads (with no connectivity to developed management zones) Unpaved roads
Perimeter buffer (Fairly high)	This area includes areas along the park boundary and adjacent to varying land uses. Park security and limiting external connectivity are the goals of this zone. Due to encroaching development at several parks, the management required for this zone can be fairly high.	Fencing Access gates
Semi-primitive (Low)	This zone includes areas adjacent to and between other management zones which contain few amenities. These areas should act as a transition between zones of high and low management. Typically contain minimal impact activities and provide a “back country experience”. The management required for this zone is very low.	Back country areas
Primitive (Lowest)	Encompasses the areas which are considered remote and inaccessible. Included, are areas which the terrain is too rugged for vehicular or pedestrian traffic as well as areas that are a great distance from any other “developed” zone without a point of access.	Wildlife areas

	The key element of this zone should be wildlife conservation and preservation. Access to this zone is available only by special permit (i.e. wildlife study) and therefore requires the least amount of management.	

5.3 Area Descriptions that Influence Park Zoning

Topography or natural and cultural resources may determine the areas that are considered semi-primitive and primitive. Many areas are too rugged for any type of development and therefore semi-primitive or primitive are inherently appropriate in a large portion of the park.

The 2009 Strategic System Plan (page 116) notes that current management zones reflect existing land uses within the park. As future connectivity and access needs change, these zones will require an update.



Map 5-1: Development Zones (Source: MCPRD 2009 Strategic System Master Plan, p 116)

CHAPTER 6 – RECOMMENDED PARK IMPROVEMENT PROJECTS

This chapter identifies new park improvement options that have been determined through the planning process that included public input, consultation with neighboring agencies, and Department staff expertise as described in previous chapters. This master plan update will also continue to uphold the concept of "maximum use without significant loss of natural character"[1] by streamlining the 1964 Master Development Plan objectives by:

Acknowledging existing uses:

This plan update acknowledges and provides space for activities that were not supported by the original master development plan, such as mountain biking[2] and RV-style camping[3]:

Supporting existing features and amenities:

This plan update provides supporting amenities to existing areas and promotes educational components of the park.

- Educational opportunities and living laboratories[4],
- Equestrian facilities[5] by recommending upgrades to existing equestrian amenities,
- Previous objectives regarding encroachment[6] by recommending continued efforts to work with local agencies and neighboring land owners and developers in order to secure park borders,
- Provides additional trail opportunities[7], and
- Utilities and basic services and staff support areas[8].

Limiting other features:

This plan update streamlines the quantity of built facilities to protect its natural and cultural resources.

- Limit the number of picnic sites and campsites to more sustainable numbers[9],
- The master development plan called for two or more entrances[10]; this plan update will limit that to two entrances and refine the location and elements of the secondary entrance,
- Limit the size of a grocery store[11] to a smaller facility; this update recommends a coffee shop/cart for visitors to purchase incidental refreshments and serve as a place to enjoy the scenic beauty of the park; this feature will enhance the existing nature center and library facility, and

[1] White Tank Mountains Regional Park Master Development Plan, page 19.
[2] White Tank Mountains Regional Park Master Development Plan, page 18. "No special provisions in the park are planned for pleasure driving, outdoor games and bicycling."
[3] White Tank Mountains Regional Park Master Development Plan, page 30. "No special areas are planned for the exclusive use of camper vehicles (travel trailers, tent trailers, pickup campers, microbuses, etc.) nor will utility hookups for camp vehicles be provided."
[4] White Tank Mountains Regional Park Master Development Plan, page 26, 27.
[5] White Tank Mountains Regional Park Master Development Plan, page 36.
[6] White Tank Mountains Regional Park Master Development Plan, page 47.
[7] White Tank Mountains Regional Park Master Development Plan, page 34.
[8] White Tank Mountains Regional Park Master Development Plan, page 38, 43.
[9] White Tank Mountains Regional Park Master Development Plan, page 28, 32.
[10] White Tank Mountains Regional Park Master Development Plan, page 21.
[11] White Tank Mountains Regional Park Master Development Plan, page 36.

- Other developed features outlined in the 1964 master development plan not currently in place or recommended within this update are not desired facilities for the park.

6.1 Issues and Constraint Analysis

The planning team met early in the planning process to discuss issues that may place constraints on the park. The plan update will make every attempt to address those items discussed within its improvement projects and operations, such as:

Table 6-1: Issues Constraints and Analysis

Issue/Constraint	Analysis
Maintain development to under 10% of land acres	Currently, 1.75% of land acres are considered developed; park is well within the 10% limit. Future development actions will need to take this guideline into account.
Management Zones	Management Zones represent existing land use. Additional development actions must complement its zone or modify the zone. The Management Zone should reflect the desired use and visitor expectation for that zone.
Rugged landscape	Prevents development or access to many areas.
Communication Towers	Ownership issues prohibit park visitor access to these areas.
Drainage/erosion	Proposed projects will address drainage and erosion to protect park resources.
Wildlife corridors/linkages	MCPRD has consulted with AZGFD to locate known corridors/linkage patterns. Any future development will be sited in locations that will accommodate linkages.
Hunting	The park can fill this niche other areas cannot; as regulated through AZGFD.
Compliment established themes	All efforts have been made to compliment park's theme.
Neighboring city/town development patterns	The Park Supervisor and/or Park Planner routinely participate with neighboring agencies regarding development patterns.
Use conflicts	Additional study is needed to determine level of use related conflicts among park visitors.
Biological consequences to development	Additional study is needed to determine level of consequence to development regardless if that development comes from inside or outside of park boundaries.

6.2 Recommended Park Improvements

These park enhancements adhere to the MCPRD vision and mission. These enhancements also address the park's priority mandates and promote the park's theme. The park improvements and features detailed in the section were based on public input, stakeholder advisory group suggestions, and park staff's knowledge, experience, and guidance from other planning documents.

A timeline for completion was not assigned to any one project as any one may be completed as the opportunity presents itself. Projects will be scheduled through the Department's Capital Improvement Plan and potential costs and funding sources will be identified through the Implementation Plan (Appendix K). However, a priority level was assigned to show which projects may be of a relative greater need than another:

- High Priority: projects that are in progress; public health or safety issues; resource protection;
- Medium Priority: important, but not a matter of public health or safety;
- Low Priority: desired features; dependent on long-term partnerships or other considerations.

A majority of these projects will be phased in individually over multiple years to maximize budgetary resources, build partnerships with other agencies, and to minimize impacts to park operations and resources. Site specific plans (including any natural or cultural resource inventories and clearances) and engineering plans will be required for new construction. The Implementation Plan and an annual Business Plan will help identify which projects will be funded at that time. *All of these improvement projects are contingent upon having adequate funding and staffing resources to implement.*

Some improvements may cross categories and may be addressed all at once. For example, upgrading a parking lot with additional facilities (Develop New Facilities) may also address erosion/drainage (Protect Park Resources) as a component of the project. Similarly, some projects, once complete (Develop New Facilities, Maintain/Rehabilitate Existing Facilities) will enhance the visitor experience (Programs, Education/Interpretation).

For the purposes of this Master Plan update, the mapped location of any new facilities herein is conceptual only; the precise location may change due to engineering feasibility and resource management issues. Additional public meetings regarding individual projects may be required and the results of which may shape the final outcome of a project.

Additionally, any trail alignments shown in these park improvements are also considered conceptual only. The locations are general corridors and not intended to be precise; new trails will be located according to MCPRD trail standards and area topography. Additional trails or deletions to the trail system may require an amendment to the Trail System Plan; the trail development planner/manager is tasked with making that determination and implementing the amendment process, if required. These trails are not open to travel until they have been properly constructed, posted, and designated by MCPRD. Traveling on undesignated routes causes damage to the land, may be hazardous, and is in violation of park rules.

As a result of public input, agency partner input, and staff expertise, this plan update recommends the following park improvement projects:

Table 6-2: Recommended Park Improvements

	Develop New Facilities		
Location	***Description***	***Priority***	***Acres***
Nature Center	**Tortoise enclosure (2013)** Park staff received Heritage Grant funding through AZGFD in the summer of 2013 to construct a Desert Tortoise enclosure. This will add an additional educational element to the park and assist with conservation of Desert Tortoise.	**High**	**0.08**
Family	**Upgrade/Expand RV Camp Sites** The Family campground is being upgraded with electric and water (FY2012-2013) and a dump station (FY2013-2014) and will require occasional campground closures while construction is underway. When complete, this will improve the camping experience for RV camping and will allow campers to stay in the park longer and more comfortably, enhancing their experience. One or two RV sites may be enlarged to accommodate corral space for those who camp with horses. The playground equipment is in need of updating and could	**High**	**17.87**

	benefit from additional landscaping to buffer the playground from other uses. This area will also be expanded by adding 20 sites. Additional steps may be taken to level and enlarge existing sites where feasible to provide more space for campers and flatter surfaces for large rigs.		
Competitive Track	**New features** This area can host large, competitive events with several hundred participants; a restroom (with showers is preferred) and a bike wash-rack at the Track's parking lot area will enhance the track experience and make it a more desirable place to hold events. A "bike park" will also be included (approx. 2 to 3 acres). A pump track is one component of a bike park. An accessible water source is desirable for bike park maintenance. A separate beginner track (approx. 0.5 to 1.0 mile with multiple loops) will facilitate youth or those new to competitive events and provide an additional experience. A connection from the parking lot to Ironwood Trail will be included in this update as a conceptual trail corridor (approx. 0.6 miles); however, the actual alignment will be further defined via a separate process under the Trail System Plan.	**High**	**3.78**
North	**New facilities and trails (at approx. 243rd Ave. / Wild Rose Pkwy)** In response to the planned development by the City of Surprise on the northern park boundary and by the Town of Buckeye on the south and west side of the park, an area will be developed and constructed to provide access to future residents and visitors. Conceptual development may include an entrance, trailheads, trails, cabins, a modest nature center building, amphitheater, stabling facilities, and other support facilities (restroom, parking, picnic areas, signage, etc.). This general area is considered optimal due to its proximity to a major road alignment and an existing well. It is also a relatively flat area that has been disturbed in the past. Development in this area will be compatible with the natural and cultural resources found in the area and will take wildlife connections into account. Additionally, facility development in these areas may require a change in Management Zone type to "Development" and/or "Semi-Primitive". *All development will be completed in phases as funding and other resources are available. Final developed features will be determined at a later date and will be contingent upon cooperation and partnerships with the City and/or Town, BLM, MCDOT, AZGFD, MCSO, or other entities, and may also entail private consultants or developers to assist with the design and implementation. Coordination with MCDOT is essential for potential signage and signaling concerns or to determine if a dedicated left-turn lane is*	**Medium**	***tbd***

	required. *Previously disturbed areas should be used to the extent possible. The area should be surveyed for sensitive species and habitats prior to construction.*		
Trails	**Connection: Mesquite to Goat Camp** A connection from Mesquite Trail to Goat Camp Trail will be included in this Master Plan update as a conceptual trail corridor (approx. 1.4 miles); however, the actual alignment will be further defined via a separate process per the Trail System Plan.	**Medium**	**0.68**
Trails	**Connection: Ford to Willow** A connection from Ford Canyon Trail to Willow Trail will be included in this Master Plan update as a conceptual trail corridor (approx. 1.5 miles); however, the actual alignment will be further defined via a separate process per the Trail System Plan.	**Medium**	**0.73**
Area 3 or Pond	**Butterfly garden** The park has design plans to construct a butterfly garden. This garden will provide educational and interpretive opportunities to park visitors. The garden will require irrigation for at least two years to allow the plants to establish themselves.	**Medium**	**0.021**
Nature Center	**Coffee shop/cart** A coffee shop or cart will allow visitors to spend more time at the Library and Nature Center building to enjoy the scenic views thus creating a leisurely atmosphere. *Development and implementation of this project will be contingent upon consultation with BLM prior to installation.*	**Medium**	**0.0**
TBD camping site(s)	**Corral or site(s) with space to assemble own corral** Campers who bring horses with them require a corral or corral space to allow horses untethered resting and overnight sleeping space. The park will identify and provide adequate space (16x16 square foot minimum) at one or two campsites for a camper to assemble their own corral; based on demand, may include constructing a permanent corral at the same camp site(s) sized 16x16 square foot minimum. This will allow the park to increase recreational opportunities to those who prefer to camp with horses.	**Low**	**0.0118**
Trails	**Connection to Skyline Regional Park** A connection from Goat Camp to Skyline Regional Park will be included in this Master Plan update as a conceptual trail corridor (approx. 3 to 4 miles); however, the actual alignment will be further defined via a separate process per the Trail System Plan. *Development of this trail or trail connection will be contingent upon a partnership and an intergovernmental agreement with the Town of Buckeye.*	**Low**	**1.94**
TBD area	**Cabins** Cabins may be constructed as a part of the future north development process, or may be sited in another appropriate area. The cabins could be but are not limited to such things a yurts, canvas tents, formal structures, etc. In addition, it would be evaluated for proper infrastructure such as electric, water, and	**Low**	**0.9**

	sewer, including any sundries sales to support it. *Development and implementation of this project will be contingent upon consultation with BLM prior to construction.*		
TBD area	**Archery Facilities** AZGFD has approached the park about including an archery range and walking course(s). Provided that the temporary archery range recommended for the Competitive Track parking lot is successful, a permanent facility can continue to fill this need. This would be done in partnership with AZGFD.	**Low**	**2.28**
	Maintain/Rehabilitate Existing Facilities		
Location	***Description***	***Priority***	***Acres***
Area 4	**Renovations** Demand for this area often exceeds its parking capacity. Multiple types of visitors use this area and a study is recommended that investigates if there are any conflicts among use groups and how to prevent future disruptions by potentially limiting the types of usage for this area. After the study is complete, park staff will have a better understanding on how to address other issues in this area. For example, parking may be expanded or separated to accommodate picnic and trail users and will include enhanced emergency response access. The heavily used playground requires upgrades and some form of buffering material (fencing, vegetation, etc.) from vehicles in the parking lot. Aged ramadas require extensive roof repairs or full replacement. Drainage issues need to be addressed to prevent erosion by correcting the slope or installing drainage devices. Additional landscaping materials, especially shade trees, will enhance the experience and may also prevent erosion.	**High**	**0.0**
Area 7	**Renovations** Demand for this area often exceeds its parking capacity. Parking will be expanded to include enhanced emergency response access. A new kiosk is needed to post informational items. The well-worn stage/shade structure needs repair work. This area is somewhat rugged and the effects of erosion are seen throughout the area and will be addressed to maintain the visual appeal of the area and to protect park resources; this may include re-grading the area or installing additional landscaping. The playground equipment is in need of updating and could benefit from landscaping to buffer the playground from other uses.	**High**	**0.0**
Waterfall	**Renovations** The Waterfall Trail area is the most used area in the park by trail users and picnickers. This area needs additional parking, a new kiosk, additional shade and resting areas. Prior to renovations, this area also will benefit from additional study for visitor use conflicts and potentially separating uses in this area to limit conflicts. Separating uses may result in adequate parking for the remaining uses; however, the other renovations are	**High**	**0.0**

	still warranted.		
Roads	**Road improvements (MCDOT)** MCDOT constructs and repairs the major roads within the park. Maintenance is on a routine schedule and should be coordinated with other park upgrades to minimize impacts to park visitors. Future road improvements may include investigating bicycle lane feasibility, improving dips, lane width, etc.	**High**	**20.07**
Maintenance Compound	**Maintenance building improvements** The maintenance building receives heavy use from park staff, park hosts, and contractors and is in need of repairs and upgrades such as additional insulation and parking. These upgrades will allow park staff to perform their duties more efficiently.	**Medium**	**0.0**
Area 1	**Convert to Family RV sites** The area is currently underutilized as a picnic area and could be redesigned to accommodate up to 80 larger RV campsites by adjusting the sites size and location, upgrading the restroom, installing electric, water, sewer or a dump station. This effort will require some additional study and a CRS. This area is close to the Nature Center to allow campers to walk over and explore everything the Nature Center has to offer and to connect to other trails. *Development and implementation of this project will be contingent upon consultation with BLM prior to construction.*	**Medium**	***tbd***
Horse staging area	**Renovations** Equestrians sometimes have difficulty parking their large horse trailers; an expansion or redesign will help alleviate the difficulty with large trailer access. A step-up area will allow riders to mount horses with ease. A shaded picnic area and restroom will allow equestrians to rest or eat a lunch as part of their visit and may help extend the number of hours a rider spends in the park. A 16x16 square foot corral and/or tie bars will allow riders to temporarily secure their horses while using the area's amenities. Stabling facilities for horse rentals may also be desired. These upgrades may require a slight realignment of Mesquite Canyon Trail to make room for new amenities. *Development and implementation of stabling facilities will be contingent upon consultation with BLM prior to construction.*	**Medium**	**0.03**
Youth	**Expansion** The Youth area receives a high level of use from scout groups or other youth groups. Additional parking is needed and would also benefit from an amphitheater or larger ramada to facilitate large group activities. Redesigning the fire pit to accommodate these groups is also needed.	**Medium**	***tbd***
Group	**Renovations** Restroom upgrades.	**Medium**	**0.0**
Willow	**Renovations** The Willow area is primarily used for smaller youth groups or overflow camping. It is also used as a day use area during busy holidays. This area is also used for tent camping. Additional parking	**Low**	***tbd***

	is needed and adding showers is desired. Making this area into a one-way road may facilitate travel and parking needs.		
Area 4 (north)	**Gravel and dirt storage lot** The area just north of Area 4 (near the pond and windmill) is currently used to store landscaping gravel and fill dirt. These materials should be moved to a more appropriate location closer to the maintenance compound. The area should then be rehabilitated and re-vegetated with native plantings.	**Low**	**6.0**
	Education/Interpretation		
Location	***Description***	***Priority***	***Acres***
Park-wide	**Educational and Interpretive Kiosks and Panels** Much of the signage, kiosks, and interpretive panels are outdated or worn. New signage shall be installed as needed throughout the park and shall comply with the MCPRD Sign Manual. Additional interpretive panels may be installed along trails or other opportune areas to highlight unique features.	**High**	**0.0**
Pond	**Wildlife viewing blind** A wildlife viewing blind near the pond will allow additional educational opportunities and allow visitors to view wildlife with minimal disruptions.	**Medium**	**0.018**
Wildlife Trail	**Convert to Barrier-free** The scenic Wildlife Trail (0.2 mile) will be converted to barrier-free or into a sensory trail to provide visitors using mobility assistance devices or strollers another trail opportunity. Interpretive panels may also be installed along the trail to highlight unique features.	**Medium**	**0.0**
Area 3	**Convert to Kids Discovery Area** The park has initial designs to renovate the area and improvements are necessary after the trailer removal; design work includes installing shade structures and interpretive stations. This will provide additional educational opportunities for youth.	**Medium**	**0.0**
Competitive Track	**Archery** AZGFD has approached the park about including an archery range. The archery range will be set up within the Competitive Track parking lot and will be removable for track event parking. Archery programs in other parks have proven to be extremely successful and would be done in partnership with AZGFD.	**Medium**	***tbd***
Area 3	**"Living Laboratories" educational displays/programs** The area is currently underutilized as a picnic area, and its proximity to the Nature Center provides a unique opportunity to utilize some portion of the area as a "living laboratory" that will provide additional educational opportunities. Utilizing additional signage and interpretive panels or educational "stations" where educators or Interpretive Rangers may lead classes will enhance the educational experience.	**Low**	**0.0**
	Administrative		
Location	**Description**	**Priority**	**Acres**
Park-wide	**New signage, kiosks**	**High**	**0.0**

	As signs wear out, they shall be replaced with new signage that adheres to the MCPRD Sign Manual. Many kiosks are worn and likewise need replacing.		
Park-wide	**Develop partnership opportunities** The park shall continue to engage with the Town of Buckeye and the City of Surprise for potential partnerships as well as with other appropriate agencies. As adjacent land use changes, it's critical to form these partnerships early.	**High**	***n/a***
Park-wide	**Engage Friends group** Continue to build upon past success with Friends of White Tank to explore fundraising activities and educational events. The park should also seek out their assistance for park improvements and park advocacy when appropriate.	**High**	***n/a***
	Resource Protection		
Location	**Description**	**Priority**	**Acres**
Waterfall, Area 4	**Capacity: social, physical, environmental (*requires study*); Mixed-use Conflict (*requires study*)** As the most popular places in the park, these areas play host to hikers, bikers, picnickers, and others; differing activities may expect different experiences which may be in conflict with other uses. Likewise, a study is needed to determine how much use or how many people a given area can handle before the experience is degraded or the environment is degraded. Research is needed to determine the level of each type of use, the expectations for that use type, ways the park may lessen those conflicts in order to improve the visitor's experiences, and impacts of use. These studies may be performed by MCPRD staff or with the assistance of ASU or other knowledgeable entities. Research methods may include visitor survey, field monitoring, literature review, aerial photography comparison, or other methods.	**High**	***n/a***
Park-wide	**Species inventory/census** Develop a plan for conducting a species inventory with the advice and guidance of AZGFD or other knowledgeable entities. Once survey work is complete, this knowledge will assist the park in managing its biodiversity.	**High**	***n/a***
Park-wide	**Protect wildlife corridor movement** MCPRD has consulted with AZGFD to identify existing wildlife corridor areas. Wildlife is a vital component to the park's health and MCPRD will plan its future park developments to accommodate known wildlife movement patterns. MCPRD will continue to consult with AZGFD.	**High**	***n/a***
Park-wide	**Encroachment** Encroachment was an issue noted in the park's 1964 Master Plan, and is still an issue today. The park will continue to meet with agencies and developers as needed to protect and maintain park borders. MCPRD has identified the majority of surrounding land as being under the jurisdiction of Arizona State Land Department and will work with the agency and future developers to acquire parcels of	**High**	***n/a***

	land or easements that will strategically buffer the park from encroachment. Acquisition will be based on a set of criteria that identifies unique or critical parcels (i.e. rich in archaeological sites; wildlife corridors; unique topography or assemblages of vegetation; etc.). Additional fencing and signage may also be required to define park boundaries or to repair damaged sections.		
Waterfall, Area 4, Area 7	**Landscaping improvements; Address drainage/erosion issues** As the most popular places in the park, additional landscaping will offer additional shade, help with erosion, and improve the scenic quality of the park. Landscaping in key areas will also provide a natural buffer between picnic areas or playgrounds and parking lots.	**High**	***n/a***
Park-wide	**Visual/Scenic Resource Protection (*requires study*)** As outside development grows closer to the park, it will also grow increasingly important to protect the viewshed of the park. Likewise, as the park develops within its own boundaries, maintaining expansive views and vistas should be considered in all planning and targeted viewpoints should be protected. The Bradshaw-Harquahala Record of Decision and Approved Resource Management Plan (April 22, 2010) (BH-RMP), a BLM document that describes visual resource management criteria, has designated areas within park boundaries as "Class II" and areas just outside park boundaries as "Class IV". Research is needed to determine the type and location of key scenic views within park boundaries. This study may be performed by MCPRD staff or with the assistance of other knowledgeable entities. Research methods may include GIS analysis, field observations, photo monitoring, literature review, or other methods.	**High**	***n/a***
Park-wide	**Water Plan (*requires study*)** AZGFD has suggested the park create a water plan to identify existing water sources (ephemeral, tanajas, springs, catchments, etc.) for wildlife and what would happen if those sources were cut off due to encroachment. Wildlife is a vital component to the park's health and MCPRD will develop this plan with the advice and guidance of AZGFD or other knowledgeable entities. This may include adding wildlife watering tanks at higher elevations.	**High**	***n/a***
Park-wide	**Lightscape Management Plan (LMP)** MCPRD will develop a Lightscape Management Plan that will outline the parks commitment to dark skies conservation and its lightscape management practices. The park will develop this plan using "International Dark-Sky Association, Dark Sky Park Program Criteria" as its guideline. Appendix L provides more information.	**High**	***n/a***

	Percentage	Acres
ACRES OF EXISTING DEVELOPMENT	1.750%	517.00
ACRES OF POTENTIAL NEW DEVELOPMENT	0.184%	54.41
TOTAL	1.934%	571.41

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Maricopa County
Parks and Recreation

Appendix A - Stakeholder Advisory Group (SAG)

The purpose of the SAG was to establish a small group representing a range of opinions in a forum small enough to allow for education of the participants, detailed discussion of issues, and informal dialogue. The group's comments and concerns were integrated into the planning process and assisted in the development of park improvement projects. Information and recreation recommendations identified by the group were used in conjunction with the recreation activity evaluation and other planning tools.

The SAG was comprised of four avid park users with varying recreational interests as noted after their name. Planning staff and the Park Supervisor served as facilitators.

- Jamil Coury (competitive running)
- Linda Gilgosch (equestrian)
- John Pesock (mountain biking)
- Frank Salowitz (Friends of White Tank Park member)

The SAG met four times between March and August 2013 at White Tank Mountain Regional Park Nature Center.

- March 8, 2013 (9:00-11:00am)
- April 19, 2013 (9:00-11:00am)
- June 28, 2013 (9:00-11:00am)
- August 16, 2013 (9:00-11:00am)

Initial comments received during these meetings expressed their general happiness with the park and its performance although the group did provide its insight on potential upgrades to the park. Briefly, the group's comments included:

- Expand the horse staging area to better accommodate large trailers, include a restroom and a covered picnic area
- For visitors who camp with horses, provide a corral (or space to set up one's own corral)
- Develop modest facilities on west side of park (small visitor center, trailhead, trails)
- Install a restroom at the competitive track
- Additional access points (from Greenway, Bell, or to the north and west)
- Trail connections (Willow to Mesquite to Goat Camp trail)
- Additional trail options (ADA or family trails, GPS trail markers)
- No shooting range, water park, OHV use, mini-golf, major roads or invasive development
- No need for the thousands of picnic or camping sites as stated in 1964 master plan
- Earlier summer hours; later evening hours.

After draft improvement projects were developed, the group met again to discuss and provided additional feedback in order to fine-tune the options. The group expressed satisfaction with the end result.

March 27, 2013
Press release issued 30-days prior to public meeting:

NEWS RELEASE

Date:
February 25, 2013

Website:
www.maricopa.gov/parks/white_tank/

Contact:
Dawna Taylor
Public Information Officer
Office: (602) 506-1114
Cell: (602) 525-5733

White Tank Mountain Regional Park Seeks Input on Master Plan Update

(Maricopa County) The Maricopa County Parks and Recreation Department is currently updating the 1964 Master Plan for White Tank Mountain Regional Park and is seeking input from the community. The goal of the Park Master Plan is to develop a long-range vision for the park that takes into account park visitors needs while also protecting the resources and natural open space found within the park.

"The department is beginning the initial phase of the planning process and it is important for us to make sure that the community is a part of that process," stated Maricopa County Supervisor Max Wilson, District 4. White Tank Mountain Regional Park abuts the rapidly growing suburbs of the Town of Buckeye and City of Surprise.

"The March 27th meeting is the first of several public meetings that will be hosted at the park. During this phase of the planning process I've asked staff to gather input from park users regarding their recreational needs and preferences. This will help to guide us in the development of the draft

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master plan," said R.J. Cardin, Maricopa County Parks and Recreation Department Director.

The public comment period for the first phase of the project will remain open for 30-days concluding at the close of business on April 27. To learn more about the public meeting being held at March 27, at 6 p.m. in the White Tank Mountain Regional Park Nature Center or the project, visit *www.maricopa.gov/parks/white_tank/* and click on the park project tab.

30

The first public meeting was held March 27, 2013 (6:00-8:00pm) at the White Tank Nature Center. A 30-day comment period followed from March 27 to April 27, 2013 to gather additional comments.

- Meeting attendees: 10
- Responses received at meeting: 3
- Additional responses received during comment period: 31
- Total number of responses (all sources): 34

Of the 34 respondents, response rates by hikers and runners were highest at 62% and 29% respectively. (Respondents were allowed to check more than one box for activity type; therefore the total percentage will be greater than 100%.)[1] Three respondents (or 9%) indicated their interest to volunteer at the park.

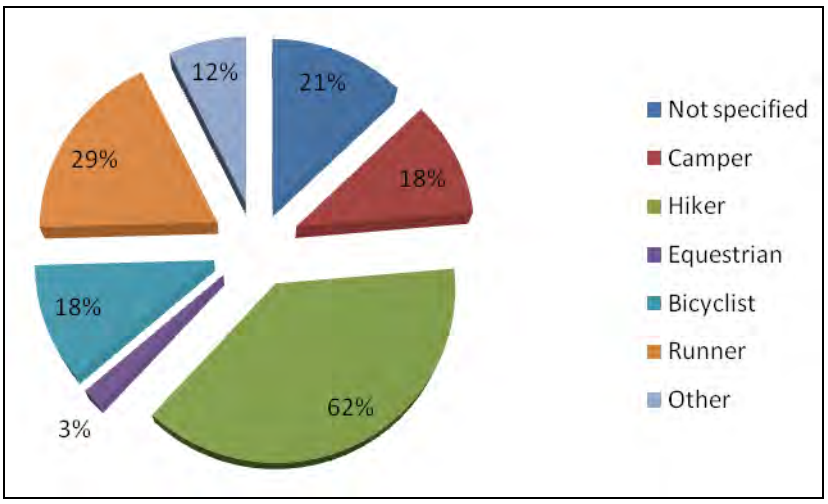


Table B-1: Response Rate by Activity Type

[1] "Other" included wildlife observer, walker, climber, and one illegible response.

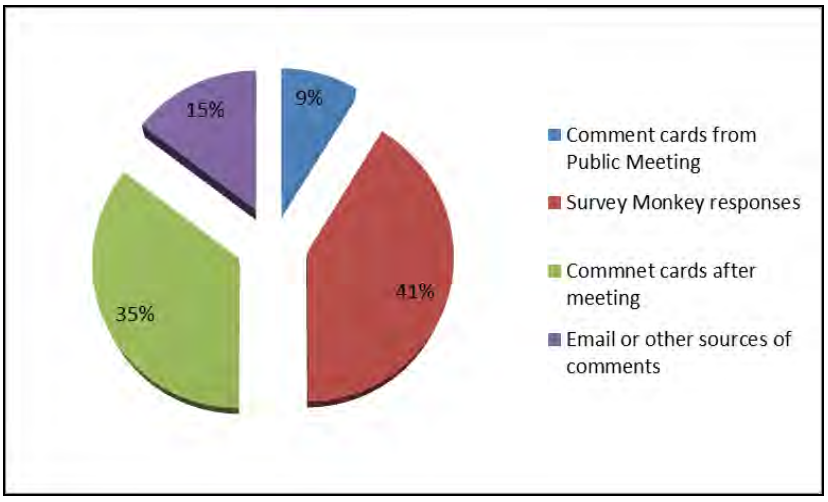


Figure B-2: Comment Source

The most common "theme" to the comments was how much the respondent generally liked the park, its services, and facilities as they are now; followed by a desire to add new trails and/or trail connections. A group of respondents would like to see the park offer earlier morning hours and a desire to protect the park's natural and cultural resources. Other comments were supportive of new facilities; stated encroachment concerns; and a desire for additional educational opportunities. Additional campsites and partnerships both had mentions each. Other comments oppose a tram or lake; are in favor of lowered rates for tent camping or local residents and development on the north and/or west side of park. Doing nothing, obesity concerns, and more signage all had at least one mention.

A complete comment matrix was developed to analyze each comment for substantive content and to respond to the comment. Most respondents provided more than one comment per comment card so the total number of comments exceeds the total number of respondents at approximately 88 comments (every effort was made to keep the perceived sentiment of the comment intact); and about 39 comments were regarded as being outside of the scope of the master plan update but were forwarded to the appropriate personnel as informational items. The complete matrix follows:

Respondent	Comments/Questions	Out of Scope	MCPRD Response
1	Limited development is good to help protect the cultural and natural resources.		Considered for draft master plan.
1	Acquiring additional property would enhance the whole experience for the really dedicated hikers.		Considered in 1964 plan and any updates.
1	I would love to see the west side of the White Tanks opened up but I know that will take some time and a lot of money. There is a lot of potential there.		Considered for draft master plan.
2	No need for a tram or lake.	x	Not considered for draft master plan. Does not reflect MCPRD vision or mission or the established theme for the Park.

Respondent	Comments/Questions	Out of Scope	MCPRD Response
2	Great to be partnering w Library District - do more partnering		MCPRD continuously looks for new ways to partner with appropriate agency partners or concessionaires and with volunteers.
2	Parks Dept P.R. Dept might want to do a "media" event to help educate park visitors about the importance of staying on the trail.	x	Comment passed on to PIO for consideration. Have participated in "stay the trail" events in the past. Existing Park Rules require visitors to remain on approved trails.
2	Continute to develop trail system		Considered for draft master plan. Trails are determined via a park Trails Plan and is considered a separate process.
3	Trailheads/trails from Buckeye & Surprise (partner/collaboration)		Considered for draft master plan. Requires additional planning and coordination with agency partner.
3	Additional campsites w/ restroom facilities - one large (50 campsite) for groups		Considered for draft master plan.
3	Maintain natural pathways for wildlife		Consulting with AZGFD to maintain linkage areas.
4	I have been visiting White Tank Mountain Regional Park for the past 17-18 years. I live in Colorado but visit my in-laws 2 or 3 times a year; my visitis to Sun City West are not complete without a hike (or 2) in WTMRP.	x	
4	I am very impressed with the recreational opportunities in the park. There seems to be a little something for everyone: hikers, bikers, horse users, picnicers, campers, photographers, educators, etc.	x	
4	I particularly value the miles of hiking trails and hiking loops that are available and the 'untrammeled' feel of the canyons, mountains, drainages and vegetation as they pass through.	x	
4	I feel the park is doing a great job managing these trails by 1) designing quality trails, both to minimize erosion impacts and to provide a great hiking experience, 2) restoring damaged and poorly designed trails, and 3) providing both 'front country' and 'back country' types of hiking trails.		Considered for draft master plan. Trails are determined via a park Trails Plan and is considered a separate process.
4	The signage on on trails is informative but not overwhelming and your maps are adequate.		Signage is designed to adhere to MCPRD standards and is currently being updated.
4	I appreciate the regulation of 'no off-trail hiking'; I feel that it protects the natural resources and the solitude, and keps folks from tromping all over and forming user created trails.		Will continue to be upheld by Park Rules and Trail standards.

Respondent	Comments/Questions	Out of Scope	MCPRD Response
4	I would like to see the park continute to manage the hiking trail system in a similar manner into the future… I can always find a remote trail with few folks on it and get a pseudo-wilderness expereince, yet there are easier, more accessible trails for less experienced and less physical hikers as well.		Considered for draft master plan. Trails are determined via a park Trails Plan and is considered a separate process. Trails are built to adhere to MCPRD standards.
4	One addition to the trails system that would be really nice would be a connecting trail from the Goat Camp/Bajada Trail back north to the Waterfall and Mesquite Trail that didn't cross the road (ie, stayed west of the main road.) That would add another wonderful loop opportunity without needed a second car for a shuttle.		Considered for draft master plan. Trails are determined via a park Trails Plan and is considered a separate process. Trails are built to adhere to MCPRD standards.
4	Other than that I think the amount of back country type trails are appropriate; any increase in trail density would negatively impact the remoteness and 'solitude' that are currently available.		Trails are determined via a park Trails Plan and is considered a separate process. Trails are built to adhere to MCPRD standards.
4	The facilities you provide (restrooms, picnic shelters, parking, playgrounds) are very nice and seem to be well used.	x	
4	I very much like the addition of the nature center/library over the past few years.	x	
4	I have never had a negative encounter with another visitor, though most of my use is in the more remote areas and I only encoutner other backcountry hikers and a few mountain bikers.		
4	I look forward to many more years of hiking in WTMRP when I visit the Valley and have recommended this park to several of my friends when they visit the Phoenix area and they have also enjoyed your park. Thanks for the opportunity to comment.	x	
5	Honestly I have no suggestions to make the park better. I love it just the way it is! Keep up the great work.		Keeping the park as is will be considered as a draft alternative.
6	I want the park to be as use friendly as it is now.	x	
6	No encroachment by people.		Considered in 1964 plan and any updates.
6	No buildings or trams as recently hoped for by Surprise.		Tram not considered for draft master plan. Does not reflect MCPRD vision or mission or the established theme for the Park.
6	Love the place.	x	
7	A reduced rate for locals.	x	Fees are considered and set by a separate process.

Respondent	Comments/Questions	Out of Scope	MCPRD Response
7	Paper towels in the restrooms. The current machines exceed a safe noise level. Also they are unsanitary. The germs in public restrooms are air born, its seems ludicrous to wash ones hands with soap & water, only to use one of those germ spraying machines to dry them.	x	Maintenance issues.
7	Also the restrooms here in this center smell horribly. I don't know what chemicals you use to clean & freshen the air but it makes me sick! I would rather smell feces and urine than feces & urine & who knows how many other mittures of toxic chemicals. Seriously, & then i have to stand around as the machine blows toxic fumes & germs @ a deafening pitch. Not pleasant... (plus i can't dry my face after I splash water on it.)	x	Maintenance issues.
8	It is butyful I love it here.	x	
9	How about if you put plant ID stakes next to the paths to the library.	x	
10	Beautiful park! Doesn't need fixed - it aint broke.		Keeping the park as is will be considered as a draft alternative.
11	We've had 2 events at area 4. Both times other groups were also there with very loud music.	x	
11	Also have seen people rock climbing and hiking well off paths many times.	x	
12	Its beauty & trails	x	
12	Have a cafe to eat and rest after a hike		Considered in draft alternative
12	The ranger lectures	x	
13	I completed the Survey, but have a few comments and additions. I recognize the value of not hiking alone, but many hikers will continue to hike alone. Perhaps solo hikers could fill out an informational form on the date, time, and route being hiked, vehicle driven, etc., and leave it at the park entrance, in case they do not return on time. Some (or all) cell phones do not work out on the trails.	x	
13	I have moved back into the area after a 12 year absence, and I am impressed and pleased with the "modest" improvements that have been made on the trails.	x	

Respondent	Comments/Questions	Out of Scope	MCPRD Response
13	I was surprised by the Visitor/Library Center that has been added, but have not spent any time in it to see if it was a good expenditure.	x	
13	Although I agree with the advice to stay on the trails, perhaps more information can be given about hiking the washes--whether it should be allowed or discouraged, and the reasons.	x	
13	All in all I love the White Tank Mountain Park, and was happy to see so many people use it for picnics and get-togethers. Also, the list of activities offered is impressive.	x	
13	Thanks for a great outdoor experience for a "70 year old."	x	
14	My friends and I spend many hours a week hiking and exploring WTM. I would like to see another campground created for tents only at a decreased rate, perhaps $17.00 per night as it is now with no electricity. For those of us who like to tent and prefer to not be right next to big RV's this would be great.		Additional camping areas or reconfiguration considered for draft plan.
14	As for other ideas about WTM's future I'm wondering how the park can be expanded when it seems like it is not being kept up with what is there presently. There is graffiti on the the ceilings of some of the ramadas which has been there for years. Many of the trails are in poor shape and could use some TLC to increase the safety for hikers. I noticed that part of Willow had some work dose in the fall and this particular trail is so much better than it has been. I have noticed a number of times while in the park where there is a big, white pickup with the county emblem on the side just driving up and down the main road. I have also seen this truck parked in the library parking lot with a large man leaning on the back smoking a cigarette.		Trails are determined via a park Trails Plan and is considered a separate process. Trails are built to adhere to MCPRD standards. Aging facilities is also considered in draft master plan update.

Respondent	Comments/Questions	Out of Scope	MCPRD Response
14	On the other hand I have witnessed the sweetest older volunteer couple cleaning bathrooms and emptying trash. I have told these two lovely folks...their name tage say Lela and Orvan, on many occasions how nice and clean the bathrooms are. Why do I always see volunteers working hard and I don't remember ever seeing a paid county employee doing any work? This seems really strange to me.	x	
14	I don't see any educational materials being offered at the gate when you enter. I've noticed that there are many out of state vistors entering the park in the winter. Do all of these folks know about the beautiful, Sonoran desert, the plants and animals that live here? It seems like everything is so money based, it's all about collecting the entrance fee. What about the little kids who come? Why is there not a kids information booklet offered to help teach??		Park is themed a nature and educational park. Child education area considered for draft master plan.
14	Why in a country where obesity is such a concern is there so much "junk" food offered at the Visitors center? I could see maybe nutritious protein bars and bottled water offered but all of those candy bars?? More emphasis should be given to good health and not the almighty dollar. I feel that the park should promote exercise, fresh air and experiencing, learning about the wonderful world of nature. How sad is it that it's so clear that the park is certainly more concerned about revenue and not about the vistors to the park.	x	

Respondent	Comments/Questions	Out of Scope	MCPRD Response
14	I think WTM has much more to work on right now than placing their energy into expanding the park for money. What about the building that is coming so close to the park. Are there any plans to buy the land to the East to prevent any more traffic noise from encroaching on the park? This is very important. As it is now, you can hear the traffic in many areas of the park. This park is a gem, if building continues it will be right in the middle of a large city...what a shame!		Buffer parcels considered in 1964 plan and any updates.
15	*{left blank by user}*	x	
16	This library is big	x	
17	Huge library	x	
18	Very nice welcome center. The competitive trail is awesome!	x	
19	Rest rooms are very clean. Of beautiful design! Excellent!	x	
20	It needs water features like a lake or something and water accents if possible		Park has water features: waterfall and pond. No other water features to be considered for master plan.
21	Anyway you can ask for the park to adjust hours in the summer to an earlier time?		
22	Wildlife habitat loss and fragmentation		Considered in draft alternative
22	Wildlife management		Considered in draft alternative
22	Special status species		Considered in draft alternative
23	Love the park but wish it opened earlier than 6 am		
24	In the future, it would be ideal to provide a trail connection between the County White Tank Regional Park to the proposed trails in Skyline Regional Park.		Considered in draft alternative. Will require agency coordination.
24	Another entrance/trailhead is also recommended in the northwestern corner of the park to provide convenient park access to residents in Festival Ranch.		North/West development considered in draft alternative. Will require agency coordination.
25	More Campsites and more trails		Considered in draft alternative
26	Open Space also seems VERY important. Please see that the park boundaries are not invaded any more than they are now. Protect the park!!		Considered in draft alternative
26	Love the hiking trails at White Tank, a great variety! - Keep up the great work!!	x	

Respondent	Comments/Questions	Out of Scope	MCPRD Response
27	It is vitally important when moving forward to consider the natural resources (flora, fauna, archaeology, etc) so as not to disrupt. It is all too common to see development in the park lean towards monetary motivations rather then preservation and conservation.		Considered for all draft alternatives.
27	As these parks grow it is also common not to see the staffing needs grow with which typically leads to run down facilities, illegal routes and and overall decline in the health of the park. Please consider building your foundation before installing the framework.		Considered for all draft alternatives.
28	The mountain biking community continues to grow in Arizona. Please keep cyclists in mind when planning additional or expanded trails. This means trails that "flow" well for bikes, drain water well, are generally not also used by equestrians (which chew up trails very badly) and connect with other trails to form a network of ridable trails. Many cyclists (including me) enjoy techinical trails for both uphill and downhill riding, but areas that are very sandy or that have lots of loose rock (i.e., washes and river beds) are virtually impossible to ride.		Trails are determined via a park Trails Plan and is considered a separate process. Trails are built to adhere to MCPRD standards.
28	A shaded pavilion area near a central trailhead to meet before a ride and rest after a ride would be very nice. Also, a water source at the pavilion for filing up water bottles and washing off bikes after a ride would be very appreciated.		Considered in draft alternative
28	Lastly, many cyclists prefer to ride in the very early morning, to avoid the heat and to avoid traffic on the trails. It would be great if the park would open at 5am to accommodate that.		
29	I would like to see the park gates open earlier (mid week and weekends).		
30	I do love the park and have been hiking there for about 5 years. It would be nice if the park was open earlier so that we could enjoy the trails out of the heat (5 am) also would be great if you could open the trails to the towers		Towers are not owned by MCPRD and no public admittance is permitted.
31	I would like to see the park open earlier in the morning. 5a would be ideal!		
31	Also, I woukd love for there to be a more extensive trail system, adding a few additional trails to explore.		Trails are determined via a park Trails Plan and is considered a separate process. Trails are built to adhere to MCPRD standards.

Respondent	Comments/Questions	Out of Scope	MCPRD Response
32	I would like to see some additional trails being opened and would like to see the park accessible earlier maybe around 5am, especially in the summer months to stay out of the heat.		Trails are determined via a park Trails Plan and is considered a separate process. Trails are built to adhere to MCPRD standards.
33	I would appreciate extended hours so we can begin our hikes earlier in the morning. Also I would love a variation in hiking trails.		Trails are determined via a park Trails Plan and is considered a separate process. Trails are built to adhere to MCPRD standards.
34	Let me start by saying I absolutely love the White Tanks and I have had numerous wonderful experience there with the park and staff. I use the park about 25-30 times a year, mostly trail running and hiking but I also have camped and had several BBQs up there this last year.	x	
34	The number one improvement I would like to see is expanded hours of operations, especially opening earlier in the morning. I would like to come up and run before work but with a 6:00 am open, it does not allow me enough time to get up there run for an hour or two and get back to clean up. I would like to open at least by 5:00 am if not earlier. The City of Phoenix parks are able to do it with Piestewa Peak. I know there are staffing issues but concerns over vandalism but I would love to see it open earlier. In the summer, I would like to be finishing hikes by 6:00 am. I lead groups in Grand Canyon R2R hikes and we use the White Tanks as our primary training grounds and just need to have more flexibility on getting up there earlier.		
34	I would also love to see an expanded trail system, especially to the different peaks.		Trails are determined via a park Trails Plan and is considered a separate process. Trails are built to adhere to MCPRD standards.

Respondent	Comments/Questions	Out of Scope	MCPRD Response
34	I have volunteered for the Boy Scouts for over 10 years and I know you could get plenty of Eagle Scout project to help expand the trails if needed. Please feel free to contact me at the phone number or email below if you have any questions about my comments. I wish I had more time to volunteer at the White Tanks but I have 4 kids at home under the age of 8 so most of my non work/non running time is dedicated to them. I bring them up to use the park 5-10 times each year and they love it. Thanks again for all you do and we love your park.		
35	First of all, fix your website so that it can be navigated. Not all "display boards" were accessible.	x	
35	Existing trails are in good shape.	x	
35	More markers with distance information are needed.		Considered in all draft alternatives
35	New trails and trail connections would be helpful.		Trails are determined via a park Trails Plan and is considered a separate process. Trails are built to adhere to MCPRD standards.
35	Create a buffer to encroachment.		Considered in all draft alternatives
35	Olive Ave. access route through developments could be improved with fewer stop signs.	x	Olive Ave is signed and maintained by MCDOT standards.

September 7, 2013

Press release issued 30-days prior to public meeting:

NEWS RELEASE

Date:
August 6, 2013

Website:
www.maricopa.gov/parks/white_tank/

Contact:
Dawna Taylor
Public Information Officer
Office: (602) 506-1114
Cell: (602) 525-5733

White Tank Mountain Regional Park to Present Proposed Park Master Plan

(Maricopa County) Six months ago, Maricopa County's Parks and Recreation Department began working on an update for White Tank Mountain Regional Parks Master Plan. "The original plan was completed in 1964. While the individuals who put the plan together did a remarkable job developing the footprint for the park, the West Valley has changed and we want to reflect that with this update," said Maricopa County District 4 Supervisor Clint Hickman.

The goal of the Park Master Plan was to develop a long-range vision for the park that takes into account park visitors needs while also protecting the resources and natural open space found within the park.

On Saturday, September 7 at 10:30 a.m., the department will host a second public meeting in the park's nature center to unveil findings and the proposed updated Park Master Plan. "I believe those who attend the public meeting will be very pleased with what they see," said R.J. Cardin, Maricopa County Parks and Recreation Department Director.

During the initial public meeting, staff and community members worked together to identify a catalog of recommended park improvements for new facilities, maintenance and rehabilitation for existing facilities, interpretive programs, resource protection and administrative actions. Each project was also assigned a priority level.

"We realize that the infrastructure in the park is outdated and are committed to tackling high priority projects identified in the proposed Park Master Plan first, when possible. For example, one project on the ***high*** priority list was upgraded RV campsites in the Group Campground. This year, we were able to allocate funds towards the renovation of the campground and are working to install electrical and water hook-ups at each site. In addition, we are in the process of drawing up plans to have a dump station added at the park. Inclusion of these services will help to enhance the visitors experience at the park." Cardin added.

Maricopa County
Parks & Recreation Dept.
234 N. Central Ave., Ste. 6400
Phoenix, AZ 85004
Phone: (602) 506-1114
FAX: (602) 506-4692

Once the public has had the opportunity to review the proposed Park Master Plan, it will be forwarded to the Maricopa County Parks and Recreation Commission for review. If approved, the plan will then be forwarded onto the Maricopa County Board of Supervisors for final review and adoption.

"I look forward to reviewing the proposed Park Master Plan and seeing what the department has planned for White Tank Mountain Regional Park. We've had discussions about additional access points and facilities on the west side of the park to accommodate future residents and park visitors. I strongly believe we can make this happen while still protecting the parks natural resources," added Hickman.

To learn more about the public meeting being held at September 7, at 10:30 a.m. in the White Tank Mountain Regional Park Nature Center or the project, visit *www.maricopa.gov/parks/white_tank/* and click on the park project tab.

30

***About the Maricopa County Parks & Recreation Department**: From hiking on a barrier-free trail, to horseback riding along a creek, Maricopa County Parks offer visitors the best of the Sonoran Desert. At approximately 120,000 acres, Maricopa County is home to one of the largest regional park system in the United States. All trails within the Maricopa County Park System are for non-motorized use only. The ten parks in the system circle the metropolitan area and all are within a 45-minute drive from downtown Phoenix. For more information on the park system, visit www.maricopa.gov/parks or phone (602) 506-2930.*

The second public meeting was held September 7, 2013 (10:30-12:30am) at the White Tank Nature Center. A 30-day comment period followed from September 7 to October 9, 2013 to gather additional comments.

- Meeting attendees: 28
- Responses received at meeting: 8
- Additional responses received during comment period: 28
- Total number of responses (all sources): 36

Of the 36 respondents, response rates by bicyclists and hikers were highest at 58% and 28% respectively. (Respondents were allowed to check more than one box for activity type; therefore the

total percentage will be greater than 100%.)[2] Two respondents (or 6%) indicated their interest to volunteer at the park.

Most comments indicated support for the park improvement projects as presented. Many comments, from bicyclists, indicated their support for additional trails for bikes, to keep the challenging nature of the trails for optimal biking riding, and to add additional trail loops. One respondent did not approve of the butterfly garden.

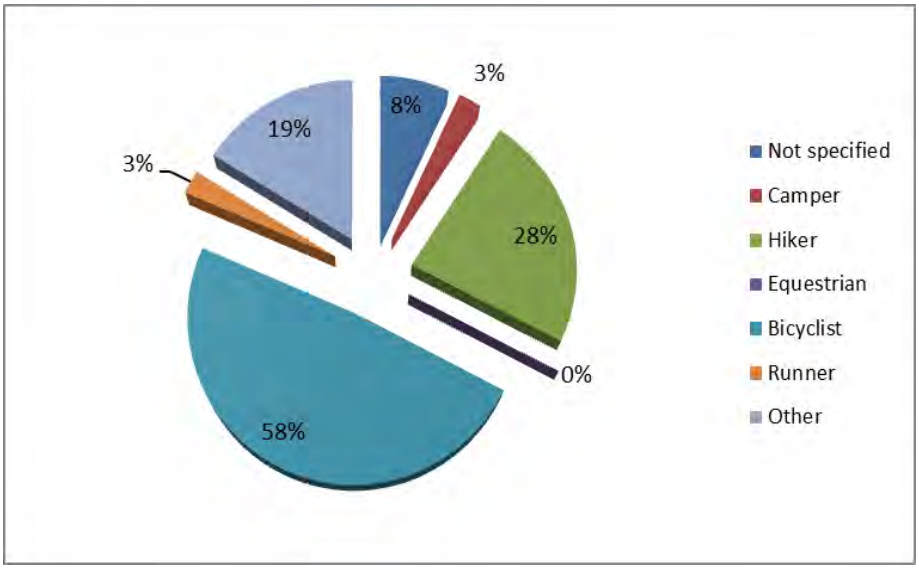


Table B-1: Response Rate by Activity Type

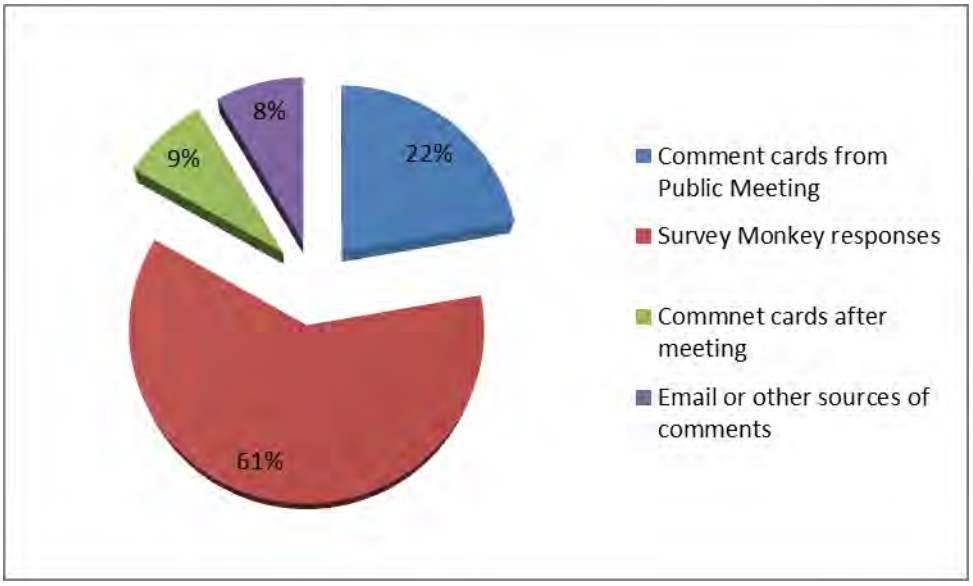


Figure B-2: Comment Source

[2] "Other" included wildlife observer, walker, climber, rock climber, picnicker, and one illegible response.

A complete comment matrix was developed to analyze each comment for substantive content and to respond to the comment, if needed. Most respondents provided more than one comment per comment card so the total number of comments exceeds the total number of respondents at approximately 62 comments (every effort was made to keep the perceived sentiment of the comment intact); and only four comments were regarded as being outside of the scope of the master plan update. The complete matrix follows:

Respondent	Comments/Questions	Out of Scope	MCPRD Response
1	Develop & Promote a Dark Sky Preserve		Recommended in final plan.
2	Upgrades to Competitive Track are good		Recommended in final plan.
2	Jr loop really not needed		Beginner track recommended in final plan to provide opportunities for youth or inexperienced competitive track users.
2	Water source is needed		Recommended in final plan.
2	Need a connector from trail to exit to trail entrance instead of going across parking lot. It would make racing events better by making a loop.		A connection from the competitive parking lot to Ironwood Trail is recommended in final plan. Competitive track entrance and exit points are separate to maintain a one-way flow of traffic.
3	I am taking this opportunity to introduce myself and to make a suggestion: I represent the "Friends" of the White Tank Library and also am a big user of the Park. It has come to my attention and needs, along with a survey of some 487 patrons that a café is desparately need here! We, the park, & Library is located many, many miles from services and requests for coffee and light drinks and sandwiches, rolls, etc is heard from both the Nature Center guests as well as those visiting the Book Store. I and my Board have been working on this for nearly two years and continue to hit a blank wall. Many individuals who do not use this area yet, may well be interested once introduced by way of a nice place to get a cup of coffee and a smile.		Recommended in final plan.
3	Would like to be a day long visitor with a place to sit & enjoy the view from the porch of the Nature Center.		Recommended in final plan.
4	No ATV's or such in this park.		Recommended in final plan.
4	Cabins good idea.		Recommended in final plan.
4	Tent area good idea.		Recommended in final plan.
4	More restroom / showers.		Recommended in final plan.
4	Signs to pick up dog poop.		New signage conforming to Sign Manual recommended in final plan.
4	How are you going to keep "free" hikers coming from Skyline Park?		Trail connections will require an intergovernmental agreement with the Town of Buckeye to establish the protocol of hikers in each park passing through the other agency's park.

4	Walkway into Library / NC is very bumpy for strollers or scooters.	x	
5	Good stuff. More trail!		Recommended in final plan.
5	Let me know how we can help.		Continued partnerships are recommended in final plan.
6	It would be nice to have a coffee shop at the nature center. I work in the bookstore and get many requests for a shop.		Recommended in final plan.
6	I think the plan to expand camping is great.		Recommended in final plan.
6	If you update the camp grounds, the Boy Scouts would use the park more.		Recommended in final plan.
7	Do not over improve - Keep it as nature built it.		Theme is on nature and education.
7	Camping can detract if too much motorized vehicles are encouraged, class "A" bus homes, etc.		Motorized camping is limited to designated areas and limited by the number of sites.
7	Additional children play areas		Recommended in final plan.
7	maintain existing - one of if not the best county parks		Maintaining existing facilities and natural/cultural resources are recommended in the final plan.
7	good general plan & involvement procedure		Thank you!
7	excellent partnership with the library. Excellent LEED facility.		Continued partnerships are recommended in final plan.
8	Town is moving on on you? Is there any chance of buying the State Land east of the park as a buffer to protect what you now have? If not purchase, could any agreement be made with them for the greater public good?		Recommended in final plan.
8	Does Buckeye support the concept of a wildlife corridor from the west side of the park to the Hassayampa River? If not, suggest it to them as a "city park opportunity". Game & Fish would likely support this concept.	x	As of Summer 2013, Arizona Game & Fish Dept. is working with the Town of Buckeye on this issue.
8	Watch for opportunities to pipe water to a wildlife drinker about 1/2 mile from every section of your water system.		Recommended in final plan.
8	Consider a permanent archery setup, as opposed to the removal & resetup labor of a portable one.		Recommended in final plan.
8	One of the neatest aspects (for me) of the campsites and picnic tables in the park is the natural space between most of them. For me it would be special if new sites can also be separated. I know that some campers like being close to each other, so when the land dictates it is fine to put some sites elbow to elbow.		Recommended in final plan.

Respondent	**MCPRD Response**		
9	The option of converting Area 1 into a big rig campground make sense. Smaller units (tents, small trailers, pop ups) can be overwhelemed by the big ones. The other option would be to use Willow for the		Recommended in final plan.

	small units.	
9	The cabin idea would be most workable for the group areas. "Dorms" for groups would eliminate the need of tents and other eqipment that can increase the cost of outings quite a bit!	Recommended in final plan.
9	Love the connecting trails that are proposed!	Recommended in final plan.
10	A big attraction to our youth is trails that climbing and repelling. Creating a natural setting for climbing & repelling versus the indoor rock climbing gyms to encourage our youth to be in tune with nature , plus increase ranger activities.	
11	I love your ideas! Can't wait to see it all implemented!	Recommended in final plan.
12	Thank You for the time & interest you gave me at the Open Forum for the Improvements of The White Tank Park, held in the Nature Center. As per our conversation, I am very hopeful and very happy to see the idea of a "Cafe" to be placed on the "improvement" list for this wonderful park. Our group of volunteers, The Friends of the White Tank Branch Library, have not only had daily requests by our many patrons of our Book Store for a Cafe, but we obtained more than 500 signatures regarding this issue over a two month period. I personally conducted a demographic study of four zip codes closest to the Park, Nature Center, Library & Book Store. The bottom line of the study was, as expected, 3.2 persons per house hold, blue collar employment, average income between $39,000 - 61,000 annually and family concentric. What this told us was that the Complex known as The White Tank Regional Park is a destination point for these families and having a "Cafe " to enjoy and help extend their stay is imperative and certainly not "rocket science" to implement. Also, during the Spring & Fall months we have many, many visitors who are retired and many who actually camp in the Park for a week or more. They are among the many who ask"way out here ,where can a person get a good cup of coffee & a sandwich?" All of us who volunteer here at the Park area, and those who work here have been asking & requesting this "Cafe" for years now. Sometimes, we were entirely mislead as to where to get our answers and others I believe we just	Recommended in final plan.

	asked the wrong questions. It was such a breath of fresh air to speak with you and to have someone honestly ready to lend a ear and a hand in making our "Cafe " request a possibility. If you need me for anything regarding this "Cafe" discussion, please feel free to contact me.		
13	{no comments}	x	n/a
14	More trails, North trailhead / entrance, and I would be a happy biker! Thanks for soliciting our feedback!		Recommended in final plan.
15	I would love to see this area improved. I rarely come out to ride due to the lack of trails suitable for mountain biking. The comp loops are great but not enough miles, would love to see them expanded. The other trails like Ford and GC are also great and would love to see more of them.		Recommended in final plan.
16	I strongly encourage the inclusion of mountain biking trail development on par with best practices exhibited by IMBA and other such org's. Some of the most recent trail building activities which have occurred in other park/preserves within the metro area leave much to be desired in terms of challenging features, offering nothing more than a dirt sidewalk for users to ride on. As the planning process continues, consultation with outside groups that specialize in planning and		Recommended in final plan.

	building sustainable trails is highly encouraged.	
17	Create additional mountain bike trail loops. Moderate trails to the top of the mountain. Sonoran mountain preserve has done a great job of having several staging areas from the west and east sides.	Recommended in final plan.
18	Like the new trail corridor ideas. Would not like the area overrun with campsites, etc. Like minimal amenities (See Spur Cross). Do not want to see any trails "dumbed down". However, the new sections should be able to be ridden with a mountain bike.	Recommended in final plan.
19	As a Surprise AZ resident and mountain biker I am happy to see the proposed connector trails. One suggestion I would like to make regarding the connector trail to Goat Camp trail is if possible to connect the trail onto the part of Goat Camp trail that is smooth singletrack. There is a distinct section of Goat Camp trail that is smooth then becomes very rocky (traveling couterclockwise). On the proposed trail map it appears as if the trail connects after it becomes very rocky, which would mean most bikers would be unable to ride that section without carrying their bike for a long distance. But regardless of w here trail is connected I am excited about the potential loop options we will have as mountain bikers, so Thank You!	Recommended in final plan.
20	I enjoy mountain bike riding the comp loops and goat camp (please do not change goat camp at all, it is PERFECT). Would enjoy more entrances to the park, preferably on the north end of the mountains. Would also enjoy more trails on the north end, and perhaps going around to the west end of the mountain range. Thanks so much for allowing us to provide feedback. Mountain bikers are respectful to other trail users and welcome horses and hikers/trail runners to share the trails with us responsibly. Thanks :)	Recommended in final plan.

21	When I mountain bike at the regional parks I'm looking for long cross-country type trails with natural features. I don't mind some smooth sections, but the appeal of mountain biking is also the challenge of conquering certain sections of trail. Sometimes it's a tricky switchback, a technical maze on a steep incline or an occasional dropoff. I love interlocking looping trail systems, it opens up endless trail combinations.	Recommended in final plan.
22	I like the plan, thanks for expanding the park, improving the trails, and welcoming mountain bikers into the park.	Recommended in final plan.
23	Never ridden out there, but would be included to if there were more trails that were mountain bike friendly.	Recommended in final plan.
24	I think a Pump Track would be a great improvement to the Park. It's a great place for kids to learn the skills needed for riding the trails around the park. They cost almost nothing to build, just need access to water for mantenance. They are also great for any level of rider.	Recommended in final plan.
25	Please preserve Goat Camp in its pristine, rocky, technical state. No sanitation. A trail connecting the radio towers to the top of Goat camp would be great as well. I am in favor of more mountain bike trails in general . Thanks.	Partially recommended in final plan.
26	More single track trail connectors, more single track elevation climbs without having to hike a majority of it.	Partially recommended in final plan.
27	I think rock climbing could have an important recreational value for the park, and it provides similar enjoyment as such activities like: hiking,cycling, and camping. To mitigate issues in the future a climbing management plan could be created. Protecting both the values of the public and internal workings of the park.	Not considered in final plan.
28	I currently really enjoy the park and the trails within it. I like that there are nice and easy family friendly trails, as well as challenging rough trails. I hope that, in the future, the park adds more trails in the same manner, allowing more for everyone. Not sure if possible, but having a trail that goes towards Sun Valley Parkway and back would be nice, running parallel to the Maricopa Trail, and perhaps another parking lot?	Recommended in final plan.
29	Please consider adding additional acreage, buying up State Trust Land. Love the West entrance idea. The Park is such a valuable asset to the community and enriches our lives.	Recommended in final plan.

30	I don't think a butterfly area is wise, or an effective use of water and resources.		Recommended in final plan.
31	Additional loops competitive track and better maintenace of existing trails on comp track.		Recommended in final plan.
32	{no comments}	x	
33	I really appreciate the mountain bike trails in the park. I would like you to consider adding more bike trails.		Recommended in final plan.
34	My husband and I are annual pass holders. We are primarily hikers. We do family hikes with our daughter for fun or to prepare for backpacking trips at Grand Canyon and Yosemite. I do hikes with my Girl Scout troop as well. It is nice to have trails that vary in length and difficulty depending on our needs. Additional connecting trails would be great. We usually use a picnic table after to enjoy a snack and maybe learn new outdoor skills.		Recommended in final plan.
34	We have also had camp outs with our Girl Scouts at the park. It is a great location because it is close to home and girls can have the "outdoor" experience while learning how to camp. We have used the Willow area because our troop is too small to use the regular youth camping area. Most Girl Scout troops are smaller that Boy Scout troops, usually 6 - 20 girls and 2- 3 adults so it is important to keep that in mind when expanding camp sites. We are too big for family sites but too small for the youth site. If Willow area is to be kept for small youth groups, it would be nice to have more restrooms in the area to better accommodate the groups. I don't think showers are needed as we usually only do weekend campouts but more toilets would be great. Maybe a few more water spigots would be nice too.		Recommended in final plan.
34	I see there are plans for more RV sites. That is fine but please have an area that is just for tent campers. It is not fun to camp in a tent when you are surrounded by RV's with their lights and tv going, kind of negates the idea of being out in nature.		Recommended in final plan.
34	We usually bring out of town guests for a hike and picnic. They love the Waterfall Trail because of the interpretive signs and petroglyphs. We usually see some wildlife as well. It gives them a nice introduction to the desert.	x	Thank you!
34	Other things we do at the park: stargazing presentations and ranger hikes	x	These programs already exist at park.

Appendix C –Photo Monitoring Program

A photo monitoring program has been established for the park to monitor scenic views, trails, and recreational resources over time. These photos will serve as the baseline conditions at each of the chosen points. Additional sites should be added as needed.

Using a digital camera and GIS will allow park staff to return to the same points each year to check for signs of change in its resources and assist managers in decision making.

The accompanying map shows the locations where photos were taken. A minimum of four photos were taken (using north, south, east, west points of view). Additional photos may also have been taken to highlight specific features at the location.


Area 7
Petroglyph Plaza
DCS00196 - 8
Best view to east
Waterfall
"Newspaper" petroglyph rock
End of barrier-free portion of trail
Waterfall Canyon
Mesquite Canyon
Ramada Way
Waterfall Canyon Rd
Willow Canyon Rd
Trailhead Staging Area
Pond
Posts
Wildlife Way
Long Loop
Short Loop
White Tank Mountain Rd
Road Overlook
Area 2
Nature Center Library Building
Olive Ave
Black Canyon
North
South
Area 1
Entrance (Olive Ave.)
Maricopa Trail
State
Private
WD
MQ
WF
BR
MU
FD
WI
BD
GC
ST
1
2
3
4
5
6
7
8
11
Scale = 1:12,000
500 0 500 1000 1500 2000 Feet
200 0 200 400 600 Meters
Contour Interval 80 Feet
N
W
E
S
White Tank Mountain Regional Park
Photo Points - October 23, 2013

Location:	Entrance (Olive Ave.)		
Coordinates:	Lat: 33 33 57.6469999999…	Long: 112 29 42.4500000000…	Altitude: 426.6
Date:	10/23/13 at 8:20am		
Comments:	Sunny, 90°, clear skies.		

Photos:

DCS00184

DCS00185

DCS00186

DCS00183

Location:	Area 1 (parking area east)		
Coordinates:	Lat: 33 33 55.39699999…	Long: 112 30 1.9789999…	Altitude: 417.5
Date:	10/23/13 at 8:30am		
Comments:	Sunny, 90°, clear skies.		

Photos:

DCS00187

DCS00188

DCS00189

DCS00190

Location:	Waterfall Trail (Petroglyph Plaza)		
Coordinates:	Lat: 33 35 11.7419999999	Long: 112 30 45.4010000	Altitude: 463.2
Date:	10/23/13 at 8:56am		
Comments:	Sunny, 90°, clear skies.		
Photos: DCS00191		DCS00192	
DCS00193		DCS00194	

DCS00195 (close up of petroglyphs)			

Location:	Waterfall Trail (Petroglyph Plaza)		
Coordinates:	Lat: 33 35 11.96899999	Long: 112 30 45.98900000	Altitude: 464.1
Date:	10/23/13 at 8:56am		
Comments:	Sunny, 90°, clear skies.		
Photos: DCS00196; DCS00197; (shown here).		DCS00198. (close up of petroglyphs)	

Location:	Waterfall Trail (at end of barrier-free portion of trail)		
Coordinates:	Lat: 33 35 8.044999999	Long: 112 30 50.47200000	Altitude: 476.4
Date:	10/23/13 at 9:04am		
Comments:	Sunny 90°, clear skies.		

Photos:

DCS00199

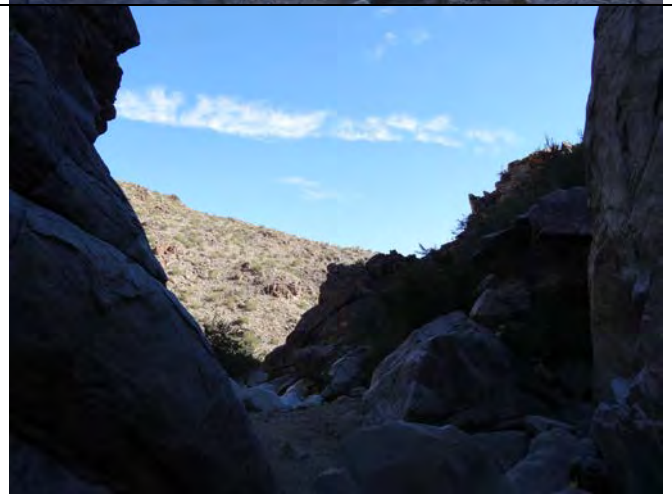
DCS00200

DCS00201

DCS00202

Location:	Waterfall Trail (“newspaper rock” petroglyph rock, near old water tank)		
Coordinates:	Lat: 33 35 6.82799999	Long: 112 31 6.87499999	Altitude: 474.1
Date:	10/23/13 at 9:15am		
Comments:	Sunny 90°, clear skies.		
Photos: DCS00203		DCS00204	
DCS00205		DCS00206	

Location:	Waterfall Trail (“best view to east”)		
Coordinates:	Lat: 33 35 5.55499999	Long: 112 31 9.2100000	Altitude: 499
Date:	10/23/13 at 9:15am		
Comments:	Sunny, 90°, clear skies. Smog on horizon.		
Photos: DCS00209		DCS00210	
DCS00207 DCS00208		DCS00211	

Location:	Waterfall Trail - Waterfall (water tank at end of trail)		
Coordinates:	Lat: 33 35 1.44599999	Long: 112 31 9.98900000	Altitude: n/a
Date:	10/23/13 at 9:24am		
Comments:	Sunny, 90°, clear skies.		
Photos: DCS00212		DCS00213	
DCS00214		DCS00215	

DCS00216 (shown); DCS00217		DCS00218; DCS00219; DCS00220 (shown); DCS00221.	

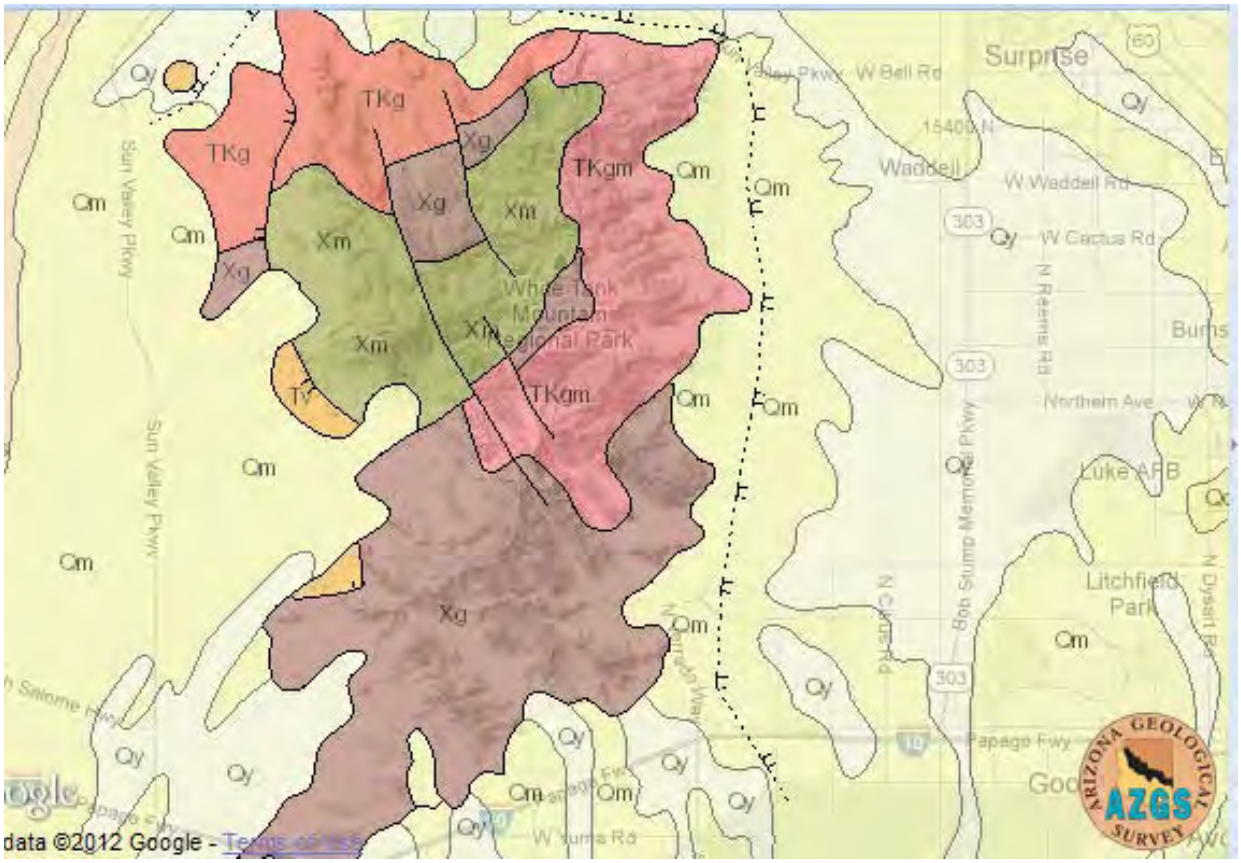
Location:	Area 7 (at back of parking lot)		
Coordinates:	Lat: 33 35 33.48600000	Long: 112 30 39.92300000	Altitude: 460.4
Date:	10/23/13 at 10:02am		
Comments:	Sunny, 90°, clear skies.		
Photos: DCS00222		DCS00223	
DCS00224		DCS00225	

Location:	Road Overlook		
Coordinates:	Lat: 33 34 39.63499999	Long: 112 30 4.54100000	Altitude: 443.6
Date:	10/23/13 at 10:11am		
Comments:	Sunny, 90°, clear skies, smog on the horizon.		
Photos: DCS00226		DCS00227	
DCS00228 (shown); DCS00230; DCS00231; DCS00232.		DCS00229	

DCS00233 (horse stable)		DCS00234 (library)	

Location:	Area 2 (Bajada Trail road crossing)		
Coordinates:	Lat: 33 34 21.50400000	Long: 112 30 13.85899999	Altitude: 446
Date:	10/23/13 at 10:20am		
Comments:	Sunny, 90°, clear skies.		
Photos: DCS00235		DCS00236	
DCS00237		DCS00238	

Location:	Nature Center / Library Building		
Coordinates:	Lat: 33 34 0.44299999	Long: 112 29 49.93099999	Altitude: 443.2
Date:	10/23/13 at 10:25am		
Comments:	Sunny, 90°, clear skies.		
Photos: DCS00239		DCS00240	
DCS00241		DCS00242	



Map 1: Arizona Geological Survey Map Services, Geologic Map of Arizona

Qr

Holocene River Alluvium (0-10 ka)

Unconsolidated to weakly consolidated sand and gravel in river channels and sand, silt, and clay on floodplains. Also includes young terrace deposits fringing floodplains.

Qy

Holocene Surficial Deposits (0-10 ka)

Unconsolidated deposits associated with modern fluvial systems. This unit consists primarily of fine-grained, well-sorted sediment on alluvial plains, but also includes gravelly channel, terrace, and alluvial fan deposits on middle and upper piedmonts.

Qm

Late And Middle Pleistocene Surficial Deposits (10-750 ka)

Unconsolidated to weakly consolidated alluvial fan, terrace, and basin-floor deposits with moderate to strong soil development. Fan and terrace deposits are primarily poorly sorted, moderately bedded gravel and sand, and basin-floor deposits are primarily sand, silt, and clay.

Qo

Early Pleistocene to Latest Pliocene Surficial Deposits (0.75-3 Ma)
Coarse relict alluvial fan deposits that form rounded ridges or flat, isolated surfaces that are moderately to deeply incised by streams. These deposits are generally topographically high and have undergone substantial erosion. Deposits are moderately to strongly consolidated, and commonly contain coarser grained sediment than younger deposits in the same area.

Tv

Middle Miocene to Oligocene Volcanic Rocks (11-38 Ma)
Lava, tuff, fine-grained intrusive rock, and diverse pyroclastic rocks. These compositionally variable volcanic rocks include basalt, andesite, dacite, and rhyolite. Thick felsic volcanic sequences form prominent cliffs and range fronts in the Black (Mohave County), Superstition, Kofa, Eagletail, Galiuro, and Chiricahua Mountains. This unit includes regionally extensive ash-flow tuffs, such as the Peach Springs tuff of northwestern Arizona and the Apache Leap tuff east of Phoenix. Most volcanic rocks are 20-30 Ma in southeastern Arizona and 15 to 25 Ma in central and western Arizona, but this unit includes some late Eocene rocks near the New Mexico border in east-central Arizona.

TKgm

Early Tertiary to Late Cretaceous Muscovite-Bearing Granitic Rocks (50-80 Ma)
Light-colored peraluminous muscovite granite with or without garnet; commonly forms sills and is associated with abundant pegmatite dikes and sills. This unit includes granites in the Harcuvar and Harquahala Mountains of western Arizona and in the Santa Catalina, Rincon, Tortolita, Picacho, and Coyote Mountains of south-central Arizona. These granites typically represent the youngest phase of voluminous magmatism during the Laramide orogeny in Arizona. This unit also includes several muscovite-bearing granites in southern Arizona that are associated with calc-alkaline granites of unit TKg, and a batho-lith in the Cabeza Prieta area of southwestern Arizona.

TKg

Early Tertiary to Late Cretaceous Granitic Rocks (50-82 Ma).
Porphyritic to equigranular granite to diorite emplaced during the Laramide orogeny. Larger plutons are characteristically medium-grained, biotite +/- hornblende granodiorite to granite. Smaller, shallow-level intrusions are typically porphyritic. Most of the large copper deposits in Arizona are associated with porphyritic granitic rocks of this unit, and are thus named 'porphyry copper deposits'.

Xg

Early Proterozoic Granitic Rocks (1600-1800 Ma)
Wide variety of granitic rocks, including granite, granodiorite, tonalite, quartz diorite, diorite, and gabbro. These rocks commonly are characterized by steep, northeast-striking foliation.

Xm

Early Proterozoic Metamorphic Rocks (1600-1800 Ma)
Undivided metasedimentary, metavolcanic, and gneissic rocks.

Contacts

Contacts between Late Tertiary and Quaternary sedimentary units are shown with grey lines while contacts between other units are shown in black

Faults

Quaternary faults

Fault, high-angle or dip unknown

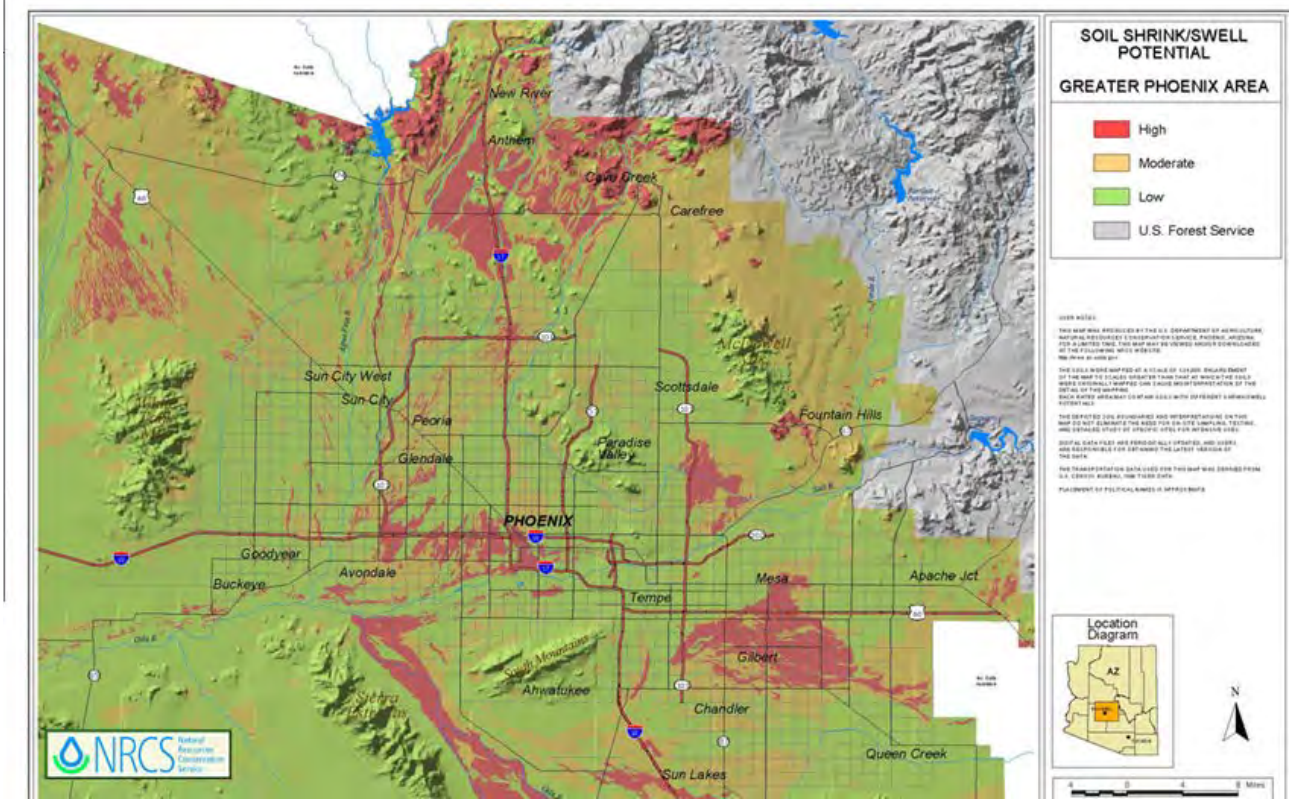
Low-angle fault; tics on hanging-wall side

Detachment fault; double tics on hanging-wall side

Thrust fault; teeth on hanging-wall side

Sources:
First: http://www.azgs.az.gov/services_azgeomap.shtml
Then click on: http://services.usgin.org/azgs/geologic-map-arizona.html

Shrink/Swell Potential Map: Phoenix Area



Map Source: http://www.az.nrcs.usda.gov/technical/soils/phoenixmap.html

OTHER

Rhyolites - light-colored volcanic rocks, relatively rich in silica, aluminum, potassium and sodium.

Basalt - dark-colored volcanic rock, rich in iron, magnesium and calcium.

AZ645 Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, AZ

Special Status Species for Maricopa County, Taxon, Scientific Name
Arizona Game and Fish Department, Heritage Data Management System
Updated: October 01, 2012

TAXON	SCIENTIFIC NAME	COMMON NAME	ELCODE	ESA	BLM	USFS	NESL	MEXFED	STATE	GRANK	S RANK
AMPHIBIAN	Anaxyrus microscaphus	Arizona Toad	AAABB01110	SC		S				G3G4	S3S4
AMPHIBIAN	Anaxyrus retiformis	Sonoran Green Toad	AAABB01140		S			PR		G3G4	S3
AMPHIBIAN	Gastrophryne olivacea	Western Narrow-mouthed Toad	AAABE01020		S	S		PR	WSC	G5	S3
AMPHIBIAN	Rana yavapaiensis	Lowland Leopard Frog	AAABH01250	SC	S	S		PR	WSC	G4	S3
AMPHIBIAN	Smilisca fodiens	Lowland Burrowing Treefrog	AAABC06010		S				WSC	G4	S2
BIRD	Aquila chrysaetos	Golden Eagle	ABNKC22010		S		3	P		G5	S4
BIRD	Ardea alba	Great Egret	ABNGA04040						WSC	G5	S1B,S4N
BIRD	Athene cunicularia hypugaea	Western Burrowing Owl	ABNSB10012	SC	S	S	4	A		G4T4	S3
BIRD	Buteo albonotatus	Zone-tailed Hawk	ABNKC19090			S				G4	S4
BIRD	Buteogallus anthracinus	Common Black-Hawk	ABNKC15010			S		A	WSC	G4G5	S3
BIRD	Charadrius alexandrinus nivosus	Western Snowy Plover	ABNNB03031	No Status					WSC	G4T3	S1
BIRD	Coccyzus americanus	Yellow-billed Cuckoo (Western U.S. DPS)	ABNRB02020	PS:C		S	2		WSC	G5	S3
BIRD	Dendrocygna autumnalis	Black-bellied Whistling-Duck	ABNJB01040						WSC	G5	S3
BIRD	Egretta thula	Snowy Egret	ABNGA06030						WSC	G5	S1B,S4N
BIRD	Empidonax traillii extimus	Southwestern Willow Flycatcher	ABPAE33043	LE			2		WSC	G5T1T2	S1
BIRD	Falco peregrinus anatum	American Peregrine Falcon	ABNKD06071	SC	S	S	4	A	WSC	G4T4	S4
BIRD	Glaucidium brasilianum cactorum	Cactus Ferruginous Pygmy-owl	ABNSB08041	SC	S	S		A	WSC	G5T3	S1
BIRD	Haliaeetus leucocephalus (wintering pop.)	Bald Eagle - Winter Population	ABNKC10015	SC	S	S	2	P	WSC	G5TNR	S4N
BIRD	Haliaeetus leucocephalus pop. 3	Bald Eagle - Sonoran Desert Population	ABNKC10014	SC	S	S	2	P	WSC	G5TNR	S2S3
BIRD	Ictinia mississippiensis	Mississippi Kite	ABNKC09010					A	WSC	G5	S3
BIRD	Ixobrychus exilis	Least Bittern	ABNGA02010					A	WSC	G5	S3
BIRD	Megaceryle alcyon	Belted Kingfisher	ABNXD01020				4		WSC	G5	S2B,S5N
BIRD	Pandion haliaetus	Osprey	ABNKC01010						WSC	G5	S2B,S4N
BIRD	Rallus longirostris yumanensis	Yuma Clapper Rail	ABNME0501A	LE				P	WSC	G5T3	S3
BIRD	Strix occidentalis lucida	Mexican Spotted Owl	ABNSB12012	LT			3	A	WSC	G3T3	S3S4
FISH	Agosia chrysogaster chrysogaster	Gila Longfin Dace	AFCJB37151	SC	S	S		A		G4T3T4	S3S4
FISH	Catostomus clarkii	Desert Sucker	AFCJC02040	SC	S	S				G3G4	S3S4
FISH	Catostomus insignis	Sonora Sucker	AFCJC02100	SC	S	S		P		G3	S3
FISH	Cyprinodon macularius	Desert Pupfish	AFCNB02060	LE				P	WSC	G1	S1
FISH	Gila elegans	Bonytail	AFCJB13100	LE			1	P	WSC	G1	S1
FISH	Gila robusta	Roundtail Chub	AFCJB13150	C		S	2	PR	WSC	G3	S2

FISH	Poeciliopsis occidentalis occidentalis	Gila Topminnow	AFCNC05021	LE				A	WSC	G3	S1S2
FISH	Ptychocheilus lucius	Colorado Pikeminnow	AFCJB35020	LE,XN			2	P	WSC	G1	S1
FISH	Rhinichthys osculus	Speckled Dace	AFCJB37050	SC	S			P		G5	S3S4
FISH	Xyrauchen texanus	Razorback Sucker	AFCJC11010	LE			2	P	WSC	G1	S1
INVERTEBRATE	Cicindela oregona maricopa	Maricopa Tiger Beetle	IICOL02362	SC						G5T3	S3
INVERTEBRATE	Maricopella allynsmithi	Squaw Park Talussnail	IMGASC9010	SC						G1	S1
MAMMAL	Antilocapra americana sonoriensis	Sonoran Pronghorn	AMALD01012	LE				P	WSC	G5T1	S1
MAMMAL	Corynorhinus townsendii pallescens	Pale Townsend's Big-eared Bat	AMACC08014	SC	S	S	4			G4T4	S3S4
MAMMAL	Eumops perotis californicus	Greater Western Bonneted Bat	AMACD02011	SC	S	S				G5T4	S3
MAMMAL	Lasiurus blossevillii	Western Red Bat	AMACC05060			S			WSC	G5	S3
MAMMAL	Lasiurus xanthinus	Western Yellow Bat	AMACC05070			S			WSC	G5	S2S3
MAMMAL	Leptonycteris curasoae yerbabuenae	Lesser Long-nosed Bat	AMACB03030	LE				|	WSC	G4	S2S3
MAMMAL	Macrotus californicus	California Leaf-nosed Bat	AMACB01010	SC	S	S			WSC	G4	S3
MAMMAL	Myotis velifer	Cave Myotis	AMACC01050	SC	S					G5	S3S4
MAMMAL	Myotis yumanensis	Yuma Myotis	AMACC01020	SC						G5	S3S4
MAMMAL	Nyctinomops femorosaccus	Pocketed Free-tailed Bat	AMACD04010			S				G4	S3
PLANT	Abutilon parishii	Pima Indian Mallow	PDMAL020E0	SC	S	S			SR	G2	S3
PLANT	Agave delamateri	Tonto Basin Agave	PMAGA010W0	SC		S			HS	G2	S2
PLANT	Agave murpheyi	Hohokam Agave	PMAGA010F0	SC	S	S			HS	G2	S3
PLANT	Agave toumeyana var. bella	Toumey Agave	PMAGA010R1						SR	G3T3	S3
PLANT	Agave x arizonica	Arizona agave	PMAGA01030	No status					HS	G1Q	SHYB
PLANT	Allium bigelovii	Bigelow Onion	PMLIL02070						SR	G3	S2S3
PLANT	Berberis harrisoniana	Kofa Mt Barberry	PDBER02030		S					G1G2	S1
PLANT	Echinomastus erectocentrus var. acunensis	Acuna Cactus	PDCAC0J0E1	C				P	HS	G3T1T2Q	S1
PLANT	Erigeron piscaticus	Fish Creek Fleabane	PDAST3M4X0	SC	S	S			SR	G1	S1
PLANT	Eriogonum ripleyi	Ripley Wild-buckwheat	PDPGN08520	SC		S			SR	G2	S2
PLANT	Ferocactus cylindraceus	Desert Barrel Cactus	PDCAC08080					PR	SR	G5	S4
PLANT	Ferocactus emoryi	Emory's Barrel-cactus	PDCAC08090						SR	G4	S1S2
PLANT	Fremontodendron californicum	Flannel Bush	PDSTE03010		S				SR	G4	S2S3
PLANT	Heuchera eastwoodiae	Eastwood Alum Root	PDSAX0E0B0			S				G3	S3
PLANT	Lotus alamosanus	Alamos Deer Vetch	PDFAB2A020			S				G3G4	S1
PLANT	Lotus mearnsii var. equisolensis	Horseshoe Deer Vetch	PDFAB2A0Q1			S				G3T1	S1
PLANT	Lupinus huachucanus	Huachuca Mountain Lupine	PDFAB2B210			S				G2	S2
PLANT	Lupinus lemmonii	Lemmon's Lupine	PDFAB2B2A0			S				G1Q	S1Q
PLANT	Mabrya acerifolia	Mapleleaf False Snapdragon	PDSCR2L010			S				G2	S2
PLANT	Mammillaria viridiflora	Varied Fishhook Cactus	PDCAC0A0D0						SR	G4	S4
PLANT	Opuntia echinocarpa	Straw-top Cholla	PDCAC0D2W0						SR	G5	S5
PLANT	Opuntia engelmannii var. flavispina		PDCAC0D224						SR	G5T3?	S3?
PLANT	Perityle saxicola	Fish Creek Rock Daisy	PDAST700P0	SC		S				G1	S1
PLANT	Purshia subintegra	Arizona Cliff Rose	PDROS1E080	LE					HS	GNA	S1

PLANT	Stenocereus thurberi	Organ Pipe Cactus	PDCAC10020						SR	G5	S4
PLANT	Tumamoca macdougalii	Tumamoc Globeberry	PDCUC0S010		S	S			SR	G4	S3
PLANT	Vauquelinia californica ssp. sonorensis	Arizona Sonoran Rosewood	PDROS1R024		S					G4T2	S1S2
REPTILE	Aspidoscelis xanthonota	Redback Whiptail	ARACJ02012	SC						G4T2	S2
REPTILE	Chionactis occipitalis klauberi	Tucson Shovel-nosed Snake	ARADB05012	C						G5T3Q	S1
REPTILE	Gopherus agassizii (Sonoran Population)	Sonoran Desert Tortoise	ARAAF01013	C		S		A	WSC	G4T4	S4
REPTILE	Heloderma suspectum cinctum	Banded Gila Monster	ARACE01011	SC				A		G4T4	S4
REPTILE	Heloderma suspectum suspectum	Reticulate Gila Monster	ARACE01012			S		A		G4T4	S4
REPTILE	Lichanura trivirgata gracia	Desert Rosy Boa	ARADA01021	SC						G4G5T3	S3S4
REPTILE	Lichanura trivirgata trivirgata	Mexican Rosy Boa	ARADA01023	SC						G4G5T3	S1S2
REPTILE	Phyllorhynchus browni	Saddled Leaf-nosed Snake	ARADB25010			PS		PR		G5	S5
REPTILE	Plestiodon "gilberti" arizonensis	Arizona Skink	ARACH01061	SC				PR	WSC	G5T1Q	S1
REPTILE	Sauromalus ater (Arizona Population)	Arizona Chuckwalla	ARACF13013	SC				A		G5T4Q	S4
REPTILE	Sauromalus ater (Western Population)	Western Chuckwalla	ARACF13012	SC			4	A		G5T4Q	S4
REPTILE	Thamnophis eques megalops	Northern Mexican Gartersnake	ARADB36061	C		S		A	WSC	G5T5	S1

Appendix G: Noxious Weeds

The most commonly found weeds in the park are:

Weed	Description
PECI *Pennisetum ciliare* (L.) Link Buffelgrass More information: http://plants.usda.gov/java/profile?symbol=PECI#	 Photo source: Larry Allain @ USDA-NRCS PLANTS Database Annual (summer, fall). Drought tolerant, low water usage.
BRRU2 *Bromus rubens* L. red brome More information: http://plants.usda.gov/java/profile?symbol=Brru2	 Photo source: Patrick J. Alexander @ USDA-NRCS PLANTS Database Annual (fall, winter, spring). Drought tolerant, low water usage.

Appendix H – Asset Inventory

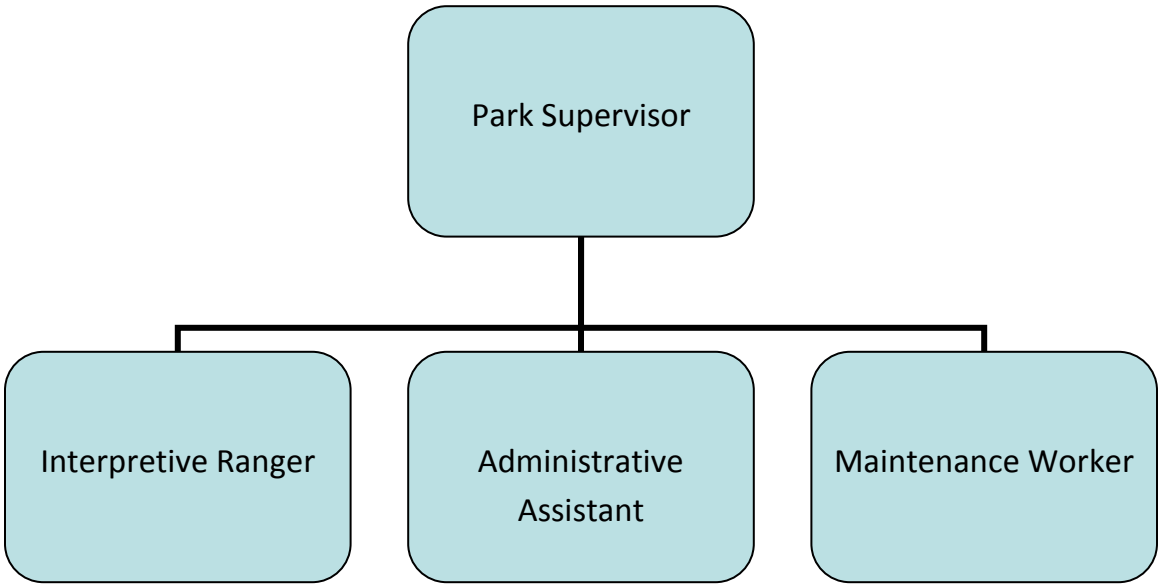
{Insert asset information after this page.}

F/A #	Location	Location Name	Address	Acquisition Date	Lifespan	Location Ownership	Value	Maintenance	Security	Loc. Factored Rate	Loc. Gross Ext. SF	Loc. Factored SF	Plannable SF	Type
B0000208	5700	WHITE TANK MNTN. - 5 BLDGS RAMADA CLASS C		1970	*Decommissioned*		$ 10,000.00							
B0000209	5700	WHITE TANK MNTN. - 4 BLDGS RAMADA MASONARY		1973	*Decommissioned*		$ 15,840.00							
I9600020A	5701	WHITE TANK MNTN. - HDQRTRS. & MAINT.	13025 N WHITE TANK MTN RD- WADDELL, MARICOPA COUNTY	1991		OWNED	$ 157,000.00	OTHER COUNTY	No	1	1,800.00	1,800.00	1,800.00	metal
B0000210	5702	WHITE TANK MNTN. - visitor center		1973	*Decommissioned*		$ 10,500.00				700.00	700.00	700.00	prefab
B0800008	5703	WHITE TANK MNTN. - CONTACT STATION	9050 N WHITE TANK MTN RD- WADDELL, MARICOPA COUNTY	2008		OWNED	$ 197,618.66	OTHER COUNTY	No	1	174.00	174.00	174.00	masonry
B0000207	5704	WHITE TANK MTN PICNIC AREA 1 RESTROOM	13025 N WHITE TANK MTN RD- WADDELL, MARICOPA COUNTY	1973		OWNED	$ 11,169.00	OTHER COUNTY	No	1	220.00	220.00	220.00	masonry
B0000207A	5705	WHITE TANK MTN PICNIC AREA 2 RESTROOM	13025 N WHITE TANK MTN RD- WADDELL, MARICOPA COUNTY	1973		OWNED	$ 11,170.00	OTHER COUNTY	No	1	220.00	220.00	220.00	masonry
B0000207B	5706	WHITE TANK MTN-GROUP RAMADA AREA 3 RESTROOM	13025 N WHITE TANK MTN RD- WADDELL, MARICOPA COUNTY	1973		OWNED	$ 11,170.00	OTHER COUNTY	No	1	220.00	220.00	220.00	masonry
B0700027	5707	WHITE TANK MTN-GROUP RAMADA AREA 4 RESTROOM	10631 NORTH WHITE TANK MOUNTAIN ROAD	8/30/2006	50	OWNED	$ 214,743.93	OTHER COUNTY	No	1	590.00	590.00	590.00	masonry
B0000207C	5708	WHITE TANK MTN - AREA 5 RESTROOM	13025 N WHITE TANK MTN RD- WADDELL, MARICOPA COUNTY	1973		OWNED	$ 11,170.00	OTHER COUNTY	No	1	220.00	220.00	220.00	masonry
B0700029	5709	WH TANK MT-AREA 6 RSTRM @ WATERFALL TRAILHEAD	20807 WEST WATERFALL CANYON ROAD	8/30/2006	50	OWNED	$ 209,834.42	OTHER COUNTY	No	1	590.00	590.00	590.00	masonry
B0800009	5710	WH TANK MT-AREA 7 RSTRM @ MESQUITE CANYON TR	20932 W RAMADA WAY, WADDELL, MARICOPA COUNTY	2007		OWNED	$ 246,699.97	OTHER COUNTY	No	1	590.00	590.00	590.00	masonry
B0000207D	5711	WHITE TANK MTN - AREA 8 RESTROOM	13025 N WHITE TANK MTN RD- WADDELL, MARICOPA COUNTY	1973		OWNED	$ 11,170.00	OTHER COUNTY	No	1	220.00	220.00	220.00	masonry
B0000207G	5712	WHITE TANK MTN - AREA 11 RESTROOM	13025 N WHITE TANK MTN RD- WADDELL, MARICOPA COUNTY	1973		OWNED	$ 11,170.00	OTHER COUNTY	No	1	220.00	220.00	220.00	masonry
I9600020B	5713	WH TANK MT-YOUTH CAMP AREA 12 RSTRM	13025 N WHITE TANK MTN RD- WADDELL, MARICOPA COUNTY	1991		OWNED	$ 75,000.00	OTHER COUNTY	No	1	510.00	510.00	510.00	masonry
I9600020C	5714	WH TANK MT-FAMILY CAMP AREA 13 RSTRM & SHOWERS	13025 N WHITE TANK MTN RD- WADDELL, MARICOPA COUNTY	1991		OWNED	$ 75,000.00	OTHER COUNTY	No	1	540.00	540.00	540.00	masonry
B0000207H	5715	WH TANK MT-FAMILY CAMP AREA 13 RSTRM ONLY	13025 N WHITE TANK MTN RD- WADDELL, MARICOPA COUNTY	1973		OWNED	$ 11,170.00	OTHER COUNTY	No	1	220.00	220.00	220.00	masonry
B0000207E	5716	WH TANK MT-GROUP CAMP AREA 14 RSTRM & SHOWERS	13025 N WHITE TANK MTN RD- WADDELL, MARICOPA COUNTY	1973		OWNED	$ 11,170.00	OTHER COUNTY	No	1	220.00	220.00	220.00	masonry
B0000307F	5717	WHITE TANK MTN - AREA 10 RESTROOM	13025 N WHITE TANK MTN RD- WADDELL, MARICOPA COUNTY	1973		OWNED	$ 11,170.00	OTHER COUNTY	No	1	220.00	220.00	220.00	masonry
n/a	5718	MARICOPA TRAIL SEG 10	13025 N WHITE TANK MOUNTAIN RD	n/a	n/a	OWNED	n/a	OTHER COUNTY	No	1	0.00	0.00	0.00	n/a

DEPT 300 LIST FOR ANNUAL VALIDATION OF CAPITAL ASSETS - AS OF MARCH 31, 2012

Type	FA Number	Btrmt Count	Asset Value	Description	Acquis Date	Loc	Loc Name	Serial Num	Model Number	Manufac Name	Fund	Agcy	Orgn	Inventoried by	Inven Date	Adjustment or Disposition
				502-71-000	12/01/66	5700	WHITE TANK MTN RP							The "other" pacel mentioned above		
L	L0006165	0	1,196	502-71-000,T3N R2W SEC	12/01/66	5700	WHITE TANK MTN RP				100	300	3010	Consists of 2 parcels with different patent numbers from BLM. Not on Assessor site.		
L	L0006166	0	413	502-71-000A, T3N R2W	12/01/66	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006167	0	800	502-71-001,SEC 13 T3N R3W	12/01/68	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006168	0	802	502-71-002,SEC 18 T3N R2W	12/01/68	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006169	0	1,012	502-71-003,LOTS 1,5,6SEC18T3NR	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006170	0	412,830	502-71-004,LTS4,8SEC19T3N R2W	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006171	0	1,000	502-71-005	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006172	0	1,000	502-71-006,S1/2NESEC24T3NR3W	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006173	0	1,511	502-73-001,LOTS1,2,3SEC30T3NR2	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006174	0	1,204	502-73-002LOTS1,2,3SEC31T3NR2W	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006175	0	1,643	502-74-001LOTS1,2,3SEC1T3NR3W	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006176	0	1,337	502-74-002LOTS1,2,3SEC2T3NR3W	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006177	0	1,600	502-74-003 ALL SEC 12 T3N R3W	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006178	0	1,600	502-74-004 ALL SEC25 T3N R3W	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006179	0	320,000	502-74-005 S1/2SEC36 T3N R3W	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006180	0	338,910	502-74-006TRACT37SEC3-5,T3NR3W	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006182	0	200	502-74-007S1/2SE1/4SEC2T3NR3W	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006181	0	62,459	502-74-008SE1/4SEC2T3NR3W	02/01/76	5700	WHITE TANK MTN RP				100	300	3010			
L	L0300074	0	3,840	502-74-009, AZ 6354	02/27/76	5700	WHITE TANK MTN RP				100	300	3039			
L	L0006183	0	1,412	502-75-001	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006184	0	1,610	502-75-002	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
				502-75-TBD USA 02-67-0030	12/23/66	5700	WHITE TANK MTN RP							NE corner of park. Not on Assessor's site.		
L	L0006187	0	1,600	503-82-005	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006186	0	1,600	503-82-014	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
L	L0006188	0	1,600	503-96-001 ALL SEC 36 T4N R3W	10/01/72	5700	WHITE TANK MTN RP				100	300	3010			
L	L0300076	0	5,758	504-72-020, 02-2002-0003	03/28/02	5700	WHITE TANK MTN RP				100	300	3039			
L	L0300078	0	960	504-72-021, 02-2002-0003	03/28/02	5700	WHITE TANK MTN RP				100	300	3039			
L	L0300079	0	7,678	504-72-022, 02-2002-0003	03/28/02	5700	WHITE TANK MTN RP				100	300	3039			
L	L0300081	0	7,678	504-72-023, 02-2002-0003	03/28/02	5700	WHITE TANK MTN RP				100	300	3039			
L	L0300080	0	240	504-72-024, 02-2002-0003	03/28/02	5700	WHITE TANK MTN RP				100	300	3039			
L	L0300077	0	240	504-72-025, 02-2002-0003	03/28/02	5700	WHITE TANK MTN RP				100	300	3039			
L	L0300082	0	4,799	504-72-026, 02-2002-0003	03/28/02	5700	WHITE TANK MTN RP				100	300	3039			
L	L0300084	0	4,319	504-72-027,02-2002-0003	03/28/02	5700	WHITE TANK MTN RP				100	300	3039			
L	L0300083	0	2,879	504-72-028, 02-2002-0003	03/28/02	5700	WHITE TANK MTN RP				100	300	3039			

Appendix I - Organization Chart



Camp Hosts are volunteer positions and report to Park Supervisor (there may be up to two host sites per campground). The Park Supervisor reports to the Regional Superintendent (Westside Parks).

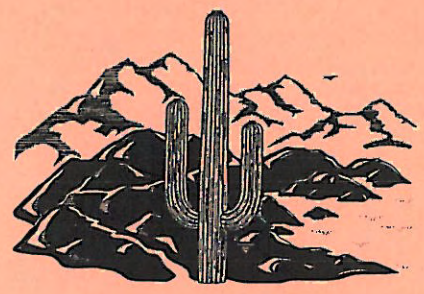
Appendix J – Trail System Plan

{Insert Trail System Plan after this page.}

Trail System Plan

White Tank Mountains Regional Park

December 2002



Maricopa County
Parks and Recreation Department

WHITE TANK MOUNTAINS REGIONAL PARK

TRAIL SYSTEM PLAN

Recommended: _____ / NOV. 21, 2002
Bob Skaggs, Trails Planner — Date

Recommended: _____ / Dec 26, 02
Ken Taylor, Park Supervisor — Date

Recommended: _____ / Dec 10, 2002
Bill Lanford, Chair — Date
Maricopa County Parks & Recreation Commission

Recommended: _____ / 12/10/02
Bill VanAusdal, Deputy Director — Date

Approved: _____ / Dec 10, 2002
William C. Scalzo, Director — Date

PARKS AND RECREATION DEPARTMENT
MARICOPA COUNTY, ARIZONA

Table of Contents

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Introduction

Purpose of the plan

The purpose of the White Tank Mountains Regional Park ("WTMRP") Trail System Plan is to determine the desired future condition of the trail system, including trail access points and service road access, and prescribe actions to achieve the planned condition. It covers trails and access points within the park boundaries; Maricopa County Parks and Recreation Department ("PRD") has no holdings (right-of-way, easement, permit, or other) adjacent to or in proximity to the park for purposes of trail-related recreation.

This Trail System Plan ("Plan") is tiered to the 1964 WTMRP Master Development Plan. The text within the 1964 Master Plan section D–Hiking and Riding Trails (page 34-35) and that portion of the map that includes trails are superceded by this Plan. If a new Master Plan is created or the current Master Plan is amended, it will include text which delegates trail planning to this Plan.

Management of trails and access within the park is guided by this Plan by developing specific management actions for the WTMRP trail system. It is consistent with federal, state and county laws and PRD rules and policies.

This Plan was developed with the involvement of the public and is of particular value to the Park Supervisor and the Trails Planner. It provides the needed framework for the management of WTMRP's trail system and the planning of specific trail work projects. Also, this Plan will be used to educate PRD personnel about the overall management of the WTMRP trail system.

The planning process

The planning team

The draft Plan was produced by a trail planning team consisting of: Ken Taylor, WTMRP Supervisor; Mark Lansing, Interpretive Ranger; Bob Skaggs, Trails Planner; and Andrew Fish, Trails Technician. This team compiled and analyzed all pertinent information including public comments, recommendations of government agencies, natural and cultural resource protection issues, specifications and guidelines for PRD trails, PRD policies, and the WTMRP Master Plan.

The scoping phase

People interested in participating in the trail planning process were sought through news releases sent to area newspapers and announcement flyers placed within WTMRP at the trailhead kiosks. In addition, announcement letters were sent to several individuals, organizations, and government agencies potentially interested in participating in the plan development process.

In response to these announcements, PRD received 16 notices of interest from those who wanted to participate in the planning process. These participants were sent a letter of information that described the planning process and requested comments and ideas concerning the current and future trail system of WTMRP. To facilitate this initial comment phase, some trail concerns were listed and a park map was included for visual reference.

During the scoping phase, PRD received comments from two individuals and organizations. The planning team reviewed every pertinent comment submitted and then developed the draft Plan.

The draft review phase

The draft Plan was mailed to citizens and organizations who were on the mailing list or otherwise requested a copy. Eight responses were received. The planning team reviewed these responses and developed the final draft Plan.

The approval phase

The final draft Plan was recommended for approval by the planning team and then presented to the Parks and Recreation Commission and the Deputy Director for review. Upon their recommendation, the Director approved the Plan. All recommendations and approval are indicated by signature on the title page.

Amendment process

As per policy in the PRD Trails Manual, additions and deletions of entire trails within the Plan (and subsequent construction or obliteration work in the field) requires an amendment to the Plan. The amendment process consists of the planning team gathering and analyzing data concerning a proposed action. The proposal is sent to participants on the Plan mailing list. The planning team compiles public comments and sends the information to the Director for approval or disapproval.

Comments

Scoping comments

Comments were received from two individuals and organizations interested in the management of trails. A summary of the comments is listed below.

Trails

- Construct a trail to the mountain summit.
- Marking on trails are important.

Competitive Track

- Expand the current single loop with creation of a second loop (immediately south of current track and west into Ford Canyon area).
- Change the old roads into singletrack.
- Create a junior loop east of the parking lot .

Draft Plan review comments

After public review of the Plan, eight letters and phone and personal conversations were received by the planning team.

Trail Use

- Two foot width for Secondary trails may not be practical for multiple uses. Make the trails wider or eliminate bikes because of speed and danger factor.
- Goat Camp Trail is too precipitous for horse travel.
- Horse travel tends to endanger flora and fauna.
- Prohibit horse and bicycle use on backcountry sections of 1-1 (Ford Canyon) and 1-2 (Willow Canyon) trails.
- Recommending against travel by horses and bicycles on certain trails is not enough to avoid heavy damage to the trails.

Summit Trail

- Plan for a trail up to the summit.
- Plan for a North-South summit trail across the entire range.
- Would like a North-South trail over the entire mountain range, but this would be well into the future. Later amendment of the Plan is acceptable.
- Establish a small trail on one of the mountain overlooks in front of the visitor center or at Waddell Trailhead [Area 7].
- BLM manages the communication sites on the mountain summits. As landowner, County has right to construct trails up to the summit. However, some communication site operators have pre-existing rights. Operators Association may choose to construct fence around sites to keep general public out of area for purposes of safety and facility protection.

Horse Stables

- For horse stables operations, any trail location is fine so long as one and two-hour loops are available.
- Do not plan for any access to the park or trails for the private horse stables.

Competitive Track

- Separation of track and service roads is supported. Wide jeep trails were not designed for mountain biking and are unattractive.
- Make the starting section (approximately 100 yards) very wide for racing competitions.
- Consider creating a loop in Ford Canyon, although another area may be more appropriate.

Other Comments

- Place more emphasis on signs discouraging short-cuts and off-trail abuse.
- Add more visitor education regarding low impact travel. Provide protection for natural and archaeological resources.
- Do not construct additional service roads.

Planning Criteria

Determining if there should be a trail and where it should go is an involved process. Laws and regulations, department policies and standards, environmental protection, visitor desires and experiences, safety, engineering, and costs all must be considered to produce a functional, high-quality trail. Below are some of the policies that control trail development and management. Also included are some guidelines that assist in making decisions.

Policies

Type of use

PRD policy encourages designating trails for multiple-use whenever possible. This means pedestrians, equestrians, and cyclists should be allowed to use all of the designated trails in WTMRP. Where essential, for visitor safety or special use conditions, use may be restricted (e.g., interpretive or barrier-free trails).

PRD is committed to development of barrier-free trails to accommodate trail-related-recreation by persons with disabilities. Barrier-free trails should be constructed and maintained where appropriate as funding allows.

Standards and objectives

Standards and management objectives for classifications of trails and tracks are directed by the PRD Trails Manual. Classifications are listed as primary, secondary, interpretive, and barrier-free trails, and competitive track. A summary of standards and objectives for each classification is found on page 6.

Definitions

Classification: A category of management objectives and standards directing the design, construction, and maintenance of designated trails aimed at providing an appropriate visitor experience.

Maximum sustained grade: Maximum inclination allowed for the tread. Grade is a function of rise over run expressed as percent (i.e., rise/run = %).

Trail: A recreational facility designed, constructed, and maintained to serve non-motorized modes of transportation. Motor travel is permitted for suitable wheelchairs and administrative and emergency vehicles.

Tread: Maintained surface of trail; may be natural earth or imported material.

Perimeter access points

Access points may be developed to allow connecting trails from the WTMRP trail system to adjacent land. Department policy covering access notes that trail access points may be located along park boundaries if:

1. There is a demonstrated public need and demand.
2. The access is legally guaranteed, long-term for the general public.
3. Other adjacent landowners concur with the establishment of access.

Access may be granted to a private commercial trail guide service if it is in the best interest of the public, serves the general public, and the operator is under contract or permit to the County.

SUMMARY OF STANDARDS AND SPECIFICATIONS

	BARRIER-FREE TRAIL	INTERPRETIVE TRAIL	PRIMARY TRAIL	SECONDARY TRAIL	COMPETITIVE TRACK
Management objectives	To provide outdoor recreation and remove barriers for visitors with mobility, sight, and hearing limitations. Has sitting benches and a hardened surface. Low speed. Non-motorized.[1]	To provide educational recreation away from distracting use and activities. Low speed. Non-motorized.[1]	To provide leisurely outdoor recreation which allows for side-by-side travel and easy passing. Medium speed. Non-motorized.[1]	To provide leisurely outdoor recreation in areas that may be distant from an access point or have rugged topography. Medium speed. Non-motorized.	To provide challenging, strenuous, and high speed outdoor recreation for individuals, groups, and organized events. Direction of travel is one-way. High speed. Non-motorized.[2]
Experience objectives	To feel safe, socialize, and be surrounded by nature.	To anticipate, discover, gain environmental awareness, and be a part of nature.	To exercise, socialize, and be surrounded by nature.	To be adventurous, discover, obtain solitude, be remote, and be a part of nature.	To be challenged, take risks, be competitive, exercise, and be active in a natural setting.
User types	Pedestrians, including the physically disabled and toddlers.	Pedestrians.	Multi-use (hikers, equestrians, and bicyclists).[3]	Multi-use (hikers, equestrians, and bicyclists).[3]	Multi-use (runners, equestrians, and bicyclists).[4]
Tread construction and maintenance standards	5% max. sustained grade. 8% (for 1/10th or less of total length) max. grade.[5] 7 ft. (two-way), or 5 ft. (one-way) width.	10% max. sustained grade. 15% max. grade.[5] 4 ft. width.	10% max. sustained grade. 15% max. grade.[5] 4 ft. width.	15% max. sustained grade. 20% max. grade.[5] 2 ft. width.	20% max. sustained grade. (No limit) max. grade.[5] Up to 10 ft. width.

[1] Except for wheelchairs, and administrative and emergency use.
[2] Except for administrative and emergency use.
[3] Certain trails may be restricted where essential.
[4] Use is restricted during organized events.
[5] For specified short distances where essential.

Note that County Board of Supervisors action established a new fee schedule effective April 1, 2002. All persons entering the park at any entry point are subject to payment of an entry fee.

Washes

Wash trails have specifications equal to primary trail standards. Since natural openings of wash bottoms typically exceed
specifications for primary trails, the primary standards are considered minimum specifications for wash trails. Where vegetation growth or other obstacles encroach upon the trail width, action is taken to remove the obstacles to meet the minimum specifications for tread width and vegetation clearance width.

Guidelines

Trail planning includes analysis of physical, social, and managerial settings, which exist in the present and may exist in the future.

Managerial Setting

Managerial settings include determining objectives for trails and other resources. Trail proposals must be compatible with other resource management activities. The land ownership status and associated regulations must be identified. (WTMRP is owned in fee simple title by Maricopa County. It is subject to certain restrictions by the federal government such as public parks and recreation land uses only, mineral rights are retained by the federal government, etc.)

Actions required to manage the trail and associated costs must be determined. Funds, personnel, and equipment must be available not only for construction but also for long-term maintenance. Resources must be available for providing support facilities such as parking lots, restrooms, drinking water, etc.

Physical Setting

Trail planning includes knowing the local geography, climate, vegetation, wildlife, watershed, soil type, and other characteristics of the area. Managers must avoid impacts to physical, visual, cultural, and other resources.

Social Setting

When planning a trail, managers must determine the expected type of use, volume of use, past and projected trends, and expected conflicts between visitors. Public issues include concerns about littering, visitor behavior, safety, crowding, and vandalism.

Trail System Plan

This Plan is based on public, organization, and agency comments, and trail planning criteria. Execution of the Plan is described under "Actions" below. A quick reference chart titled "Summary of Action Items" is on pages 14 and 15.

The included Plan map shows the planned trail system. If a pre-existing designated trail or an unauthorized route currently used by the public does not appear on the map, it is slated for closure and obliteration. The locations of trails on the map are general corridors and not intended to be precise; new trails will be located according to PRD standards and area topography.

All of the trails are subject to modifications and improvements as needed to eliminate hazards, prevent erosion, or address other management concerns. Trails may be reconstructed or re-aligned if they exceed standards.

Please note: planned trails are not open to travel until properly constructed, posted, and designated by PRD. Traveling on these undesignated routes causes damage to the land, may be hazardous, and is in violation of park rules.

Actions

The following action items provide direction for the establishment of the WTMRP Trail System and access to trails. Each action item's number corresponds to numbers on the attached map and the chart on page 14 and 15. Unless otherwise indicated, all trails are designated for non-motorized, multiple-use by hikers, cyclists, and equestrians.

Trail Management

1-1. Maintain a trail from the horse staging area to a junction with trails 1-3 and 1-4.

- Classification is primary from the horse staging area to the narrow mouth of Ford Canyon; secondary from there to the canyon bottom; wash from there for approximately 1½ mi; then secondary to the ridge top terminus.
- The backcountry sections are not recommended for use by cyclists or equestrians.
- Maintain a spur trail to Area 9 trailhead; classification secondary.
- Maintain a spur trail to the Youth Group Area; classification primary.

1-2. Maintain a trail from trail 1-1 to trail 1-3.

- Classification is secondary.
- Travel by cyclists or equestrians is not recommended.
- If travel by livestock increases in the future, the Willow Springs area must be carefully monitored. If impacts to the area become unacceptable, build an exclusion fence with a walk-through gate away from the spring. Install a watering trough piped down from the spring. Construct a hitchrail or reconstruct the old corral at the site.

1-3. Maintain a trail from the horse staging area to a junction with trails 1-1 and 1-4.

- Classification is primary from the horse staging area to the foot of the mountain, then secondary to the junction with trails 1-1 and 1-4.
- The backcountry section is not recommended for use by cyclists or equestrians.
- Maintain a spur trail to the east end of Area 7; classification is primary.

1-4. Construct and maintain a trail from the horse staging area to a junction with trails 1-1 and 1-3.

- Classification is primary from the horse staging area to the junction with 1-5, then secondary to the junction with trails 1-3 and 1-4.
- The backcountry section is not recommended for use by cyclists or equestrians.
- If a small parcel of land is purchased from the State Land Department, the trail will be located east of the hillside (see map Option 1). If not, the trail will be located over the ridge (see map Option 2).
- Maintain a spur to the trailhead west of Area 1; classification is primary.
- Construct and maintain a spur to the visitor center; classification is primary.
- Construct and maintain a spur to Area 3; classification is primary.
- Construct and maintain a spur to Area 4; classification is primary.
- Construct and maintain a spur for a bypass east of the horse staging area.

1-5. Maintain a trail from Area 1 to a junction with trail 1-4.

- Classification is primary.

1-6. Maintain a trail from junction with trail 1-1 to another junction with 1-1.

- Classification is primary.
- Maintain a spur to the campground; classification is primary.
- Maintain a spur to the group campground; classification is primary.

1-7. Maintain a double loop trail west from Area 4.

- Classification of the short loop is barrier-free and interpretive.
- Classification of the long loop section is primary.
- Bicycles and livestock are prohibited.
- Maintain a spur connecting to trail 1-8; classification is primary.

1-8. Maintain a trail from Area 6 to a terminus in a box canyon.

- Classification is barrier-free and interpretive from Area 6 to the junction with trail 1-7 spur. From there the classification is primary.
- Maintain the "petroglyph plaza" area; very short paths may be constructed to provide access to the ramada and viewing of petroglyphs. Install barricades and warning signs to keep visitors on the trail and protect the cultural features.
- Post and maintain a cautionary sign at the end of the trail in the box canyon. It should caution visitors there is no maintained trail beyond that point.

1-9. Maintain a trail from Area 7 to trail 1-1.

- Classification is primary.
- Maintain a spur to parking lot west of Area 9.

1-10. Construct and maintain trails primarily used by the private horse stables.

- Construct and maintain three trails from access point 3-4; classification is primary. Construct these trails only in coordination with access management action item 3-4.
- Construct and maintain a trail from trail 1-1 to trail 1-4.
- The purpose of these trails is to provide one-hour and two-hour loop rides for the private horse stables.
- Classification is primary for all 1-10 trails.

Competitive Track Management

2-1. Maintain a competitive track in the northeast area of the park.

- Classification is competitive track.
- Track is generally one large loop with several crossing segments making for multiple loops.
- Maintain segments with different levels of difficulty to accommodate visitors with different skill levels.
- Maintain outward and return segments immediately adjacent to parking lot for easy level of difficulty.
- Shortest loop maintained to serve as "junior-level" loop.
- Develop new track segments to separate track from service roads.

Access Management

3-1. Maintain access point at Area 1 for terminus of trail 1-5.

- Blacktop surface.
- Lot accommodates passenger vehicles only.

3-2. Maintain access point at north end of Black Canyon Drive (west of Area 1) for terminus of trail 1-4.

- Blacktop surface.
- Lot accommodates passenger vehicles only.

3-3. Maintain access point at visitor center for spur to trail 1-4.

3-4. Maintain access point at east boundary for private access to trails 1-10.

- Open gate maintained so long as access criteria are met (see "Policies – Perimeter Access Points" pg. 3).
- Provides access to private, commercial horse stables.
- Gate and fence designed to block motor vehicle access.

3-5. Develop and maintain access point at Area 3 for spur to trail 1-4.

- Blacktop surface.
- Lot accommodates passenger vehicles only.

3-6. Maintain access points at Area 4 for spur to trail 1-4 and terminus of trail 1-7.

- Blacktop surface.
- Lot accommodates passenger vehicles only.

3-7. Maintain parking lot at the horse staging area for trails 1-1, 1-3, and 1-4.

- Gravel surface.
- Lot accommodates passenger vehicles and trailers.

3-8. Maintain access point at Area 6 for trail 1-8.

- Blacktop surface.
- Lot accommodates passenger vehicles only.

3-9. Maintain access points at Area 7 for terminus of trail 1-9 and spur to trail 1-3.
- Blacktop surface.
- Lot accommodates passenger vehicles only.

3-10. Maintain access point at parking lot west of Area 9 for spur to trail 1-9.
- Blacktop surface.
- Lot accommodates passenger vehicles only.

3-11. Maintain access point at Area 9 for spur to trail 1-1.
- Blacktop surface..
- Lot accommodates passenger vehicles only.

3-12. Maintain access point at Youth Group Area for spur to trail 1-1.

3-13. Maintain access point at Campground for spur to trail 1-6.

3-14. Maintain access point at Group Campground for spur to trail 1-6.

3-15. Maintain parking lot for access to the competitive track.
- Gravel surface.
- Lot accommodates passenger vehicles and trailers.

3-16. Maintain service road.
- Separate from competitive track (see item 2-1.
- Dirt surface.
- Maintain to MCDOT specifications for a Class IV Administrative Park Road.
- Use restricted to authorized personnel only.
- Install fence and gates at parking lot if necessary to deter unauthorized use.
- Construct end of road to allow convenient turn-around of vehicles. Install barriers if needed.

3-17. Maintain service road.
- Separate from competitive track (see item 2-1).
- Dirt surface.
- Maintain to MCDOT specifications for a Class IV Administrative Park Road.
- Use restricted to authorized personnel only.
- Install fence and gates at parking lot if necessary to deter unauthorized use.
- Construct end of road to allow convenient turn-around of vehicles. Install barriers if needed.

3-18. Maintain locked gate at east boundary.
- Authorized use only.
- Delete access point (remove gate and patch the fence) if access through state land is eliminated.

3-19. Construct and maintain a service road.
- Dirt surface.
- Maintain to Maricopa County Department of Transportation (MCDOT) specifications for a Class IV Administrative Park Road. East end of road may be constructed to accommodate official ATV traffic only.
- Restricted to authorized use only.
- Install locked gate at tower road if necessary.
- Install fence and other barricades as necessary to obstruct unauthorized use.
- Construct end of road to allow convenient turn-around of vehicles. Install barriers if needed.

3-20. Construct and maintain a service road.

- Dirt surface.
- Maintain to Maricopa County Department of Transportation (MCDOT) specifications for a Class IV Administrative Park Road. South end of road may be constructed to accommodate official ATV traffic only.
- Restricted to authorized use only.
- Install fence, gates, and other barricades as necessary to obstruct unauthorized use.
- Construct end of road to allow convenient turn-around of vehicles. Install barriers if needed.
- Obliterate adjacent roads.

Other Actions Related to Trails

Maintenance

Trail maintenance is scheduled on an as needed, on-going basis throughout the county parks. Routine maintenance work includes repair of eroded tread, clearance of encroaching vegetation, installing surface water control structures (waterbars, dips). Reconstruction is heavy maintenance that brings a severely degraded or improperly constructed trail into compliance with the standards according to its classification. This may involve reconstructing tread to comply with standard gradient and width, constructing tread stabilizing structures (walls, rip-rap, block and fill), and/or re-aligning segments of tread.

Obliteration of paths and roads

Undesignated paths and roads not planned for inclusion into the trail and access system will be obliterated and "naturalized" by scarifying the tread, planting native vegetation and/or scattering native debris as directed by the PRD Trails Manual.

Control of off-trail use

As per Park Rules R-118-3 and R-118-4, horses and bicycles must stay on designated trails, and shortcutting by any trail user is prohibited. Trail user education and, if necessary, law enforcement will be used to attain compliance. Signs will be posted and barriers constructed at obliterated paths, roads, and undesignated washes if these areas are subject to continued use after closure.

Trail names

New names will be chosen for new trails established in the park. Some segments of previously designated trails may be renamed to provide an easier to follow trail system.

Trail and access signs

Signs will be posted in accordance with the PRD Trails Manual. Directional signs will be posted at junctions and terminus points. Markers and regulatory and warning signs may be posted where essential for visitor safety and resource protection. Damaged signs will be replaced in a timely manner. All unauthorized signs will be removed.

Markers may be posted along trails where determined to be essential for visitor safety, such as vague sections that are difficult to follow. When the tread is reconstructed and following the trail is no longer a problem, the markers should be removed.

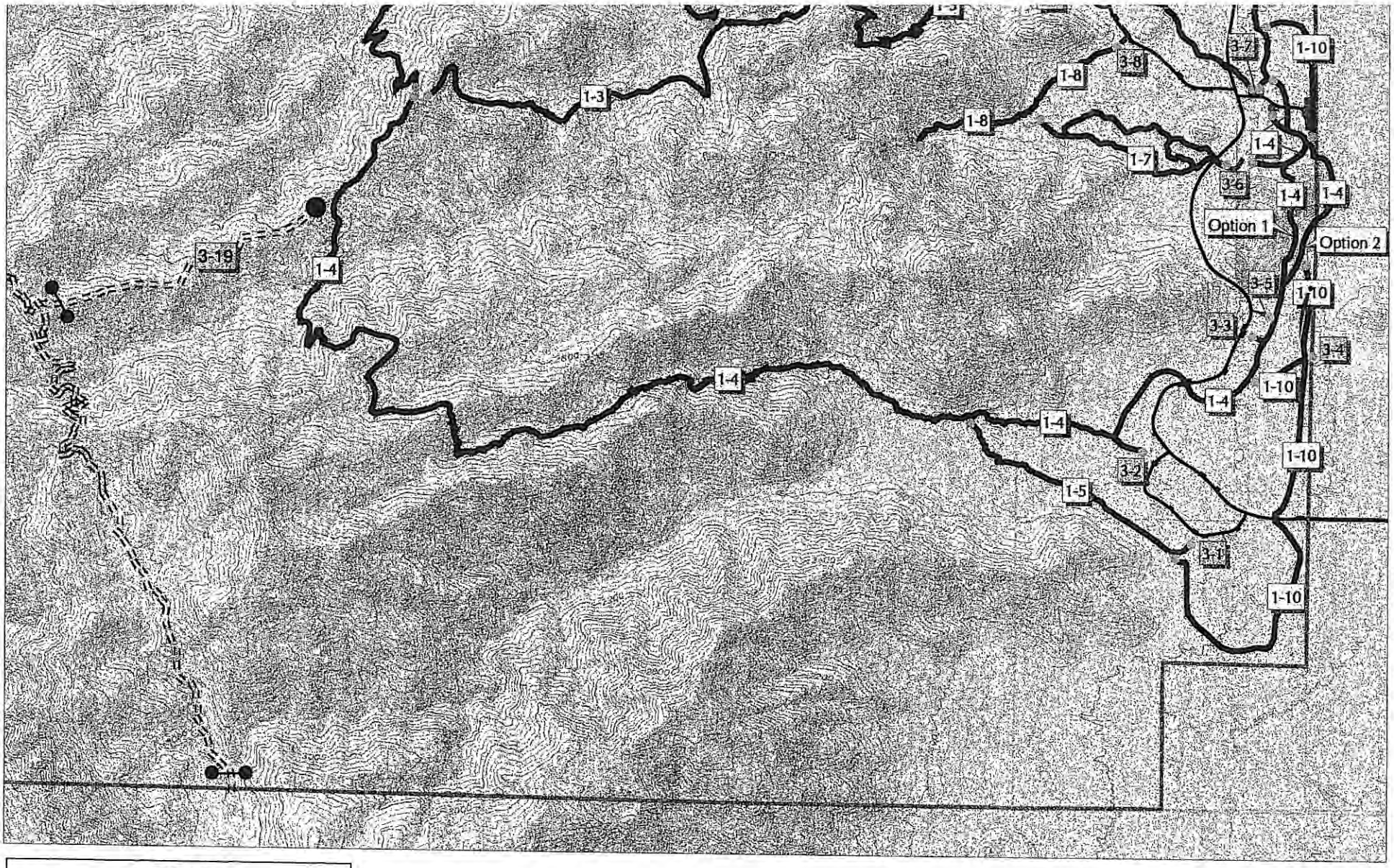
SUMMARY OF ACTION ITEMS

Trail Management			
#	Action	Classification	Use
1-1	Maintain trail. Maintain spur to Youth Group Area. Maintain spur to Area 9.	Primary, wash, secondary Primary Secondary	Multiple-use " " " "
1-2	Maintain trail.	Secondary	Multiple-use
1-3	Maintain trail. Maintain spur to Area 7.	Primary, secondary Primary	Multiple-use " "
1-4	Maintain trail. Construct new segment north of Area 1. Maintain spur to lot west of Area 1. Construct & maintain spur to Visitor Center. Construct & maintain spur to Area 3 Construct & maintain spur to Area 4.	Primary, secondary Primary Primary Primary Primary	Multiple-use Multiple-use " " Multiple-use " "
1-5	Maintain trail.	Primary	Multiple-use
1-6	Maintain trail. Maintain spur to campground. Maintain spur to group campground.	Primary Primary Primary	Multiple-use " " " "
1-7	Maintain double-loop trail. Maintain spur to trail 1-8.	Barrier-free, interpretive, primary Primary	Pedestrian only " "
1-8	Maintain trail. Maintain "petroglyph plaza" area.	Barrier-free, primary	Pedestrian only
1-9	Maintain trail. Maintain spur to lot west of Area 9.	Primary Primary	Multiple-use " "
1-10	Construct & maintain trails.	Primary	Private horse stables

Track Management			
#	Action	Classification	Use
2-1	Maintain track. Construct new segments separate from service roads.	Competitive Track Competitive Track	Multiple-use " "

Access Management		
#	Action	Use
3-1	Maintain access point at Area 1 for trail 1-5.	Public
3-2	Maintain access point west of Area 1 for spur to trail 1-4.	Public
3-3	Maintain access point at Visitor Center for spur to trail 1-4.	Public
3-4	Maintain access point at east boundary for private horse stables.	Private
3-5	Maintain access points at Area 3 for spur to trail 1-4.	Public
3-6	Maintain access points at Area 4 for trail 1-7 & spur to trail 1-4.	Public
3-7	Maintain horse staging area & access points for trails 1-1, 1-3, & 1-4.	Public
3-8	Maintain access point at Area 6 for trail 1-8.	Public
3-9	Maintain access points at Area 7 for trail 1-9 & spur for trail 1-3.	Public
3-10	Maintain access point west of Area 9 for spur to trail 1-9.	Public
3-11	Maintain access point at Area 9 for spur to trail 1-1.	Public

Access Management		
#	Action	Use
3-12	Maintain access point at Youth Group Area for spur to trail 1-1.	Public
3-13	Maintain access point at Campground for spur to trail 1-6.	Public
3-14	Maintain access point at Group Campground for spur to trail 1-6.	Public
3-15	Maintain parking lot for access to competitive track.	Public
3-16	Maintain service road.	Authorized only.
3-17	Maintain service road.	Authorized only.
3-18	Maintain locked gate.	Authorized only.
3-19	Construct and maintain service road.	Authorized only.
3-20	Construct and maintain service road.	Authorized only.



LEGEND

- Planned Trail
- Planned Competitive Track
- Terminus of Planned Trail
- Planned Service Road
- Locked Gate
- Park Boundary

N

W E

S

1:30000

1000 0 1000 2000 3000 4000 5000 Feet

White Tank Mountain Regional Park

December 2002

Appendix K – Implementation Plan

{Insert Implementation Plan after this page.}

White Tank Mountain Regional Park: Implementation Plan

An appendix to the 2013-3033 Master Plan update.

Maricopa County Parks and Recreation Department

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Table of Contents

1.0 Project Background

The White Tank Mountain Regional Park entered the Maricopa County park system in 1961 and its Master Plan was written in 1964 and is, to date, the largest regional park at 29,572 acres and features rugged mountain terrain, gentle foothills, and open valley views. Many components of the master plan have never come into fruition while at the same time public use has often dictated when and where development has occurred. The 2013-2033 Master Plan update is meant to bring those two components back into alignment and to steer future development of the park. The master plan update is based on a 20-year outlook and this implementation plan will assist park management with analyzing and identifying potential funding mechanisms.

1.1 Themes and Priority Mandates

The White Tank Mountain Regional Park Master Plan update is aligned with the Maricopa County Parks and Recreation 2009 Strategic System Master Plan that recommends keeping the park as a "preservation, conservation, and education" based park. Park improvement recommendations will address one or more of these mandates and have been identified as:

1. Preserve the natural setting and environmental aspects of the park by heavily restricted use and limited public access.
2. Devote resources to the repair and replacement of existing infrastructure.
3. Pursue limited development to enhance the quality and diversity of recreational opportunities.
4. Acquire additional property to create a buffer from encroaching external development.

1.2 Priority Level

A timeline for completion was not assigned to any one project as any one may be completed as the opportunity presents itself. Instead, a priority level was assigned to indicate which projects may be of a relative greater need than another:

- High Priority: projects that are in progress; public health or safety issues; resource protection.
- Medium Priority: important, but not a matter of public health or safety.
- Low Priority: desired features; dependent on long-term partnerships or other considerations.

Some projects will be phased in individually over multiple years to maximize budgetary resources, build partnerships with other agencies, and to minimize impacts to park operations and resources. Site specific plans (including any natural or cultural resource inventories and clearances) and engineering plans will be required for new construction.

2.0 Park Improvement Recommendations

This analysis is limited to those park improvement recommendations that are ranked as a high priority and the most likely to impact park visitation and/or revenue. Medium and low priority recommendations will have a similar analysis performed prior to construction. However, ***all*** park improvement recommendations are found in Chapter 6 of the master plan update.

2.1 Assumptions

This implementation plan uses a number of assumptions to estimate costs and funding mechanisms. The first and foremost assumption is that *all improvement projects are contingent upon having adequate funding and staffing resources to implement.* Assumptions are noted on each project's return on investment analysis spreadsheet. Other assumptions may include:

- Costs are planning level costs.
- Not all costs will be incurred directly; some may be funded through grants or other sources.

- Some cost estimates are based on similar facilities/programs at comparable parks.
- Staffing needs should be considered prior to implementation of any project; some projects may increase fulltime equivalent (FTE) employee needs (or Have other operational needs). FTE may include park staff and/or volunteers to equal a 40-hour workweek.
- Projects will be scheduled through the Annual Operations Budget or CIP as budget allows.
- All new trail additions combined will increase annual visitation rate by 3% to 5%.
- Campsites/picnic tables are fully booked for the peak season, unless otherwise noted.
- Daily entrance fee of $2.05 is paid by each park visitor. (Based on each vehicle paying $6.00 and each vehicle containing 2.92 people.[1])
- Visitation is based on FY2012-2013 of 144,395 park visitors.
- Projects pertaining to health and/or human safety will not be analyzed for "return on investment" potential.
- Projects pertaining to protecting park resources will not (or cannot) be analyzed for "return on investment" potential.
- Projects pertaining to administrative issues will not (or cannot) be analyzed for "return on investment" potential.
- Projects pertaining to educational/interpretive projects may not be analyzed for "return on investment" potential.

2.2 Funding sources

Funding for the projects identified in the master plan update will come from a variety of sources and may include any one or more of the following:

- Grants
- Private donations
- Partnerships
- Park budget
- Special one-time only funding allocations
- Other sources

2.3 Return on Investment Analysis

The high priority projects provided in this analysis include the following and are detailed in the subsequent charts:

- New Facilities: Family Campground
- New Facilities: Competitive Track
- Maintain/Rehabilitate Existing Facilities: Area 4
- Maintain/Rehabilitate Existing Facilities: Area 7
- Maintain/Rehabilitate Existing Facilities: Waterfall

[1] 2012-2013 ASU Parks Visitor Study Final Report, p306, question 16.

Parks and Recreation - New Facilities
Family Campground: Upgrade/Expand RV Camp Sites
Priority: High

Revenue (1)	**Camping Season**	**Per Night Fee**	**Reservation Fee (one time only)**	**Est. Cost**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**	**Year 21**	**Year 22**	**Year 23**	**Year 24**	**Year 25**
Future camping season - 40 sites	180	25	8		237,600	238,788	239,982	241,182	242,388	243,600	244,818	246,042	247,272	248,508	249,751	251,000	252,255	253,516	254,784	256,057	257,338	258,624	259,918	261,217	262,523	263,836	265,155	266,481	267,813
Projected season - 20 additional sites	180	25	8		118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800	118,800
Total Revenue					356,400	357,588	358,782	359,982	361,188	362,400	363,618	364,842	366,072	367,308	368,551	369,800	371,055	372,316	373,584	374,857	376,138	377,424	378,718	380,017	381,323	382,636	383,955	385,281	386,613
Costs - Initial Capital Outlay (2)																													
Playground updates				121,000																									
Electric installation				190,000																									
Water installation				125,000																									
Dump station installation				720,000																									
20 additional campsites (with water & electric)				517,500																									
Total Outlay				1,552,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Costs - Annualized Operating																													
Maintenance (3)					785	800	816	832	848	863	879	895	910	926	942	957	973	989	1,004	1,020	1,036	1,052	1,067	1,083	1,099	1,114	1,130	1,146	1,161
Landscape (4)					1,570	1,601	1,632	1,664	1,695	1,726	1,758	1,789	1,821	1,852	1,883	1,915	1,946	1,978	2,009	2,040	2,072	2,103	2,135	2,166	2,197	2,229	2,260	2,292	2,323
Landscape (4)									500					500					500					500						500
Trail grooming (5)									1,000					1,000					1,000					1,000						1,000
Capital repairs short-term (6)														116,438										116,438						
Capital replacement long-term (7)																								310,500						
Electricity (8)					36,000	37,152	38,304	39,456	40,608	41,760	42,912	44,064	45,216	46,368	47,520	48,672	49,824	50,976	52,128	53,280	54,432	55,584	56,736	57,888	59,040	60,192	61,344	62,496	63,648
Water (9)					500	525	550	575	600	625	650	675	700	725	750	775	800	825	850	875	900	925	950	975	1,000	1,025	1,050	1,075	1,100
Insurance (10)					1,808	1,880	1,953	2,025	2,097	2,170	2,242	2,314	2,387	2,459	2,531	2,604	2,676	2,748	2,820	2,893	2,965	3,037	3,110	3,182	3,254	3,327	3,399	3,471	3,544
Administrative Overhead (11)					43,305	44,171	45,037	45,903	46,769	47,636	48,502	49,368	50,234	51,100	51,966	52,832	53,698	54,564	55,430	56,297	57,163	58,029	58,895	59,761	60,627	61,493	62,359	63,225	64,091
Total Operating				-	83,967	86,130	88,292	90,455	94,117	94,780	96,942	99,105	101,267	221,367	105,592	107,755	109,917	112,080	115,742	116,405	118,567	120,730	122,892	553,492	127,217	129,380	131,542	133,705	137,367
Total Facilities Cost				1,552,500	83,967	86,130	88,292	90,455	94,117	94,780	96,942	99,105	101,267	221,367	105,592	107,755	109,917	112,080	115,742	116,405	118,567	120,730	122,892	553,492	127,217	129,380	131,542	133,705	137,367
Net Profit (Expense)				(1,552,500)	272,433	271,458	270,490	269,527	267,070	267,620	266,675	265,737	264,805	145,941	262,959	262,045	261,137	260,236	257,841	258,453	257,570	256,695	255,825	(173,475)	254,106	253,256	252,413	251,576	249,246
Cumulative (Payback Period in Years)				(1,552,500)	(1,280,067)	(1,008,609)	(738,119)	(468,592)	(201,522)	66,098	332,773	598,510	863,315	1,009,256	1,272,215	1,534,259	1,795,397	2,055,633	2,313,474	2,571,926	2,829,497	3,086,191	3,342,016	3,168,541	3,422,647	3,675,903	3,928,315	4,179,891	4,429,137
PV Analysis				(1,552,500)	268,407	263,494	258,674	253,944	247,911	244,750	240,282	235,898	231,596	125,753	223,234	219,171	215,184	211,272	206,235	203,669	199,974	196,349	192,792	(128,800)	185,878	182,518	179,222	175,988	171,782
Investment Rate				1.50%																									
Cumulative (Payback Period in Years) using PV analysis				(1,552,500)	(1,284,093)	(1,020,599)	(761,925)	(507,981)	(260,070)	(15,321)	224,961	460,859	692,455	818,207	1,041,442	1,260,613	1,475,797	1,687,069	1,893,304	2,096,972	2,296,946	2,493,295	2,686,087	2,557,286	2,743,164	2,925,683	3,104,905	3,280,893	3,452,675
Assumptions				**Annual**	**5 year**	**10 year**	**20 year**																						
1. Revenue estimated growth rate				0.50%																									
2. Cost - Initial Capital Outlay is from all sources (Grants, Special Revenue Funds, General Fund, etc.)																													
3. Maintenance (cleaning, trash, etc.)																													
MRT Park Specialist (Mid point)				$ 16.53																									
Benefits as a percentage of wages for FY13 (11% retirement, 15.6% benefits)				26.6%																									
Estimated allocated time				2.50%																									
Estimated annual salary increase				2.00%																									
Annual work hours				1,500																									
4. Landscape (new plants, trim plants, repair drip lines, etc.)																													
New plant replacement is estimated every 5 years					$ 500.00																								
MRT Park Specialist (Mid point)				$ 16.53																									
Benefits as a percentage of wages for FY13 (11% retirement, 15.6% benefits)				26.6%																									
Estimated allocated time				5.00%																									
Estimated annual salary increase				2.00%																									
Annual work hours				1,500																									
5. Trail grooming is provided by volunteers																													
Nominal Cost every 5 years					$ 1,000.00																								
6. Capital repairs short-term (facility painting, parking lot stripping, signage, dumping station leach line cleaning)																													
Estimated cost as a percentage of facility every 10 years							7.50%																						
CPI un-adjusted one year ended Aug. 2013 All Items							1.50%																						
7. Capital replacement long-term (major facilities repairs)																													
Estimated cost as a percentage of facility every 20 years								20.00%																					
CPI un-adjusted one year ended Aug. 2013 All Items								1.50%																					
8. Electricity																													
Estimated base level				$ 36,000.00																									
CPI un-adjusted one year ended Aug. 2013 Energy Services				3.20%																									
9. Water																													
Estimated base level				$ 500.00																									
USA Today predicts water increases every few years				5.00%																									
10. Insurance																													
Estimated base level				$ 1,808.00																									
Risk Management Insurance Premium increases				4.00%																									
11. Administrative Overhead allocated																													
Central Service Cost Allocation A300 Parks and Rec				$ 8,678.00																									
Parks and Recreation Administration Cost				$ 34,627.00																									
Estimated growth rate				2.00%																									

CPI - As an economic indicator. As the most widely used measure of inflation, the CPI is an indicator of the effectiveness of government policy.
In addition, business executives, labor leaders and other private citizens use the index as a guide in making economic decisions.
http://www.bls.gov/news.release/pdf/cpi.pdf

Parks and Recreation - New Facilities
Competitive Track: new features
Priority: High

Revenue (1)	**Est. Cost**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**	**Year 21**	**Year 22**	**Year 23**	**Year 24**	**Year 25**
Running/Jogging park usage 9.8%		29,009	29,154	29,300	29,446	29,594	29,741	29,890	30,040	30,190	30,341	30,492	30,645	30,798	30,952	31,107	31,262	31,419	31,576	31,734	31,892	32,052	32,212	32,373	32,535	32,698
Mtn. Biking park usage 9.3%		27,529	27,667	27,805	27,944	28,084	28,224	28,365	28,507	28,650	28,793	28,937	29,081	29,227	29,373	29,520	29,667	29,816	29,965	30,115	30,265	30,417	30,569	30,721	30,875	31,029
Organized events (8 per year/1766 participants)		4,220	4,241	4,263	4,284	4,305	4,327	4,349	4,370	4,392	4,414	4,436	4,458	4,481	4,503	4,526	4,548	4,571	4,594	4,617	4,640	4,663	4,686	4,710	4,733	4,757
Total Revenue	-	60,758	61,062	61,367	61,674	61,982	62,292	62,604	62,917	63,231	63,548	63,865	64,185	64,506	64,828	65,152	65,478	65,805	66,134	66,465	66,797	67,131	67,467	67,804	68,143	68,484
Costs - Initial Capital Outlay (2)																										
Restroom (with showers & bike wash)	495,000																									
Cultural resource survey (bike park)	5,000																									
Bike park elements (3.0 acre approx)	81,000																									
Cultural resource survey (beginner track)	2,500																									
Beginner track (1.0 mile approx)	20,000																									
Cultural resource survey (trail connection)	2,500																									
Trail connection to Ironwood (0.6 mile approx)	6,000																									
Total Outlay	612,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Costs - Annualized Operating																										
Maintenance (3)		785	800	816	832	848	863	879	895	910	926	942	957	973	989	1,004	1,020	1,036	1,052	1,067	1,083	1,099	1,114	1,130	1,146	1,161
Landscape (4)		1,570	1,601	1,632	1,664	1,695	1,726	1,758	1,789	1,821	1,852	1,883	1,915	1,946	1,978	2,009	2,040	2,072	2,103	2,135	2,166	2,197	2,229	2,260	2,292	2,323
Landscape (4)						500					500					500					500					500
Trail grooming (5)						1,000					1,000					1,000					1,000					1,000
Capital repairs short-term (6)											45,900										45,900					
Capital replacement long-term (7)																					122,400					
Electricity (8)		600	619	638	658	677	696	715	734	754	773	792	811	830	850	869	888	907	926	946	965	984	1,003	1,022	1,042	1,061
Water (9)		250	263	275	288	300	313	325	338	350	363	375	388	400	413	425	438	450	463	475	488	500	513	525	538	550
Insurance (10)		618	643	667	692	717	742	766	791	816	840	865	890	915	939	964	989	1,014	1,038	1,063	1,088	1,112	1,137	1,162	1,187	1,211
Administrative Overhead (11)		14,811	15,107	15,403	15,700	15,996	16,292	16,588	16,885	17,181	17,477	17,773	18,069	18,366	18,662	18,958	19,254	19,551	19,847	20,143	20,439	20,735	21,032	21,328	21,624	21,920
Total Operating	-	18,633	19,033	19,433	19,832	21,732	20,632	21,032	21,431	21,831	69,631	22,631	23,030	23,430	23,830	25,729	24,629	25,029	25,429	25,828	196,028	26,628	27,028	27,427	27,827	29,727
Total Facilities Cost	612,000	18,633	19,033	19,433	19,832	21,732	20,632	21,032	21,431	21,831	69,631	22,631	23,030	23,430	23,830	25,729	24,629	25,029	25,429	25,828	196,028	26,628	27,028	27,427	27,827	29,727
Net Profit (Expense)	(612,000)	42,125	42,029	41,935	41,842	40,250	41,660	41,572	41,485	41,400	(6,083)	41,235	41,154	41,076	40,998	39,423	40,849	40,777	40,706	40,637	(129,231)	40,504	40,440	40,377	40,316	38,757
Cumulative (Payback Period in Years)	(612,000)	(569,875)	(527,846)	(485,912)	(444,070)	(403,820)	(362,159)	(320,587)	(279,102)	(237,701)	(243,784)	(202,550)	(161,395)	(120,320)	(79,321)	(39,898)	950	41,727	82,433	123,070	(6,161)	34,343	74,782	115,159	155,476	194,233
PV Analysis	(612,000)	41,502	40,796	40,103	39,423	37,363	38,100	37,458	36,827	36,208	(5,242)	35,006	34,421	33,847	33,285	31,532	32,190	31,658	31,136	30,624	(95,950)	29,628	29,144	28,669	28,203	26,712
Investment Rate	1.50%																									
Cumulative (Payback Period in Years) using PV analysis	(612,000)	(570,498)	(529,702)	(489,599)	(450,177)	(412,814)	(374,714)	(337,256)	(300,429)	(264,220)	(269,462)	(234,456)	(200,035)	(166,188)	(132,903)	(101,371)	(69,181)	(37,523)	(6,386)	24,238	(71,712)	(42,084)	(12,939)	15,730	43,933	70,645

Assumptions	**Annual**	**5 year**	**10 year**	**20 year**
1. Revenue estimated growth rate	0.50%			
2. Cost - Initial Capital Outlay is from all sources (Grants, Special Revenue Funds, General Fund, etc.)				
3. Maintenance (cleaning, trash, etc.)				
MRT Park Specialist (Mid point)	$ 16.53			
Benefits as a percentage of wages for FY13 (11% retirement, 15.6% benefits)	26.6%			
Estimated allocated time	2.50%			
Estimated annual salary increase	2.00%			
Annual work hours	1,500			
4. Landscape (new plants, trim plants, repair drip lines, etc.)				
New plant replacement is estimated every 5 years		$ 500.00		
MRT Park Specialist (Mid point)	$ 16.53			
Benefits as a percentage of wages for FY13 (11% retirement, 15.6% benefits)	26.6%			
Estimated allocated time	5.00%			
Estimated annual salary increase	2.00%			
Annual work hours	1,500			
5. Trail grooming is provided by volunteers				
Nominal Cost every 5 years		$ 1,000.00		
6. Capital repairs short-term (facility painting, parking lot stripping, signage, dumping station leach line cleaning)				
Estimated cost as a percentage of facility every 10 years			7.50%	
CPI un-adjusted one year ended Aug. 2013 All Items			1.50%	
7. Capital replacement long-term (major facilities repairs)				
Estimated cost as a percentage of facility every 20 years				20.00%
CPI un-adjusted one year ended Aug. 2013 All Items				1.50%
8. Electricity				
Estimated base level	$ 600.00			
CPI un-adjusted one year ended Aug. 2013 Energy Services	3.20%			
9. Water				
Estimated base level	$ 250.00			
USA Today predicts water increases every few years	5.00%			
10. Insurance				
Estimated base level	$ 618.00			
Risk Management Insurance Premium increases	4.00%			
11. Administrative Overhead allocated				
Central Service Cost Allocation A300 Parks and Rec	$ 2,968.00			
Parks and Recreation Administration Cost	$ 11,843.00			
Estimated growth rate	2.00%			

CPI - As an economic indicator. As the most widely used measure of inflation, the CPI is an indicator of the effectiveness of government policy.
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http://www.bls.gov/news.release/pdf/cpi.pdf

Parks and Recreation - Maintain/Rehabilitate Existing Facilities
Area 4: Rennovations
Priority: High

Revenue (1)	**Est. Cost**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**	**Year 21**	**Year 22**	**Year 23**	**Year 24**	**Year 25**
Playground park usage 6.8%		20,129	20,229	20,330	20,432	20,534	20,637	20,740	20,844	20,948	21,053	21,158	21,264	21,370	21,477	21,584	21,692	21,801	21,910	22,019	22,129	22,240	22,351	22,463	22,575	22,688
Ramada rental (six 4-table ramadas) - (180 day peak season)		32,400	32,562	32,725	32,888	33,053	33,218	33,384	33,551	33,719	33,888	34,057	34,227	34,398	34,570	34,743	34,917	35,092	35,267	35,443	35,621	35,799	35,978	36,157	36,338	36,520
Total Revenue	-	52,529	52,791	53,055	53,321	53,587	53,855	54,124	54,395	54,667	54,940	55,215	55,491	55,769	56,047	56,328	56,609	56,892	57,177	57,463	57,750	58,039	58,329	58,621	58,914	59,208
Costs - Initial Capital Outlay (2)																										
Playground updates	121,000																									
Playground buffering (landscaping)	5,000																									
Ramada repairs	115,000																									
Drainage/Erosion control	50,000																									
Total Outlay	291,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Costs - Annualized Operating																										
Maintenance (3)		785	800	816	832	848	863	879	895	910	926	942	957	973	989	1,004	1,020	1,036	1,052	1,067	1,083	1,099	1,114	1,130	1,146	1,161
Landscape (4)		1,570	1,601	1,632	1,664	1,695	1,726	1,758	1,789	1,821	1,852	1,883	1,915	1,946	1,978	2,009	2,040	2,072	2,103	2,135	2,166	2,197	2,229	2,260	2,292	2,323
Landscape (4)						500					500					500					500					500
Trail grooming (5)						1,000					1,000					1,000					1,000					1,000
Capital repairs short-term (6)											21,825										21,825					
Capital replacement long-term (7)																					58,200					
Electricity (8)		5,000	5,160	5,320	5,480	5,640	5,800	5,960	6,120	6,280	6,440	6,600	6,760	6,920	7,080	7,240	7,400	7,560	7,720	7,880	8,040	8,200	8,360	8,520	8,680	8,840
Water (9)		250	263	275	288	300	313	325	338	350	363	375	388	400	413	425	438	450	463	475	488	500	513	525	538	550
Insurance (10)		373	388	403	418	433	448	463	477	492	507	522	537	552	567	582	597	612	627	642	656	671	686	701	716	731
Administrative Overhead (11)		8,926	9,105	9,283	9,462	9,640	9,819	9,997	10,176	10,354	10,533	10,711	10,890	11,068	11,247	11,425	11,604	11,782	11,961	12,139	12,318	12,496	12,675	12,853	13,032	13,210
Total Operating	-	16,903	17,316	17,729	18,142	20,055	18,968	19,381	19,794	20,207	43,946	21,034	21,447	21,860	22,273	24,186	23,099	23,512	23,925	24,338	106,276	25,164	25,577	25,990	26,403	28,316
Total Facilities Cost	291,000	16,903	17,316	17,729	18,142	20,055	18,968	19,381	19,794	20,207	43,946	21,034	21,447	21,860	22,273	24,186	23,099	23,512	23,925	24,338	106,276	25,164	25,577	25,990	26,403	28,316
Net Profit (Expense)	(291,000)	35,625	35,475	35,326	35,178	33,532	34,887	34,743	34,601	34,459	10,995	34,181	34,044	33,909	33,775	32,142	33,511	33,381	33,252	33,125	(48,526)	32,875	32,752	32,631	32,511	30,892
Cumulative (Payback Period in Years)	(291,000)	(255,375)	(219,900)	(184,574)	(149,396)	(115,864)	(80,977)	(46,234)	(11,634)	22,826	33,821	68,002	102,046	135,955	169,730	201,872	235,383	268,763	302,015	335,140	286,614	319,489	352,241	384,872	417,383	448,275
PV Analysis	(291,000)	35,099	34,434	33,783	33,144	31,126	31,905	31,304	30,715	30,138	9,474	29,018	28,474	27,942	27,420	25,709	26,407	25,916	25,435	24,963	(36,029)	24,048	23,604	23,169	22,743	21,291
Investment Rate	1.50%																									
Cumulative (Payback Period in Years) using PV analysis	(291,000)	(255,901)	(221,467)	(187,684)	(154,540)	(123,414)	(91,508)	(60,204)	(29,489)	649	10,123	39,141	67,615	95,557	122,977	148,686	175,093	201,009	226,444	251,407	215,378	239,426	263,030	286,199	308,942	330,233

Assumptions	**Annual**	**5 year**	**10 year**	**20 year**
1. Revenue estimated growth rate	0.50%			
2. Cost - Initial Capital Outlay is from all sources (Grants, Special Revenue Funds, General Fund, etc.)				
3. Maintenance (cleaning, trash, etc.)				
MRT Park Specialist (Mid point)	$ 16.53			
Benefits as a percentage of wages for FY13 (11% retirement, 15.6% benefits)	26.6%			
Estimated allocated time	2.50%			
Estimated annual salary increase	2.00%			
Annual work hours	1,500			
4. Landscape (new plants, trim plants, repair drip lines, etc.)				
New plant replacement is estimated every 5 years		$ 500.00		
MRT Park Specialist (Mid point)	$ 16.53			
Benefits as a percentage of wages for FY13 (11% retirement, 15.6% benefits)	26.6%			
Estimated allocated time	5.00%			
Estimated annual salary increase	2.00%			
Annual work hours	1,500			
5. Trail grooming is provided by volunteers				
Nominal Cost every 5 years		$ 1,000.00		
6. Capital repairs short-term (facility painting, parking lot stripping, signage, dumping station leach line cleaning)				
Estimated cost as a percentage of facility every 10 years			7.50%	
CPI un-adjusted one year ended Aug. 2013 All Items			1.50%	
7. Capital replacement long-term (major facilities repairs)				
Estimated cost as a percentage of facility every 20 years				20.00%
CPI un-adjusted one year ended Aug. 2013 All Items				1.50%
8. Electricity				
Estimated base level	$ 5,000.00			
CPI un-adjusted one year ended Aug. 2013 Energy Services	3.20%			
9. Water				
Estimated base level	$ 250.00			
USA Today predicts water increases every few years	5.00%			
10. Insurance				
Estimated base level	$ 373.00			
Risk Management Insurance Premium increases	4.00%			
11. Administrative Overhead allocated				
Central Service Cost Allocation A300 Parks and Rec	$ 1,789.00			
Parks and Recreation Administration Cost	$ 7,137.00			
Estimated growth rate	2.00%			

CPI - As an economic indicator. As the most widely used measure of inflation, the CPI is an indicator of the effectiveness of government policy.
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Parks and Recreation - Maintain/Rehabilitate Existing Facilities
Area 7: Rennovations
Priority: High

Revenue (1)	**Est. Cost**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**	**Year 21**	**Year 22**	**Year 23**	**Year 24**	**Year 25**
Amphitheater rental - (180 day peak season)		9,000	9,045	9,090	9,136	9,181	9,227	9,273	9,320	9,366	9,413	9,460	9,508	9,555	9,603	9,651	9,699	9,748	9,796	9,845	9,895	9,944	9,994	10,044	10,094	10,144
Ramada rental (three 2-table ramadas) - (180 day peak season)		10,800	10,854	10,908	10,963	11,018	11,073	11,128	11,184	11,240	11,296	11,352	11,409	11,466	11,523	11,581	11,639	11,697	11,756	11,814	11,874	11,933	11,993	12,052	12,113	12,173
Total Revenue	-	19,800	19,899	19,998	20,098	20,199	20,300	20,401	20,503	20,606	20,709	20,813	20,917	21,021	21,126	21,232	21,338	21,445	21,552	21,660	21,768	21,877	21,986	22,096	22,207	22,318
Costs - Initial Capital Outlay (2)																										
Parking realignment	100,000																									
Kiosk	3,000																									
Amphitheater reapirs	60,000																									
Playground updates	121,000																									
Drainage/Erosion control	50,000																									
Total Outlay	334,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Costs - Annualized Operating																										
Maintenance (3)		785	800	816	832	848	863	879	895	910	926	942	957	973	989	1,004	1,020	1,036	1,052	1,067	1,083	1,099	1,114	1,130	1,146	1,161
Landscape (4)		1,570	1,601	1,632	1,664	1,695	1,726	1,758	1,789	1,821	1,852	1,883	1,915	1,946	1,978	2,009	2,040	2,072	2,103	2,135	2,166	2,197	2,229	2,260	2,292	2,323
Landscape (4)						500					500					500					500					500
Trail grooming (5)						1,000					1,000					1,000					1,000					1,000
Capital repairs short-term (6)											25,050										25,050					
Capital replacement long-term (7)																					66,800					
Electricity (8)		5,000	5,160	5,320	5,480	5,640	5,800	5,960	6,120	6,280	6,440	6,600	6,760	6,920	7,080	7,240	7,400	7,560	7,720	7,880	8,040	8,200	8,360	8,520	8,680	8,840
Water (9)		250	263	275	288	300	313	325	338	350	363	375	388	400	413	425	438	450	463	475	488	500	513	525	538	550
Insurance (10)		58	60	63	65	67	70	72	74	77	79	81	84	86	88	90	93	95	97	100	102	104	107	109	111	114
Administrative Overhead (11)		1,394	1,422	1,450	1,478	1,506	1,533	1,561	1,589	1,617	1,645	1,673	1,701	1,729	1,756	1,784	1,812	1,840	1,868	1,896	1,924	1,952	1,979	2,007	2,035	2,063
Total Operating	-	9,056	9,306	9,556	9,806	11,555	10,305	10,555	10,805	11,055	37,854	11,554	11,804	12,054	12,303	14,053	12,803	13,053	13,303	13,552	107,152	14,052	14,302	14,552	14,801	16,551
Total Facilities Cost	334,000	9,056	9,306	9,556	9,806	11,555	10,305	10,555	10,805	11,055	37,854	11,554	11,804	12,054	12,303	14,053	12,803	13,053	13,303	13,552	107,152	14,052	14,302	14,552	14,801	16,551
Net Profit (Expense)	(334,000)	10,744	10,593	10,443	10,293	8,644	9,995	9,846	9,699	9,551	(17,145)	9,258	9,113	8,968	8,823	7,179	8,535	8,392	8,249	8,107	(85,384)	7,825	7,685	7,545	7,405	5,767
Cumulative (Payback Period in Years)	(334,000)	(323,256)	(312,663)	(302,221)	(291,928)	(283,284)	(273,290)	(263,443)	(253,744)	(244,193)	(261,338)	(252,080)	(242,967)	(234,000)	(225,177)	(217,998)	(209,463)	(201,071)	(192,822)	(184,714)	(270,099)	(262,274)	(254,589)	(247,044)	(239,639)	(233,872)
PV Analysis	(334,000)	10,585	10,282	9,986	9,698	8,023	9,141	8,872	8,610	8,354	(14,774)	7,860	7,622	7,389	7,163	5,742	6,726	6,515	6,310	6,110	(63,395)	5,724	5,538	5,357	5,180	3,974
Investment Rate	1.50%																									
Cumulative (Payback Period in Years) using PV analysis	(334,000)	(323,415)	(313,133)	(303,146)	(293,449)	(285,425)	(276,285)	(267,413)	(258,803)	(250,449)	(265,223)	(257,363)	(249,741)	(242,352)	(235,189)	(229,447)	(222,721)	(216,206)	(209,896)	(203,786)	(267,181)	(261,457)	(255,919)	(250,562)	(245,382)	(241,408)

Assumptions	**Annual**	**5 year**	**10 year**	**20 year**
1. Revenue estimated growth rate	0.50%			
2. Cost - Initial Capital Outlay is from all sources (Grants, Special Revenue Funds, General Fund, etc.)				
3. Maintenance (cleaning, trash, etc.)				
MRT Park Specialist (Mid point)	$ 16.53			
Benefits as a percentage of wages for FY13 (11% retirement, 15.6% benefits)	26.6%			
Estimated allocated time	2.50%			
Estimated annual salary increase	2.00%			
Annual work hours	1,500			
4. Landscape (new plants, trim plants, repair drip lines, etc.)				
New plant replacement is estimated every 5 years		$ 500.00		
MRT Park Specialist (Mid point)	$ 16.53			
Benefits as a percentage of wages for FY13 (11% retirement, 15.6% benefits)	26.6%			
Estimated allocated time	5.00%			
Estimated annual salary increase	2.00%			
Annual work hours	1,500			
5. Trail grooming is provided by volunteers				
Nominal Cost every 5 years		$ 1,000.00		
6. Capital repairs short-term (facility painting, parking lot stripping, signage, dumping station leach line cleaning)				
Estimated cost as a percentage of facility every 10 years			7.50%	
CPI un-adjusted one year ended Aug. 2013 All Items			1.50%	
7. Capital replacement long-term (major facilities repairs)				
Estimated cost as a percentage of facility every 20 years				20.00%
CPI un-adjusted one year ended Aug. 2013 All Items				1.50%
8. Electricity				
Estimated base level	$ 5,000.00			
CPI un-adjusted one year ended Aug. 2013 Energy Services	3.20%			
9. Water				
Estimated base level	$ 250.00			
USA Today predicts water increases every few years	5.00%			
10. Insurance				
Estimated base level	$ 58.00			
Risk Management Insurance Premium increases	4.00%			
11. Administrative Overhead allocated				
Central Service Cost Allocation A300 Parks and Rec	$ 279.00			
Parks and Recreation Administration Cost	$ 1,115.00			
Estimated growth rate	2.00%			

CPI - As an economic indicator. As the most widely used measure of inflation, the CPI is an indicator of the effectiveness of government policy.
In addition, business executives, labor leaders and other private citizens use the index as a guide in making economic decisions.
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Parks and Recreation - Maintain/Rehabilitate Existing Facilities
Waterfall: Rennovations
Priority: High

Revenue (1)	**Est. Cost**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**	**Year 21**	**Year 22**	**Year 23**	**Year 24**	**Year 25**
5% increase in visitation including picnic/trail use ($2.05 per person)		14,800	14,874	14,949	15,024	15,099	15,174	15,250	15,326	15,403	15,480	15,557	15,635	15,713	15,792	15,871	15,950	16,030	16,110	16,191	16,272	16,353	16,435	16,517	16,600	16,683
Total Revenue	-	14,800	14,874	14,949	15,024	15,099	15,174	15,250	15,326	15,403	15,480	15,557	15,635	15,713	15,792	15,871	15,950	16,030	16,110	16,191	16,272	16,353	16,435	16,517	16,600	16,683
Costs - Initial Capital Outlay (2)																										
Parking realignment	100,000																									
Kiosk	3,000																									
Shaded resting area	115,000																									
Total Outlay	218,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Costs - Annualized Operating																										
Maintenance (3)		785	800	816	832	848	863	879	895	910	926	942	957	973	989	1,004	1,020	1,036	1,052	1,067	1,083	1,099	1,114	1,130	1,146	1,161
Landscape (4)		1,570	1,601	1,632	1,664	1,695	1,726	1,758	1,789	1,821	1,852	1,883	1,915	1,946	1,978	2,009	2,040	2,072	2,103	2,135	2,166	2,197	2,229	2,260	2,292	2,323
Landscape (4)						500					500					500					500					500
Trail grooming (5)						1,000					1,000					1,000					1,000					1,000
Capital repairs short-term (6)											16,350										16,350					
Capital replacement long-term (7)																					43,600					
Electricity (8)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water (9)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Insurance (10)		134	139	145	150	155	161	166	172	177	182	188	193	198	204	209	214	220	225	230	236	241	247	252	257	263
Administrative Overhead (11)		3,208	3,272	3,336	3,400	3,465	3,529	3,593	3,657	3,721	3,785	3,850	3,914	3,978	4,042	4,106	4,170	4,235	4,299	4,363	4,427	4,491	4,555	4,620	4,684	4,748
Total Operating	-	5,696	5,813	5,929	6,046	7,663	6,279	6,396	6,513	6,629	24,596	6,862	6,979	7,096	7,212	8,829	7,445	7,562	7,679	7,795	69,362	8,028	8,145	8,262	8,378	9,995
Total Facilities Cost	218,000	5,696	5,813	5,929	6,046	7,663	6,279	6,396	6,513	6,629	24,596	6,862	6,979	7,096	7,212	8,829	7,445	7,562	7,679	7,795	69,362	8,028	8,145	8,262	8,378	9,995
Net Profit (Expense)	(218,000)	9,104	9,062	9,019	8,978	7,436	8,895	8,854	8,814	8,774	(9,116)	8,695	8,656	8,618	8,580	7,042	8,505	8,468	8,432	8,395	(53,090)	8,325	8,290	8,255	8,221	6,688
Cumulative (Payback Period in Years)	(218,000)	(208,896)	(199,834)	(190,815)	(181,837)	(174,401)	(165,506)	(156,652)	(147,838)	(139,065)	(148,180)	(139,485)	(130,829)	(122,211)	(113,632)	(106,589)	(98,085)	(89,617)	(81,185)	(72,789)	(125,880)	(117,555)	(109,265)	(101,010)	(92,789)	(86,101)
PV Analysis	(218,000)	8,970	8,796	8,625	8,458	6,903	8,135	7,978	7,824	7,674	(7,855)	7,382	7,240	7,101	6,965	5,633	6,702	6,574	6,449	6,327	(39,418)	6,089	5,974	5,862	5,751	4,609
Investment Rate	1.50%																									
Cumulative (Payback Period in Years) using PV analysis	(218,000)	(209,030)	(200,235)	(191,609)	(183,151)	(176,248)	(168,113)	(160,136)	(152,311)	(144,638)	(152,493)	(145,111)	(137,871)	(130,770)	(123,804)	(118,172)	(111,470)	(104,895)	(98,446)	(92,119)	(131,537)	(125,447)	(119,473)	(113,612)	(107,860)	(103,251)

Assumptions	**Annual**	**5 year**	**10 year**	**20 year**
1. Revenue estimated growth rate. Most popular & used area in park.	0.50%			
2. Cost - Initial Capital Outlay is from all sources (Grants, Special Revenue Funds, General Fund, etc.)				
3. Maintenance (cleaning, trash, etc.)				
MRT Park Specialist (Mid point)	$ 16.53			
Benefits as a percentage of wages for FY13 (11% retirement, 15.6% benefits)	26.6%			
Estimated allocated time	2.50%			
Estimated annual salary increase	2.00%			
Annual work hours	1,500			
4. Landscape (new plants, trim plants, repair drip lines, etc.)				
New plant replacement is estimated every 5 years		$ 500.00		
MRT Park Specialist (Mid point)	$ 16.53			
Benefits as a percentage of wages for FY13 (11% retirement, 15.6% benefits)	26.6%			
Estimated allocated time	5.00%			
Estimated annual salary increase	2.00%			
Annual work hours	1,500			
5. Trail grooming is provided by volunteers				
Nominal Cost every 5 years		$ 1,000.00		
6. Capital repairs short-term (facility painting, parking lot stripping, signage, dumping station leach line cleaning)				
Estimated cost as a percentage of facility every 10 years			7.50%	
CPI un-adjusted one year ended Aug. 2013 All Items			1.50%	
7. Capital replacement long-term (major facilities repairs)				
Estimated cost as a percentage of facility every 20 years				20.00%
CPI un-adjusted one year ended Aug. 2013 All Items				1.50%
8. Electricity				
Estimated base level	$ -			
CPI un-adjusted one year ended Aug. 2013 Energy Services	3.20%			
9. Water				
Estimated base level	$ -			
USA Today predicts water increases every few years	5.00%			
10. Insurance				
Estimated base level	$ 134.00			
Risk Management Insurance Premium increases	4.00%			
11. Administrative Overhead allocated				
Central Service Cost Allocation A300 Parks and Rec	$ 643.00			
Parks and Recreation Administration Cost	$ 2,565.00			
Estimated growth rate	2.00%			

CPI - As an economic indicator. As the most widely used measure of inflation, the CPI is an indicator of the effectiveness of government policy.
In addition, business executives, labor leaders and other private citizens use the index as a guide in making economic decisions.
http://www.bls.gov/news.release/pdf/cpi.pdf

Appendix L – Dark Sky Initiative

{Insert Dark Sky information after this page.}

Impacts of Artificial Night Lighting on Wildlife

Arizona Game and Fish Department

Wildlife Economics

- Combined Hunting, Fishing, and Wildlife Viewing
- Arizona (2000-2003)
  - $100M in trip items – Food, fuel, lodging
  - 1,936 positions
  - $829M in non-trip items – Souvenirs, hunting supplies, entertainment
  - 16,217 positions





General Impacts to Wildlife

- Disorientation or unnatural stimulus
- Disrupt reproduction for many species
- Increase and/or decrease competition between species
- Benefit some predators to the detriment of their prey species

Mammals

- Reduction in activity, movement, and food consumption of rodents (Vasquez 1994; Kramer and Birney 2001; Brillhart and Kaufman 1991; Clarke 1983; Falkenberg and Clarke 1998)
  - Responded to 0.1 lux (half moon) and 0.3 lux (full moon)
  - Roads use minimum of 3 lux

- Seed harvest in desert rodents declined 21% (Kotler 1984)
  - Illumination from 1 camping lantern

Ords kangaroo rat

Western harvest mouse

Mammals

- Mountain lions avoided urban glow (Beier 1995)
  - Resulted in movement through unfavorable topography and habitat
- Bats avoided illuminated areas (Stone et al. 2009)
  - Increased predation
  - Disrupts normal 24hr pattern of light and dark

Mountain lion

California leaf-nosed bat

Reptiles and Amphibians

- Predation on snakes increased with elevated levels of illumination (Bouskila 1995)
- Snake prey reduced foraging activity in response to increased illumination (Bouskila 1995; Bowers 1988)
- Ability of navigation through corridors (Beier 2006) can be impaired as well as implications in the decline of reptile populations noted by Perry and Fisher 2006.
- Eastern newts orientation and homing behavior can be disrupted during migration (Phillips and Borland 1992, 1994)

Eastern newt

Shovelnose snake

Birds

- Nocturnally migrating birds disorientated by red and white light (Poot et al. 2008)
  - Mortalities from collisions with towers and buildings (Gehrinig et al. 2009)

- Robins initiated morning chorus on average of 116min before civil twilight (Miller 2006)
  - Light averaged 3.91 lux (0.3 lux = fullmoon)

NY Twin Tower Memorial

So How Can Light Pollution be Addressed?

- Local and regional ordinances can educate the public, and such regulations have been shown to address this challenge effectively.
- Efforts to mitigate the effects of light pollution on species and habitats should consider five essential elements of lighting:
  - Need
  - Direction
  - Intensity
  - Duration
  - spectrum

Some Options…

- Eliminate all bare bulbs and any lighting pointing upward. This is especially true for decorative lighting, and would reduce contributions to overall light pollution.
- Use only the minimum amount of light needed for safety.
- Use narrow spectrum bulbs as often as possible to lower the range of species affected by lighting.
- Shield, canter or cut lighting to ensure that light reaches only areas needing illumination and significantly reduce the glow.
- Light only high-risk stretches of roads, such as crossings and merges, allowing headlights to illuminate other areas. Where possible, use embedded road lights to illuminate the roadway.
- In Flagstaff and Coconino County, the desire to maintain dark skies for the Flagstaff Naval Observatory and Lowell Observatory has led to city and county ordinances protecting dark skies. These ordinances have coincidentally offered wildlife relief from the negative impacts of light pollution.
- All new developments should use the latest management technologies so that continued growth and expansion leads to no increase in the impact of light pollution (Salmon 2003).
- Do not install artificial lighting on rural roads that pass through areas of linkage designs for wildlife and instead consider speed bumps, curves, artificial constrictions and other traffic calming devices.

Questions or Comments?

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Chapter 2

Effects of Artificial Night Lighting on Terrestrial Mammals

Paul Beier

All 986 species of bats, badgers and most smaller carnivores, most rodents (with the notable exception of squirrels), 20% of primates, and 80% of marsupials are nocturnal, and many more are active both night and day (Walls 1942). Thus it would be surprising if night lighting did not have significant effects on mammals. Compared with investigations on birds, lepidopterans, other insects, and turtles, however, few studies, or even anecdotal reports, document the effects of artificial night lighting on mammals in the wild. Because of the dearth of empirical evidence, this chapter begins with a review of the biology of mammalian vision, including the extensive literature on how moonlight affects nocturnal behavior of mammals and how light influences mammalian biological clocks. I then discuss several classes of likely effects of artificial night lighting on mammals, namely disruption of foraging patterns, increases in predation risk, disruption of biological clocks, increases in mortality on roads, and disruption of dispersal movements through artificially lighted landscapes. I include recommendations for experiments or observations that could advance our understanding of the most likely and significant effects.

Light and the Ecology and Physiology of Mammals

Insight into the potential consequences of artificial night lighting on mammals can be gained from an understanding of the activity patterns, visual ability, and physiological cycles of species under normal patterns of light and dark. Artificial light at night may disrupt the various daily, monthly, and annual cycles described in this section.

Mammals vary in their activity periods, with corresponding adaptations in their visual systems (Walls 1942). Activity patterns can be classified into five types (Halle and Stenseth 2000). Mammals with a nocturnal pattern obviously are most likely to be affected by artificial night lighting. I will treat the crepuscular pattern, defined as nocturnal with activity peaks at dawn and dusk, as a variant on the nocturnal theme; this group includes most lagomorphs. Diurnal mammals include all squirrels except the flying squirrels and most primates, including humans. Indeed, if human vision were not so anatomically diurnal, artificial lighting would not be necessary. Mammals with the 24-hour pattern include ungulates and larger carnivores, plus some smaller carnivores. These species have excellent night vision and usually are most active at night but have regular daytime activity periods as well. I ignore the ultradian pattern—periodicity less than 24 hours, typically 3- to 5-hour cycles—because it has been documented only in voles and is light-independent (Gerkema et al. 1990).

Anatomy and Physiology of Vision in Mammals

How various mammals respond to light depends, among other things, on the architecture of the eye, including its pupil, type of lens, and especially whether the photosensitive cells in the retina are dominated by rods or cones. Nocturnal mammals have large pupils to admit more light, huge lenses to minimize spherical aberration, and rod-rich retinas (Walls 1942). The rod system has high sensitivity but low acuity; that is, it can be stimulated by a few photons, but ability to see detail is poor because many rod cells connect to a single neuron. This means that small stimuli from several rods can act in concert to stimulate a neuron and thus deliver a signal to the brain. Because the brain is unable to determine exactly which rods were stimulated, however, it cannot discern the exact size and shape of the perceived object. In contrast, there is little summation among neurons where cones and neurons approach a 1:1 ratio in parts of some mammalian retinas.

Most nocturnal mammals have few cones; bats and armadillos have nearly cone-free retinas (Walls 1942). Nocturnal mammals with few cones are temporarily blinded by bright light because the rods become unresponsive (i.e., saturated) above 120 cd/m^2, approximately the light level at twilight. Narrowing the pupil is the primary short-term defense of cone-poor mammals against rod saturation in bright light but is only marginally effective at reducing the blinding effect of light (Perlman and Normann 1998).

Because they lack high-resolution cones, few nocturnal mammals eat seeds, small fruits, or small mobile insects unless such foods are clumped into large, visually detectable aggregations such as inflorescences or anthills or are detectable by other means such as echolocation or scent. Nocturnal animals can partially overcome the poor resolving power of the rod-dominated retina by having large eyes that permit large retinal images. Because the size of rods does not decrease with body size, what matters here is the absolute, not relative, size of the retinal image (Walls 1942). Thus the limited skull size of small nocturnal mammals limits their evolutionary ability to improve visual resolution.

The retina of diurnal mammals is rich in cones, which provide clear images at close range or in good light. A large number of photons is needed to stimulate a cone, however, which makes cones useless in dim light. Most, perhaps all, diurnal squirrels are similar to diurnal birds in having retinas so poor in rods that they are nearly blind at night. Although most diurnal mammals, including humans, have fewer cones than rods, most of these mammals are large, and their large retinal image ensures high visual acuity in daylight. The lenses of diurnal mammals resemble those of 24-hour mammals.

Like some nocturnal and crepuscular mammals, most mammals capable of 24-hour activity have a retina composed mostly of rods, but they have enough cones for a second image-forming system useful in bright light (Perlman and Normann 1998). Changes in pupil size are less important than photon saturation of the rods in switching between systems (Perlman and Normann 1998). When a mammal with a 24-hour eye comes from darkness into light, the rods saturate, thereby becoming incapable of stimulation, and the shift to the cone system occurs within about 2 seconds. The shift from bright to low light takes much longer (Lythgoe 1979) and involves more complex chemical reactions for the rods to fully resensitize (Perlman and Normann 1998). Although the rod system may gain a 100-fold increase in sensitivity within 10 minutes after the transition to darkness, another 10-fold gain in sensitivity can occur between 10

and 40 minutes (Lythgoe 1979). The presence of a bright light in an otherwise dark environment may suppress the rod system in part or all of the retina, leaving the animal not fully adjusted to the dark.

Many 24-hour mammals, and some nocturnal and crepuscular mammals, have a highly reflective layer behind the photoreceptive cells, the tapetum lucidum, that amplifies the light reaching those cells. The tapetum is found in most carnivores and ungulates but rarely in rodents, lagomorphs, or higher primates.

In mammals with both rod and cone systems, the shift between systems is accompanied by a change in spectral sensitivity called the Purkinje shift. Cone cells have a variety of photoreactive pigments, and this variety creates a capacity for color vision in the cone system. Because rods rely on only one photoreactive pigment, rhodopsin, with maximum absorption around 496 nm, the color-blind rod system discriminates only on the basis of brightness.

Influence of Moonlight on Behavior of Nocturnal Mammals

Most nocturnal mammals react to increasing moonlight by reducing their use of open areas, restricting foraging activity and movements, reducing total duration of activity, or concentrating foraging and longer movements during the darkest periods of night. Such behaviors have been recorded in studies of desert rodents (Lockard and Owings 1974, Price et al. 1984, Bowers 1988, Alkon and Saltz 1988), temperate zone rodents (Kaufman and Kaufman 1982, Travers et al. 1988, Vickery and Bider 1981, Wolfe and Summerlin 1989, Topping et al. 1999), desert lagomorphs (Butynski 1984, Rogowitz 1997), Arctic lagomorphs (Gilbert and Boutin 1991), fruit bats (Morrison 1978, Law 1997, Elangovan and Marimuthu 2001), a predatory bat (Subbaraj and Balasingh 1996), some primates (Wright 1981), male woolly opossums (Julien-Laferrière 1997), and European badgers (Cresswell and Harris 1988).

Most authors attributed these changes to increased predation risk in open habitats under bright moonlight. Although no field study conclusively confirms or refutes this explanation, circumstantial evidence supports it. Increased coyote howling during the new moon is consistent with the unprofitability of hunting rodents under these conditions (Bender et al. 1996). In laboratory studies (Clarke 1983, Dice 1945), owls were better able to catch deer mice in brighter light. However, as Clarke (1983) explained, these laboratory results may not reveal much about the effect on predation rate under natural conditions. On bright nights, most prey

remain in secure places, but the few that are in bright conditions may be readily killed. On dark nights, owl efficiency per prey may be reduced, but with many active prey available, the total prey consumption and the prey's mortality rate from the owl may be unchanged (Daly et al. 1992). Similarly, ocelot behavior is consistent with the hypothesis that fewer but more successful prey encounters occur under bright light (Emmons et al. 1989).

Some nocturnal species neither decrease activity nor seek habitats with canopy cover during bright moonlight. Many insectivorous bats do not decrease activity during bright moonlight (Negraeff and Brigham 1995, Hecker and Brigham 1999), although some species do, at least in captivity (Erkert 2000). Some insectivorous bats prefer to forage in upper canopy under bright moonlight (Hecker and Brigham 1999) or under artificial night lighting (Rydell and Baagøe 1996), in both cases because insect prey are more abundant in the brighter areas (for further discussion of bats see Chapter 3, this volume). Moonlight is associated with increased activity in woodland rodents such as *Peromyscus leucopus* (Barry and Francq 1982), the nocturnal monkey *Aotus trivirgatus* (Wright 1981), and the galagos (Galagonidae; Nash 1986). In most instances, these studies provided adaptive reasons for increased activity in moonlight. For example, the galagos, although nocturnal, visually detect their insect prey, and they avoid predation not by concealment but by visual detection, mobbing, and flight. Moonlight does not change the activity pattern of ocelots (Emmons et al. 1989) or white-tailed deer (Beier and McCullough 1990; but see Kie 1996).

The Circadian Clock in Mammals

The freerunning period of activity, the activity cycle for an animal under constant light or darkness, ranges from 23 to 25 hours for most vertebrates, with extremes of 21 to 27 hours (Foster and Provencio 1999). Because the freerunning clock is not exactly 24 hours, the internal circadian system must be synchronized to local time by a cue in the animal's environment. This process is called entrainment, and the cue used to synchronize the internal clock is called a zeitgeber. For all vertebrates, the primary zeitgeber is change in the quantity, and perhaps the spectral quality, of light at dawn and dusk (Foster and Provencio 1999). In vertebrates, the two image-forming visual systems (i.e., the rod and cone systems) do not entrain the biological clock, which is governed by a special photoreceptor system separate from them. In mammals, this photoreceptor sys-

tem lies in the retina and communicates to a different part of the brain, the suprachiasmatic nuclei (SCN), via a different neural system, comprising less than 0.01% of retinal ganglion cells (Foster and Provencio 1999). Loss of the eyes or SCN blocks entrainment of the circadian clock in all mammals studied. Shifting circadian rhythm requires more light than that needed to form a visual image, and the stimulus must be of longer duration, 30 seconds to 100 minutes (Figure 2.1; Foster and Provencio 1999).

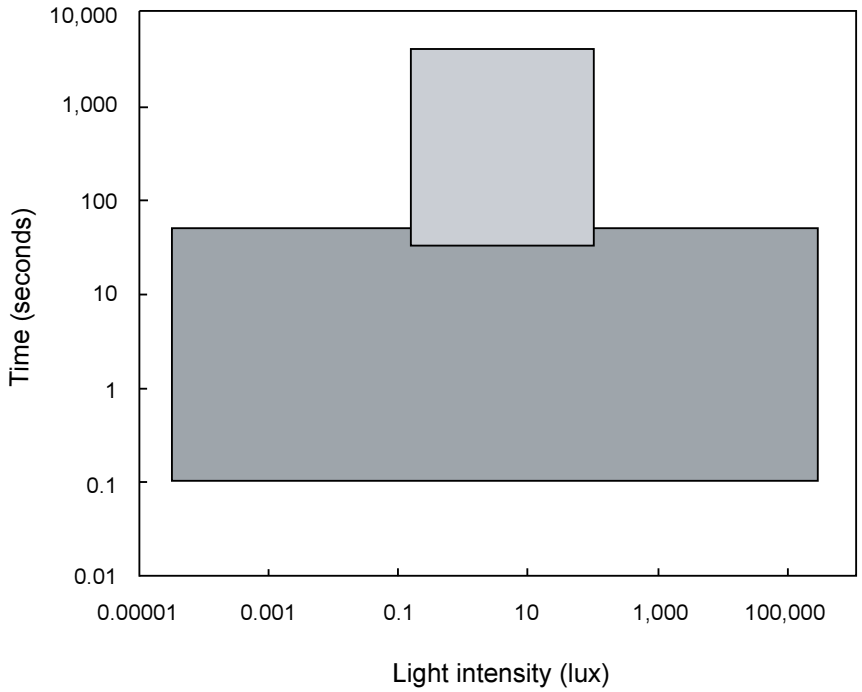

Figure 2.1. The response range of the visual imaging system (large box) has minimal overlap with the response range of the circadian system in vertebrates (small box). Influencing the biological clock requires both more light (*x*-axis) and longer duration (*y*-axis) than forming a visual image. This protects the circadian system from many photic stimuli that do not provide reliable time cues. The upper threshold in light intensity makes the circadian clock more sensitive to twilight intensities than to full sunlight. Artificial lights within the range of duration and intensity described by the small box disrupt the mammalian biological clock. Figure adapted from Foster and Provencio (1999: Figure 3), with the *x*-axis converted from photons per unit area. Although there is no exact conversion to lux, this approximation allows the reader to compare these light intensities with those illustrated in Figure 2.2.

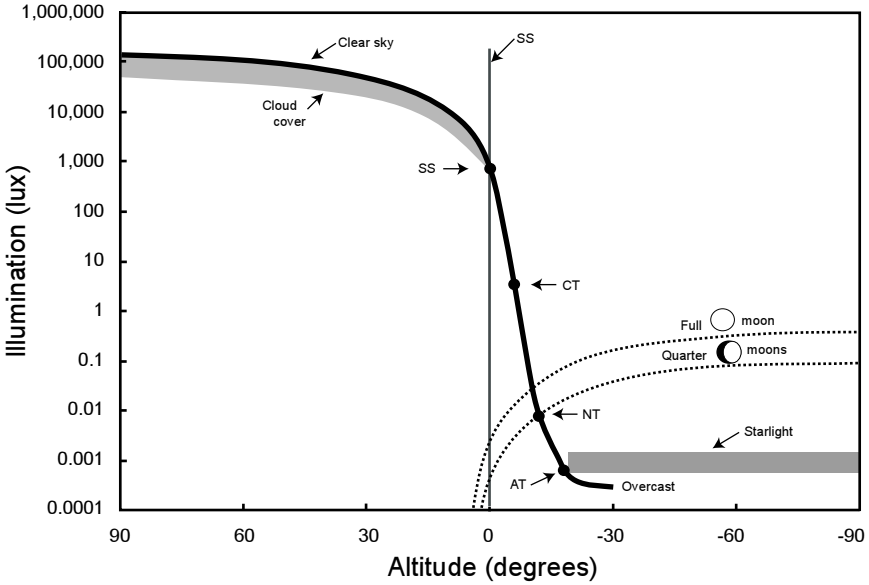

Figure 2.2. Illumination at Earth's surface varies with solar and lunar altitude above the horizon. For comparative purposes, the Illuminating Engineering Society recommends 3–16 lux illumination for U.S. highways or as a maximum for off-site spill from recreational sports facilities. In practice, these recommendations often are exceeded by an order of magnitude. Note log scale on *y*-axis. The altitude of the moon above the horizon is deliberately displayed on the negative (below horizon) half of the *x*-axis so that the *x*-axis can be interpreted as time relative to sunset. AT, astronomical twilight with sun 18° below horizon; CT, civil twilight with sun 6° below horizon; NT, nautical twilight with sun 12° below horizon; SS, sunset. Figure adapted from McFarland et al. (1999: Figure 1).

Light level at twilight falls at the lower end of this range (Figure 2.2; McFarland et al. 1999). These thresholds—as well as the upper limits—are useful in preventing photic noise from resetting the circadian clock. For instance, lightning, which can be fifty times brighter than direct sunlight, would confuse circadian rhythm if it were of sufficient duration. It has long been thought that the irradiance of starlight and the full moon both fall below the threshold for entrainment and cannot reset the circadian clock, although entrainment of circadian rhythm recently has been recorded at illuminances as low as 10^{-5} lux in bats (Erkert 2004). Low-intensity stimuli of sufficient duration can suppress melatonin production in rats (Dauchy et al. 1997) and humans (Brainard et al. 1997), suggesting that such stimuli also affect the circadian clock, at least in humans (Shanahan et al. 1997) in addition to bats.

The light regime and the circadian clock also influence production of some hormones, notably melatonin, which mediates not only the activity patterns discussed earlier but also almost every physiological or behavioral rhythm in mammals (Bartness and Goldman 1989). In all species, melatonin production is high at night and suppressed during daytime, although reaction to melatonin often differs between diurnal and nocturnal species. Among its many roles, melatonin suppresses tumor growth by regulating production and tumor use of linoleic acid. In a laboratory experiment, Dauchy et al. (1997) determined that minimal light contamination of 0.2 lux, simulating a light leak around a laboratory door during an otherwise normal dark phase, disrupted normal circadian production of melatonin and promoted tumor growth in rats. Compared with rats experiencing a cycle of 12 hours light and 12 hours total darkness per day, rats experiencing light contamination produced 87% less melatonin, similar to the 94% decline observed in rats held in full light 24 hours per day. There were corresponding dramatic increases in tumor growth. Remarkably, low-intensity light exposure during the subjective dark phase had virtually the same effect as constant light in blocking melatonin production and stimulating tumor growth.

The Circannual Clock and Lunar Clock in Mammals

Mammals also have an endogenous rhythm with a freerunning period of about 1 year. The circannual clock influences annual changes in body mass, hormones, reproductive status, hibernation, and the circadian activity pattern over the course of the year. By controlling breeding season, delayed fertilization of the ovum, and delayed implantation of the blastocyst, the circannual clock causes parturition of most species of mammals to occur in a highly compressed period. This reduces the neonatal mortality rate by predator swamping and synchronizes parturition with favorable foraging conditions (Vaughan 1978, Gwinner 1986).

Because experiments on the circannual clock take years to complete, our understanding of it remains poor, and only three mammal species have been studied in any detail, namely the golden hamster (*Mesocricetus auratus*; Bronson 1989), domestic sheep (Bronson 1989), and golden-mantled ground squirrel (*Spermophilus lateralis*; Dark et al. 1990, Zucker et al. 1983, Pengelley and Fisher 1963, Lee et al. 1986). Light appears to be the most important—perhaps the only—zeitgeber for the circannual clock of hamster and sheep (Bronson 1989). Both of these species are

highly domesticated, however, and all laboratory stocks of the hamster are highly inbred, having descended from a single mother and her litter captured in 1930. These factors may limit the extent to which we can extrapolate to wild mammals.

Light may be of equal or lesser importance than temperature in setting the circannual clock of the golden-mantled ground squirrel and especially in governing the hibernation cycle of the species. Zucker et al. (1983) demonstrated that light was involved in entraining the circannual clock in golden-mantled ground squirrels. However, loss of the SCN disrupted the annual reproductive cycle and the annual cycle of body mass in only eight of nineteen squirrels, indicating existence of a circannual oscillator that is anatomically separate from the SCN. Although the neural structure that functions as the circannual oscillator has not been identified, it is influenced by the retinal system that terminates in the SCN (Dark et al. 1990). Although Hock (1955) reported a strong role for light in initiating hibernation of the Arctic ground squirrel (*Spermophilus undulatus*), Pengelley and Fisher (1963) reported that although an artificially reversed thermal regime caused golden-mantled ground squirrels to hibernate in summer, it was impossible to produce a similar reversal in the phase of the hibernation cycle by changing light conditions. Emergence from hibernation in spring cannot possibly be influenced by photoperiod because these squirrels hibernate in dark burrows.

In summary, studies of circannual cycles of a few mammalian species suggest that light is an important zeitgeber but perhaps not the only one. The importance of light as a circannual regulator is also a logical necessity, given the crucial role of light in production of melatonin and the well-documented importance of melatonin in governing reproductive activity (Bartness and Goldman 1989). Bronson (1989) and Gwinner (1986) provide excellent overviews of this complex topic.

Lunar cycles also may play an important role in timing of mammalian reproductive behaviors. Murray (1982) and Skinner and van Jaarsveld (1987) suggested that moonlight may synchronize estrus in some ungulates. Both of these were observational studies, and there appears to be no experimental work on how lunar cycles affect mammalian reproduction or whether the mammalian brain has a neural circalunar oscillator that is entrained by moonlight. The absence of such evidence is a result of a lack of effort and cannot be construed as refuting the existence or importance of a circalunar clock.

Plausible Effects of Artificial Night Lighting on Mammals

In the rest of this chapter I make inferences about plausible effects of artificial night lighting by considering the foregoing information in relation to the properties of artificial night light and evaluating the handful of studies on how artificial lighting influences mammal behavior in the wild. Potential influences of artificial lights at night on mammals include disruption of foraging behavior, increased risk of predation, disruption of biological clocks, increased deaths in collisions on roads, and disruption of dispersal movements and corridor use.

Disruption of Foraging Behavior and Increased Risk of Predation

Many studies cited in this chapter have shown that bats, nocturnal rodents, and other nocturnal mammals respond to moonlight by shifting their activity periods, reducing their activity, traveling shorter distances, and consuming less food. Artificial light of similar intensity to moonlight caused rodents in experimental arenas to reduce their activity, movement, and food consumption (Vasquez 1994, Kramer and Birney 2001, Brillhart and Kaufman 1991, Clarke 1983, Falkenberg and Clarke 1998). These experiments used both fluorescent and incandescent lights to simulate moonlight, with rodents responding to stimuli equivalent to that of a half moon (0.1 lux) as well as a full moon (0.3 lux). Thus, artificial night lighting of similar intensity to moonlight reduces activity and movement of many nocturnal animals, particularly those that rely on concealment to reduce predation risk during nocturnal foraging. Because roadway lighting in the United States is designed to illuminate the road surface at a minimum of 3 lux (the lowest acceptable value midway between light standards) and an average of 4–17 lux, depending on type of pavement and roadway, with maximum values two or three times the average directly under lampposts (IESNA 2000), all artificial night lighting can be expected to have such effects along road edges.

Although small mammals can respond to bright moonlight by shifting foraging and ranging activities to darker conditions, this option is not available to animals experiencing artificially increased illumination throughout the night. Under these circumstances, unless they abandon the lighted area, nocturnal animals have only two unfortunate choices. One is to accept the risk of predation by foraging under bright light, as Alkon and Saltz (1988) observed when food shortages forced crested por-

cupines (*Hystrix indica*) to abandon their light-phobic behaviors. The other option is to continue to minimize predation risk even at the cost of loss of body mass, as observed in an experiment on the cricetid rodent *Phyllotis darwini* (Vasquez 1994). The rodents responded to simulated moonlight by carrying 40% of their food to the refuge site in the arena and consuming it there, compared with less than 4% of food consumption under dark conditions. On bright nights, the rodents consumed 15% less food and lost 4.4 g, compared with a 1.1-g weight loss on dark nights. Despite difficulties in translating these experimental results to field conditions, artificial night lighting undoubtedly reduces food consumption and probably increases predation risk for nocturnal rodents in the wild.

Few studies have investigated the effects of artificial light on feeding behavior of mammals in natural populations. In one study Kotler (1984) strongly confirmed that artificial night lighting affects nocturnal rodents. During the new moon, Kotler observed that seed harvest by the desert rodent community (four species of *Dipodomys*, *Peromyscus maniculatus*, and possibly *Perognathus longimembris* and *Microdipodops pallidus*) decreased an average of 21% in response to a single fluorescent or gasoline camping lantern placed to cast light equivalent to 160% (8 m [26 ft] from lantern) to 25% (35 m [115 ft] from lantern) of the light of a full moon. He also reported that, within trials, harvesting rate was lower at feeding sites that were most brightly illuminated, but he did not quantitatively describe that relationship. To help planners estimate the magnitude of this effect, future research should determine the functional relationship between food harvest (or other variables related to fitness) and illumination and determine whether there is a threshold illumination below which no effect occurs. Although lighting at sport stadiums, gas stations, and some commercial operations is brighter than highway lighting, the latter probably is the brightest lighting that affects large areas of wildlands. Thus, research focusing on the intensities and heights of lighting that are prescribed or implemented along highways, and their effects in a landscape context, would be most helpful.

Bird et al. (2004) also investigated the effects of artificial lighting on rodent foraging. In coastal Florida, they measured foraging of Santa Rosa beach mouse (*Peromyscus polionotus leucocephalus*) as a proxy for another threatened and endangered subspecies of *Peromyscus polionotus*. Resource patches of food were placed along transects with arrays of low pressure sodium lights, "bug" lights, and no lights. The percentage of resource patches foraged by mice was significantly higher in dark arrays than light arrays and higher at arrays with bug lights than low pressure sodium

lights. Effects of actual beachfront lighting were presumed to be greater those observed in the experiment because taller and more intense light sources are commonly used in coastal development.

De Molenaar et al. (2003) studied mammal response to streetlamps experimentally installed on small earthen dams that crossed flooded drainage ditches in the Netherlands. Aquatic mammals such as muskrats (*Ondatra zibethicus*) had to cross these dams to move along the ditch, and other mammals used the dams to pass between patches of upland habitat without swimming. The four predators—polecat (*Mustela putorius*), stoat (*Mustela erminea*), weasel (*Mustela nivalis*), and fox (*Vulpes vulpes*)—were more likely to walk on or near illuminated dams than unlit ones, and the brown rat (*Rattus norvegicus*) seemed to avoid lighted dams. The four other species studied (muskrat, hedgehog [*Erinaceus europaeus*], hare [*Lepus europaeus*], and roe deer [*Capreolus capreolus*]) showed no marked response.

With their cone-rich retinas, most sciurids probably are nearly blind at night, even under moonlight or artificial night lighting. To conceal themselves from visual predators, most tree squirrels spend the night in nests in trees, and ground squirrels sleep underground. To the extent that artificial night lighting assists visual predators at night, it could decrease squirrel survival rates.

Does artificial night lighting benefit owls, bats, or other predators? If desert rodents are more vulnerable to owls and other nocturnal predators under moonlight or its equivalent, it is tempting to think of artificial night lighting as enhancing habitat for these predators. Many species of insectivorous bats aggregate at streetlamps to exploit aggregations of moths and other insects that are attracted to the light (Blake et al. 1994, Rydell and Baagøe 1996). Some reports have implied that this is good for bats, but this makes sense only under the nonecological valuation that more is better. Certainly such aggregations are not natural, nor are they beneficial to insect prey of the bats. Such lighting should not be justified in terms of benefits to bats unless the feeding stations are explicitly intended to compensate for human-caused loss of other food sources or human-caused excess of the insect populations attracted to the lights.

Disruption of Biological Clocks

Assuming that the circadian clock evolved to maximize foraging efficiency, to reduce risk of predation, to enhance parental care, or for similarly important reasons, artificial night lighting can adversely affect ani-

mals by disrupting that clock. These individuals also would be out of phase with their neighbors living in a natural light–dark cycle; in more social mammals this could affect mating success, group-mediated antipredator vigilance, and other processes.

Almost all studies of how light pulses can shift the biological clock used artificial light, either fluorescent or incandescent, as the stimulus. All of these studies demonstrate that brief (10- to 15-minute duration) and moderately bright (about 1,000 lux, equivalent to bright twilight) stimuli can shift the circadian clock by 1–2 hours (Halle and Stenseth 2000). This finding suggests that artificial night lighting can disrupt circadian patterns in the wild. These experiments were conducted only on captive animals held in 24-hour darkness except for the experimental stimuli, however. One experiment on the nocturnal flying squirrel *Glaucomys volans* came much closer to natural conditions in that the experimental animals had free access to a completely dark nest box and could choose when to emerge to a larger chamber where they might encounter artificial light (DeCoursey 1986). If the squirrel encountered light at arousal time, when it expected to enter a dark world, it would return to its nest box to sleep, delaying its circadian clock by 40 minutes. Because most nocturnal animals spend the day in burrows or cavities with unmeasured but presumably very low light levels, these experimental results probably are ecologically relevant to all nocturnal mammals.

Only two studies compared artificial light with daylight in terms of their effects on the circadian clock. In one study, wild-caught nocturnal mice were subjected to pulses of daylight, incandescent light, and fluorescent light, each 1,000 lux and 15 minutes in duration, at various points in the circadian cycle (Sharma et al. 1997). The phase shift response was strongest 2–3 hours after the transition from subjective day to subjective night, at which time the daylight stimulus produced a greater delay in activity (about 2.5 hours) than the two types of artificial light (each about 1.5 hours). The other study (Joshi and Chandrashekaran 1985) applied the same experimental protocol on a bat and found that incandescent lights produced large phase shifts in the opposite direction as the shifts elicited by daylight and fluorescent light. Artificial night lighting is about as effective as natural light in setting or disrupting the circadian clock.

The effect of the circadian clock on melatonin production may have serious ecological consequences. Dauchy et al. (1997) documented that modest levels of nocturnal light suppressed melatonin production with dramatic effects on tumor growth in rats. Although these results cannot be directly translated to wild mammals, this study suggests that disruption

of biological clocks by artificial night lighting could have profound effects on individual animals. If a significant fraction of individuals in a population are affected, population and ecosystem effects are also possible. In the golden hamster, the visual system that regulates the circadian clock is responsive to stimuli between 300 and 500 nm but insensitive to wavelengths of 640 nm or longer and 290 nm or shorter (Brainard et al. 1994). Further research on the spectral sensitivity of additional mammals may provide guidance that would allow the selection of outdoor lighting to avoid or minimize this potential effect, perhaps in the red–yellow spectrum.

Despite ample evidence that artificial lighting can disrupt circadian and circannual clocks in the laboratory setting—where all existing research has been conducted—there is no confirmation of these effects in wild populations. In part this is an intractable problem because phase shifts have been defined in a way (Gwinner 1986) that can be measured only in a laboratory. However, melatonin levels in wild populations subject to artificial night lighting could be compared with levels in undisturbed populations, controlling for time of day, to yield a biologically meaningful estimate of the magnitude of this problem in nature. In addition, population-level studies can demonstrate the overall effect of artificial night lighting on mammal populations, although it may be difficult or impossible to disentangle the effects of disrupted biological clocks from those of other mechanisms, such as reduced foraging or increased predation risk.

Effect of Street Lighting on Roadkill of Mammals

Intensity and type of street lighting may influence the probability of wildlife mortality in collisions with vehicles. It seems logical that most types of lighting will make animals more visible to drivers and thus reduce risk of mortality by giving the driver more time to react. There is no research supporting this idea, however, and Reed (1995), Reed et al. (1979), and Reed and Woodward (1981) concluded that increased highway illumination was not effective at reducing deer–vehicle accidents in the United States.

Some artificial night lighting makes it difficult for nocturnal mammals to avoid collisions with vehicles if the animal experiences a rapid shift in illumination. Many nocturnal species are using only the rod system, and bright lighting saturates their retinas. Although many nocturnal mammals have a rudimentary cone system and can switch over to it within a

couple seconds, during those seconds they are blinded. Once they switch to the cone system, areas illuminated to lower levels become black, and the animal may become disoriented, unable to see the dark area across the road and unwilling to flee into the unseeable shadows whence it came. This is not solely a problem for a rod-dominated visual system because even a cone-dominated system is ineffective when a small part of the visual field is many orders of magnitude brighter than the remaining field. This glare phenomenon is familiar to any backcountry camper who has been temporarily blinded by a companion's flashlight. Finally, if the animal is in the lighted area long enough to saturate its rod system, it will be at a distinct disadvantage for 10–40 minutes after returning to darkness.

The lowest possible lighting level consistent with human safety is the best for mammals crossing roads. There is no advantage to using lighting that is closer to the sunlight spectrum for these cone-poor animals. Indeed, low pressure sodium lights, with emission at 589 nm, provide reasonably effective vision for human drivers, who have mixed cone and rod vision, while interfering least, of the available lamp types, with the dominant rod-based vision of nocturnal mammals. Because the rod system has peak sensitivity near 496 nm, low pressure sodium lights should appear about one-tenth as bright to a rod-dominated retina as to a human retina.

Little ecological research, and a modest amount of human and engineering research, is needed on the issue of designing highway lighting to minimize roadkill mortality. Our knowledge of mammalian vision is sufficient to conclude that, from the animal's perspective, less is better. Research should focus on the straightforward issue of determining the lowest level of illumination that increases the ability of human drivers to see a large animal, thus allowing the driver to avoid collision, without disabling the rod-dominated retina of mammals, thus allowing them to escape into the darkness. Other technical questions, relevant not only to roadkill but also to biological clocks, predation risk, and foraging behavior, include developing cost-effective designs to confine lighting to the roadway and balancing them with a lamp height and beam pattern that reduces effects on the sensitive central part of the driver's retina.

Disruption of Dispersal Movements and Corridor Use

With increasing emphasis on providing biotic connectivity at the landscape scale, there is an increased need for information on how various factors influence the utility of a connective area. It follows from the preceding that street lighting negatively affects a mammal's ability and

willingness to cross a road or to move through any area with artificial night lighting. Although planners and conservationists have focused on the issue of how wide a corridor should be, it is obvious that the answer depends on how bright it is.

Only two studies attempted to address how a mammal, moving at night through unfamiliar terrain, might react to natural or artificial light or otherwise use visual information to find suitable habitat. A study of dispersing puma (*Puma concolor*) in urban southern California noted several exploratory movements that did not follow favored topography or vegetation patterns (Beier 1995). Beier speculated that the pumas were moving away from the urban glow and navigating toward the darkest horizon. Beier also noted instances in which an animal, exploring new habitat for the first time, stopped during the night at a lighted highway crossing its direction of travel with unlit terrain beyond. In several instances, the animal would bed down until dawn, selecting a location where it could see the terrain beyond the highway after sunrise. The next evening, the puma would attempt to cross the road if wildland lay beyond or would turn back if industrial land lay beyond.

Another study revealed that white-footed mice (*Peromyscus leucopus*) are capable of a similar "look now and move later" strategy (Zollner and Lima 1999). Zollner and Lima experimentally released woodland mice in bare agricultural fields at night under dark or moonlit conditions and at various distances from a single woodland patch, which was suitable habitat for the mouse, in the area. Under dark conditions, the mice were incapable of perceiving and orienting to the woodland patch at distances of 30 m (98 ft) or more. Full moonlight extended the perceptual range to 60 m (197 ft), and mice given a twilight look at the landscape before sunset were able to orient from 90 m (295 ft) away. Thus, if mice were not deterred by psychology, activity pattern, and predation risk, interpatch dispersal by mice would be more successful under daylight illumination. The study demonstrates that mice are able to assess the landscape under full light and use that information to move successfully in the dark, however.

Zollner and Lima (1999) also open a new realm of research, namely empirically determining the perceptual range of an animal, or the distance at which habitat patches can be perceived. Goodwin et al. (1999) provide helpful suggestions for sound statistical analyses and alternative approaches. Such research, using species for which corridors are designed, may provide a scientific basis for designing corridors and determining how animals use vision to explore new terrain.

Although perceptual range of mice increased in moonlight, there are two reasons that artificial night lighting may not similarly increase perceptual range and help animals find new patches. First, by saturating an animal's rod system, artificial night lighting plunges most of the landscape into darkness. Second, because a dispersing animal can anticipate this effect, it may orient away from the lights.

Movement in connective areas can be affected by adjacent lights of recreational fields, industrial parks, service stations, and housing. In southern California, where the South Coast Missing Linkages effort is attempting to maintain and restore landscape linkages between fifteen pairs of large wildlands, three riparian corridors are lined with homes sitting atop a low manufactured slope, and all fifteen linkages are crossed by lighted freeways (Beier et al. in press). Efforts to maintain and restore these landscape linkages should incorporate the general rule that less light is better for animal movement.

Research Issues

The literature on the effects of light on foraging behavior, predation risk, and biological clocks consists of two distinct approaches with little overlap. One approach is to study effects of moonlight on behavior of individual wild mammals; the other is to study the effects of artificial light on animals in laboratories. The discussion in this chapter underscores the need for studies using artificial lights on natural populations. Substantial expertise already exists, and productive collaborations between ecologists and laboratory physiologists could result in rapid progress.

Population-Level Research

A simple fusion of the two approaches will fall short of the mark unless at least some research efforts focus above the level of the response of individual animals. For instance, if research were to confirm that artificial night lighting increased numbers of tumors in wild mice by 25% or increased predation risk by 15%, this finding still would not address the issue of effects on the wild population. Conceivably, the induced tumors could shorten the lifespan of affected mice by only a few weeks or days, or predation mortality could act in a compensatory fashion with other types of mortality to reduce greatly the net effect on survival rates of animals living in the light-polluted zone. This effect could be further diluted if the light-polluted zone were part of a larger habitat, most of which was not directly

affected by light, in which case the polluted zone may be a small population sink. Conversely, interactions between individuals from the polluted zone with neighbors in dark zones, such as dissolution of the synchrony of estrus and parturition, could amplify the effect. Only careful, whole-population studies can address these more important questions.

A critical element in study design is to include both treatment populations and control populations. Ideally, studies will include both replication with more than one treatment and control population and observations in both treatment and control populations before light pollution (Stewart-Oaten et al. 1986). This paired before–after–control–impact study design also is appropriate for situations in which replication is not possible. Although this design lacks random allocation of treatments to experimental units, it can provide meaningful answers to important applied questions (Beier and Noss 1998). It is far better to have an approximate answer to the right question than a precise answer to the wrong question.

Equivalence Testing

In the study of individuals or populations, the statistical analysis of the effects of artificial night lighting should use equivalence testing (Patel and Gupta 1984, McBride et al. 1993), in which the null hypothesis is "artificial night lighting has biologically meaningful negative effects on mammals," rather than the traditional null hypothesis of "no effect." Failure to reject the traditional null hypothesis typically leads to complacency, even if the failure to reject resulted from undersampling or other design flaws. The burden of proof falls, inappropriately, on the most plausible point of view. In contrast, in an equivalence test, failure to reject the null hypothesis lends continued support to the most plausible state of nature, namely that there is an effect, and shifts the burden of proof to proponents of the idea that there is no biologically significant effect. Equivalence testing therefore is appropriate in all situations in which related studies and known cause–effect relationships suggest an environmental impact. Because the procedure requires the analyst to specify the direction and magnitude of a biologically meaningful effect, rejection of the null hypothesis is by definition a biologically, as well as statistically, significant outcome. This is in marked contrast to tests of traditional null hypotheses, in which the "insignificance of significance testing" (Johnson 1999) is an intractable issue.

Conclusion

For small, nocturnal, herbivorous mammals, artificial night lighting increases risk of being killed by a predator and decreases food consumption. Such lighting probably also disrupts circadian rhythms and melatonin production of mammals. Most research has documented the response of individual wild animals to moonlight or of laboratory animals to artificial light, however. Research on how artificial lights affect wild mammals at the population level is lacking. Significant progress relevant to management decisions will entail collaboration between ecologists and laboratory physiologists and assessment of population-level responses (e.g., rates of survival and reproduction) as well as individual behavioral and physiological responses (e.g., food consumption, avoidance of lighted areas, and melatonin levels). I recommend an experimental design that includes observation on paired control (dark) and treatment (lighted) landscapes both before and after installation of artificial night lighting. Given the preponderance of evidence from previous studies and known cause–effect relationships, statistical procedures should test the null hypothesis that artificial night lighting has a biologically significant negative effect on survival and reproduction, appropriately placing the burden of proof on proponents of the idea that such lighting is benign.

Night lighting also may increase roadkill of animals and can disrupt mammalian dispersal movements and corridor use. Research on these issues is a straightforward matter of determining an intensity, spectral output, and physical arrangement of lighting fixtures that enhances human safety while minimally affecting the rod-dominated visual system of nocturnal mammals. In addition, experiments to determine the perceptual range of mammals (i.e., the distance at which habitat patches can be discerned by an animal exploring new terrain) may enhance significantly a land manager's ability to locate artificial night lighting adjacent to wildlife linkages such that it minimizes interference with perception of habitat patches by species to be served by the linkage.

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The effects of the illumination of buildings on house-dwelling bats and its conservation consequences

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As the illumination of buildings at night increases, light pollution and negative impacts on wildlife also increase. In order to assess the effect of direct lighting on house-dwelling bats, we examined colonies of *Rhinolophus ferrumequinum*, *Myotis emarginatus* and *M. oxygnathus* in illuminated and non-illuminated buildings found in close proximity to each other. We investigated the onset and timing of nocturnal emergence and measured the body mass and the forearm length of juvenile bats. Results show that bright artificial lighting delays the onset or significantly prolongs the duration of emergence and, in the worst cases, may destroy the whole colony. Juveniles are significantly smaller in illuminated buildings than in non-illuminated ones. The differences in length of the forearm and in body mass may suggest that the parturition time starts later and/or the growth rate is lower in bats living in illuminated buildings. Thus, the illumination of buildings could have serious implications for the conservation of house-dwelling bat colonies.

Key words: light pollution, bat, conservation, artificial roost, *Myotis oxygnathus*, *M. emarginatus*

INTRODUCTION

Light pollution resulting from the increasing illumination of the planet by mankind is having an increasing influence on wildlife (Longcore and Rich, 2004; Rich and Longcore, 2006). The ecological consequences of artificial night lighting are becoming increasingly clear (e.g., Fedum, 1995; Borg, 1996; Harder, 2002; Eisenbeis, 2006; Frank, 2006; Montevecchi, 2006). Scientific data shows that this artificial disturbance also influences nature conservation policy and activities (e.g., Eisenbeis and Hassel, 2000; Health Council, 2000; Le Corre *et al.*, 2002; Salmon 2003, 2006).

Ecological light pollution has obvious effects on bats as well as many other diurnal, crepuscular and nocturnal species. Many groups of insects, of which moths are the most well-known, are attracted in large numbers to lights, and bats are quick to take advantage of these concentrations of prey (Rydell, 1991, 2006; Blake *et al.*, 1994; Rydell and Baagøe, 1996*a*, 1996*b*; Gaisler *et al.*, 1998; Swensson and Rydell, 1998). However, artificial illumination not only affects the hunting-ground but may also influence roosts and emergence behaviour (Downs *et al.*, 2003). In 2003, we observed that bats did not emerge after dusk from a church which was directly illuminated by

floodlighting. In another case, a colony disappeared after lights had been installed by the local council. If bats can be restricted or deterred by illumination, this must have important implications for bat conservation. The floodlighting of buildings (mainly churches) was not a common practice in villages in Central and Eastern Europe 10 years ago, but recently it has become increasingly common. The aim of such lighting is to emphasize the attractiveness of the buildings. The abundance of house-dwelling bat colonies in Hungary (see Dobrosi, 1996; Matis *et al.*, 2002; Boldogh, 2006) and the many different practices of lighting make the study particularly relevant.

Materials and methods

Emergence Activity

House-dwelling bat colonies were surveyed in the north and south-east of Hungary (Table 1). The species composition and the size of the roosting colonies were determined beforehand by day.

Firstly, to test whether bright lighting causes any differences in emergence activity, we examined the timing of the nightly onset of emergence and the characteristics of the emergence behaviour in illuminated (roosts 4 and 6) and non-illuminated buildings (roost 7 — Table 1).

Secondly, we disconnected the lights at the illuminated buildings (roosts 4 and 6 — Table 1) for several days (1–3) so the roost-buildings remained dark and examined the onset of nightly emergence and the duration of emergence behaviour. The temporary elimination of lighting was carried out during the days immediately following the basic investigation, in order to avoid and/or reduce the effect of the lunar cycle and the natural shortening of daylength. The investigations were carried out on days with calm weather to avoid the influence of meteorological factors (strong wind, clouds) on the emergence behaviour. During the investigation bats were counted and identified visually and with the help of an ultrasound bat detector (Mini-3 Bat Detector®).

The Growth of Juveniles

To investigate the effect of lighting on the growth of juveniles, the length of the forearm and body mass of bats in the illuminated and the non-illuminated control buildings were compared (Table 1). Control buildings with the same species and similar condition (same type of roof) were selected. The data were collected in the paired colonies on the same day. To minimize disturbance the young bats were usually measured after their mothers had left the roost at dusk; only one parallel measurement was taken in the daytime on warm days (roosts 1 and 4). Random sampling of juveniles was carried out by hand catch. Measurement of pups was carried out immediately after they were captured. The pups of *R. ferrumequinum* were not investigated considering the sensitivity of this species.

We used callipers for measuring the length of the forearm to the nearest 0.1 mm and a spring scale (Pesola Light-Line 50®) for measuring body mass. The body mass was measured to the nearest 0.1 g. The analysis of the data was performed with SPSS 12.0®.

Results

Emergence Activity

Differences in the emergence activity of the bats in the illuminated and non-illuminated buildings were remarkable. Almost all the bats left the undisturbed roosts in the first 30 minutes after dusk, whereas there was a considerable delay in the onset of emergence in the illuminated buildings where most of the bats remained in the roof until the disconnection of the lights (Fig. 1). Some bats flew out but never totally left the site whilst the lights were on. They re-entered repeatedly, flew back into the darkness of the roof and fluttered inside for a long time. The evidence suggests that we can separate the species by their sensitivity: while several *R. ferrumequinum* and *M. oxygnathus* departed when the lights were on, the great majority of *M. emarginatus* remained behind until it was totally dark.

During the first unlit night, the majority of the colony of *M. emarginatus* emerged at the same time as they had done during the previous illuminated nights whilst the

TABLE 1. The details of investigated roosts and colonies

Roost No.	Locality	Roosting species	Date of experiment	Description of illumination	Measured species
1	Kelemér (N Hungary), church	*Myotis oxygnathus*, *M. myotis*, *Plecotus austriacus*	29.06.2006, 16.08.2006	No lights	*M. oxygnathus*[b, c]
2	Alsószuha (N. Hungary), church	*Rhinolophus hipposideros*, *R. ferrumequinum*, *M. oxygnathus*, *M. myotis*, *M. emarginatus*	27.06.2006, 16.08.2006	All night[a]	*M. oxygnathus*[b, c]
3	Ragály (N Hungary), church	*M. emarginatus*	30.06.2005, 27.06.2006	All night from 01.11.2005[a]	
4	Szõlõsardó (N Hungary), church	*M. oxygnathus*, *R. ferrumequinum*	29.06.2006, 16.08.2006, 17.08.2006	1 hour (after dusk)	*M. oxygnathus*[b, c, d]
5	Komádi (SE Hungary), castle	*M. emarginatus*	16.07.2005		*M. emarginatus*[b, c, d]
6	Geszt (SE Hungary), church	*R. ferrumequinum*, *M. emarginatus*, *Myotis dasycneme*, *P. austriacus*	07–17.07.2003, 15.07.2005	From dusk until 23:30	*M. emarginatus*[b, c, d]
7	Geszt (SE Hungary), castle	*R. ferrumequinum*, *M. emarginatus*, *P. austriacus*	07–17.07.2003	No lights	All species[d]
8	Tatárszentgyörgy (E Hungary), church	*M. oxygnathus*, *Eptesicus serotinus*	13.07.2006	From dusk until 23:00	*M. oxygnathus*[b, c]
9	Mezõberény (SE Hungary), church	*M. oxygnathus*, *Nyctalus noctula*, *P. austriacus*	13.07.2006	No lights	*M. oxygnathus*[b, c]

[a] – from dusk until dawn
[b] – body mass
[c] – length of the forearm
[d] – emergence activity

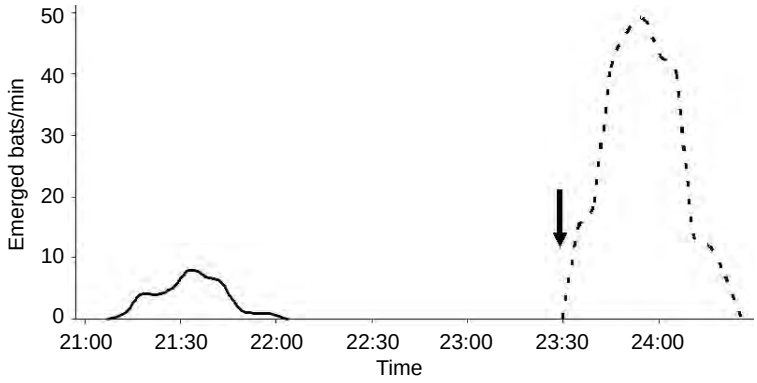

FIG. 1. The nightly emergence activity in *M. emarginatus*, in an illuminated (dashed line, roost number 6, $n = 1460$) and a non-illuminated roost (continuous line, roost number 7, $n = 200$) at the same night (07.07.2003). Arrow shows the time when lights were switched off at the illuminated roost

other species (*M. oxygnathus, R. ferrumequinum*) flew out earlier. During the second period after the lights had been disconnected, *M. emarginatus* also flew out earlier than they had during the illuminated nights (Fig. 2). *M. emarginatus* was the slowest to adjust to the modified circumstances; *M. oxygnathus* and *R. ferrumequinum* reacted more quickly to the change.

An unfortunate example of the direct effect of illumination was when the largest known *M. emarginatus* colony, consisting of approximately 1,000–1,200 females, left the roost after lights had been installed by the local council; the floodlights poured light directly through the wide exit-hole and completely flooded the loft (roost 3).

The Growth of Juveniles

The forearm length of juvenile bats was significantly shorter in illuminated than in non-illuminated colonies (Table 2). The difference was greatest during the lactation period (Mann-Whitney *U*-Test, $P < 0.001$) and disappeared by mid-September (Mann-Whitney *U*-Test, $P > 0.05$ — Table 2).

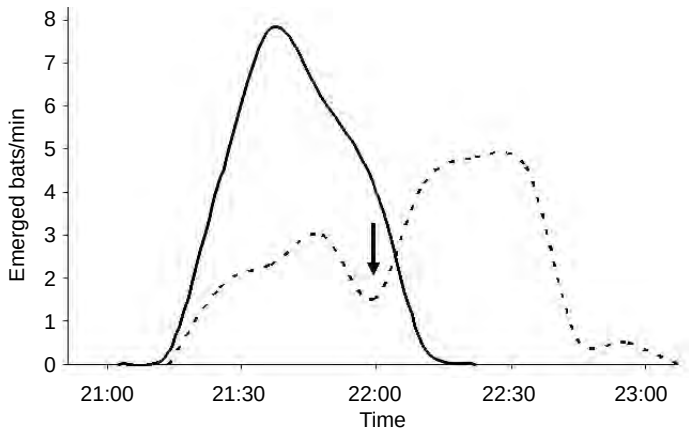

FIG. 2. The nightly emergence activity in *M. oxygnathus* ($n = 230$), during an illuminated (dashed line) (16.07.2006) and the following first non-illuminated night (continuous line) (17.07.2006) at the same roost (roost number 4). Arrow shows the time when lights were switched off during the illuminated nights

The body mass of juveniles was also different between illuminated and non-illuminated colonies. Young bats were larger in dark roosts (Mann-Whitney *U*-Test, $P < 0.001$) and this difference persisted until late summer (Mann-Whitney *U*-Test, $P < 0.015$ — Table 2).

Discussion

Bright artificial illumination negatively affects bats, therefore, the illumination of roosts has serious implications for the conservation of house-dwelling bat colonies. The highest abundance of aerial insects usually occurs around dusk (e.g., Nyholm, 1965; Jones and Rydell, 1994; Rydell *et al.*, 1996); hence bats, especially aerial-hawking bats, emerge from their roosts soon after sunset (e.g., Gaisler, 1963; Herreid and Davis, 1966; Kunz, 1974; Kunz and Anthony, 1996). Our study is consistent with other studies (Erkert, 1982; Kunz and Anthony, 1996) in showing that most bats synchronize the onset of their nightly emergence with sunset. However, we found — correspondingly with Downs *et al*. (2003) — that bright artificial lighting affects the number of bats emerging. Our results even show that lighting delays the onset and the duration of the emergence of bats. Due to such delayed emergence bats miss the highest abundance of aerial insects and lose a significant proportion of their foraging time. In one instance we found that artificial lighting forced the whole colony to leave the roost.

The difference in the length of the forearm may show that the parturition time starts later and/or that the growth rate is slower in bats living in illuminated buildings. Our field observations suggest that both effects occur. The exact time of parturition was not known, therefore, the disparity in age could only be estimated. The length of the forearm can be used for

Table 2. The development stages of juvenile bats measured by the length of the forearms (mm) and body mass (g) in the different roosts; *n* — sample size (Mann-Whitney *U*-test)

Species (roost number[a])	Length of forearm						Body mass					
	Non-illuminated roost		Illuminated roost		*U*-value	*P*-level	Non-illuminated roost		Illuminated roost		*U*-value	*P*-level
	n	$\bar{x} \pm$ SD	*n*	$\bar{x} \pm$ SD			*n*	$\bar{x} \pm$ SD	*n*	$\bar{x} \pm$ SD		
M. emarginatus (5, 6)[b]	53	35.62 ± 4.13	76	31.43 ± 5.14	906.0	0.001	53	6.07 ± 0.95	76	5.27 ± 1.03	1032.0	0.001
M. oxygnathus (8, 9)[b]	19	54.95 ± 4.72	23	46.28 ± 7.56	67.0	0.001	18	14.65 ± 4.65	23	10.74 ± 3.41	112.5	0.013
M. oxygnathus (1, 4)[b]	18	46.40 ± 8.31	23	36.46 ± 7.84	82.0	0.001	19	20.37 ± 2.77	23	14.01 ± 3.16	29.0	0.001
M. oxygnathus (1, 2)[c]	18	57.57 ± 1.26	14	56.79 ± 1.63	92.5	0.203	18	22.96 ± 1.68	14	19.6 ± 1.47	20.5	0.001

[a] — See Table 1 for roost details and date of measurements
[b] — in the lactation period
[c] — post-weaning period

estimating the absolute age of juveniles during the rapid and linear phase of growth in the first two weeks (Tuttle and Stevenson, 1982; Anthony, 1988; Kunz and Stern, 1995; Reiter, 2004; Sharifi, 2004*a*); correct estimation is more difficult for older juveniles (De Paz, 1986; Kunz and Hood, 2000). Since our research involves data from the initial phase, and the gross growth rate in the initial phase is known in *M. oxygnathus* (Sharifi, 2004*b*) we were able to make a relatively good estimation. However, as Sharifi's (2004*b*) study was conducted at an undisturbed maternity roost, his results could only be used for estimations at the non-illuminated roosts in our research. Another problem is that there is nothing known about the degree of asynchrony at birth in the different roosts which results in an even more complicated and questionable estimation. Regarding these experiences, we used the detected differences in the length of the forearm only for a rough estimation of disparity in age between the illuminated and non-illuminated colonies. The estimated disparity is at least 7–10(11) days. We had one concrete observation at the early stage of the parturition, when only pregnant females and neonates were found at the illuminated roost while the undisturbed roost had well-developed young. This apparently indicated that birth had been delayed in illuminated buildings.

In natural conditions the growth rate of the forearm in *M. oxygnathus* reaches the plateau about 35–40 days after birth (Sharifi, 2004). Similar rapid progress has also been reported in other free-ranging and captive insectivorous bats in the temperate zone (e.g., Kleiman, 1969; O'Farrell and Studier, 1973; Burnett and Kunz, 1982; Kunz and Anthony, 1982; De Fanis and Jones, 1995; Kunz and Stern, 1995; Swift, 2001; Reiter, 2004). Since we did not find significant differences in the length of forearms between the two different roosts at the end of summer, it suggests that the individuals at the light-disturbed roosts had also already reached the normal length of the forearm by that time. This equalization may be caused by compensatory growth which has also been reported in other studies (Hoying and Kunz, 1998; Kunz and Hood, 2000). The question of how much the variation is due to different dates of birth and how much to the different rates of growth, is one which deserves further investigation.

In young bats body mass growth rate reflects environmental conditions more responsively than the growth rate of forearms (Kunz and Robson, 1995). The lower availability of insects to lactating females owing to the illumination of roosts, directly leads to lower body mass in juveniles. This is a similar effect to that of bad weather during the maternity period (Kunz and Robson, 1995; Hoying and Kunz, 1998; Kunz and Hood, 2000; Reiter, 2004). The present study shows that in illuminated colonies the body mass remains reduced even after the weaning season. The juvenile bats concerned could probably not compensate for their early disadvantage and/or they had deposited less fat by mid-September. Since hibernation success mainly depends on the body mass achieved, the illumination of maternity roosts may reduce the hibernation success of young bats. Whereas, the earlier born individuals have higher survival rates compared to the ones were born later (Ransome, 1998), the bats born in unlit roosts may have an advantage over those who were born in the illuminated ones.

The conservation strategy for maintaining important house-dwelling colonies is clear: to eliminate direct illumination totally during the whole reproductive season. According to our results, reducing the hours of illumination in the night has little effect: even a one-hour long lighting period after dusk causes significant disruption in behaviour and growth. Summer nights are short in

the temperate zone and even shorter further north, so any artificial reduction in foraging time is disadvantageous.

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TO PRESERVE AND PROTECT THE NIGHTTIME ENVIRONMENT AND OUR HERITAGE OF DARK SKIES THROUGH QUALITY OUTDOOR LIGHTING

International Dark-Sky Association
Dark Sky Park Program Criteria

May 2013

TABLE OF CONTENTS

DEFINITION OF AN IDA DARK SKY PARK

An IDA Dark Sky Park (DSP) is a public land possessing an exceptional or distinguished quality of starry nights and a nocturnal environment that is specifically protected for its scientific, natural, educational, cultural heritage, and/or public enjoyment.

GOALS FOR IDA DARK SKY PARK CREATION

- To identify, restore, and protect public lands (national, state, provincial, and other parks and notable public lands) with exceptional commitment to, and success in implementing, the ideals of dark sky preservation and outstanding night skies.
- To promote ecotourism;
- To promote protection of nocturnal habitat and human health, public enjoyment of the night sky and its heritage, and/or areas ideal for professional and amateur astronomy;
- To encourage park administrators to recognize dark skies as a valuable resource in need of proactive protection;
- To provide international recognition for such parks;
- To encourage parks and similar public entities to become environmental leaders on dark sky issues by communicating the importance of dark skies to the general public and surrounding communities, and by providing an example of what is possible with proper stewardship.

BENEFITS

Achieving this designation brings recognition of the efforts a park has made towards protecting dark skies. It will raise the awareness of the park, staff, visitors, and the surrounding community. Designation as an IDA DSP (Dark Sky Park) entitles the park to display the IDA DSP logo in official park publications and promotions, and use of this logo by commercial or other groups within the community when identifying the park area itself (e.g. an organization can say “located in Cherry Springs State Park, an IDA DSP” or other words to the same effect). IDA will maintain a web page identifying and describing all IDA DSPs. The park agency may also identify IDA as a park partner and erect a public sign in the park announcing the dark sky park status.

ELIGIBILITY (ALL MUST BE MET)

A) All protected public lands, whether managed by national, state, provincial, or local agencies, are eligible. These may include parks, refuges, forests, wilderness areas, monuments, protected rivers, or other categories of protected lands. For this document, they are generically referred to as a “park;”

B) The park must provide the opportunity for public nighttime access, with or without supervision. Regular visitation by the public is essential to meet the goals of the IDSP program. A portion of designated land may meet this requirement, or access must be

available for a portion the night. In some cases, such as when working with areas that protect endangered wildlife, this requirement may be adjusted;

C) The park must provide an exceptional dark sky resource, relative to the communities and cities that surround it. Core night sky quality must fit in one of the three tier qualifications Gold, Silver, or Bronze. See Sky Quality Tiers Section.

MINIMUM REQUIREMENTS FOR ALL PARKS

A) A quality comprehensive Lightscape Management Plan (LMP) with the following minimum standards (see "Lightscape Management Plan Guidelines" section for more details):

   i) New, current, and retrofitted lighting must meet the park's LMP (which must meet the "Lightscape Management Plan Guidelines" included in this document). The RASC/IDA Guidelines for Outdoor Lighting (GOL) should be used while creating the park's LMP. These guidelines may be found on IDA's website at www.darksky.org/RASCGOL AND;

   ii) Included policy for determining whether an area should or should not be lighted, at what times an area should or should not be lighted, and appropriate illumination levels, AND;

   iii) Fully shielded fixtures are standard throughout the park. Any lighting fixtures above 600 lumens are required to use fully shielded fixtures emitting no light at or above the horizontal. An exception to this may be when lighting fixtures contain lamps emitting less than 600 lumens. When such unshielded fixtures are used, impacts to the lightscape must be minimized with the use of timers and/or curfews, AND;

   iv) Methods for determining the appropriate type of lamp (color, efficiency, technology) and fixture that should be used with goals to maximize energy efficiency and minimize impact to human vision dark adaptation/recovery time, wildlife, and the nocturnal ecology. It is recommended that only lighting under 3100K correlated color temperature (CCT) be used as this will minimize the impact on most wildlife, AND;

   v) LMP should conform to or surpass agency or departmental policy on lighting and dark sky protection as well as other applicable guidance and laws (e.g. environmental leadership programs, agency orders, wilderness act, energy management guidelines).

B) The park's commitment to dark skies and lightscape management, as shown by:

   i) The park recognizes dark skies as an important natural, cultural, and/or scientific resource value as demonstrated by inclusion in approved management documents (e.g. General Management Plan, Resource Management Plan, Facility Development Plan), AND

   ii) At least two-thirds (67%) of existing outdoor lighting fixtures within park boundaries conform to the park's LMP at the time of IDA DSP application (or an alternative fraction approved by the IDA Dark Sky Places Committee (DSPC) AND;

   iii) A schedule defining a five-year plan for when 90% of all outdoor lighting on park land will conform with the park's LMP, and a written commitment that 100% of the lighting will conform in the future, AND;

iv) A measurement program must be maintained either by the park or by another public or private organization (university, research center, IDA chapter, astronomy club, etc.) to follow the evolution of light pollution in the IDA DSP and assert that the night sky quality does not degrade. Installation of at least one permanently mounted, approved, night sky brightness meter (NSBM) and participation in the IDA Global Sky Monitor website is recommended, AND;

v) The park has set a leadership example in the restoration of dark skies by implementing at least one of the following:

(1) Producing at least one "night sky friendly" lighting project that is publicly visible and interpreted, OR

(2) Involving at least two external partners in dark sky restoration efforts (e.g. chamber of commerce, power utility, university research, tribal nations, environmental groups, conservation groups, natural history association), OR

(3) Cooperation with at least two nearby municipalities that results in adoption of lighting codes that improve sky conditions in the park, OR

(4) Inventorying and monitoring night sky quality and using results to educate the public, OR

(5) A combination of the above or an alternative restoration project may be suggested.

C) The park's commitment to public education.

i) The importance of dark skies/natural darkness and the benefits of good lighting should be part of park interpretation/outreach programs. (Dark skies education refers not only to astronomy education but also education about wildlife, energy efficiency, safety, and human health.) If park typically provides interpretive programs, then dark skies must be one of the central themes communicated through on-site interpretation. If interpretive programs are not typically offered, then extensive publications, flyers, press releases, media, social media, or other outreach are appropriate substitutes, AND

ii) Dedicated programming must occur at least four times per year, however, more events are preferable. These events may highlight the dark night sky in any appropriate way (e.g. cultural or historic value, importance to wildlife, astronomical or stargazing events, and a portion of the event must include dark sky awareness or preservation specifically including reference to the IDA and what it means to be an IDA DSP).

D) IDA reserves the right to request stronger or alternative requirements if deemed appropriate and deny IDA DSP status if these requirements are not met. Any requests by IDA will be made through direct contact and communication with the park.

E) Once established, the park must erect and maintain a sign indicating the IDA Dark Sky Park designation along a roadway entrance, along a footpath entrance if no roadway exists, or a visitor contact center. Sign must include IDA DSP text and logo. With Dark Sky Places Committee (DSPC) approval, an alternative wording may be used, such as Dark Sky Wilderness, Night Sky Refuge, or similar. The park may include the awarded tier if desired. Once the sign is erected a picture documenting this sign must be taken and sent to IDA for records along with a description of its location.

F) Designation is permanent, but is subject to regular review by IDA and possible revocation if

minimum requirements are not maintained. More details may be found in the "Reassessment of IDA DSP designation" section.

G) The Park will submit an annual report to IDA by October 1st detailing activities and progress towards fulfilling IDA DSP goals during the previous year. The Park should include dates and brief descriptions of interpretive events, lighting retrofit projects, community outreach, etc. Samples of printed materials and press articles should also be included. The annual report should not require a lot of time to produce, as it should be a compilation of information generated during the previous year. A form will be provided to aid in the compilation of these details. Electronic submission of these documents is required in MS Word or PDF format. If the annual report is not sent in a timely fashion, IDA may suspend the IDA DSP's status until the annual reporting requirements have been met.

H) Sky Quality Tiers

i) Once the minimum requirements have been met, an IDA DSP is designated by IDA at one of three levels – Gold, Silver, or Bronze indicating the estimated sky quality of the site.

ii) Gold corresponds to natural, non-polluted or near-natural night.

iii) Silver corresponds to nighttime environments that have minor impacts from light pollution and other artificial light disturbance, yet still display good quality night skies and has exemplary nighttime lightscapes.

iv) Bronze corresponds to areas not meeting the requirements of Silver, yet still offering people, plants, and animals a respite from a degraded nocturnal environment.

v) The determination of whether the minimum sky quality standard has been met and what tier will be awarded will be decided by IDA based on submitted information.

vi) For a breakdown of requirements for each tier designation, see the table on the next page:

GOLD, SILVER, AND BRONZE TIER DESIGNATION

Indicator	Gold	Silver	Bronze
Philosophy	Nighttime environments that have negligible to minor impacts from light pollution and other artificial light disturbance, yet still display outstanding quality night skies and have superior nighttime lightscapes.	Nighttime environments that have minor impacts from light pollution and other artificial light disturbance, yet still display good quality night skies and have exemplary nighttime lightscapes.	Areas not meeting the requirements of *Silver*, yet still offering people, plants, and animals a respite from a degraded nocturnal environment and suitable for communicating the issue of light pollution and connecting people with the many aspects of the night sky.
Artificial Light and Skyglow	Typical observer is not distracted by glary light sources. Light domes are only dim and restricted to sky close to horizon.	Point light sources and glary lights do not dominate nighttime scene. Light domes present around horizon but do not stretch to zenith.	Areas with greater artificial light and skyglow than *Silver*, but where aspects of the natural sky are still visible.
Observable Sky Phenomena	The full array of visible sky phenomena can be viewed—e.g. aurora, airglow, Milky Way, zodiacal light, and faint meteors.	Brighter sky phenomena can be regularly viewed, with fainter ones sometimes visible. Milky Way is visible in summer and winter.	Many sky phenomena cannot be seen. Milky Way is seen when pointed out to the average person, as is the Andromeda Galaxy.
Nocturnal Environment	Area is devoid of obvious lights that can cause wildlife disorientation. Artificial light levels are thought to be below the threshold for plant and animal impact. Ecological processes related to nocturnality are unaltered. No lighting atop towers or buildings within park boundary.	Areas that have minor to moderate ground illumination from artificial skyglow. Lights that may cause disorientation to wildlife are distant. Disruption of ecological processes is minor with no impairment to plants or wildlife.	Areas with greater nocturnal impact than *Silver*, but where ecosystems are still functional.
Visual Limiting Magnitude	Equal or greater than 6.8 under clear skies and good seeing conditions	6.0 to 6.7 under clear skies and good conditions	5.0 to 5.9 under clear skies and good seeing conditions
Bortle Sky Class	1-3	3-5	5-6
Unihedron Sky Quality Meter	> 21.75	21.74-21.00	20.99-20.00

LIGHTING INVENTORY

A) When there are numerous outdoor lights it is acceptable to group lights by facility or area. Whether the fixtures are fully-shielded, are special purpose fixtures under 600 lumens, and what the lighting application is should be noted for each fixture or group of fixtures.

B) Lighting Inventory should also include a plan or stated commitment to bring all outdoor lights into compliance with the Lightscape Management Plan (LMP).

C) Daytime photographs or manufacturer diagrams of each fixture type may also accompany the inventory.

A sample table from portion of a Lighting Inventory:

Location	Fixture	Fully-Shielded	Special Purpose <600 lumens	Application	Conformity with LMP
Visitor Center	12 fixtures on 14' pole, 70 W HPS	YES	NO	Parking log, timer off at 10pm	YES
	2 door lights, 100 W MH	YES	NO	Building egress	YES
	6 bollard (post) lights, 32 W CFL	NO	NO	Walkway	NO – see plan
Historic Cabin	2 carriage style lights at doorways, 40 W incandescent	NO	YES	Historic Preservation, egress	YES
Maintenance Yard	6 wall packs, 250 W MH	NO	NO	Occasional night operations	NO – see plan
	8 Glarebusters, 11 W CFL	YES	NO	Egress, security	YES

Lamps of 600 lumens output and less include: 40 watt incandescent and less; 35 watt tungsten (quartz) halogen and less; 8 watt linear fluorescent and less; 11 watt compact fluorescent and less.

LIGHTSCAPE MANAGEMENT PLAN GUIDELINES

The LMP should embody good lighting ethics such as:

A) Meet or exceed agency or departmental policies regarding outdoor lighting

B) Only use light when it is needed, where it is needed, and in the appropriate amount.

C) Outdoor lighting fixtures should be fully-shielded and have appropriate use of timers and motion sensors.

i) Lighting of less than 600 lumens may be unshielded lights for special purposes, such as historical preservation. The approved special uses should be stated in the LMP. IDA will scrutinize these uses to ensure that park lighting is a suitable example of good lighting for the public and protects the nighttime environment to the maximum practical extent. IDA may request additional descriptions, photographs, or drawings of these lights. These lights are not exempt from the lighting guidelines, and must still be designed to minimize impact to the lightscape.

D) IDA has collaborated with the Royal Astronomical Society of Canada to develop the RASC/IDA Guidelines for Outdoor Lighting (GOL) www.darksky.org/RASCGOL These guidelines should be adopted as part of the LMP for the park. If there are provisions of the GOL that are not appropriate for the park, the GOL may be amended or substituted with more suitable guidelines. IDA will review the modifications or substitution and determine on a case-by-case basis if the changes are acceptable for the individual park.

PROVISIONAL STATUS

- In some cases, a park interested in being designated may lack the resources to do so. If minimum sky quality criteria and appropriate outreach requirements have been met, a park may apply for and be granted Provisional status. Provisional status recognizes the park's ongoing work to become an IDA DSP and is intended to be used as a leverage point to enable the necessary lighting upgrades or retrofits and policy changes.
- Provisional status expires after three years. At any time before the end of its provisional status, a park may reapply for full status. Material submitted for the removal of provisional status may be an addendum to the initial application as long as the material includes a current assessment of night sky quality, goals, outreach, and programs listed in the original application.
- To be considered for a provisional status, send a nomination package to support the following needed information:
  - Initial sky quality measurements;
  - The minimum quality night sky described under "Eligibility" must be met in order to attain Bronze IDA DSP designation.
  - Documented intent to create and support an IDA DSP;
  - An action plan describing how the aspiring Park will meet minimum requirements;

GUIDELINES ON IDA DSP PROCESS

NOMINATION

The nomination may be initiated by an IDA qualified nominator who has personally reviewed a park's outdoor lighting and commitment to natural lightscapes, or by a member of the park staff who maintains an IDA membership. To become an IDA qualified nominator you must be an IDA member and be approved by the IDA Dark Sky Places manager. The nomination may be a joint effort between park administration and the qualified nominator. Nominators are encouraged to correspond with IDA staff and the park throughout this process—from first consideration of an IDA DSP through the final submission package.

IDA DSP APPLICATION PROCESS

STEPS FOR APPLICANT

A) Initial contact with IDA by phone or email to discuss the process and make recommendations followed by regular contact to consult with IDA staff and to review progress;

B) A formal point of contact (POC) person is designated and their phone, address and email information is forwarded to IDA staff. Before and after designation, any changes to this POC, or their information, must be communicated to IDA in order to ensure accurate communication at all times;

C) Upon completion, the park sends the application to IDA staff for review of the document. IDA staff confirms that the application is complete and ready for submission;

D) Completed application packet in .pdf and/or MS Word .doc format sent electronically to DSPC by IDA staff for review.

E) Submit in plenty of time for IDA staff to review and prepare your application to make the bi-monthly deadline that you prefer, as found on www.darksky.org/idsp Requests to rush applications will NOT be accepted; meaning that planning ahead is essential if the park is planning to meet a deadline.

TO BE INCLUDED IN AN IDA DSP SUBMISSION

A) Map(s) of area to be designated. (For larger parks, with a minimum total size of 1,000-km^2, a smaller portion of the park may be designated with special permission. A description explaining why this subset of the larger park was chosen must be approved in advance by IDA's Dark Sky Places program manager.)

B) Letter of nomination support from appropriate park administrator.

C) Any management documents supporting dark skies and/or natural lightscapes as a valued resource.

D) If it exists, agency or departmental policy on outdoor lighting and dark sky protection.

E) Documentation of sky quality, light pollution measures, satellite pictures, maps, photographs, or other evidence that demonstrates the noteworthiness of the resource. Measurements of night sky brightness using an approved night sky brightness meter (NSBM), such as the Unihedron Sky Quality Meter or the IDA Night Sky Brightness Monitor, showing at least 12 locations within the park. Measurements should document the approximate darkest and brightest areas of the park. Data included in the application must contain an updated survey of the park completed no more than two years before the application's submission along with any other relevant surveys. Learn more about creating a night sky quality survey on IDA's website www.darksky.org/nightsurvey

F) Lightscape Management Plan.

G) Documentation signed by park administrator showing a Lighting Inventory of the Park and plan to bring 90% of outdoor lighting into compliance with the IDA-DSP-GOL within five years.

H) Description of restoration project (e.g. lighting project, community outreach, etc.).

I) Description of interpretive program or interpretive products related to dark skies/natural darkness. Any related examples of successful education (photos, documentation of student projects, etc.)

J) Future plans

K) Proposed alternative wording for IDA DSP (e.g. Dark Sky Wilderness, Dark Sky Refuge, etc.), if desired.

L) An outline of an application is available and may be used upon request.

IDA REVIEW PROCESS

A) Applications are sent to the committee on a bi-monthly basis.

B) Before the park's final application is submitted it is highly recommended that the park be in regular conversation with IDA staff to perfect the application before the deadline. Applications not ready for submission by the current deadline for committee consideration will be considered at the next committee meeting.

C) IDA staff forwards application to Dark Sky Places committee for review at the deadline.

D) Approval of application by DSPC is by a 2/3-majority vote, or denial with reasons and recommendations. The DSPC committee may consider the application for up to two months before releasing a decision;

E) Determination of sky quality tier - Gold, Silver, or Bronze;

F) If approved the location will be notified and the program manager will organize a press release with the location during a 10-day waiting period during which the Board of Directors will have the formal right to veto should they perceive a problem with the application. The park has the right to choose when the press release is made public but must organize the announcement to be made at the same time as IDA's release unless otherwise discussed and decided upon by both parties;

G) If approved, the park is awarded the IDA DSP designation and listed along with their application on the IDA website. By submitting the application the park agrees to have their application posted to IDA's website unless otherwise stated;

H) If denied, a letter is sent to applicant outlining elements of the application that need improvement and specific recommendations for ways to remedy them. Applications can be resubmitted for future consideration after remediation is complete.

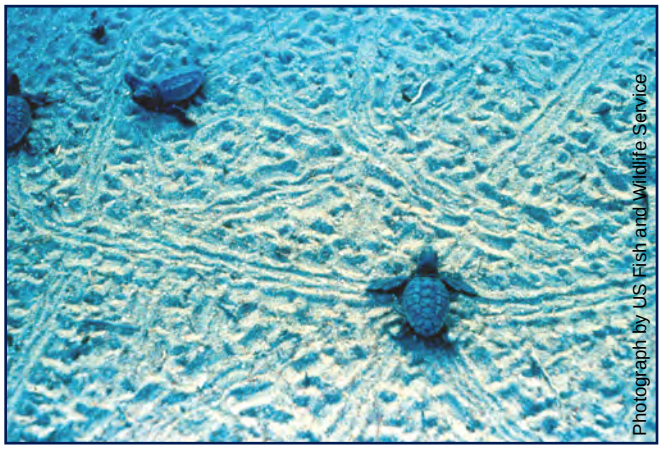
I) Periodic checks, through the submission of the annual report, will be preformed to ensure that minimum standards and objectives of the program are being upheld and adequate progress is being made.

REASSESSMENT OF IDA DSP DESIGNATIONS

To ensure that parks continue to be exemplary in their protection and restoration of natural lightscapes, IDA will periodically reevaluate DSPs. Annual reports are due October 1st. This is done to confirm that parks continue to meet the minimum requirements, are sustaining partnership and interpretation efforts, and are making adequate progress toward 90% compliance with Lightscape Management Plans. If the annual report is not sent in a timely fashion or questions or concerns cannot be resolved after the review, it may be necessary for IDA to suspend/revoke the IDA DSP's status until resolution can be achieved. A form for the annual report may be found on IDA's website at www.darksky.org/parks

IDA Practical Guide

Turtle trails that go straight to the ocean, as they should.



Turtles that are confused by light pollution (shown above with their erratic trails), are unable to find their way to the ocean.

Topic:

Effects of Artificial Light at Night on Wildlife

From the beginning of existence, humans have controlled their immediate environment, building shelters to keep out the elements and fires to banish the darkness. As civilizations continue to develop, humans are able to affect dizzying change on habitats in all corners of the globe. Though agreeable to us, many of the comforts of advanced society are devastating to the creatures that share the earth. A growing body of data suggests that artificial night lighting has negative and deadly effects on a wide range of creatures, including amphibians, birds, mammals, insects, and even plants.

Humans have evolved as diurnal animals, biased toward the daytime and dependant on visual cues, so illumination of our nightscapes seems comfortable and necessary. All animals, including humans, depend on a regular interval of daylight and darkness for proper functioning of behavioral, reproductive and immune systems. Many of these animals need the natural night to survive. For thousands of species, the natural dark night of the evolutionary past is an integral component of their continued existence.

Artificial night lighting harms species directly by triggering unnatural periods of attraction or repulsion that lead to disruptions in reproductive cycles, by fixation, by

disorientation, or by interfering with feeding and sustenance. Light pollution has been shown to disorient migratory birds and hatchling turtles, disrupt mating and reproductive behavior in fireflies and frogs, and interfere with communication in species from glowworms to coyotes. Disruptions such as degradation of habitat, creation of artificial and dangerous habitat, and energy waste that may lead to climate change can all be linked to excessive artificial night lighting. Research biologists are warning that the negative synergy of such combinations can result in a cascade effect, with disastrous results for entire ecosystems around the world.

Diurnal— active during daylight
Photoperiod—duration of sunlight as determined by season (photoperiodic—internal clock governed by how long the day is)
Phototaxis—movement in response to light
Predation—predatory behavior in animal relationships

Climate characteristics vary from one year to the next; it is not uncommon to experience cool summers, dry springs, and slow falls. A season's photoperiod is the only consistent factor in the natural environment. Therefore, many species of plants and animals rely on the length of the day to indicate the proper season for mating, molting, and other life cycle activities. This photoperiodic sensitivity is often so acute that many species can detect discrepancies in natural light as short as one minute. Reproduction cycles are most often disrupted when artificial light at night interferes with species' natural detection systems. Trees have been known to bud prematurely; some flowers cease blooming. Artificial light also can cause animals such as squirrels and robins to mate out of season. Changes in plant and animal reproductive activity can create difficulty in finding food and increase chances of starvation.

Pine Barrens tree frog

There is evidence that the use of high and low pressure sodium light in ecologically sensitive areas such as wetlands, woods, and coastal areas has less impact on habitat and life cycle behavior than use of other kinds of light. The relatively monochromatic wavelength emitted by the yellow tinted sodium vapor lights attracts fewer insects and can be more easily filtered to minimize negative effects.

Insects, frogs, toads, and salamanders have demonstrated both physical and behavioral disruptions as a result of artificial night lighting. A majority of frog and toad species are nocturnal and, because they must remain close to a water source, are less able to compensate for changes in the environment by relocating.

Like other amphibians, salamanders are currently suffering population declines around the world. Many species of pond-breeding salamanders show strong site fidelity to their home ponds, and studies to date have shown that artificial illumination can disrupt salamanders' ability to return to home ponds to breed.

Insects are attracted to the white light of floodlights.

Artificial light at night contributes to lack of food (starvation) by interfering with predator/prey relationships. For instance, moths and other night-flying insects are attracted to lights. This involuntary phototaxis leads to their easy capture. Their incessant gravitation toward artificial points of light not only makes them vulnerable as prey and subjects them to increased predation, but disrupts the normal nocturnal patterns of predator species by creating an artificial feed concentration around points of light. For some species of predators, such as bats or birds that are not repelled by light, this disruption means a change in the concentration and location of their feed, which can lead to imbalances in predator/prey ratio. For species repelled by light, such as horseshoe bats, long eared bats, and mouse eared bats, feed becomes scarcer and difficult to procure, as many insects swarm around lights, leaving fewer to be caught as they fly free. The decreasing amount of available food due to

Visible for miles, squid boat lights unnaturally attract species of fish and migratory birds.

Relentless lights are common on offshore oil platforms.

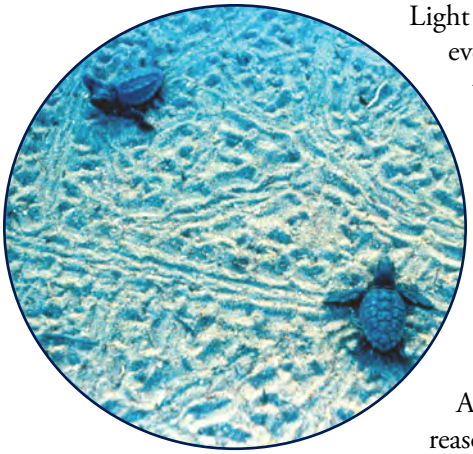
Upon discovering the magnitude of fatal bird collisions, some cities are initiating mitigation procedures. The Lights Out Toronto campaign, established in 2006 in Toronto, Canada calls for residents to turn out any unnecessary lights for the protection of migratory birds. In addition, the city has issued bird friendly development guidelines for all new buildings, which include the control of unnecessary artificial light. In September 2008, Boston, MA, USA began a two-month initiative to conserve electricity by shutting off lights at 34 city skyscrapers. A stated purpose of this project was the protection of migrating birds. Chicago, IL and New York, NY USA also participate in a "Lights Out" during migration season.

As awareness of the danger of artificial light to sea turtles grows, an increasing number of communities are restricting coastal illumination. Countries all over the world have passed ordinances that control the amount and type of light used in coastal environments. As the list grows, hatchling sea turtles are starting to be able to find the sea without the help of human volunteers to guide them. Learn more about local and regional action by visiting *www.seaturtle.org*.

a combination of habitat loss and life cycle disruption is causing many bat populations, such as Europe's horseshoe bat, to become threatened or endangered.

Since the eyes of nocturnal animals are specially evolved for foraging in low-light conditions, small changes in illumination can compromise strategies and profoundly alter their relationship with prey species. Even fish are affected by artificial light. Some species of fish, normally exposed only to natural light sources such as phosphorescence, can be temporarily blinded and left vulnerable by artificial light. Artificial light also inhibits normal anti-predation behavior such as schooling, and can affect migratory patterns in species such as salmon and sockeye fry.

Offshore, brightly lit oil and gas platforms and squid vessels that attract prey and affect numerous species of fish with lights pose both primary and secondary hazards to marine birds. The illumination and heat of offshore hydrocarbon platforms and squid fishing vessels also encourage algae growth, attracting fish and invertebrates. Marine birds are then killed around squid vessels by swallowing hooked prey or by feather contamination in oil-fouled water at hydrocarbon platforms. Marine birds that feed on bioluminescent prey may be particularly sensitive to light source attraction, many threatened and endangered species at great risk from artificial ocean lighting. Many species are susceptible to fixation—also known as "capture"—on artificial lights at sea; exhausted birds will circle for hours or days until they fall into the sea. Off eastern Canada in 1998, tens of thousands of seabirds were observed circling the newly operational Hibernia platform, fixated by an unrelenting point of illumination.



Light fixation is a constant bird hazard that continues to kill thousands of birds in urban areas every year. Hundreds of terrestrial bird species fly and migrate under cover of night. While the mechanisms for birds' attraction to artificial night lighting are not well understood, its hazards to birds have been well documented. During the 1960s, it is estimated that over a million birds a year were killed in collisions with lighted television towers in the United States. Since that time, the number and height of communication towers has increased exponentially. Skyscrapers and other urban buildings also threaten birds, posing collision, fixation, and disorientation hazards.

Light and Sea Turtles

Artificial light at night is devastating sea turtle populations around the world for several reasons. Studies in Florida have shown that loggerhead, leatherback, and green turtle females choose the darkest beaches for their nest sites and will not nest at beaches lit by mercury vapor lights. On beaches subject to indirect light trespass, turtles will avoid the more brightly lit areas in preference to the dark. Nests are, therefore, more concentrated in the dwindling dark spaces, causing more hatchlings to succumb to predators and other site-specific hazards.

However, the most deadly problem facing these internationally protected sea turtles is disorientation from excessive and carelessly placed light. Many types of coastal illumination, including street, residential, and business lighting, confuses newly emerged hatchlings, which instinctively orient to the brightest light source. For thousands of years, this source was the reflection of moon and starlight on the sea. The turtles' natural programming allowed them to reach the water safely. Today, development along coastlines can cause hatchlings to head inland instead toward artificial lights, where they die of exhaustion, dehydration, predation, and road traffic. Each year, Florida alone loses hundreds of thousands of hatchlings.

Inappropriate artificial night lighting disrupts physiological as well as environmental functions. Hormone production in vertebrates, for example, is regulated by the circadian rhythm. Studies in humans and rats show a correlation between exposure to even low levels of illumination during normally dark hours and depressed levels of melatonin (a hormone produced in the retina), resulting in an increased risk of accelerated growth in breast cancer tumors. The effect of artificial night lighting on melatonin and other hormonal systems has yet to be studied in the wild, a study made more difficult by the scarcity of natural dark night conditions in most Western ecosystems.

While the wide range of potential damage caused by artificial light at night is still being discovered, steps to reset the natural balance between light and darkness are already being taken. To help preserve wildlife and minimize damage to ecosystems, start by following the steps listed in the Practical Actions to the right. A list of resources to increase knowledge of these topics and links to information on local and regional action groups can be found at the end of this practical guide.

Practical Actions:

Turn off unnecessary lights around your house and yard. Use timers and sensors to help put light only where and when it is needed.

Use fully shielded fixtures to direct the light ONLY WHERE NECESSARY FOR COMFORT AND SAFETY.

See red: Use red filters on house and street lights. Red lights emitting a low wavelength generally have less of an impact on wildlife. Sea turtles and other coastal creatures, as well as amphibians and many species of insects, react especially well to red light—by hardly reacting at all.

…or yellow: Yellow lights such as high pressure sodium (HPS) or low pressure sodium (LPS) lamps attract fewer insects and moths (think of your typical yellow front porch bug light). If light is required, advocate for their use in environmentally sensitive areas such as coastal regions or forest preserves.

Get educated: field guides and nature walks will help identify vulnerable species in your area.

Raise awareness: Most people are blind to the impact artificial light has on wildlife. A presentation to a social club or activist group could increase interest and win supporters.

Ask that any further development in your community include a report on ecological issues of light pollution in their environmental impact statement.

Referenced Material:

Cinzano, P., F. Falchi, and C.D. Elvidge. "The First World Atlas of the Artificial Night Sky Brightness." *Monthly Notices of the Royal Astronomical Society.* 328 (2001): 689-707.

Rich, Catherine, and Travis Longcore, eds. *Ecological Consequences of Artificial Night Lighting.* Washington: Island Press, 2006.

Related Practical Guides and Web Links:

Blair E. Witherington and R. Erik Martin. "Artificial Lighting and Sea Turtle Hatchling Behavior." *Florida Marine Research Institute Technical Reports.* TR-2 (1996)—*http://research.myfwc.com/features/view_article.asp?id=2156*

Cinzano, P., F. Falchi, and C.D. Elvidge. "The First World Atlas of the Artificial Night Sky Brightness." *Monthly Notices of the Royal Astronomical Society.* 328 (2001): 689-707. *Light Pollution in Italy.* 2006—*http://www.lightpollution.it/cinzano/download/0108052.pdf.*

FLAP—Fatal Light Awareness Program—http://www.flap.org/.

FWC—Florida Fish and Wildlife Conservation Commission— http://www.myfwc.com/WILDLIFEHABITATS/Seaturtle_Lighting.htm

seaturtle.org— http://www.seaturtle.org

For information on IDA membership and donations, visit our Web site at www.darksky.org.

Guidelines for Outdoor Lighting
in
RASC Dark-sky Preserves and IDA Dark Sky Places
(RASC-DSP-GOL, IDA-DSP-GOL)

Adopted by the Royal Astronomical Society of Canada
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TABLE OF CONTENTS

1.0 SCOPE

This document presents Guidelines for Outdoor Lighting (GOL) in Royal Astronomical Society of Canada (RASC) Dark-sky Preserves and International Dark-Sky Association (IDA) International Dark Sky Places (IDSP's), and herein after referred to as Parks and describes the types of equipment required to satisfy these guidelines. It refers to areas classified as "Zone 0", which encompasses pristine areas that are sensitive to artificial lighting and other environmental disruptions.

The goals of these DSP Programs are to promote the reduction in light pollution, demonstrate good night-time lighting practices, improve the nocturnal environment of wildlife, protect and expand dark observing sites for astronomy, and provide accessible locations for the general public to experience the naturally dark night sky.

This DSP-GOL has three objectives: to limit glare and the adverse ecological impact of artificial lighting throughout the DSP, provide technical specifications for acceptable illumination levels required for navigation within the Park, and it presents lighting policies that may be applied to urban areas beyond the Park boundaries. This will protect the DSP from deterioration by surrounding light pollution.

We present in Section 3.0 the rationale for the need for a DSP and the protection of the urban nighttime environment from the excessive use of artificial lighting. To support these guidelines, this document presents references to useful web sites and to general research into the effects of nocturnal lighting on humans, human activity and wildlife.

The general guidelines for outdoor lighting within the DSP are presented in Section 4. Lighting hardware and signage are described in Section 5 to assist Park managers minimize the impact of artificial lighting on the nighttime environment while maintaining a degree of visibility for visitors.

A bibliography in Section 6 provides a set of references and useful websites. Supplementary technical information is provided in the appendices to this document.

2.0 GLOSSARY

2.1 Acronyms

CARS Canadian Aviation Regulations
CFL Compact Fluorescent lamps
CO Cut-off luminaires (>0% and <2% up-light)

DSP RASC Dark-sky Preserve and IDA International Dark Sky Places

FAA Federal Aviation Administration
FCO Full Cut-Off luminaires (0% up-light or Fully Shielded)

GOL Guidelines for Outdoor Lighting

HID High Intensity Discharge lamps (LPS, HPS, MH lamps)
HPS High Pressure Sodium lamps (“yellow” coloured lamps)

IESNA Illumination Engineering Society of North America

LEDs Light Emitting Diodes
LPS Low Pressure Sodium lamps (monochromatic, single colour lamps)

MH Metal Halide lamps (“white” coloured lamps)

NC Non cut-off (no restriction on up-light)

SCO Semi Cut-off luminaires (<2% and <5% up-light)
SAD Seasonal Affective Disorder

2.2 Definitions

Amber – a colour of light. Light that does not have any emissions at wavelengths shorter than 500 nm. Typically associated with the emitted colour of light emitting diodes. Generally has a yellowish colour but with better colour recognition than non-amber sources and has less impact on circadian rhythm than other colours.

Dark Time – a period after which scheduled outdoor activity has ended and visitors are expected to minimize their activity to permit other visitors to sleep.

Foot-candles (fc) - an English unit measure of the amount of light that falls on a defined area[1]. Examples of levels are provided in Appendix A and C.

Lux – a metric unit measure of the amount of light that falls on a defined area[2]. Examples of levels are provided in Appendix A and C.

Photobiology – the study of the effects of light on biological systems

Photopic Vision – vision that uses the lower sensitivity photoreceptors (cones) that have evolved for daytime vision and high illumination levels

Scotobiology – the study of the effects of darkness on biological systems

Scotopic Vision - vision that uses the higher sensitivity photoreceptors (rods) that have evolved for nighttime vision and low illumination levels.

DSP Buffer - Region within DSP surrounding the Core area under control of the park manager, or others. The Buffer is to prevent glare and light trespass from shining into the Core area

DSP Core - Region within DSP surrounded by a Buffer area under control of the park manager

[1] www.physlink.com/Education/AskExperts/ae409.cfm
[2] www.physlink.com/Education/AskExperts/ae409.cfm

3.0 RATIONALE

Most people take artificial nighttime lighting for granted. In cities it is considered to be an acceptable component of our society, and indeed many think it is a necessity for safety and security. Specifications and guidelines for street and roadway lighting[3] address these urban assumptions. This has led to lighting policies that encourage the illumination of all urban areas to allow the use of human photopic (daytime) vision. (Figure 3.0.1).

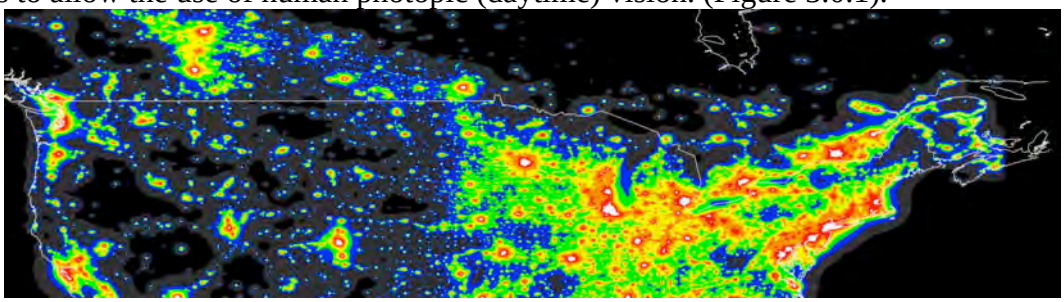

Figure 3.0.1 Mid Latitudes at Night[4]

The availability of electrical energy and efficient lighting fixtures have enabled the current urban lifestyle of non-stop "24-7" activity. Further, the advances in lighting technology have permitted illumination levels to increase over the last 50 years by a factor 10, with the use of the same amount of electrical energy. The result is most commercial luminaires are designed for high levels of illumination. Low intensity fixtures are primarily limited to decorative lighting such as Christmas lights.

It is now common in a city to be able to read a newspaper at night under the city's artificial sky glow. In Figure 3.0.2, the light polluted skies of Toronto are compared to relatively good skies southwest of Ottawa on the Rideau Canal system. Bright red corresponds to high levels of sky glow that illuminated the ground at a sufficient level to read outdoors (0.010 Lux[5], 0.009 fc) and green is an intermediate amount (0.00025 Lux, 0.000023 fc). The area of Algonquin Park appears black with very dark skies (0.00015 Lux, 0.000014 fc).

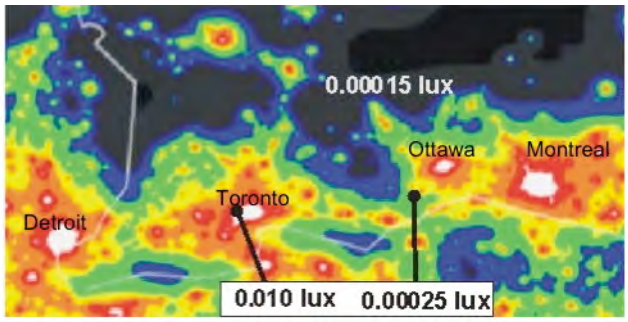

Figure 3.0.2 Light Pollution in Southern Ontario[2]

[3] Illumination Engineering Society of North American (IESNA) Handbook
[4] P. Cinzano, et. al. 2001
[5] 10 Lux – 1.078 foot-candles

In Toronto only the brightest stars are visible. On the Rideau Lake, the Milky Way is easy to see but the sky glow from Ottawa extends halfway up the sky in the northeast, and with sky glow from Kingston on the southwestern horizon. From Algonquin Park, there is virtually no visible sky glow and the Milky Way dominates the landscape after dark.

3.1 Crime

The most prevalent reason given for nighttime lighting is to reduce crime in cities. This is generally based on the notion that more light improves visibility, and that this visibility discourages criminals. Based on before and after studies of crime statistics, there is no clear evidence that outdoor lighting reduces crime[6]. Although there are anecdotal reports that "improved lighting" (i.e. improved visibility) reduces crime[7], there is no evidence that crime is reduced with "more or brighter lighting"[8]. In some cases crime was simply displaced, or the altered lighting was prompted by or caused a change in use of the streets by "…strengthening informal social control and community cohesion"[9] and this may have affected the pattern of crime.

There are different types of crime. Theft is more prevalent during daytime hours, violent crime occurs more often in the evening and after midnight.[10] Anecdotal studies report that most property crime occurs during the day and violent crime is usually between persons that know each other. The public's belief in the prevalence of random violence is not proven by the research.

There was an unconfirmed report that the brightly lit City of Manila found violent crime was more prevalent after dark and the presence of police was effective at reducing nighttime crime. The city lights were not the deterrent to crime. In a lengthy Report to Congress, by the National Institute of Justice[11] it is stated that there is no evidence that artificial lighting deters crime. It reports that most studies are poorly designed, without controls, which undermines any conclusions to the contrary. They state that: "We can have very little confidence that improved lighting prevents crime". It further reports that lighting can assist in the crime by putting the victim on display. The feeling of safety provided by the light may have the opposite effect.

Vandalism provides an example of the opposite effect of securing lighting than is generally believed. Studies conclude that lighted areas are more subject to vandalism and graffiti. Anecdotal evidence[12] and more focused studies[13] support the policy of turning lights off when security staff is not around. Apparently, vandals want to see the results of the damage

[6] The Influence of Street Lighting on Crime and Fear of Crime, Prevention Unit Paper No. 28, Stephen Atkins, Sohail Husain and Angele Storey, 1991, ISBN 0 86252 668 X
[7] Effects of Improved Street Lighting on Crime: A Systematic Review, Home Office Research Study 251, by David P. Farrington and Brandon C. Welsh, August 2002
[8] The Indiana Council on Outdoor Lighting Education (ICOLE), P.O. Box 17351, Indianapolis, IN 46217
[9] ibid, page 2.
[10] www.bpap.org/bpap/research/DCA_briefing_dtd.pdf
[11] National Institute of Justice Grant Number 96MUMU0019 (www.ncjrs.gov/works/)
[12] "Darkened Streetlights Fail to Raise Crime Rate", DesMoines Register, T. Alex and T. Paluch, May 6, 2004 www.dmregister.com
[13] Effects of improved street lighting on crime: a systematic review, Home Office Research Study 251, August 2002

and for others to see it. When lights are off, there is less gratification in vandalising an area or painting graffiti.

3.2 Human Lighting Needs

Humans are predominantly a daytime species. Although we can see at night, our vision is significantly reduced compared to the daytime. In the past, starlight provided sufficient levels of illumination for most activities. However our modern fast paced and mechanized activity requires better visual acuity for driving cars, bicycles and avoiding urban hazards.

Some artificial lighting may be required for nighttime activities, but this lighting must be designed to increase visibility. Paradoxically, more light can sometimes reduce visibility, especially for persons over 40 years of age[14].

The average age of our population is increasing. Sensitivity to glare also increases with age, as does our chance of developing cataracts. In the face of a bright light, our iris constricts, letting light into the eye only through the centre of our lens. Since cataracts begin in the centre of the lens, the vision of adults can be severely degraded by glare. With the aging of our population, it is becoming increasingly important to reduce glare in the urban environment.

3.3 Human Health

This proliferation of outdoor lighting has a significant impact on the health and behaviour of humans[15]. "Biological clocks control our sleep patterns, alertness, mood, physical strength, blood pressure, and other aspects of our physiology"[16]. The dominant mechanism for synchronizing this biological clock to our activity (the circadian rhythm) is the day-night contrast and the timely release of the hormone melatonin. This hormone regulates the ebb and flow of other hormones in our bodies. These "repair the damage" we do to our bodies each day. Without the proper release of these hormones, healing takes longer and our bodies are less able to fend off disease[17].

The timing of the circadian rhythm also affects our behaviour. For example, Seasonal Affective Disorder (SAD) is an emotional condition experienced by travellers and others. The symptoms can be reduced with exposure to bright light[18] as it shifts (or entrains) and resets our biological clock. If this entrainment occurs during the late evening or at night due to artificial outdoor lighting, the biochemistry that controls our physiological well-being will also be shifted away from the proper daytime hours.

3.4 Environmental Health

Although many people are familiar with the activity of the natural world during the day (i.e., photobiology), few people are as familiar with similar activity at night. Humans are not the only species whose biological clock is controlled by day-night contrasts and the

[14] Work, Aging, and Vision: Report of a Conference, ISBN-10: 0-309-07793-1
[15] Light Research Organization, Electric Power Research Institute, (www.epri.com/LRO/index.html)
[16] WebMD, March 06, 2007, www.webmd.com/cancer/news/20040908/light-at-night-may-be-linked-to-cancer
[17] [17] "Light at night and cancer risk", Schernhammer E, et.al., Photochem Photobiol. 2004 Apr;79(4):316-8.
[18] "Shutting Off the Night", H. Marano, Psychology Today, Sep/Oct 2002

release of melatonin. It is found in plants and animals wherein it plays a similar role[19]. Wildlife depends on the darkness of the night, and the study of this dependence is called "scotobiology".

Research into the nocturnal environment is relatively recent compared to research into the daytime environment. Consequently there is far less published literature documenting the sensitivity of the general nighttime ecology to artificial lighting. Most of the research is on specific species in the wild or laboratory studies. However, mounting scientific evidence is documenting the profound impact of artificial light on the ecology of the night.

Plants are affected by the colour and duration of lighting. Whether the effects are considered beneficial or not depends on the desired outcome. Generally, artificial lighting will change the natural growth patterns and may affect the resistance of plants to infestations and disease. Many plants respond to the length of the day and normally recognize it as an indication of the season. By extending light past the evening, may slow the plant's biochemistry from changing to prepare for winter[20]. The various effects of colour, duration, type of plant, etc. make sweeping conclusions impossible however, they indicate that changing the lighting environment will change the natural ecology of the area.

3.5 Animal Behaviour

Artificial sky glow extends well beyond the city boundaries. Therefore in considering urban outdoor lighting, we must also consider its impact on rural areas in the region.

Exposure to short periods of bright illumination (less than a minute) does not seem to affect the biological rhythm in animals[21]. However, longer exposures to light can shift (or entrain) their circadian rhythm and modify their behavioural patterns. Minimizing the duration of exposure to artificial light is necessary to limit its impact.

Seasonal variations will shift the time of sunset by over four hours (from roughly 16:30 in winter to 21:00 in summer). During the peak of Park activities in summer, the time of sunset can vary by two hours. In addition to this, dusk can extend the daylight by as much as an hour.

Artificial lighting changes the nighttime behaviour of species[22]. Over a month, the changing phases of the Moon affect the ground illumination at night. Nocturnal mammals adapt their behaviour over the month in response to moonlight to avoid predators. This behaviour includes, in part, limiting the foraging area and carrying food back to their shelters instead of eating it in the field. This latter adaptation limits how much they can eat[23].

Predator and prey behaviour depends on the darkness of the night[24]. Illumination levels that significantly affect wildlife are believed to be at the level of the full Moon, although the

[19] "Lighting for the Human Circadian Clock", S. M. Pauley, Medical Hypotheses (2004) 63,588–596
[20] Ecological Consequences of Artificial Night Lighting, C. Rich, T. Longcore, Island Press, 2006, Pg. 405
[21] Ecological Consequences of Artificial Night Lighting, C. Rich, T. Longcore, Island Press, 2006, Pg. 24
[22] The Urban Wildlands Group (www.urbanwildlands.org/abstracts.html)
[23] Ecological Consequences of Artificial Night Lighting, C. Rich, T. Longcore, Island Press, 2006, Pg. 28
[24] ibid., Chapter 2

effect begins to be evident at lower light levels[25]. To put this in context, it is generally recommended by the IESNA that an urban parking lot be lighted to more than 100 times this level (see Appendix A).

It is well documented that some insects are drawn towards light sources. This interrupts their normal mating and foraging activities and it concentrates them within a small area thus enhancing predation[26]. They may swarm the light fixture until they are exhausted. The resulting pile of insects must then be cleaned up[27].

Animals separated from their normal foraging grounds by an illuminated road cannot see the area beyond the lights. They can be temporarily blinded by headlights from passing cars. Their natural instinct is to wait until they can see where they are going. This can leave them in the open and vulnerable to predation. They may abandon their established foraging patterns for new ones, which will impact other species as they compete for resources[28].

3.6 Shorelines

Historically, waterways have been used for transportation and recreation. However, they are also important ecosystems that support wildlife in the water and on the lands adjacent to the shoreline. Shoreline property is valued by our society and this is causing human developments along rivers and around lakes. An increasing number of properties have shoreline lighting that illuminates the waterway. This impacts the river and lakes in two ways.

From the human stand point; bright lights along the shoreline make it very difficult to navigate the channel. Glare from unshielded shoreline lighting prevents our eyes from becoming adapted to the darkness. At night, a boater will only be able to see the points of light along the shore rendering the channel markers and out-of-channel hazards very difficult to see. Clearly, glare along the shoreline results in a safety hazard that should be corrected.

The second impact is on the fish and aquatic plants[29]. The effect of light on fish is not clear. Fish are attracted to the light from their natural feeding depths. The increase in the concentration of fish changes the hunting efficiency of predators. Although the behaviour of the nocturnal predator may not be compromised by artificial light, the ability of its prey to recognize the danger and to escape will affect their survival.[29]

3.7 Cultural Impact

There is a cultural imperative to protect the darkness of the night sky. Throughout recorded history (about 6,000 years) astronomy has been a focus of stories and mythologies. Those who have seen a dark sky are impressed by the serene majesty of the celestial sphere. It

[25] ibid., Chapter 11
[26] ibid., Chapter 13
[27] Communication with Parks Canada, 2008
[28] Ecological Consequences of Artificial Night Lighting, C. Rich, T. Longcore, Island Press, 2006
[29] Ecological Consequences of Artificial Night Lighting, C. Rich, T. Longcore, Island Press, 2006, Part V
[29] Skyglow and Zooplanktin, eg. Moore et al. 2001

comes as no surprise that all civilizations have the constellations and asterisms woven into their culture.

After stepping outside from a lighted room and under a dark rural sky, our initial count of a few stars with photopic vision increases a hundred fold after only 10 minutes. This may increase by another order of magnitude after less than an hour as our eyes become fully dark-adapted. However, urban sky glow overwhelms the faint stars, and the glare from discrete light fixtures prevents our eyes from becoming dark-adapted. These limit the number of stars we can see from many thousands to only a few hundred. Our current generation is the first for whom much less than half the population has seen a star-filled night sky. Most children have never seen the Milky Way.

3.8 Summary

Generally there is limited research on the environmental benefits and costs of artificial lighting. In the absence of clear conclusions, the best policy is to minimize its effects on the ecosystem.

Studies have been published that present conflicting conclusions about outdoor lighting and the reduction of crime. The fact that these studies cannot reach a consensus undermines the argument that more light makes a safer environment. It has not been shown that the cost of lamping, or re-lamping, large areas of a city will result in reduced crime. Yet, the cost of lighting an area may cause funds to be redirected away from other more effective measures.

There is growing medical evidence for the degradation of human health with the illumination of the night. The reduction in day-night contrast can uncouple the circadian rhythm from our normal daytime activities that may cause an increase in chronic diseases.

It is clearly shown in published research, that artificial outdoor lighting affects ecology by disrupting food webs. Although the actual mechanism for this disruption is not always clear, this does not weaken the evidence for the damaging impact of artificial light on the ecosystem and the need to minimize it.

Education is the key to correcting this degradation of the nocturnal environment by our nighttime culture. As the main source of light pollution, cities are key components in education and solving this problem. Establishing Dark-sky Preserves and Dark Sky Places are an obvious way to help inform the public about the virtues of a dark night.

Artificial lighting that is installed for human activity is altering the natural environment. This environmental degradation continues without resistance, and is indeed supported by human nighttime culture. Primarily due to ignorance, our civic policies and the legal system are strongly biased in favour of human demands. New research is revealing how artificial lighting degrades both human health and the health of wildlife within and well outside our cities. Wildlife has no voice in law and cannot control their environment. We must act on their behalf. Cities must take action and advocate against change in their environment.

4.0 GUIDELINES FOR OUTDOOR LIGHTING

A RASC Dark-sky Preserve and IDA International Dark Sky Place (DSP) is defined as an area whose night sky has little or no sky glow and minimal lighting within the DSP. If there is significant sky glow due to close proximity to an urban area, it may be classified as an Urban Star Park, or an International Dark Sky Community in accordance with the RASC USP Program and the IDA IDSC Program, respectively. Persons interested in USP, or IDSC Designations should refer to the documents: RASC-USP GUIDELINES and RASC-USP-GOL, or contact the IDA.

There are several facilities that may be within a DSP. The illumination levels for these facilities are summarized in tables for each area and application. The rationales for the limits in these tables are provided in Section 3.

Before determining what type of lighting should be installed or retrofitted, it is important to ask the basic question "Is the lighting necessary?". If no valid reason for lighting can be found, it is better to remove the current lighting than replacing it with better technology. Don't assume that the mere fact that lighting is currently installed means that there was or currently is a valid reason to light the area.

This section provides guidelines that should be followed to minimize light pollution within a Park. Similar fixture hardware is recommended to minimize the inventory for repairs or replacement.

Where necessary for basic safety and navigation:

1. Illumination should be to the minimum practical level,
2. The affected area of illumination should be as small as practical,
3. The duration of the illumination should be as short as practical, and
4. Illumination should minimize the amount of short wavelength spectral content including UV and blue light (avoid cool or wide spectrum white light).

What is “practical” depends upon the specific facilities in the area and the technology available at that time.

Illumination levels specified in this document are lower than urban areas for which most luminaires have been designed. This restricts the type of light sources that may be used. Although High Intensity Discharge (HID) lamps are very efficient, they may emit more light than is recommended in these guidelines. To address this, relatively inefficient, incandescent lights may be used for short periods of time or more advanced Light Emitting Diode (LED) lamps may be installed.

These guidelines address the use of the facility and expected pedestrian and vehicle traffic. Eleven specific facilities and areas are identified with a range of lighting conditions that reflect their varied use. Priority is given to respecting and protecting the natural environment.

Park managers have the discretion to assess what levels are most appropriate for each facility within the limits outlined in Section 3 of this document. Lighting is limited to provide only what is required for navigation in built up areas. The artificial lighting is restricted to these areas and for the periods of human activity unless otherwise noted.

"Dark Time" is a term used in some parks to identify the end of significant activity within an area. This term is used herein to identify when light should be discouraged. In this document Dark Time is further assumed as being 2-hours after sunset.

The following tenets have been used in developing these specifications.

1. Buildings require illumination only when open or available to people. After the office is closed to the public, all lighting visible from the outside should be turned off or covered.

2. To save energy and minimize the duration and extent of light pollution, lighted pathways should be illuminated only when pedestrians are in transit. All reasonable effort should be made to turn off lighting when pedestrian traffic is low or is no longer expected.

3. To minimize the impact of artificial lighting on the ecosystem, the areas covered by this specification should only provide a safe transition between lighted structures and the surrounding unlighted area and to assist in navigation.

4. To minimize the extent of light pollution, the area of illumination should be strictly limited.

5. To limit the duration of light exposure on the ecosystem and to save energy, light activated timing circuits should turn off outdoor lighting. The time delay should begin at sunset and should extend to an appropriate time into the evening to permit scheduled activity to end.

6. Where vehicle and pedestrian traffic is at a low speed or infrequent, retro-reflective signage should be used instead of installed lighting fixtures.

4.1 Buildings

This section identifies six types of structures that may require illumination within a park. In all cases, full cut-off (FCO) luminaires should be used and illumination should be controlled to prevent light scattering beyond the immediate area of the light fixture. Further, the colour of this light should have minimal UV and blue (short wavelength) content and dark time lighting curfews should apply.

Interior and exterior lighting that remains on for extended periods after operating hours not only wastes energy but can also be a nuisance. Insects are attracted to exterior building lights and interior lighting that shines through windows. In addition to the need for cleaning up dead flies before the building opens in the morning for the public, the light distracts

insects from their normal activity. Outdoor illumination from indoor lighting is approximately equivalent to the natural illumination 30-minutes after sunset (Ref. Measurements by author). After this time effort should be made to shield indoor lighting.

Illumination levels and luminaire types for various buildings are listed in Table 4.1 at the end of this sub-section. Signage on buildings is discussed in Section 4.6.

This document uses five classifications for buildings:

- Administration Buildings,
- Public Buildings,
- Retail Outlets,
- Vending Machine Enclosures, and
- Toilet and Washroom Facilities.

4.1.1 Administration Buildings

Park administration buildings are defined as those with private offices and will generally be closed after dark. Illumination of the main doorway and especially any steps leading to the main door may be required after sunset in the early spring, late autumn and winter. After hours, either all interior lighting should be turned off, or window and door blinds should be used to prevent interior light from shining outside. Light activated timing circuits should turn off all outdoor lighting within 30 minutes of the office being closed. Manual reset switches may be used to extend this period for late-working staff.

4.1.2 Public Buildings

Public buildings are defined as those open to the public during business hours and may also contain private offices. Due to the public nature of these buildings with high pedestrian traffic, exterior illumination may be higher than for park administration buildings.

After hours, either all interior lighting should be turned off, or window and door blinds should be used to prevent interior light from shining outside. All outdoor lighting should be turned off within 30 minutes of the office being closed. Exterior lighting should be limited to the main door area and steps (if any). Light activated timing circuits should turn the lighting on after sunset and off after a period of time specified by Park manager and subject to the building use. Manual reset switches or motion detectors may be used to extend this period by a pre-programmed duration.

4.1.3 Retail Outlets

It is assumed retail stores will have higher pedestrian traffic than most other areas while they remain open for business after dark.

Window coverings should be used so that interior lighting will not shine outside 30 minutes after sunset. Exterior light is permitted, and restricted to, the area around the door using

Full Cut-off (FCO) fixtures. All exterior lighting should be turned off within 30 minutes after business hours.

4.1.4 Vending Machines

Vending machines should be located in an enclosed space and their lights should not shine directly outside through doorways or windows. Where practical, these machines should be enclosed in existing public buildings. Figure 4.1.4 shows an example of a dedicated vending machine enclosure. Only FCO fixtures should be used to illuminate the area outside the entrances. The extent of this outside illuminated ground area is restricted to less than 5 metres from the entrance.

Light from vending machines is usually from a number of fluorescent tubes behind the translucent display and may emit significant amounts of UV and blue light. This light undermines dark adaptation and attracts flying insects. Therefore, the illumination levels outside these enclosures may be higher than for other buildings to allow the transition for visitors from the bright interior to the dark surroundings.

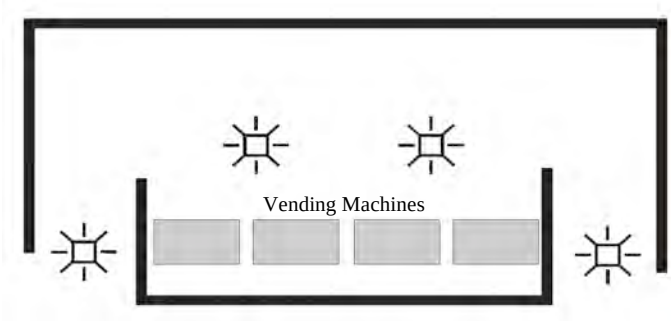

Figure 4.1.4 – Sample Vending Machine

Doorway lighting should be turned off within two hours after sunset. Interior lighting may remain on at the owner's discretion.

Table 4.1 Building Illumination Guidelines (Maximum Values)

4.1 Area	Type	Lamp*	Illumination** Level lux (fc)	Height m (ft)	Curfew
4.1.1 Administrative Bldgs.	FCO	Incandescent, Yellow CFL or Amber LED	~2 (0.2)	2.5 (8)	Yes
4.1.2 Public Bldgs.	FCO	Incandescent, Yellow CFL or Amber LED	~2 (0.2)	2.5 (8)	Yes
4.1.3 Retail Stores	FCO	Incandescent, Yellow CFL or Amber LED	~2 (0.2)	2.5 (8)	Yes
4.1.4 Vending Machine	FCO	Incandescent, Yellow CFL or Amber LED	~2 (0.2)	2.5 (8)	Yes
4.1.5 Toilet & Washroom Facilities	Marker (FCO)	Incandescent, Yellow CFL or Amber LED	~2 (0.2)	2 (6.5)	No

*The wattage for indivdual lamp types are not specified due to differences in efficacy, Park Managers should consult Appendix C for guidance in meeting the recommended illumination level in all tables in Section 4.

**Note: 2 Lux (0.2 fc) = illumination of dusk about 20 minutes after sunset

4.1.5 Toilet and Washroom Facilities

Toilet and washroom facilities should be available throughout the night. If illuminated, Full Cut-off (FCO) fixtures should be used to illuminate the entrance and any steps leading to the doorway. If deemed necessary by Park managers, these structures may have a non-cut-off marker light by the door. This marker light should be the lowest practical wattage. For example, a small 15-watt incandescent lamp can be easily seen for 200 metres. Alternatively, a 1w red or amber LED fixture may be used.

Interior lighting in these facilities must also be considered. Excessive interior lighting levels can produce serious glare that impairs exterior visibility if windows are present. Interior lighting should use bug light or yellow color whenever possible and lighting levels as measured horizontally at the floor should not exceed 10 lux (1 fc).

4.2 Parking lots

Generally, parking lots have less traffic at night than during the day. Parking lots may require lighting due to scheduled after-dusk activities. This lighting will be necessary until gate closure or Dark Time, whichever occurs first.

Where required, pole mounted Full Cut-off (FCO) luminaires should be placed one pole-height from the extreme corners of the parking lot and distributed evenly along the perimeter with an approximate pole spacing of no less than 4-times the luminaire height. Their light distribution pattern should be “full forward” and aimed into the lot. This is symbolically shown in Figure 4.2. If necessary, poles may be located within the parking lot area. Retro reflective markers should be fixed to the poles extending from ground level up to approximately one metre (3.3 feet) to increase visibility for motorists while backing up.

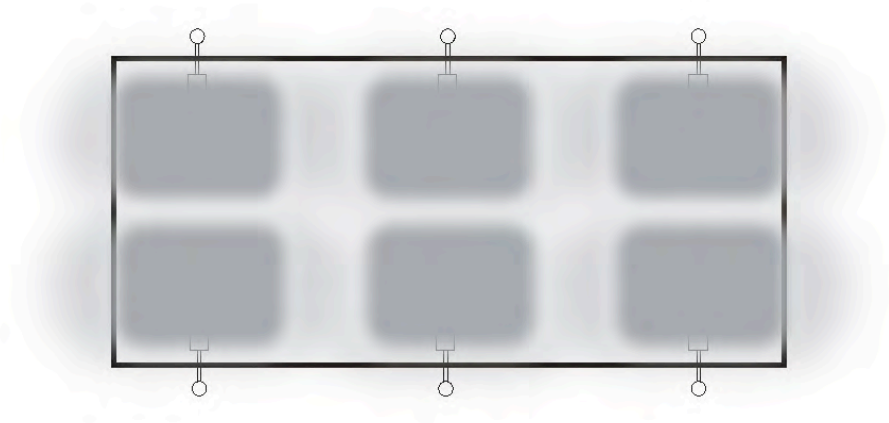

Figure 4.2 Parking Lot

4.2.1 Administration Parking Lots

Administrative personnel will generally leave when offices close. Luminaires in administration parking lots should be turned off within 30 minutes of the office closure. A timing circuit should control the lights with a manual reset for employees working late.

4.2.2 Visitor Parking Lots (Small)

Generally small lots (less than 10 cars) experience little traffic and should not be illuminated.

4.2.3 Visitor Parking Lots (Large)

Larger parking lots (spaces for approximately more than 10 cars) may require better visibility than smaller lots. These lots may be illuminated at the discretion of the Park manager. However illumination levels should not exceed the limits listed in Table 4.2.

Table 4.2 Parking Lot Illumination Guidelines (Maximum Values)

4.2 Parking Area	Type	Lamp	Illumination Level Lux (fc)	Height m (ft)	Curfew
4.2.1 Administration Lot	FCO	LPS, HPS or Amber LED	~3 (0.3)	6 (20)	Yes
4.2.2 Visitor Lot < 10 cars	N/A	None	N/A	N/A	N/A
4.2.3 Visitor Lot > 10 cars	FCO	LPS, HPS or Amber LED	~3 (0.3)	6 (20)	Yes

N/A – not applicable

4.3 Roadways

Intersections are some of the most dangerous areas for drivers. Drivers of high-speed vehicles require sufficient time to react when they approach an intersection. Therefore, major intersections should be marked with signage or luminaires. Illumination of adjacent areas should be minimized.

4.3.1 Class 1 to Class 3 Roadways

Class 1 to Class 3 roadways are subject to high (Class 1) to medium (Class 3) traffic volumes. Due to the high speed and volume of traffic, marker lighting may be required to alert drives to an intersection.

Where necessary, marker lights may be installed at intersections between Class 1 to Class 3 roadways. To further minimize the impact of these luminaires on the environment, the luminaire should be mounted no higher than six metres (20 feet) and the fixture should use Low Pressure Sodium (LPS) or Amber LED to minimize the exposure to the environment of UV and blue light.

Retro-reflective signage should be used for all other intersections between the Class 1 to 3 roadways and lesser roadways. Illuminated signage should not be permitted (see Section 4.6).

Where applicable, federal and provincial highway standards may take precedence when safety or security can be shown to be compromized.

4.3.2 Class 4 to Class 6 Roadways

Class 4 to Class 6 roadways have low traffic volumes with class 6 roads seeing occasional and local traffic. These roads provide access to large areas of the Park. Recognizing the infrequent use of these roads and the potential impact they may have on remote areas, these roads and intersections should not be illuminated.

Table 4.3 Roadway Illumination Guidelines (Maximum Values)

4.3 Roadways	Type	Lamp	Illumination Lux (fc)	Ht m (ft)	Curfew
4.3.1 Class 1-3 roadways	None	N/A	N/A	N/A	N/A
4.3.2 Class 1-3 roads & intersections	FCO Marker	LPS, HPS or Amber LED	~3 (0.3)	6 (20)	No
4.3.3 Class 4-6 Roads & intersections	Signage only	N/A	N/A	N/A	N/A

N/A – not applicable

4.4 Pathways

Pathways and sidewalks provide a relatively level surface for pedestrian traffic, and aid in site navigation. Visibility is necessary for navigation but excessive illumination will prevent pedestrians from seeing off the path. Although visitors use flashlights, additional pathway lighting may be required to guide visitors to public facilities.

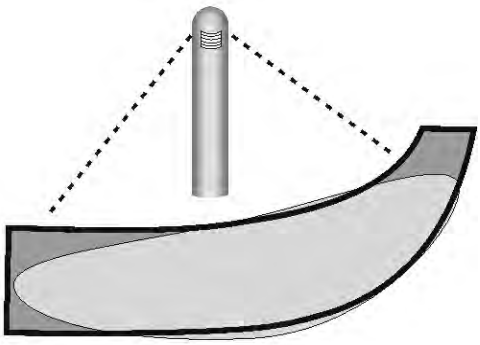

Figure 4.4.1 Bollard Luminaire

Paths are also used by wildlife. Therefore, pathway lighting should be restricted to only those paths near buildings, parking lots and campgrounds, and only those paths that the Park Manager considers appropriate should be illuminated.

Since overhead FCO luminaires will illuminate areas much wider than the path, low wattage bollard lighting should be used such that the bollard-mounted lights are directed down and along the path. The fixture should be FCO and shielded or lensed such that the illumination pattern is approximately limited to the path width.

Pathways should use white or light coloured crushed stone (limestone) instead of asphalt to help reflect ambient light. Retro reflective or passive fluorescent markers may also be used to mark the extent and direction of the pathway. These may be mounted on bollards or in the pathway surface.

Generally, individuals walking along a pathway will have left the area after a minute or so (a distance of 30 metres) unless they remain for an activity. To minimize unnecessary light exposure, switches with timing circuits may be used manually to activate the lighting and to automaticaly turn them off after a few minutes. Proximity detectors should be installed at the entrances to pathways.

The closeness of the luminaires to the ground necessitates very low intensity lights. This limits the current products available to low wattage incandescent lamps and LEDs. These guidelines for pathway lighting can be reduced to four points.

1. Whenever possible pathways in the DSP should not be illuminated. If deemed absolutely necessary by the Park manager, specific pathways may be illuminated or lined with fluorescent markers.
2. Illuminated pathways should have full cut-off bollard mounted lighting fixtures.
3. Pathway lighting should be turned off at the Dark Time lighting curfew. Retro-reflective markers on the bollards may assist pedestrians after Dark Time.
4. Main pathways leading to night facilities may be illuminated throughout the night at the discretion of the Park manager.

Table 4.4 Pathway Illumination Guidelines (Maximum Values)

4.4 Pathways	Type	Lamp	Illumination Lux (fc)	Height m (ft)	Curfew
4.4.1 Pathways	None	None	N/A	N/A	N/A
4.4.2 Illuminated Paths	FCO	Incandescent, Yellow CFL or Amber LED	~1 (0.1)	1 (3.3)	Yes
4.4.3 Main Pathways	FCO	Incandescent, Yellow CFL or Amber LED	~1 (0.1)	1 (3.3)	No

N/A – not applicable

4.5 Shoreline Areas

Shoreline areas consist of docks, jetties, lock facilities, boat launching areas, beaches, homes, cottages and undeveloped lands. The direct illumination of the shallow water near shore alters the behaviour of aquatic species and the foraging patterns of landed species and insects.

This document provides guidance to Park managers for reducing the impact of lighting along a waterway. These guidelines are relatively general due to the limited authority of Park managers over some of these properties.

1. Park personnel should inform the owners and users of shoreline property of the impact artificial light has on the ecology of the water and adjacent lands.
2. The public should be advised to shield all outdoor lighting to comply with Full Cut-off (FCO) requirements and to turn off this lighting when they go to bed.
3. Shoreline lighting should consist of amber or red light with no UV and blue spectral content. Blue and white lights should not be permitted.
4. Light fixtures should be prohibited within ten metres (33 feet) of a shoreline unless they are deemed necessary by the Park manager. Overhead luminaires that shine into the water should not be permitted.
5. Where shoreline lighting is permitted, it should have Full Cut-off (FCO) fixtures with low wattage amber or red light. Shielded bollard lighting with incandescent or LEDs should be used where dock managers have identified their need. High traffic areas and near machinery (lock facilities) may require higher levels of illumination at the discretion of the Park manager if machinery is operated after dark.

Table 4.5 Shoreline Illumination Guidelines (Maximum Values)

4.5 Waterways	Type	Lamp	Illumination Lux (fc)	Height m (ft)	Curfew
4.5.1 General Areas	N/A	None	N/A	N/A	N/A
4.5.2 Dock Bollards	FCO	Incandescent, Yellow CFL or Amber LED	~1 (0.1)	1 (3.3)	No
4.5.3 Lock Facilities	FCO	Incandescent, Yellow CFL or Amber LED	~1 (0.1)	6 (20)	Yes

N/A – not applicable

4.6 Signage

Signs within a Park are essential to the efficient navigation of the site. They may display three forms of information: names for sites or buildings (usually mounted in proximity to buildings or other structures), directions (located along roadways or pathways and their intersections) and those meant to convey other information (located to the side of roadways and pathways).

Illuminated signs should be prohibited in a DSP. These include, but are not limited to, internally illuminated signs, signs illuminated from below and above the sign, and in front of the sign. To improve the visibility of signs after dark, their location, colour scheme, and material should permit reading the sign with flashlights or existing lighting.

Retro-reflective signage should be used to ensure signs are visible only when necessary. Signs may be mounted on or near buildings such that exterior building lighting may provide some illumination, and they should use colours consistent with retro-reflective materials and illumination with flashlights.

Signs should be located so pedestrians can easily see them. Elevated signs are less likely to be illuminated by Full Cut-off (FCO) luminaires. Pathway and information signs should be located less than one metre above the grade of the path so that they may be found and read by pedestrians with flashlights after dark. Signs mounted at a higher elevation may be missed as flashlights are aimed at the ground. All bollards should be marked with retro-reflective material so they may be visible to pedestrians after Dark Time. Roadway signs should be mounted in accordance with standard roadway practice.

Table 4.6 Signage Illumination Guidelines (Maximum Values)

4.6 Signage	Type	Lamp	Illumination Lux (fc)	Height m (ft)	Curfew
4.6.1 Building	Retro-reflective	Amber/Red LED*	N/A	1-2 (3-6)	N/A
4.6.2 Navigation	Retro-reflective	Amber/Red LED*	N/A	<1 (<3)	N/A
4.6.3 Information	Retro-reflective	Amber/Red LED*	N/A	1-2 (3-6)	N/A

* Lowest practical wattage to illuminate surface to 1 lumen per square meter (0.1 lumen/ft^2)

N/A – not applicable

4.7 Tower Navigation Avoidance Beacons

There is a proliferation of communication towers for cell phones and the acceptance of wind turbine power generation. Park managers should be aware of the options available for Tower navigation beacons that are regulated by national or federal transportation authorities.

Tower and wind turbine lighting may not be required unless the tower exceeds a specific height. Consult applicable national aviation standards for your location. There are several types of navigation avoidance beacons that may be used on towers (see Appendix D). Birds are not attracted to red light as much as white light and they appear to be less able to orient themselves to the flashing beacons compared to non-flashing types[30].

There are several types of navigation avoidance beacons that may be used on towers (see Appendix D). For example, in Appendix D1, there is a beacon with a collimated rotating beam (CL864). In principal, its luminous intensity can be lower than other types of beacons and would emit less light into the air, resulting in less scattered light into the environment.

Communication towers erected on or near Parks should not be fitted with nighttime navigation beacons unless strictly required by the National transportation authority. All towers requiring nighttime navigation beacons should use red flashing lights.

4.8 "Developed" Properties within Park Facilities

These properties include, but are limited to, privately owned and rental properties and towns within Park boundaries.

Owners of private properties within the Park should be informed of the impact of artificial lighting on wildlife. They should be encouraged to remove "dusk to dawn" lights, replace "yard lights" with Full Cut-off (FCO) luminaires and replace MH lamps with either HPS, Low Pressure Sodium (LPS) fixtures or amber LED fixtures. They should be encouraged to turn off all exterior lighting when they are indoors. All municipal lighting should be FCO and illumination levels should be no greater than minimum recommended by Illumination Engineering Society (IESNA) Guidelines.

[30] Gehring,J. Aviation Collision Study for the Michigan Public Safety Communications System (MPSCS): Summary of Spring 2005 Field Season. Central Michigan University. August 12, 2005.

The outdoor lighting on properties under the control of Park managers should use Full Cut-off (FCO) fixtures. Area lighting fixtures, such as "yard lights" and “dusk to dawn” fixtures or similar luminaires, should not be permitted nor should Metal Halide (MH) or mercury vapour lamps be permitted. These products produce excessive glare and light trespass and emit short wavelength light that affects wildlife.

Use of outdoor lighting on private properties within Parks should be discouraged 2-hours after sunset, and should be turned off when people are indoors. Outdoor lights should not be permitted to remain on throughout the night.

Table 4.8 Other Properties Illumination Guidelines (Maximum Values)

4.8 Other Properties	Type	Lamp*	Illumination Lux (fc)	Height m (ft)	Curfew
4.8.1 Door Lights	FCO	Incandescent, Yellow CFL or Amber LED	~2 (0.2)	2 (7)	Yes
4.8.2 Yard Lights	FCO	LPS, HPS, Yellow CFL or Amber LED	~2 (0.2)	6 (20)	Yes
4.8.3 Roadway Lights	FCO	LPS, HPS, Yellow CFL or Amber LED	≤ minimum IESNA	TBD	When possible

* Wattage of lamps should be based on illumination limits, where 3 Lux = 3 lumens/square meter (0.3 fc = 3 lumens/ square foot)

4.9 Light Pollution Abatement Beyond Park Boundaries

As with air and water pollution, light pollution has no boundaries. It is only reduced by increasing the distance to the source. Some cities are actively promoting the replacement of luminaires that contribute to sky glow but these policies are not wide spread. Parks may influence the producers of air and water pollution that passes through Parks. This influence should be extended to include light pollution.

- Park managers should introduce and encourage programs of light pollution abatement in municipalities around the Park facilities with the goal of reducing glare across Park boundaries and sky glow from artificial lighting.
- Park managers should approach individuals whose lights shine onto Park facilities. The goal of these contacts is to have those lights shielded, reduced in brightness or removed.

4.10 Historic Sites

The guidelines in this document give priority to wildlife in Parks; but historic sites may be located within urban areas where light pollution is generally so bad that lighting to the above standards will not improve the situation. The philosophy of not over-lighting the area is prudent for better visibility, which leads directly to safety, aesthetics, and it will reduce operating costs.

Outdoor lighting at historic sites should use Full Cut-off (FCO) fixtures and should be lighted to the minimum levels of standards and guidelines in the surrounding area. If "Period Lighting Fixtures" are used on the site, then the FCO variety should be used where possible.

4.11 Wilderness Areas

Wilderness areas are all "undeveloped" property in their natural state. The use of red or amber flashlights should be encouraged but high power flashlights (> 300 lumens) should not be allowed. As with permanent lighting, amber and red light flashlights will reduce glare and help maintain dark adaptation., The use of white flashlights should be discouraged or used sparingly. Installation and extended use of portable outdoor lighting is strictly prohibited.

5.0 LIMITATIONS

No assurance is made regarding the accuracy and completeness of these data. The RASC disclaims responsibility for consequential financial effects on transactions or property values, or requirements for follow-up actions and costs.

This document is based on data and information collected during work undertaken by the RASC. The RASC will not be held responsible for the errors and omissions of work carried out by third parties.

This document provides a professional opinion and, therefore, no warranty is either expressed, implied, or made as to the conclusions, advice and recommendations offered in this document. This document does not provide a legal opinion regarding compliance with applicable laws. With respect to regulatory compliance issues, it should be noted that regulatory statutes and the interpretation of regulatory statutes are subject to change.

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Ecological Consequences of Artificial Night Lighting, edited by T. Longcore, C. Rich Island Press, 2006 ISBN 1-55963-129-5

Environment and Crime in the Inner City, Environment and Behavior, Vol. 33, No. 3, 343-367 (2001)

FMRI Technical Report TR-2, B. E. Witherington, R. E. Martin, Florida Fish and Wildlife Conservation Commission, Second Edition 2000

Handbook, Illumination Engineering Society of North American (IESNA)

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Observers Handbook, Royal Astronomical Society of Canada, Patrick Kelly, Ed. 2007, ISBN 0-9738109-3-9

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Shutting Off the Night, H. Marano, Psychology Today, Sep/Oct 2002

Skyglow and Zooplanktin, eg. Moore et al, 2001

Tested Strategies to Prevent Crime: A Resource for Municipal Agencies and Community Groups, National Crime Prevention Council, Copyright © 1995

Wind Turbine and Windfarm Lighting, CAR621.19 Advisory Circular 1/06 DRAFT 9, Transport Canada

6.2 Web Sites

International Dark Sky Association
www.darksky.org

Royal Astronomical Society of Canada (RASC) Light Pollution Abatement Program
www.rasc.ca/lpa/index.shtml

National Crime Prevention Council
www.ncpc.org/ncpc/ncpc/?pg=2088-10802
National Institute of Justice Grant Number 96MUMU0019
www.bpap.org/bpap/research/DCA_briefing_dtd.pdf

Canadian Aviation Regulations (CARS) 621.19
www.tc.gc.ca/CivilAviation/publications/tp14371/AGA/6-0.htm

Shoreline Booklet downloadable from IDA
www.uwsp.edu/cnr/uwexlakes/humanimpact/lighting.pdf

Ecology of the Night Conference Proceedings
www.muskokaheritage.org/ecology-night/

Light Pollution by Pierantonio Cinzano
www.lightpollution.it/indexen.html/

WebMD, March 06, 2007,
www.webmd.com/cancer/news/20040908/light-at-night-may-be-linked-to-cancer

Psychology Today, Sep/Oct 2002
http://psychologytoday.com/articles/pto-20021002-000003.html

BC Hydro Power Smart Program – 42 watt LED sufficient for urban pathway
http://dmdeng.com/pdf/learning/Power_Smart_Roadway_Lighting,_BCH.pdf

Light Research Organization, Electric Power Research Institute,
www.epri.com/LRO/index.html

The Indiana Council on Outdoor Lighting Education (ICOLE),
P.O. Box 17351, Indianapolis, IN 46217, USA
http://home.att.net/~icole/crime_ref_guide.html

Fatal Light Awareness Program
www.flap.org/new/nestegg_3.htm/

Florida Fish and Wildlife Conservation Commission
www.floridamarine.org/publications/default.asp

Web Sites (continued)

The Urban Wildlands Group
www.urbanwildlands.org/abstracts.html

Sample of Luminaire Product Sources
http://store.starrynightlights.com/depali.html

LED Landscape Lighting
www.superbrightleds.com/malibu.htm

Astronomy Outreach and Education Materials
www.starlight-thatre.ca

Wildlife Lighting
www.state.hi.us/dlnr/dofaw/fbrp/sos.htm

Work, Aging, and Vision: Report of a Conference, National Academy Press, Washington, DC, 1987, ISBN-10: 0-309-07793-1, http://books.nap.edu/openbook.php?isbn=POD252

APPENDIX A - Reference Illumination Levels

Condition	Illumination Levels* Lux (fc)**
Clear night sky (no Moon)	0.000 05 (0.000 005)
Clear Urban Sky with Light Pollution	0.015 (0.014)
Twilight	0.1 (0.009)
Overcast Urban Sky with Light Pollution	0.15 (0.014)
Full Moon	1 max. 0.3 typ. (0.1 0.03 typ.)
Urban Road Artificial Illumination	2 (0.18)
Open Parking Lot	11-22 (1–2)
Car Dealership Lot	200 (18.6)
Full Sunlight	100,000 (9,300)

* Clarity of the atmosphere is highly variable over hours and days. These values are presented to provide only a rough guide to approximate illumination levels.

** “lux” is a Système internationale (SI) unit of illumination equal to 1 candela/m^2 (cd/m^2) = 0.093 foot-candles (fc)

To place these levels in context, people have reported seeing “fine” at full Moon illumination levels in the absence of glare[31].

[31] Preliminary Recommendations: Outdoor Lighting at Highlands Center, Cape Cod National Seashore, Chad Moore, March 25, 2006

APPENDIX B - Colour from Various Light Sources

There are six lamp types that convey “colour” from bright white to amber. The last light source, LEDs can be customized to provide a range of colours. The accompanying table lists these sources in order from white to amber.

MH – Metal Halide	They allow very good colour recognition because of the wide spectrum emission (blue to red) from the lamp. It is a “High Intensity Discharge’ (HID) lamp that must be warmed up before it can reach full brightness. The white light gives very good colour recognition. MH has high blue spectral content, produces a significant amount of UV and therefore its use should be avoided in all DSPs.
Incandescent	These emit a warm white light and have very low energy efficiency. Two characteristics make them desirable for some applications. They can be turned off and on very quickly so they can be used for motion detection systems. Incandescent should only be considered if Amber LED or Yellow CFL lamps are not available due to their inefficiency and attraction to flying insects.
HPS - High Pressure Sodium	These are bright yellow and allow fair colour recognition. A HPS lamp has a small light-emitting region for very good control over where the light is focused. As a HID source, they require a few minutes to heat up before they reach their full brightness.
Yellow CFL – Compact Fluorescent Lamps	These produce filtered white light and are commercially sold as bug and party lights. They may be identified as yellow and orange. Color and quality vary greatly and they produce a much wider spectrum of light than LED. Choose darker yellow and orange whenever possible to avoid flying insect attraction. They typically do not perform as well in cold temperatures and may take several minutes to warm up in sub-zero temperatures.
LPS - Low Pressure Sodium	Deep yellow light is virtually a single colour offering very poor colour recognition. It is the most energy efficient of the above lamps. They are so efficient that even low wattages may produce too much light for use in DSPs. The light-emitting region in the lamp is quite large compared to other HID lamps making shielding more difficult.
LEDs - Light Emitting Diodes	These are available in a range of colours, amber and red LEDs minimizes their impact on the environment. They can produce very focused and narrow band illumination, which is very desirable for DSP applications. For DSP purposes “Amber” is defined as light in the wavelength of 500 – 650 nm and includes portions of “Green”, “Yellow”, and “Red” light.

APPENDIX C - Light Output from Typical Lamps for Comparison Purposes (Metric and English Units)

Lamp Types	Lumens[//] (Intensity)	Lux[///] at 6 m[////] (fc at 20 ft)	Lux[///] at 2 m[////] (fc at 6.5 ft)	Lux[///] at 1 m[////] (fc at 3.3 ft)
Incandescent*				
7 watt	60	0.13 (0.01)	1.2 (0.11)	4.8 (0.45)
15 watt	128	0.28 (0.03)	2.6 (0.24)	10.2 (0.95)
40 watt	342	0.8 (0.07)	6.8 (0.63)	27.2 (2.5)
60 watt	513	1.1 (0.10)	10.2 (0.95)	40.8 (3.8)
100 watt	855	1.9 (0.18)	17.0 (1.6)	68.0 (6.3)
Metal Halide (MH)				
70 watt	3,000	6.6 (0.61)	59.7 (5.5)	238.7 (22)
100 watt	5,800	12.8 (1.2)	115.4 (11)	461.6 (43)
High-pressure Sodium (HPS, LED**)				
35 watts	2025	4.5 (0.42)	40.3 (3.7)	161.1 (15)
50 watts	3600	8.0 (0.74)	71.6 (6.6)	286.5 (27)
70 watts	5450	12.1 (1.2)	108.4 (10)	433.7 (40)
100 watts	8550	18.9 (1.8)	170.1 (16)	680.4 (63)
Low Pressure Sodium (LPS)				
18 watts	1570	3.5 (0.32)	31.2 (2.9)	124.9 (12)
35 watts	4000	8.8 (0.82)	79.6 (7.4)	318.3 (30)
55 watts	6655	14.7 (1.4)	132.4 (12)	529.6 (49)
Compact Florescent Lamps (CFL)				
9 watt (40 w equivalent)	550	1.2 (0.11)	10.9 (1.0)	43.8 (4.1)
13 watt (60 w equivalent)	850	1.9 (0.18)	17.9 (1.7)	71.6 (6.6)
LED				
1 watt (White) ***	100	2.8 (0.3)	25 (2.3)	100 (9.3)
1 watt (amber) ***	75	2.1 (0.2)	19 (1.8)	75 (7.0)
3 watt amber A19[+]	90	0.5 (0.005)	4.0 (0.37)	12 (1.1)
3 watt amber PAR16[+]	90	1.8 (0.17)	16 (1.5)	50 (4.6)
7 watt amber PAR30[+]	200	5.5 (0.51)	50 (4.6)	200 (19)
13 watt amber PAR38[+]	400	11 (1.0)	100 (9.3)	400 (37)

* Incandescent lamp luminous efficiency is approximately 1/10 HPS (photopic vision)
** Efficacy of commercially available white LEDs are approximately same as HPS (ca. 2012)
*** Assumes a 1 steradian illumination angle and no external optics, typical for 2011
Note: Fixture, lamp degradation before cleaning or replacement may decrease these to <50%.

// Lumens is the total amount of light emitted in all directions (over 4π steradians)

/// Assumes no fixture losses.

//// Lux (fc) is the amount of light illuminating a surface of one metre (foot) square

1 Lux = 1 Lumen / (4π dist^2) (where distance is in metres) = 0.093 foot candles
1 fc = 1 Lumen / (4π dist^2) (where distance is in feet) = 10.78 Lux

[+] Measurements by IDA

Note: Lamp and light luminaire technologies are under constant development resulting in more lumen per watt (efficacy). This table can be used for comparative purposes. The author advises care in using this table to prevent over-lighting a given area. We advise users to obtain current information on the lamp being considered for use.

APPENDIX D1 - Canadian Specifications for Navigation Light Photometric Distribution[32]

			Minimum Intensity (candelas) **(a)**				Intensity (candelas) at given elevation angles when the light is levelled				
Light Type	Colour	Signal type	day	twilight	night	Vert. beam spread **(b)**	- 10 deg **(d)**	- 1 deg **(e)**	± 0 deg **(e)**	+ 2.5 deg	+12.5
CL810	red	fixed	N/A	32min	32min	10deg	-----	-----	-----	32 min	32 min
CL864	red	flashing 20-40fpm	N/A	N/A	2,000 ±25%	3 deg min	-----	50% min 75% max	100% min	-----	-----
CL865 **(f)**	white **(f)**	flashing 40fpm	20,000 ±25%	20,000 ±25%	2,000 ±25%	3 deg min	3% max	50% min 75% max	100% min	-----	-----
CL866	white	flashing 60fpm	20,000 ±25%	20,000 ±25%	2,000 ±25%	3 deg min	3% max	50% min 75% max	100% min	-----	-----
CL885 Catenary	red	flashing 60fpm	N/A	N/A	2,000 ±25%	3 deg min	-----	50% min 75% max	100% min	-----	-----
CL856	white	flashing 40fpm	270,000 ±25%	20,000 ±25%	2,000 ±25%	3 deg min	3% max	50% min 75% max	100% min	-----	-----
CL857 Catenary	white	flashing 60fpm	140,000 ±25%	20,000 ±25%	2,000 ±25%	3 deg min	3% max	50% min 75% max	100% min	-----	-----

(a) Effective intensity, as determined in accordance with External Transport Canada Document
(b) Beam spread is defined as the angle between two directions in a plane for which the intensity is equal to 50% of the lower tolerance value of the intensity shown in columns 4, 5 and 6. The beam pattern is not necessarily symmetrical about the elevation angle at which the peak intensity occurs.
(c) Elevation (vertical) angles are referenced to the horizontal.
(d) Intensity at any specified horizontal radial as a percentage of the actual peak intensity at the same radial when operated at each of the intensities shown in columns 4, 5 and 6.
(e) Intensity at any specified horizontal radial as a percentage of the lower tolerance value of the intensity shown in columns 4, 5 and 6.
(f) In the case of rotating type CL865 one third of the flash display should be red in colour. e.g. WWR

[32]Wind Turbine and Windfarm Lighting, CAR621.19 Advisory Circular 1/06 - DRAFT 9, Transport Canada

APPENDIX D2 Federal Specifications for Obstruction Lighting Equipment Classification [33]

Type	Description
L-810	Steady-burning Red Obstruction Light
L-856	High Intensity Flashing White Obstruction Light (40 FPM)
L-857	High Intensity Flashing White Obstruction Light (60 FPM)
L-864	Flashing Red Obstruction Light (20-40 FPM)
L-865	Medium Intensity Flashing White Obstruction Light (40 FPM)
L-866	Medium Intensity Flashing White Obstruction Light (60 FPM)
L-864 / L-865	Dual: Flashing Red Obstruction Light (20-40 FPM) and Medium Intensity
L-885	Red Catenary 60 FPM
FPM = Flashes Per Minute	

[33] AC 70/7460-1K CHG 1, Appendix 1 (Pg. 42)

APPENDIX E – Summary of Lighting Protocol
Canadian Dark-sky Preserves / International Dark Sky Parks

This summary applies to all property and structures within the Dark-sky Preserve.

1. No additional light fixtures should be installed.

If additional light fixtures are considered necessary by the park manager, and with approval by the DSP nominators, additional fixtures may be installed. All new fixtures should conform to the requirements of Items 3-8 below.

2. Signage should not use active lighting.

Signage should use retro reflective materials. Pedestrian signs should be mounted at a height suitable for illumination with flashlights (<1 metre or 3.3 ft from the ground).

3. Only full cut-off (FCO) fixtures should be used.

All existing light fixtures should be replaced with FCO fixtures or shielded to prevent light from shining above the horizon or beyond the immediate area requiring illumination.

4. The illumination level produced by all light fixtures should be as low as practical.

Dusk and nighttime pedestrian and vehicle traffic densities should be used in assessing the level of illumination. For vehicles, typically 3 Lux, or 0.3 fc for large parking lots and high traffic density areas where low speed limits are in effect. Major pedestrian routes may be illuminated by typically at 1 Lux, or about 0.1 fc. Due to the use of vehicle headlights and pedestrian flashlights, lower light wattages can be used with the understanding that they are used only as marker lights. Phosphorescent markers may be used.

5. Structures and barriers should be used to confine illumination to the immediate area.

Illuminated areas should be bordered by trees and bushes or other barriers to prevent the light from shining and scattering beyond the area being illuminated.

6. All light sources should be turned off within 2-hours of sunset

Automatic timers should be used to avoid the need for staff to turn off the lights. The timers should detect nightfall and should turn the lights off within 2-hours. If the park manager considers lights will occasionally be required after this time, the timer should be capable of being reset by staff.

7. Indoor lighting should be prevented from shining through exterior windows.

If interior lights must be used after sunset, window curtains should be closed within 30-minutes of sunset or interior illumination levels must be reduced significantly so as not to produce glare or light trespass.

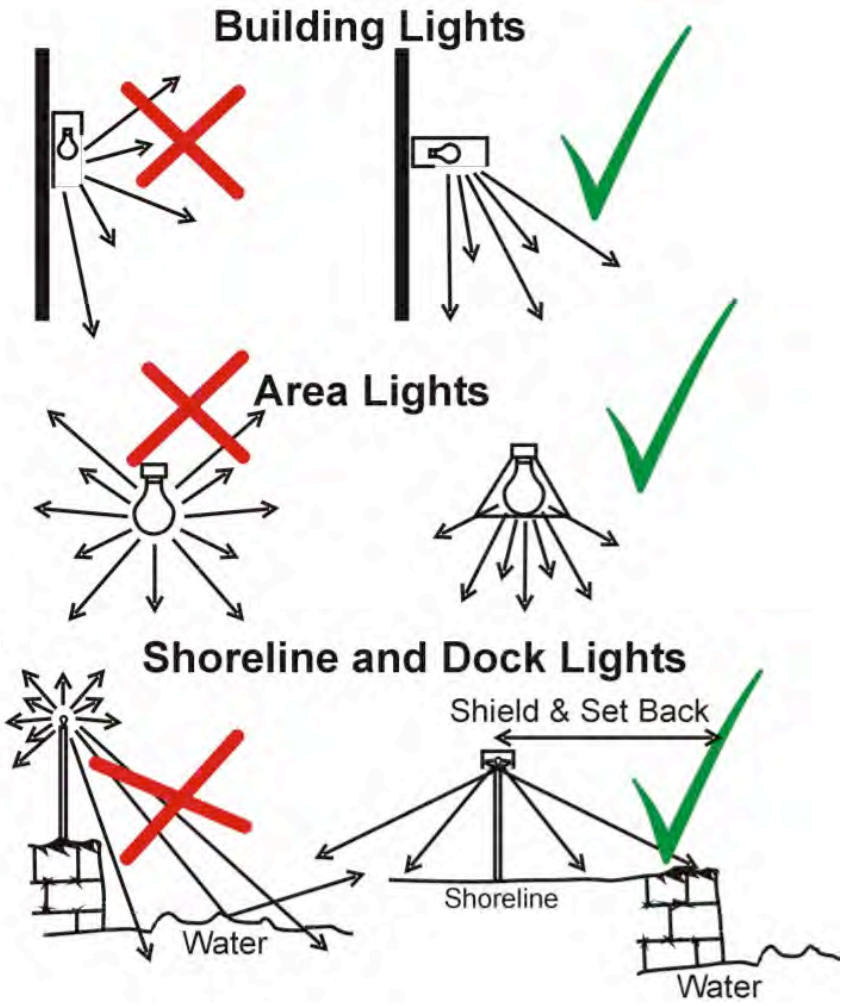
8. The colour of all light fixtures should emit a minimum of UV & blue spectral content.

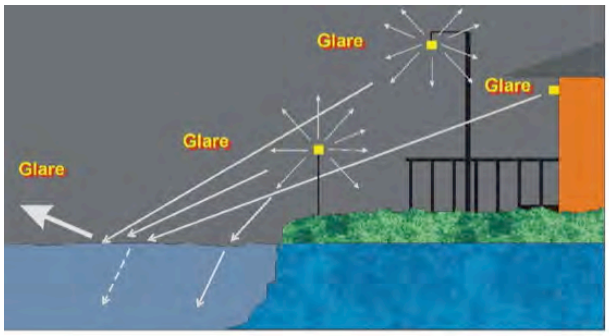
“White” light sources such as metal halide lamps, white CFLs and white LEDs should not be used. High-pressure and low-pressure sodium lamps, incandescent lamps and amber LEDs may be used. Lamps with UV content should not be used because of its increased attraction to flying insects.

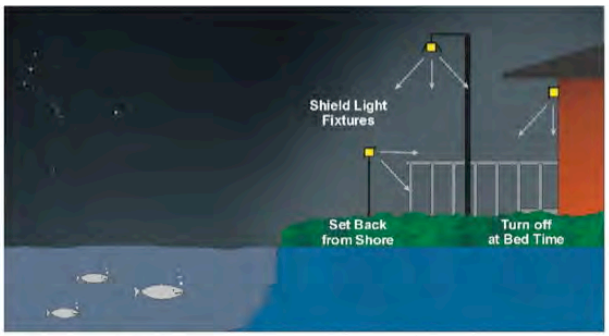
Use Timers
- on at sunset
- off 2-hours later

Use Motion Sensors
- lights on only when needed

Use "Warm Light"
- not blue white light







The Bad and the Good
Shoreline Lighting

White Stone on Pathway
and Shielded Bollard

Use "Warm Light"
- not white light

Use Timers
- on at sunset
- off 2-hours later

Use Motion Sensors
- lights on only
when needed