# Public Health Assessment

## Rodeo-Chediski Fire
## June 18, 2002 – July 9, 2002
## Navajo County, Arizona

**Prepared by**
**Arizona Department of Health Services**
**Office of Environmental Health**
**Environmental Health Consultation Services**
**Under Cooperative Agreement with the Agency for Toxic Substances and Disease Registry (ATSDR)**

## Forward

In 1980, Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the Superfund law. As part of the Superfund law, Congress established the Agency for Toxic Substances and Disease Registry (ATSDR) [EPA 1980]. The Superfund law also established a fund to identify and clean up designated hazardous waste sites. The U.S. Environmental Protection Agency (EPA) and the individual states have primary responsibility for the investigation and clean up of these sites. The National Priorities List, maintained by the EPA, identifies the most serious uncontrolled or abandoned hazardous waste sites in the United States.

A 1986 amendment to the Superfund law requires ATSDR to conduct a public health assessment at each site on the EPA National Priorities List. These evaluations determine whether people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are conducted by environmental and health scientists from ATSDR and by states with which ATSDR has cooperative agreements. As a cooperative agreement state, Arizona has designated the Department of Health Services (ADHS) to conduct public health assessments on its behalf.

**Exposure:** As the first step in an evaluation, scientists from ADHS and ATSDR review environmental data to see how much contamination is at a site, where it is, and how people might come in contact with it. Generally, ATSDR does not collect its own environmental sampling data. It usually reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data are needed.

**Health Effects:** If the review of the environmental data shows that people have or could have contacted hazardous substances, scientists from ADHS and ATSDR evaluate whether these contacts could result in harmful effects. ATSDR and ADHS recognize that children, because of their outdoor play activities and their growing bodies, could be more vulnerable to these effects than are adults. As a policy, unless data are available to suggest otherwise, ATSDR and ADHS consider children to be more sensitive and vulnerable than adults to hazardous substances. Thus, the health impact to children is considered first when evaluating the health threat to a community. The health impacts to other high-risk groups within the community (such as the elderly and the chronically ill) also receive special attention during an evaluation.

ATSDR/ADHS use several types of scientific information. The results of medical, toxicological, and epidemiologic studies, as well as the data collected in disease registries, can all identify health effects that could result from exposures. The science of environmental health is still developing, and occasionally scientific information on the health effects of certain substances is not available. When this occurs the evaluation report will suggest what further public health actions are needed.

**Conclusions:** The report presents conclusions about the public health threat, if any, posed by a site. When health threats have been determined for high-risk groups (such as children, the elderly, and the chronically ill), they are summarized in the conclusion section of the report. In the public health action plan the report will recommend ways to stop or reduce exposure.

ATSDR and ADHS are primarily advisory agencies. Consequently these reports usually identify actions appropriate for environmental agencies, other responsible parties, or both**.** But if an urgent health threat exists, ATSDR and ADHS can issue a public health advisory warning people of the danger. ATSDR and ADHS can also instigate health education activities or pilot studies of health effects, full-scale epidemiology investigations, disease registries, surveillance studies, or research on specific hazardous substances.

**Interactive Process:** The health assessment process is interactive. ATSDR and ADHS solicit and evaluate information from numerous city, state, and federal agencies, the companies responsible for clean up, and the community. ATSDR and ADHS then circulate their conclusions for public comment. To make sure that the data they have provided is accurate and current, contributing public health agencies are often asked to respond to an early version of the report.

**Community:** ATSDR and ADHS also need to learn what residents in the area know about the site and what concerns they might have about its impact on their health. Consequently, throughout the evaluation process, ATSDR/ADHS actively gather information and comments from those who live or work near a site. This community effort includes residents of the area, civic leaders, health professionals, and interest groups. To ensure the report responds to the community's health concerns, a preliminary version is also circulated to the public. Public comments are incorporated into the final report. All comments received from the public are addressed in the final report.

**Comments:** If after reading this report you have questions or comments, you are encouraged to contact us. Please address letters to:

*Attention: Chief, Office of Environmental Health*
*Arizona Department of Health Services*
*3815 N. Black Canyon Highway*
*Phoenix, AZ 85015*

# Table of Contents

## Glossary

| | |
|---|---|
| *Alveoli* | Alveoli are the numerous tiny air sacs at the end of the bronchioles in the lungs, where exchange of oxygen and carbon dioxide takes place with the blood. There are an estimated 300 million alveoli in each lung, each of which is smaller than a grain of salt. |
| *Cardiopulmonary* | Cardiopulmonary pertains to both the heart and the lungs and their functions. For example, cardiopulmonary resuscitation, or CPR, is an emergency procedure consisting of external cardiac massage and artificial respiration. |
| *Cilia* | Cilia are tiny hair-like cells that line the passageways to the lungs. The motion of the cilia propels tiny dirt particles and germs out of the respiratory tract. |
| *Hot Shot Crew* | Hot Shot Crews are highly trained, skilled, and experienced crews made up of a minimum of 18 firefighters. Hot Shot Crews must meet training and fitness standards, and they have no geographical restriction on assignments. There are roughly 70 Hot Shot Crews in the United States. |
| *Material Safety Data Sheet (MSDS)* | A Material Safety Data Sheets (MSDS) contains basic information concerning a hazardous chemical that is needed to ensure the safety and health of the user at stages of its manufacture, storage, use, and disposal. Under the Occupational Safety and Health Act, MSDSs are required of all manufacturers and other employers for all shipments of hazardous chemicals leaving the workplace and from all importers of such shipments |
| *Micron* | A micron, or micrometer, is a unit of length which is one millionth of a meter or about 1/25,000 of an inch. |
| *Mogollon Rim* | The Mogollon Rim marks the southern edge of the Colorado Plateau in Arizona. It is a rugged escarpment, as much as 2,000 feet in some areas, extending approximately 200 miles from just south of Flagstaff to the White Mountains in eastern Arizona. |
| *Mop-Up* | Mop-up is a firefighting term that describes the extinguishing of all remaining embers or sparks after the fire has been contained to keep them from crossing the fire line. Mop-up consists of two tasks: putting small fires out and disposing of fuel by burning or removing it. |

| | |
|---|---|
| *Particulate Matter (PM)* | Small particles of solid and liquid matter found in the atmosphere, including soot, dust, organic matter, smoke, or smog. Particulate matter is one of the six major air pollutants for which there are national air quality standards. |
| *$PM_{10}$* | Particulate matter that measures 10 microns or less in diameter. |
| *$PM_{2.5}$* | Particulate matter that measures 2.5 microns or less in diameter. |
| *Pulmonary* | Of or relating to the lungs. |
| *Special Populations* | Persons at increased risk from exposures due to their increased sensitivity, behavior patterns that may result in high exposure, or current or past exposures from other sources. Groups that may be more sensitive to chemical exposures include infants and children, the elderly, pregnant and nursing women, and people with chronic illnesses. |
| *Subwatershed* | A subwatershed is a land area within a watershed draining a specific tributary area. |
| *Watershed* | Watersheds are areas in which all water, sediments, and dissolved materials flow or drain into a common river, lake, or other body of water. Watersheds may vary in size from the largest river basins to just a few acres, but within their boundaries, all living things (including humans) are inextricably linked by their common water course. Watersheds cross county, state, and national boundaries. |

## Introduction

The Rodeo-Chediski Fire Complex began as a small blaze in a remote region of east-central Arizona and within days erupted into the largest wildfire in Arizona history. Fortunately, no lives were lost. However, from June 18, 2002 to the time of its containment on July 7, 2002, the Rodeo-Chediski fire destroyed over 490 structures and 467,000 acres of ponderosa pine and pinyon-juniper woodland—an estimated 500 million to 1.3 billion board feet of timber. Jurisdictions involved included the Fort Apache Indian Reservation, the Apache-Sitgreaves National Forest, the Tonto National Forest, and private lands adjacent to Highway 260, from the Town of Forest Lakes east to the City of Show Low. Virtually all of the acres burned were in Navajo County, with some damage in the contiguous counties of Coconino, Apache, and Gila Counties.

More than 30,000 residents of the communities of Forest Lakes, Pinedale, Clay Springs, Linden, Timberline Acres, Heber, Overgaard, Aripine, Show Low, Pinetop-Lakeside, Hon-Dah, and McNary were evacuated at the recommendation of the U.S. Forest Service to area Red Cross shelters and to shelters as far south as the Mesa, Glendale and Tucson. Most of the evacuees stayed with family and friends in non-evacuated areas. But large informal recreational vehicle encampments also formed throughout Navajo and Apache Counties and makeshift corrals and kennels housed hundred of livestock, horses and family pets.

At its peak, more than 4,400 firefighters and hundreds of county and city law enforcement officers were deployed to battle the fire at an estimated cost of $43 million. On June 19, 2002, the Arizona Division of Emergency Management (ADEM) established a State Emergency Operations Center in Phoenix to support firefighting activities. The Arizona Department of Environmental Quality (ADEQ) activated its mobile Hazardous Assessment Response Team, which collected air quality data in affected communities. The Arizona Department of Health Services (ADHS) issued smoke exposure public health advisories, using data collected by the Arizona Department of Environmental Quality.

The fire was 100% contained by July 9, 2002, after burning more than 467,000 acres of forested land. Figure 1 shows a map of the burned area. The aerial extent of the Rodeo-Chediski Fire by landowner is given in Table 1.

**Table 1. Aerial Extent of the Rodeo-Chediski Fire by Landowner**

| Landowner | Acres | Percent |
|---|---|---|
| Fort Apache Indian Reservation | 280,000 | 60% |
| Apache-Sitgreaves National Forest | 167,000 | 36% |
| Tonto National Forest | 11,000 | 2% |
| Privately-Owned Lands | 9,000 | 2% |
| **Total** | **467,000** | **100%** |

This health assessment describes the fire events and summarizes the resulting public health impacts from the fire.

## Background

### Terrain

The Rodeo-Chediski fire swept through some of the most rugged, scenic, and well-forested land in Arizona. Running east to west through the fire area, the escarpment known as the Mogollon Rim separates the steep-walled canyons, gorges, and forests of the Fort Apache Indian Reservation to the south from the Colorado Plateau to the north. The Apache-Sitgreaves National Forest occupies the plateau from the Rim to 10 to 25 miles north, extending from the communities of Payson to Springerville. The Mogollon Rim, known for the largest ponderosa pine stand in the United States, serves as both a drainage and property divide. Streams with headwaters near the south side of the rim drain south into the Salt River drainage basin; streams with headwaters on the north side flow north or northwest into the Little Colorado drainage basin. Land south of the rim is tribal; to the north is national forest [ADEQ 2002].

### Fort Apache Indian Reservation

As shown in Table 1, the greatest portion of the fire occurred on the Fort Apache Indian Reservation and the Apache-Sitgreaves National Forest. The Fort Apache Indian Reservation is the home of the White Mountain Apache Tribe, population 12,500 in 1999. Encompassing more than 1.6 million acres in portions of Navajo, Apache, and Gila Counties, the reservation contains some of Arizona's most beautiful country. Twenty-five fishing lakes, 420 miles of trout streams, and 7,000 campsites lie within its boundaries. Principal economic activities include the Fort Apache Timber Company and a lumber and hardware retail center in Hon-Dah. The Tribe boasts one of the best ski resorts in the Southwest, Sunrise Park Resort. The Hon-Dah Casino is located just around the corner from the ski resort [ADOC 2002].

### Apache-Sitgreaves National Forest

The 2 million acre Apache-Sitgreaves Forest borders the north and east sides of the Fort Apache Indian Reservation. Water makes the Apache-Sitgreaves a special place in the typically arid Southwest with 34 lakes and reservoirs and 680 miles of rivers and streams—more than can be found in any Southwestern national forest. The Forest also offers a spectrum of campground development levels from 48 developed campgrounds to primitive sites scattered throughout the Forest. The Forest also contains 1,000 miles of trails, 200,000 acres of wilderness areas, numerous scenic drives, and hosts many winter recreational activities [USFS 2002a]. One of the major attractions for visitors to the Sitgreaves portion of the Forest are the vista points from the Mogollon Rim's 7,600-foot elevation, providing views of the low country to the south and west. Two million visitors visited the Forest in fiscal year 2001 [USFS 2002c].

**Communities**

The disaster area includes 22 scattered communities which form a 110-mile chain on the Mogollon Rim between the towns of Payson on the west and Show Low on the east, as well as the nearby evacuated towns of Pinetop-Lakeside and the smoke-damaged communities of Snowflake-Taylor. The economic base of these communities is largely dependent upon tourism, timber, and ranching. Population estimates for these communities are contained in Appendix A.

The communities affected by the fire can be grouped according to the degree of damage they sustained [Dye 2002]:

- Pinedale, Linden, Timberline Acres, Clay Springs, Heber, Overgaard, and Aripine - communities that were evacuated and suffered severe loss of homes and community infrastructure;

- Show Low, Pinetop-Lakeside, Hon-Dah, Forest Lakes, and McNary - communities that were evacuated but not directly damaged by the fire; and

- Payson, Eager, Snowflake-Taylor, Holbrook, and Winslow - "host" communities in the area that mobilized to provide shelter and support to evacuees.

Additional shelters for the estimated 30,000 evacuees were located in Whiteriver, Globe, Mesa, Glendale, and Tucson. According to estimates from the Arizona Division of Emergency Management, 29,978 evacuees registered at the shelters, 5,500 teleregistered and 1,530 persons actually stayed at the shelters [Barbara Taylor, Arizona Division of Emergency Management, personal communication, 2003].

**Fire Chronology**

Both the Rodeo and Chediski fires started on the Fort Apache Indian Reservation in Navajo County, Arizona. On June 18, 2002, an unemployed fire worker started the Rodeo fire near the remote town of Cibecue on the Fort Apache Reservation. Fueled by high winds and severe drought conditions, the Rodeo fire erupted to consume more than 50,000 acres of ponderosa pine within 24 hours. By the evening of June 19, 2002, 5,000

residents of the Mogollon rim communities of Pinedale, Clay Springs, and Linden were evacuated to a Red Cross shelter in Eager, Arizona. A fire progression map is shown in Figure 2.

On the morning of June 20, 2002, a lost hiker started a small signal fire near Chediski Peak, some 30 miles west of the Rodeo outbreak. Twenty-four hours later the fire had consumed nearly 30,000 acres and was racing north to the Rim communities of Heber and Overgaard which were ordered to evacuate. By evening, the Rodeo and Chediski fires were 8 miles apart and over 8,000 citizens from six towns had been evacuated. On June 22, 2002, evacuation orders were announced for the communities of Show Low, Pine Top-Lakeside, and Hon-Dah.

By June 23, 2002, the two fires had merged into a single, roaring "monster" more than 50 miles long, covering about 300,000 acres, with flames topping 200 feet. Early on June 25, 2002, President Bush declared Apache and Navajo Counties and the Fort Apache Reservation major disaster areas, making them eligible for federal aid and low-cost loans. Later that day, President Bush and then-governor Jane Hull toured the fire area, met with a group of firefighters, and visited the Eager evacuation shelter.

Over the next week, the Rodeo-Chediski fire raged, uncontained and out of control, through the forest communities of the White Mountains and the Mogollon Rim. The fire confounded even the most experienced Forest Service Hot Shot Crews with its rapid progression and erratic, unpredictable behavior.

By June 26, 2002, the fire grew to 409,000 acres; however, for the first time it was partially contained, but only by 5%. By nightfall of June 28, 2002, 447,000 acres had been burned and 27% of the fire had been contained. On June 29, 2002, residents of Show Low and Pinetop-Lakeside were allowed to return to their homes. On July 3, 2002, with the fire reported to have burned approximately 468,000 acres and with 85% containment, the residents of Forest Lakes and Heber-Overgaard also returned to their homes.

By July 9, 2002, the fire was 100% contained. Authorities reportedly spent $43 million to put out the Rodeo-Chediski fire, not including the cost of mop-up and rehabilitation operations. As of September, 2002, federal disaster aid to Arizona in the wake of the Rodeo-Chediski fire topped $34 million [ADEM 2002].[1]

[1] This fire chronology was primarily taken from the article "Biography of a Monster" in the June 30, 2002 edition of the *Arizona Republic* available at http://www.azcentral.com/news/specials/wildfires/

# Environmental Exposures and Impacts

## Air Quality Impacts

### *Particulate Matter*

Wildfire smoke consists primarily of carbon dioxide, water vapor, carbon monoxide, particulate matter, hydrocarbons and other organics, nitrogen oxides, and trace minerals. In general, particulate matter is the major pollutant of concern from wildfire smoke. Particulate matter larger than 10 microns in diameter collects in the upper respiratory system (throat and nose) and is eliminated by sneezing, coughing, nose blowing, spitting, or through the digestive system. Other large particles are removed by cilia or hair-like structures on the respiratory tract cells. Cilia clear mucous and catch and help remove larger particulate matter from the lungs with a rhythmic motion [WDOE 1997].

The majority of particulate matter in wood smoke, however, is ultra-fine, only 0.15 to 0.4 microns in diameter [WHO 1999c]. For comparison, the period at the end of this sentence is about 500 microns in diameter. These ultra-fine particles rapidly agglomerate to form fine particles of less than 2.5 microns in diameter. These particles are still so small that they evade the cilia and collect in the most remote portions of the lungs, called alveoli—the tiny air sacs where oxygen enters the blood stream. These tiny wood smoke particles cause structural and chemical changes deep in the lungs. Other toxic and cancer-causing compounds can attach to the small smoke particles and enter the lungs at the same time [Washington State Department of Ecology 1997].

Outdoor particulate levels in the smoke from the Rodeo-Chediski fire were measured and the results are presented in Table 4. However, indoor particulate levels in homes and other buildings in the fire area were not measured. Particulate matter infiltrates indoors even when windows and doors are shut. Estimates show that in non-air conditioned homes anywhere from 70 to 100% of fine particulate matter will penetrate indoors from the outside air [Missoula City-County Health Department 2001]. Fine particulate matter infiltrates more readily than larger particles, which tend to stick to surfaces. Factors that influence the amount of particulate matter infiltrating indoors include the outdoor particle concentration, how airtight the home is, and the use of various types of air conditioners and air filters.

### *Air Standards and Guidelines*

Arizona communities with established air quality programs and alert systems traditionally base their public advisories on the 24-hour particulate average. Under the Clean Air Act, the U.S. Environmental Protection Agency (EPA) has established an annual arithmetic mean and a 24-hour average standard for particulate matter of 10 microns or less ($PM_{10}$) and 2.5 microns or less ($PM_{2.5}$). Under Arizona Administrative Code (R-18-2-220), the Arizona Department of Environmental Quality has established Alert, Warning, Emergency, and Significant Harm levels of $PM_{10}$ based on 24-hour averages.

Smoke from the Rodeo-Chediski fire, however, did not lend itself to the use of 24-hour average criteria. Smoke concentrations tended to be very high for a few hours, and then drop off dramatically. Research has shown that these spikes could be the cause some of the most deleterious effects. Also, because smoke scatters light so well, visibility changes drastically as smoke concentrations increase. Consequently, even without an official announcement, the public can tell when the smoke is getting worse, and they want authorities to respond to those changes as they are happening, rather than wait until they have been going on for 24 hours or until they are over [Missoula City-County Health Department 2003].

Although no federal or state particulate standards have been established for durations shorter than 24 hours, several organizations have defined particulate levels for 1- and 4-hour time periods. The guidelines used in this health assessment to evaluate the particulate data from the Rodeo-Chediski fire are the 1- and 4-hour averages from the World Health Organization Guidelines for Vegetative Fires [WHO 1999 a,b] and the 1-hour averages developed by the Missoula City-County Health Department for wildfire smoke [Missoula City-County Health Department 2003]. These guidelines are shown in Tables 2 and 3.

**Table 2. World Health Organization Guidelines for Vegetative Fires**

| Categories | Particulate Levels |
|---|---|
| Stage 1 Alert | $PM_{10}$ Concentration > 100 ug/$m^3$ 4-hour average |
| | $PM_{2.5}$ Concentration > 85 ug/$m^3$ 4-hour average |
| Stage 2 Warning | $PM_{10}$ Concentration > 150 ug/$m^3$ 4-hour average |
| | $PM_{2.5}$ Concentration > 130 ug/$m^3$ 4-hour average |
| State 3 Emergency | $PM_{10}$ Concentration > 400 ug/$m^3$ 1-hour average |
| | $PM_{2.5}$ Concentration > 340 ug/$m^3$ 1-hour average |

**Table 3. Missoula City-County Health Department Wildfire Smoke Guidelines***

| Categories | Visibility in Miles | Particulate Levels(Averaged 1-Hour, ug/$m^3$) |
|---|---|---|
| Good | 10 miles and up | 0-40 |
| Moderate | 6 to 9 | 41-80 |
| Unhealthy for Sensitive Groups | 3 to 5 | 81-175 |
| Unhealthy | 1 ½ to 2 ½ | 176-300 |
| Very Unhealthy | 1 to 1 ¼ | 301-500 |
| Hazardous | ¾ mile or less | over 500 |

*Does not designate if particulate matter is $PM_{10}$ or $PM_{2.5}$

### *Air Monitoring Results*

Below average rainfall for the last 3 years coupled with brisk westerly and southwesterly winds for several of the fire days produced an extremely hot and fast-moving fire. The smoke produced by the fire formed an immense plume towering to 30,000 feet, which after transport to the north and east settled down to ground level in the communities of Winslow, Holbrook, and Snowflake.

From June 20 to 27, 2002, the mobile Hazardous Air Response Team of the Arizona Department of Environmental Quality took measurements of particulate matter 10 microns and smaller ($PM_{10}$) in the communities of Snowflake, Show Low, Holbrook, and Springerville. U.S. Forest Service and ADEQ staff then set up semi-permanent monitors, and from June 28, 2002 to July 10, 2002 measured particulate matter 2.5 microns and smaller ($PM_{2.5}$) in the communities of Snowflake, Show Low, Holbrook, Forest Lakes, Heber, St. Johns, and the Ponderosa Fire Camp.

Air monitoring results presented in Table 4 and discussed below are from a draft Arizona Department of Environmental Quality report entitled "Air Pollution Monitoring at the Rodeo-Chediski Fire: June-July 2002" [ADEQ 2002]. The report concluded that, from June 20 through June 30, 2002, smoke from the Rodeo-Chediski fire constituted a public health hazard in several communities, including Show Low, Snowflake, Heber, and Holbrook. On nine different occasions in Heber, Holbrook, and Snowflake both 1-hour and 4-hour averages of $PM_{10}$ or the smaller $PM_{2.5}$ exceeded the "hazardous" and "emergency" guidelines. On many other occasions the $PM_{10}$ concentrations exceeded the "very unhealthy" and "alert" guidelines. The highest $PM_{10}$ average concentration (522 $ug/m^3$) was measured at Snowflake (an un-evacuated community) for 10.5 hours on June 22-23. Monitoring conducted after the fire confirmed that little if any smoldering was occurring and that the air along the Mogollon Rim normally has low concentrations of $PM_{2.5}$, in the range of 5 to 25 $ug/m^3$.

The population exposed to these elevated concentrations of smoke numbered about 30,000, all of whom were breathing particulate-laden air for at least several hours to a few days from June 20 through June 30, 2002. Based on the measured levels, the Arizona Division of Emergency Management and the Arizona Department of Health Services issued public health advisories on June 21, 2002, through the duration of the Fire.

**Table 4. Particulate Concentrations Downwind of the Rodeo-Chediski Fire**

| Dates | Location | PM | Duration | Average Level ($ug/m^3$) | Maximum Health Hazard? | |
|---|---|---|---|---|---|---|
| | | | | | Level ($ug/m^3$) | |
| 6/20 - 6/21* | Snowflake | 10 | 9 hrs | 110 | 289 | Yes |
| 6/21* | | 10 | 4.5 hrs | 153 | 342 | Yes |
| 6/22 - 6/23* | | 10 | 10.5 hrs | 522 | 927 | Yes |
| 6/24 - 6/25* | | 10 | 14 hrs | 365 | 776 | Yes |
| 6/25* | | 10 | 5.25 hrs | 134 | 228 | Yes |
| 6/28 - 7/10† | | 2.5 | 12 days | 5 | 25 | No |
| 6/21* | Show Low | 10 | 6.5 hrs | 145 | 342 | Yes |
| 6/21 - 6/22* | | 10 | 9 hrs | 25 | 106 | No |
| 6/29 - 7/4† | | 2.5 | 6 days | 32 | 49 | No |
| 6/22* | Holbrook | 10 | 4 hrs | 296 | 442 | Yes |
| 6/22* | | 10 | 6 hrs | 251 | 436 | Yes |
| 6/23 - 6/24* | | 10 | 24 hrs | 178 | 548 | Yes |
| 6/28 - 7/2† | | 2.5 | 5 days | 13 | 50 | No |
| 6/25 - 6/26* | Springerville | 10 | 14.5 hrs | 170 | 227 | Yes |
| 7/3 – 7/10† | Forest Lakes | 2.5 | 8 days | 8.1 | 58 | No |
| 6/28 - 6/30† | Heber | 2.5 | 3 days | 244 | 798 | Yes |
| 6/30 - 7/2† | | 2.5 | 4 days | 34 | 57 | No |
| 7/3 - 7/8† | | 2.5 | 5 days | 11 | 42 | No |
| 6/30 - 7/4† | Ponderosa Fire Camp | 2.5 | 5 days | 27 | 126 | No |
| 6/29 - 7/5† | St. Johns | 2.5 | 7 days | 27 | 83 | No |

*.Hazardous Air Response Team
†.Continuous, in-place monitor

*Native Voices*, a publication of the Institute for Tribal Professionals at Arizona State University in Flagstaff, states that only one of the three tribal air monitors were operational at the time of the fire. That monitor was sited off-reservation in the Town of Taylor, 40 miles northeast of the fire. Consequently, accurate particulate measurements from smoke on the reservation during the fire are not available [NAU 2002].

### *Health Effects of Wood Smoke*

The concentrations of particulate matter measured by the mobile air monitoring van and the semi-permanent air monitoring stations during the Rodeo-Chediski fire established that the levels of $PM_{10}$ and $PM_{2.5}$ were high enough to cause adverse health effects. The data collected during the community survey described below suggest that the smoke

likely caused an increase in respiratory problems in some area residents consistent with wood smoke inhalation. Consequently, it can be concluded that the fire caused an acute (short-term) public health hazard.

Studies indicate associations between levels of particulate air pollution produced from wildland fires and a range of adverse health impacts. While most healthy adults will recover quickly from short-term smoke exposures and not suffer long-term consequences, certain sensitive populations may experience more severe acute and chronic symptoms of smoke exposure [Missoula City-County Health Department, 2003]. These sensitive populations are described below.

- **Children.** Children are considered a sensitive population because their lungs are still developing which makes them more susceptible to environmental threats than healthy adults. Children also have increased exposure compared to adults because of their greater activity; children breathe about 50% more air per pound of body weight. Studies have shown that particulate pollution is associated with increased respiratory and decreased lung function in children, including symptoms such as aggravated coughing and difficulty or pain in breathing.

- **Elderly**. Studies estimate that thousands of elderly people die prematurely each year from exposure to particulate pollution. This is due in part to the fact that the elderly are more likely to have pre-existing lung and heart diseases, lose important respiratory defense mechanisms as they age, and have more difficulty clearing particles from their lungs. In addition, particulates can compromise the immune system, increasing susceptibility to bacterial or viral respiratory infections which can lead to increased incidence of pneumonia and other complications.

- **Individuals with asthma and other respiratory diseases.** Particulate levels that might not interfere with normal breathing can affect adults and children with asthma in profound ways, causing severe inflammation or constriction of airways. Because children's airways are narrower than those of adults, irritation that would produce only a slight response in an adult can result in significant obstruction in the airways of a young child.

- **Individuals with cardiovascular disease.** Cardiovascular diseases include ailments such as hardening of the arteries, high blood pressure, angina pectoris, heart attacks, and strokes. Studies have linked particulate pollution to increased heart attacks and symptoms in those with cardiovascular disease. Particulate matter causes respiratory symptoms, changes in lung function, alteration of mucociliary clearance, and pulmonary inflammation. Any or all of these symptoms can lead to increased permeability of the lungs, causing fluid to accumulate in the lungs. Other studies have shown that the particles can trigger certain neurons in the respiratory tract, leading to effects on the nervous system.

- **Smokers.** People who smoke have already compromised their lung function. Exposure to high levels of particulates can exacerbate any lung problems, leading

to chest pain, trouble breathing, and other respiratory symptoms. These effects can occur more quickly than in non-smokers.

Wood smoke exposure is a well-recognized cause of decreases in lung function. The occurrence of respiratory illness in children has been shown to increase with increased exposure to wood smoke. Symptoms include lower respiratory infections and bronchitis. Wood smoke aggravates asthma, emphysema, and bronchitis. It can also irritate the eyes and can trigger headaches and allergies.

Epidemiological studies have consistently found that prolonged exposure to fine particulate matter can cause many respiratory problems. Among these are shortness of breath, increases in coughs, aggravation of asthma, decreases in lung function and lung defense mechanisms, chronic obstructive pulmonary disease, and increased rates of hospitalization for respiratory and cardiovascular illnesses [Dockery and Pope 1994].

**Other Environmental Exposures**

The Arizona Department of Health Services pamphlet entitled "What to Do After a Fire" is contained in Appendix B. Over 20,000 of these pamphlets were distributed in shelters and to evacuees as they returned to the fire area. Pamphlet topics included the effects of wood ash, residual fire retardant, food, and water, as discussed below.

***Wood Ash***

Large quantities of ash blanketed homes, vehicles, and lawns in fire area communities. Wood ash is composed of the noncombustible nutrients and minerals left behind by the wood that has burned. The ash from vegetation can be messy to clean, but it is not harmful. Ash from burned homes or garages built with chemically–treated wood or that contained chemical consumer products—or both—might not be as harmless. To reduce potentially harmful dust, the ash should be wetted before attempting its removal.

***Fire Retardant***

Residual red fire retardant slurry, applied by air tankers to contain the fire, covered some houses and nearby outside surfaces after the fire. The red-pink aerial fire retardant used to help contain the Rodeo-Chediski fire was Fire-Trol®. According to the Material Safety Data Sheet for Fire-Trol®, its major ingredient is ammonium polyphosphate, a commonly used agricultural fertilizer. Fire-Trol® has a low order of toxicity and is fairly safe as evidenced by its Level 1 Health Score. Fire-Trol® will, however, cause eye irritation and upon prolonged contact is mildly irritating to skin.

***Food***

During the fire, Arizona Department of Health Services employees worked with the Navajo County Health Department to monitor sanitation, food safety, infectious diseases, and foodborne illnesses at evacuation shelters, and to ensure adequate vaccine supplies such as tetanus. Arizona Department of Health Service and Navajo County employees

also prepared for possible "re-entry" food safety problems from food spoilage in homes and stores during evacuation. There were no reports of illness due to contaminated food.

Power outages occurred at several locations on the Fort Apache Indian Reservation during the fire. The freezer at the Hon-Dah casino failed, but emergency workers were able to transfer the food before it deteriorated. Indian Health Service engineers worked with the White Mountain Apache Housing and Utility Authority to identify critical equipment in need of backup generators. Backup generators were connected to the regional community water system and sewage lift stations to prevent overflows. [NAU, 2002b].

***Drinking Water***

The Arizona Department of Environmental Quality prepared two pamphlets for distribution in the fire area: "Water Quality Concerns of the Rodeo-Chediski Fire" and "Private Well After The Fire." These are contained in Appendix C. The Arizona Department of Environmental Quality performed drinking water quality inspections in the Rodeo-Chediski fire area beginning July 1, 2002, when the department's inspectors were first granted access to the area. The inspectors focused on assisting regulated water system owners in restoring service while identifying possible compromises in system integrity that might adversely affect the health of the users. Inspectors also provided information and assistance to owners of private wells, which are not regulated by the state. Initially, eight regulated systems in the fire area were advised to boil drinking and cooking water because it was unknown whether those systems sustained damage that would compromise water quality. Six of the eight advisories were lifted on July 8, 2002, and the two remaining advisories were lifted on July 17, 2002.

On the Fort Apache Indian Reservation, the Tribe was concerned that post-fire floods might contaminate drinking wells and ruin electrical pumps in flood-prone areas. The Indian Health Service Office of Environmental Health and Engineering surveyed community wells and developed mitigation strategies [NAU, 2002b].

**Physical Hazards**

Due to the intensity, magnitude, and size of the fire, a tremendous number of standing dead and dying trees remain within the burned area. Falling dead trees and potential fuel loadings in portions of the burned area now pose short- and long-term hazards to forest users, local communities, private property, and other forest resources. Several treatments are under consideration to meet public health and safety concerns and at the same time conserve other resources.

On December 23, 2002, supervisors of the Apache-Sitgreaves and the Tonto National Forests signed three Decision Memos describing three separate salvage operations (treatments) in places where dead or burned trees could fall and injure people, damage property, or pose a threat to resources. Altogether, the three separate salvage logging proposals would affect over 24,700 acres of land and remove about 25 million board feet of timber from lands affected by the Rodeo-Chediski fire.

The three Decision Memos are available at http://www.fs.fed.us/r3/asnf/salvage/news/. The first Decision Memo authorized, for public health and safety reasons, measures to remove dead, fire-killed trees within or adjacent to administrative sites, roads, trails, developed recreation sites, and concentrated-use areas. Specific distances from these facilities were identified in the memo to protect the public and agency employees from falling trees. A second Decision Memo authorized treatment of dead trees that could fall and damage private land structures located adjacent to private land fences. The memo also called for tree removal along the right-of-way boundaries for State Highway 260 and near endangered utility lines. The third Decision Memo treats dead trees within ½ mile of private lands adjacent to the forest (commonly referred to as the wildland/urban interface) to lessen the risk of a future wildfire to private holdings.

On January 9, 2003, the Sante-Fe based Forest Conservation Council filed a lawsuit in Federal District Court in Phoenix to prevent the salvage logging in the Rodeo-Chediski fire area on the Apache-Sitgreaves and Tonto National Forests. The U.S. Forest Service had attempted to hasten the project by using a categorical exclusion to exempt the logging from environmental reviews required by the National Environmental Policy Act and National Historic Preservation Act. The Forest Conservation Council claims that the proposed salvage sale is too big to qualify for an exclusion and that complete environmental and archeological studies must be completed before the dead trees are cut.

**Flooding and Erosion**

***Watershed Model***

The Little Colorado River watershed drains the fire area above the Mogollon Rim and includes the subwatersheds of Hog Wash, Black Canyon, and Linden Draw. Communities within or adjacent to these subwatersheds include Heber-Overgaard and Timberland Acres. Below the Rim, the Salt River watershed drains the fire area to Roosevelt Lake in Gila County. Roosevelt Lake provides the major water supply to over 2 million persons in the Phoenix Metropolitan Area. Subwatersheds include Carrizo Creek and Cibecue Creek which contain the White Mountain Apache Tribe communities of Carrizo and Cibecue [ADEM 2003].

Burned soil becomes more like a parking lot than a sponge, repelling water instead of absorbing it. Consequently, the amount of water runoff from a burned area is much greater than before a fire; however, the water cannot infiltrate the soil to promote seed germination and root growth. This delays the growth of vegetation that reduces runoff, increasing the length of time that post-burn runoff will be a potential threat. Not only will the amount of runoff increase, the velocity of the runoff will also increase, causing increased erosion. Silt and debris-laden flows may clog channels creating the potential for damaging floods.

After the Rodeo-Chediski fire, even minor rainfall events in Navajo County have resulted in severe flooding in several areas. The county is currently working on several projects to minimize flooding in areas with little or no previous flood history. Information from a hydrologic computer model designed to project post-burn runoff shows that within

watersheds north of the Mogollon Rim in Navajo County, the 5-year post-burn flows will equal or exceed the pre-burn 100-year flows. For watersheds south of the Mogollon Rim, on the Fort Apache Indian Reservation, the 5-year post-burn flows will be generally equivalent to the pre-burn 50-year flow [ADEM 2003]. Navajo County has placed a high priority on projects to minimize runoff to private residences and public infrastructure, and to provide uninterrupted emergency services to its citizens [ADEM 2003].

**Burned Area Emergency Rehabilitation Teams**

***Apache-Sitgreaves/Tonto National Forests Burned Area Emergency Rehabilitation Team***

Organized under the authority of the U.S. Department of the Interior, the interagency Burned Area Emergency Rehabilitation Team (BAER) has conducted intensive surveys of the Apache-Sitgreaves and Tonto Forests. The Team concluded that the fire was outside the range of natural fire behavior and had the potential to affect soils beyond accepted limits of natural variability. This included reduced soil aggregate stability, reduced permeability, increased runoff and erosion, and reduced organic matter/nutrient status. The Team's report listed 20 areas of concern, the most relevant of which are: increased peak flows, flooding and erosion on roads and private property; sedimentation and scouring of impoundments, riparian areas, wet meadows, and high quality fish habitat; damage to spring boxes which are source of domestic water; and risk to the Black Mesa District wastewater treatment system from flooding and channel scour. The Team also noted an increased accessibility and visibility of archeological sites making them more accessible to vandalism and unauthorized recreation. [BAER 2002].

***White Mountain Apache Burned Area Rehabilitation Team***

A second interagency Burned Area Emergency Rehabilitation Team evaluated the Fort Apache Indian Reservation lands. The Team's initial mission was to prevent hazardous flooding in the Cibecue and Carrizo area communities, which suffered 75% watershed damage. The concern was that heavy rain would cause massive flooding and mudflows into streambeds. These floods would continue building speed until they reached the main river which flows into the downstream communities. Team members initially cleaned storm drainages, posted warning signs, and, most importantly, established an early flood-warning system through the Remote Automated Weather Station (RAWS). As a means to provide residents with at least 1-hour's notice to evacuate, the Team installed a stream-gauging system upstream of Cibecue. During the summer monsoons immediately after the fire, Carrizo was evacuated twice, but only as a precautionary measure. The black ash that washed down into the communities testified to the soil's fragile composition.[2]

***Flooding and Erosion Control Projects***

Apache-Sitgreaves and Tonto National Forest Burned Area Emergency Rehabilitation projects continue. These include helicopter distribution of straw bales (called "bale

[2] This information is from an article entitled "White Mountain Apache tribe uses BAER to restore charred land" in the March 17, 2003 edition of "Indian Country" available at http://www.indiancountry.com

bombing") , seeding, hydromulching (distribution of a cellulose based, moist green material that contains seeds), and road repair to keep open those travel routes affected by erosion and flooding. Volunteers began fire rehabilitation work in mid-July shortly after the fire. They have spread straw mulch by hand, distributed a special seed mix, and installed erosion control devices such as straw bale check dams and small diameter timber structures referred to as "Lincoln Logs" [USFS 2002]. Aerial seeding and mulching have been conducted on the Fort Apache Indian Reservation.

The Natural Resource Conservation Service (NRCS) approved the use of 2.9 million dollars from the Emergency Watershed Protection (EWP) program for erosion control and for reduction of flood damage in the fire area. The U.S. Environmental Protection Agency awarded $200,000 to the White Mountain Apache Tribe to monitor creeks and streams compromised by the fire.

## Public Health Outcome Data

### Community Survey

The Arizona Department of Health Services, with assistance from the U.S. Centers for Disease Control and Prevention (CDC), conducted a community survey from July 5-9, 2002, to assess the public health impact of the Rodeo-Chediski fire. One of the survey goals was to identify and describe the cardiopulmonary effects of exposure to smoke from the fire. Investigators completed 416 interviews, including 207 interviews in Show Low/Lakeside/Pinetop and 209 interviews in Snowflake/Taylor. The Towns of Show Low/Lakeside/Pinetop were ordered to evacuate because of imminent fire danger. Residents of Snowflake and Taylor were **not** ordered to evacuate, although some residents did so voluntarily. A second goal of the survey was to evaluate evacuation issues; however, this analysis was not available as of the writing of this health assessment.

Preliminary results of the survey suggest that a large proportion of the residents in both the evacuated and non-evacuated communities experienced pulmonary symptoms related to the fire, including asthma exacerbation, shortness of breath, allergies, and coughing. Of the 416 participants surveyed, 121 (29%) reported **no** symptoms before the fire and at least one symptom after the fire. This suggests that smoke exposure may have contributed to new pulmonary symptoms. Two-hundred nineteen (219) out of 416 (53%) reported having **one or more** symptoms before the fire, but 334 (80%) reported having one or more symptoms after the fire, for an overall 1.5-fold increase in symptoms. Nine to 10% of all respondents reported having asthma before the fire, of which 64% reported exacerbations after the fire [Cronquist and Morris 2002].

As shown in Table 5, the rate of smoke-related symptoms is higher in the non-evacuated communities of Snowflake-Taylor. These communities received a substantial amount of smoke from the fire (Table 4). Although the Snowflake and Taylor respondents appear to have experienced higher rates of pulmonary symptoms related to the fire, they reported less stress and anxiety than respondents from the evacuated communities.

**Table 5. Rates of Smoke-Related Symptoms in Evacuated and Non-Evacuated Communities**

| Symptom | Show Low/Pinetop/Lakeside (Evacuated) Percent Reporting Symptom (n=207) | Snowflake/Taylor (Not Evacuated) Percent Reporting Symptom (n=209) |
|---|---|---|
| No symptoms before the fire and at least one symptom after the fire | 22% | 37% |
| Asthmatics who reported asthma exacerbation | 39% | 86% |
| Percent of respondents who felt the fire had a detrimental impact on their health | 33% | 52% |
| Reported high stress levels | 54% | 32% |
| Reported lost days of work | 5.2 days | 2.3 days |

The results of the community health survey are consistent with the studies described above which found that exposure to particulate matter could cause a variety of respiratory symptoms. Further analysis is needed to more fully explore the differences in health and economic impacts between the evacuated and non-evacuated communities. Such an analysis will be challenging because the communities differ in many respects other than just evacuation characteristics. Still, the comparison of the fire and evacuation effects in these two communities may help teach future emergency responders about the benefits and costs of evacuation [Cronquist and Morris 2002].

**Clinical Encounters at Red Cross Shelters**

The two largest American Red Cross shelters housing fire evacuees were located in the communities of Eager and Holbrook. Both shelters operated a nursing station staffed around-the-clock by volunteer nurses and intermittently by other medical professionals including internists and pediatricians. Shelter residents visited the nursing stations for a wide variety of complaints (see Table 6) [Cronquist and Morris 2002]. Of the 703 visits to the nursing station at the Eager shelter and the 265 visits to the nursing station at Holbrook, 172 (24%) and 30 (11%) were related to upper respiratory irritation, asthma, shortness of breath, or exacerbation of chronic lung disease.

At each shelter, the most common visit reason was classified as “other”: 34% at Eager and 37% at Holbrook. These visits were mostly reassurance checks, including blood pressure and glucose monitoring. Health care providers saw few acute medical

emergencies. The majority of injuries were minor conditions such as blisters and small lacerations. Approximately 15% of visits made at both shelters were requests for prescriptions for medication left at home during the evacuation. Anticipating these requests, physicians had previously made special arrangements with local pharmacies.

Mental health contacts are discussed in the next section.

**Table 6. Summary of clinical encounter data at Eager and Holbrook Shelters**

| Chief Complaint | Eager Shelter (703 Total Visits) | | Holbrook Shelter (265 Total Visits) | |
|---|---|---|---|---|
| | Frequency | % of visits | Frequency | % of visits |
| Other | 240 | 34.1 | 97 | 36.6 |
| Upper Respiratory | 122 | 17.4 | 20 | 7.5 |
| Medication Refill | 103 | 14.7 | 39 | 14.7 |
| Injury (including minor) | 101 | 14.4 | 44 | 16.6 |
| Asthma Exacerbation | 43 | 6.1 | 4 | 1.5 |
| Psychiatric | 30 | 4.3 | 14 | 5.3 |
| Rash | 21 | 3.0 | 4 | 1.5 |
| Chest Pain/Cardiac | 11 | 1.6 | 4 | 1.5 |
| Heat/Sun Exposure | 11 | 1.6 | 0 | 0 |
| Gastroenteritis | 10 | 1.4 | 7 | 2.6 |
| Lung Disease Exacerbation | 7 | 1.0 | 6 | 2.3 |
| Fever | 4 | 0.6 | 0 | 0 |
| Unknown | 0 | 0 | 26 | 9.8 |
| Total Visits | 703 | | 265 | |
| Mental Health Contacts | 4,900 | | 500 | |

## Behavioral Health Effects

### *Mental Health Emergency Response Plan*

During the early stages of the fire, the Arizona Department of Health Services, in consultation with Red Cross and Federal Emergency Management Agency (FEMA) representatives, developed a detailed mental health response plan. The plan addressed three key areas [Dye 2002]:

- **Mental Health Response**. Activities included: 1) the immediate transfer of hospitalized patients from Show Low to psychiatric facilities in Flagstaff; 2) relocation of an adolescent group home to Holbrook; 3) establishing a daily crisis

briefing with providers to oversee patient issues; 4) identifying enrolled mentally ill clients in the shelters; and 5) ensuring consistent access to medication for clients displaced to Phoenix and Tucson.

- **Mental Health Relief.** Activities included: 1) assignment of mental health counseling teams to shelters in Eager, Payson, Holbrook, and Winslow; 2) providing critical incident stress debriefing to fire workers and emergency personnel; 3) dispatching crisis teams to staff Red Cross and FEMA help centers; and 4) providing mental health staff on vans used to transport residents to view their properties.

- **Mental Health Recovery.** Activities included establishing a team to begin designing the Crisis Counseling and Outreach Program.

***Behavioral Health Stressors***

In the community survey described above, 32% of the respondents from the non-evacuated communities of Snowflake/Taylor and 54% of the respondents from the evacuated communities of Show Low/Lakeside/Pinetop reported high stress levels as a result of the fire. However, only 6% of respondents from the evacuated community sought out formal therapy or counseling [Cronquist and Morris 2002]. A common stressor reported by Rodeo-Chediski fire victims was simply not knowing the fate of one's home. Many shelter residents described dialing their personal answering machines to find out if their phone still rang. Others discovered the fate of their property on the television news. The retired population, which is large in the region, was particularly aggrieved by the loss of heirlooms and other unrecoverable keepsakes, and the loss of their retirement properties. Many residents of the severely burned regions refused to leave their homes in the weeks after the fire to avoid seeing the destruction of the surrounding forests [Dye 2002].

***Behavioral Health Clinical Encounters***

Mental health needs of shelter residents were great, and visits to the mental health stations at both shelters far exceeded those made to nursing stations. As of June 29, 2002, at the Eager shelter, the mental health care supervisor reported approximately 4,900 significant mental health care encounters with shelter residents and Red Cross Staff. A total of 35 staff members provided mental health care (6 from Red Cross disaster teams and 29 local volunteers). Clients counseled included 4,355 adults, 426 children, and 156 staff (4,883 total encounters). Concerns of those counseled included stress, family problems, frustration with communication problems (only one payphone was available), and questions about when the evacuation order would be lifted. One patient, exhibiting symptoms of schizophrenia, was hospitalized [Cronquist and Morris 2002].

Data are less reliable from the Holbrook shelter. The mental health care supervisor reported an average of 40 to 50 mental health care encounters per day among adults, yielding an approximate total of 500 encounters by June 30, 2002 [Cronquist and Morris 2002].

***Community Forums***

Health workers conducted community meetings and forums in the Holbrook, Eager, and Payson evacuation shelters between June 27 and July 1, 2002 to identify immediate and long-term mental health crises intervention and support services needs. Interviews were also held with key actors including Red Cross representatives, local social service providers, clergy, mental health agencies, and county and tribal officials [Dye, 2002].

Key needs identified in the community forums tended to focus on practical and material assistance for residents—assistance such as information on disaster relief assistance and the application process, material support for families (child care, transportation), and mental health crisis counseling. In particular, forum attendees emphasized the need for a single crisis coordinator to oversee all mental health efforts in the disaster area.

Among mental health workers, major concerns included: 1) a potential resource issue if the fire resulted in a spike in utilization of local psychiatric services; 2) stress and fatigue of local therapists who staffed the shelters fulltime for 2 weeks and still needed to see their regular clients; and 3) a lack of local staff trained in formal critical stress de-briefing models. Mental health workers also described specific incidents illustrating the stress-related, emotional and behavioral fallout of life in the shelters and among the evacuees. These included parents arguing with children, retirees upset at the lack of information provided on the status of their homes, domestic violence incidents, and the special challenges of monolingual Spanish evacuees faced with English-only information on the progress of the fire.

***Risk Factors***

Social indicators may be used to estimate mental health risks. While most individuals have great resilience in the face of adversity, risk factors can impede emotional adjustment to a traumatic event [Dye 2002].

Compared to Arizona averages, Apache and Navajo Counties are significantly higher on key measures of economic risk, including unemployment, net migration, participation in school free-lunch programs, and the number of families receiving TANF cash assistance (Temporary assistance for needy families). Several indicators of risk among adolescents are also significantly higher in Apache and Navajo Counties as compared to statewide averages including the number of public school dropouts prior to ninth grade, alcohol arrests among 10–14 year olds (Navajo County only), and adolescent suicides [Dye 2002]. Clearly, for Apache and Navajo Counties, the primary areas impacted by the fire, a number of social indicators were significantly elevated in comparison to state averages indicating potential difficulties in adjusting to a fire event.

A member of the White Mountain Apache Tribe was responsible for setting the Rodeo Fire. This has strained relations between nearby fire-affected non-Indian communities and tribal members, creating further emotional turmoil. Additionally, the White Mountain Apache Tribe faces behavioral risk factors unique to reservation residents. The forest devastation was greatest on the Fort Apache Indian Reservation, with 280,000 acres

burned. Logging is a main source of economic security for the Tribe. The Tribe continues to operate the Sunrise Ski Resort and Hon-Dah Casino, but the fire damaged forest will not be ready to harvest as commercial timber for another 100-150 years. This may jeopardize the Tribe's economic security for the next two to three generations.

The White Mountain Apache also have a multi-generational connection to the land. As stated by Tribal Historic Preservation Officer John Welch, "Their relationship to the land is right at the core of their being." The Tribe estimates that the fire charred about a dozen religious sites on the reservation, the best known being Pumpkin Lake. Some of the burned sites provided the Tribe with various colors of ceremonial earth used in sand paintings and dances. The fire burned most of the Cibecue district, home to the Tribe's most remote and traditional villages, and where 100% of the residents still speak Apache.[3]

***White Mountain Recovery Partnership-Immediate Services Program***

The Arizona Department of Health services received $403,000 from the Federal Emergency Management Agency to develop behavioral health programs and counseling services in the affected communities. The "Immediate Services Program" was operational from July 12, 2002 to November 18, 2002. The program's objective was the implementation of the Federal Emergency Management Agency crisis-counseling model to address the mental health needs of individuals and to support community education and recovery.[4] A brochure on the White Mountain Recovery Partnership is contained in Appendix D.

Two project sites were established for the Immediate Services Program: the **White Mountain Recovery Partnership**, headquartered in Show Low, which served the affected areas of Navajo, Apache, Coconino, and Gila Counties, and the **Apache Behavioral Health Services**, stationed in Whitewater, which served the Fort Apache Indian Reservation. The White Mountain Recovery Partnership operated an 18-member crisis outreach team deployed into the Mogollon Rim. Due to the large geographic area involved, two separate teams were organized, one to serve the Rim communities of Heber/Overgaard and Aripine, and the other to serve the Mountain communities of Pinedale, Clay Springs, Linden, Show Low, and Pinetop/Lakeside. Phase 1 of the program (July 25-August 31, 2002) focused on providing immediate relief services for individuals and reducing acute reactions to the fire. Phase 2 (September 1, 2002–November 18, 2002) shifted to a broader role, emphasizing community-wide disaster recovery.

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[3] Information on risk factors for the White Mountain Tribe was taken from Northern Arizona University (2002), available at http://www4.nau.edu/itep; the January 29, 2003 edition of MSNBC News, available at http://www.msnbc.com/news/ (keyword: white mountain apache) and the December 30, 2002 edition of the Arizona Daily Star, available at http://www.rense.com/general33/harv.htm.

[4] The information in this section is from ADHS (2003a) and Dye (2002).

Overall, the Immediate Services Program of the White Mountain Recovery Partnership served 1,843 individual disaster area residents (individual counseling contacts) who were either displaced from or lost their homes, and 102 local groups [ADHS 2003a]. A profile of the exposure characteristics of the 1,843 individuals receiving individual crisis counseling indicated that many of these persons were exposed to multiple risk factors, increasing their likelihood of requiring post-disaster mental health support. Evacuation or loss of one's home was the single largest disaster impact, with 100% of contacts reporting this exposure factor. Twenty-seven percent (27%) temporarily or permanently lost their jobs, 22% assisted in the rescue or recovery effort, 6% reported a physical disability that limited their mobility, 4% reported a pre-existing mental health or substance abuse disorder, and 3% reported other exposure factors such as risk of death or anxiety over missing family members.

Data from the first 4 months of the program reflect more than 15,000 contacts. These included 4,715 participants in group education, 1,253 participants in group counseling, 1,566 individual crisis counseling session, 6,479 materials distributed, and 1,115 mailings. Of the 1,566 individuals counseled during the first four months, 26% reported physical reactions such as fatigue and exhaustion, worsening of chronic medical conditions, and difficulty in falling or staying asleep. Thirty-three percent (33%) reported emotional reactions such as sadness, anxiety, and anger, 23% reported cognitive symptoms such as difficulty concentrating, and 23% reported behavioral symptoms such as isolation/withdrawal and mood changes.

The Partnership identified the following populations as the most critical: At-Risk (youth and older adults), First Responders, Health Service Personnel, Faith-based Organizations, and Business and Civic Leaders, and made special efforts to contact these groups. Outreach to youth was compromised by the summer school break and a lack of buy-in from school administrators. The older adult population required the most assistance due to their fragile health, lack of support systems, and economic hardships. The economically marginalized populations who lost property and personal possessions experienced great emotional difficulty.

Concerning first responders, stresses and communication breakdowns between firefighting and law enforcement groups became important topics. Attempts were made to start a dialogue between the two groups with growing support for reconciliation between these two populations. Much of the strongly Mormon population in the region chose to work directly with their own counseling resources. However, faith-based organizations regularly provided referrals, donated tables and chairs, and provided space for meetings. A number of individual counseling sessions came from the business and civic leader population, but those most in need of services were the smaller, financially stressed businesses.

The White Mountain Recovery Partnership also coordinated or supported a variety of community counseling activities and community events. Counseling activities included organizing community coffees and other gatherings focused on community strengthening and healing and providing direct support to local service providers including fire/police, business and civic groups, and health and social service agencies. The Partnership also

distributed fire literature, hosted information tables at stores and churches, and gave presentations at community forums and to service agencies and local government groups. Partnership-supported community events included the Pinedale Park Community Picnic, the Heber/Overgaaard Oktoberfest, and Pinetop/Lakeside's Fall Festival.

***Apache Behavioral Health Services-Immediate Services Program***

Apache Behavioral Health Services, a tribal mental health program located in Whiteriver, served as the contractor for White Mountain Recovery Partnership on the Fort Apache Indian Reservation. By mid-August, Apache Behavioral Health Services had implemented its Immediate Services Program and recruited a staff of seven counselors and outreach workers. During the Immediate Services Program, Apache Behavioral Health Services provided crisis outreach and counseling services to 623 individual disaster area residents on the reservation.[5]

Apache Behavioral Health Services staff went door-to-door in the communities of McNary and Hon-Dah in an effort to contact individuals who had been evacuated from the fire. Outreach workers also handed out food and clothing and met with individuals from the communities of Cibecue, Carrizo and Cedar Creek who were evacuated from their homes after the fire due to increased risk of flooding. The outreach workers helped people as they worked through trauma symptoms and difficult issues related to loss of traditional and sacred lands, loss of future employment, loss of employment income due to the evacuations, and difficulties in dealing with assistance agencies. Common mental health problems observed by staff included denial, depression, and grief. Twenty (3%) of the individuals contacted by outreach teams received a referral for professional mental health or substance abuse services, or both.

The Apache Behavioral Health Services outreach teams also provided a wide variety of community assistance referrals. The types of assistance provided for tribal members included referrals for legal aide, clothing, food, stress management, flood prevention, assistance with utility bills, and alcohol prevention services. For example, Apache Behavioral Health Services supplied 10 adults who complained about ruined floors and homes with names and telephone numbers of people to contact for assistance.

Apache Behavioral Health Services also presented their program to the tribal community via the tribal radio station and in staff-organized weekly community coffee meetings. A key event was the Apache Behavioral Health Services-sponsored Women's Conference. This event, held on the reservation, focused on powerful leadership skills for women and how to balance career and family during disaster recovery.

Apache Behavioral Health Services frequently encountered an increase in problematic racial interactions between residents of the Fort Apache Indian Reservation and community members from Lakeside/Pinetop, Show Low, and Heber/Overgaard. To address this problem, workers created a Racial Discrimination Hotline for tribal

[5] Information in this section is from ADHS (2003a).

members, advertising it over the White Mountain Apache Tribe's radio station for a 6-month period. Actions taken by the Tribe included writing letters in which they addressed grievances to off-reservation agencies and city and county officials. Tribe representatives also met with local Chambers of Commerce.

***White Mountain Recovery Partnership-Regular Services Program***

The Arizona Department of Health Services received $1,106,320 from the Federal Emergency Management Agency for a "Regular Services Program", (a continuation of the Immediate Services Program), to be conducted in the fire area from November 19, 2002 to August 18, 2003. During the Regular Services Program, the White Mountain Recovery Partnership will provide services to the Fort Apache Indian Reservation and they have hired a former Apache Behavioral Health Services employee to assist on the reservation.

During the first quarter of the Regular Services Program (November 19, 2002 to February 18, 2003), the White Mountain Recovery Partnership delivered services to 3,427 residents, including 73 local groups (1,069 persons) and 1,465 individuals - 1196 of whom were displaced from or lost their homes and 379 of whom had lost their jobs [ADHS, 2003b]. Table 7 presents a comparison of the reactions of individuals counseled during the Immediate Services Program with the reactions of individuals counseled during the first quarter of the Regular Services Program.

**Table 7. Comparison of Reactions Of Individuals Receiving Services During the Regular Services Program and the Immediate Services Program**

| Reaction Category | Regular Services Program<br>First Quarter<br>N=1,465 | Immediate Services Program<br>N=1,566 |
|---|---|---|
| Emotional Reactions | 38% | 32% |
| Physical Reactions | 28% | 26% |
| Behavioral Reactions | 26% | 23% |
| Cognitive Reactions | 8% | 19% |

As shown in Table 7, emotional, physical, and behavioral reactions increased during the first quarter of the Regular Services Program, while cognitive reactions decreased. Emotional reactions, consistently the most commonly reported reactions, were dominated by feelings of anxiety and fear. Irritability and anger remained high as individuals moved through their initial anger responses to loss and into a more pervasive anger in the

disillusionment stage of coping with disaster. This movement of reactions is consistent with the stages of disaster mental health model discussed in the next section. In the physical reaction category, fatigue and exhaustion were the most frequently reported responses, twice that of any other physical response. This is understandable since, in addition to the emotional drain of the fire, residents had the tasks of clearing, cleaning, and re-establishing livable homesites and, in some cases, reviving failing businesses or finding work. The behavioral reactions of isolation and withdrawal increased significantly; however, this may have been caused by the onset of winter in this very rural area. In spring, the Partnership intends to emphasize door-to-door outreach and getting people out of their homes. Cognitive reactions, which decreased during the first quarter of the Regular Services Program, included responses such as difficulty concentrating and problems with decision making.

The Partnership expanded its focus during the first quarter of the Regular Services Program to include the organization of region-wide community healing projects. Examples of region-wide projects include the "Red-Tape Public Forums" and the "Tax Information Forum" which addressed fire-related insurance and federal/state tax concerns. The Partnership organized these forums because of their perception that the resident's great difficulty in accessing funds was hindering their ability to move through the recovery process. Although the Partnership has had little success in gaining access to the region's schools to provide services to youth, the Partnership was able to host an all-day "Teen Summit-2003" for at-risk youth grades 9-12. The Teen Summit focused on after-fire issues such as teen suicide/depression, access to employment in a fragile economy, issues surrounding diversity and tolerance, and also contained an inspirational segment. The Partnership-sponsored "Writing to Heal" was an eight-week workshop designed to give residents an opportunity to express and release their fire experiences through writing.

The Partnership is now preparing to work with community leaders and stakeholders on "anniversary issues". According to the stages of disaster model, the disillusionment phase of disaster recovery is believed to be exacerabated during the first anniversary of a disaster. In the Rodeo-Chediski fire area, communities little impacted by the fire consider the event history and are planning celebrations to mark the event, while those communities actually burned are planning memorial events. The Partnership initially planned to develop a region-wide strategy for addressing anniversary reactions, but now must develop a plan to consider the individual needs of each community.

### *Stages of Disaster Mental Health Model*

Disaster mental health is grounded in a theoretic model that portrays community response to a disaster as a series of predictable phases or stages [Dye 2002]. Each stage is characterized by a unique set of identifiable emotional and behavioral responses as individuals and communities struggle to cope with the crisis.

The first stage begins with periods of heroism. During this stage, disaster victims cooperate and often expend enormous amounts of personal energy saving their own lives or the lives and property of others. The second phase is a strong sense of a shared

community experience and recognition of the need to work together in rebuilding efforts. The third phase, which can last up to 1 year, is a period of disillusionment and disappointment brought about, for example, by relief agencies leaving the area, overwhelming government paperwork, financial assistance running out, family problems, waning media attention, and blame for the disaster. In the final "reconstruction" stage, victims recognize that they alone are responsible for solving the problems of their families and communities. The reconstruction phase lasts from 1 to 3 years and includes development of new programs and plans by community leaders to meet unaddressed local needs.

The "Final Report of the Immediate Services Program" states that changes in the types of symptoms experienced by the Rodeo-Chediski fire victims over time are indicative of movement through the disaster model stages [ADHS 2003] in which acute stress reactions give way to anger and fatigue. The continuing challenge for the White Mountain Recovery Partnership will be to remain sensitive to changes in the community mood over the coming months in order to support its long-term recovery [ADHS 2003].

## Other Impacts

### Sales Tax and Unemployment Impacts

The Arizona Division of Emergency Management [2003] states that "Currently, with the aftermath of the wildfire, Navajo County can only provide minimally adequate levels of the services to which its citizens are entitled". It also states that "The long-term effect of the Rodeo-Chediski on the economy of Navajo County and subsequently on Navajo County Government may yet prove to be sufficiently devastating a cripple Navajo County." Services affected would likely include ongoing and new public health programs (author's note).

The economic impact[6] of the Rodeo-Chediski fire is both obvious and subtle. The most visible impact is the physical destruction caused by the fire. It consumed nearly half-a-million acres and destroyed over 490 residences. Of the affected communities, Heber-Overgaard and the Fort Apache Indian Reservation were probably the most visibly impacted. Heber-Overgaard experienced the highest number of destroyed residences (200+) and businesses (6). The Fort Apache Indian Reservation suffered 280,000 burned acres of forest, leaving approximately 800 million board feet of dead timber.

Two of the less sensational economic impacts of the fire are its effect on employment and on the region's sales tax revenue. The fire disrupted most trade and commerce for almost 30 days, devastating the region's economy. The loss of sales tax revenue and jobs from displaced residents, lost businesses, and reduced tourism may be even more significant than the physical damage.

[6] This summary economic impact in the fire area is taken from a report entitled "Employment and Sales Tax Revenue Impacts of the Rodeo-Chediski Fire" [Thomas, Warren & Associates 2002].

Fire-attributable job losses are estimated at 272 jobs in Navajo County and 80 jobs in Apache County. This represents a fire-related increase in unemployment in July 2002 of 21% for Apache County and 26% for Navajo County. These job losses are for the non-reservation portions of the counties and represent short-term losses through the end of calendar year 2002. Longer-term losses will depend in large part on the recovery efforts undertaken in the affected communities. The estimated number of jobs lost due to the Rodeo-Chediski fire and the associated estimated lost wages might not be large in terms of the total number of jobs and wages in the state. However, because the counties and communities affected by the fire already had a relatively high unemployment rate (compared to the rest of the state), the effects on these counties and communities could be substantial.

One measure of a region's economic activity is its taxable sales as estimated by sales tax revenues. Local levels of government in the region are heavily dependent on sales tax collections. Sales tax revenue accounts for at least 20%, and in some cases as much as 80%, of a municipality's total general fund revenues. County governments are also dependent on sales tax collection for a large share of their general fund revenues.

Local governments' dependency on sales taxes, combined with the fire devastation during the height of the tourist season, could lead to large budget deficits for some of those governments. During parts of June and July, the fire essentially closed the economy down. By mid-July, businesses started to operate again, but at unseasonably low levels. June and July are traditionally among the strongest months for business activity and revenue collections, accounting for approximately 20% of total annual sales tax collection for the region. At a minimum, sales tax revenue collections for these two months will be severely impacted.

The relative size of the decreases in sales tax collections in relation to the community's 2001 total sales tax collections ranges from a low of about 4% for St. Johns to a little over 26% for Taylor. The estimated percent reductions in sales tax collections for the rest of these communities ranges between 5% and 10%, except for Payson and Show Low, estimated to be in the 13% to 14% range. Thus the effects of decreased sales tax revenue collections in all of the communities could be substantial.

For the 12-day period of full evacuation, sales tax revenue from the southern part of the county was non-existent. The evacuation areas of Show Low, Pinetop/Lakeside, Heber/Overgaard and the surrounding areas generate a large portion of the county sales tax. Sales tax revenue in this tourism-dependent area was further devastated after the fire.

**White Mountain Apache Tribe Economic Impacts**

We are unaware of any formal study commissioned to evaluate the economic impact of the Rodeo-Chediski Fire on the White Mountain Apache Tribe. However, based on the nature of the tribal economic enterprises and government-compiled socioeconomic

indicators (presented below), it is apparent the Tribe is facing a severe economic loss which will affect the reservation for the next several generations[7].

The Tribe's principal economic industries are mostly dependent on the reservation's plentiful natural resources and scenic beauty. A mainstay of the Tribe is the Fort Apache Timber Company, which employs approximately 330 people to harvest ponderosa pine, spruce, and fir within 800,000 acres of tribal forest land. Two sawmills located on the reservation in Cibecue and Whiteriver process about 48 million board feet a year. Tribal lands also support some of the best outdoor recreation in Arizona. In addition to the Sunrise Park Ski Resort, the reservation contains 25 fishing lakes, 420 miles of trout streams, 7,000 campsites, and offers canoeing, kayaking, and whitewater rafting. The reservation also possesses superb elk habitat and hosts the country's premier commercial elk hunting operation. The Tribe generates income from the sale of hunting, fishing, vehicle, and boating permits and licenses. The Hon-Dah casino and hotel also generate income for the Tribe.

Despite these successful enterprises, the White Mountain Apache Tribe suffers from depressed economic conditions that plague many reservations. Table 8 compares year 2000 census data for the White Mountain Apache Tribe to 2000 census data for the State of Arizona. The Table shows that almost half of the White Mountain Apache Tribe live below the poverty level. Census data shows a 22.5% unemployment rate for the Tribe; however, anecdotal information contained in newspaper accounts consistently place the Tribe's unemployment rate at closer to 60%. The 2000 census data also shows that a larger than average portion of the reservation's population is too young to work.

**Table 8. Socioeconomic Indicators for the White Mountain Apache Tribe**

| Indicator | White Mountain Apache Tribe | State of Arizona |
|---|---|---|
| Population by Age | | |
| Under 20 years | 47.4% | 29.6% |
| 20-54 years | 43.5% | 48.8% |
| 55 years and over | 9.1% | 21.6% |
| Median Age | 21.7 years | 34.2 years |
| High School Degree | 54.3% | 81.0% |
| College Degree | 9.7% | 30.3% |
| Families Below Poverty Level | 42.2% | 13.6% |

[7] Information in this section is primarily from *Native Voices* at http://www4.nau.edu/itep and year 2000 census data (keyword: NE Tribal Economies) at http://www.commerce.state.az.us.

| | | |
|---|---|---|
| Median Household Income<br><br>Per Capita Income | $18,903<br><br>$6,358 | $40,558<br><br>$20,275 |
| Unemployment Rate | 22.5% | 5.6% |
| Jobs to Population Ratio | 0.23 jobs/person | 0.44 jobs/person |
| No Electricity | 9.3% (1990 decennial census) | N/A |
| Households Without Telephone Service | 42.8% | 2.1% (Maricopa County)<br><br>25.4% (Navajo County) |

Sixty percent of the Rodeo-Chediski Fire raged through the White Mountain Apache's tribal forest land. Over 280,000 acres of the Tribes's 800,000 acres of timber, or approximately one-third of the reservation's forested land, was consumed by the fire. Although no tribal homes were lost, an estimated five years worth of salable timber (250 million board feet) was destroyed or badly scorched in the fire [NAU 2002]. Newspaper accounts generally place the estimated cost of the destroyed timber at around $332 million. The Tribe has begun a massive timber salvage operation, but reliable information as to how much money the sales will bring in is not available. Lumber mill jobs on the reservation were lost during and immediately after the fire. By mid-July, 2002, 112 employees remained laid off at the reservation's two mills out of a total of 330 employees. Employment at the mills has increased during timber salvage operations, but this is a short-term activity. The time window for harvesting fire-damaged trees is usually about twelve months. After that time, the wood is susceptible to staining and insect infestation (some blue staining has already occurred) which further decreases its economic value. The Hon-Dah Casino and Hotel were also closed during and after the Fire at the height of the tourist season. LA Times staff writers writing for the RedNationStar estimate that closure of the casino and hotel cost the Tribe $3.3 million in expected revenues (http://www.rednationstar.com).

The long-term economic impacts may be the hardest to bear. After the short-term salvaging of the burnt timber, reservation milling and logging operations will fall off possible requiring the closure of one of the mills. The damaged forest will not return to its pre-fire growth (be ready to harvest as commercial timber) for 100 to 150 years representing a lost work and revenue source to the Tribe for the next **two to three generations**. During that time, the Tribe will have to rely on the timber stands on the east side of the reservation. Tourism and recreation associated with the forest are also a concern. Although relatively few recreational sites, such as fishing lakes and campgrounds, were burnt over, the public's perception, in many cases, is that the entire reservation is a "moonscape" and recreators may stay away. By mid-September, 2002, tourism dollars had slumped to 50% below normal. Since the Tribe depends on tourism and its associated amenities, they are working hard to turn public perception around through the print media and brochures. Still, the loss of habitat and scenic beauty will

likely reduce tourism dollars as well as income from the sale of recreational permits and licenses for the foreseeable future.

**Loss of Recreation**

The fire "burned over" 5 administrative sites, 10 developed recreation sites, and 23 concentrated-use areas in the Apache-Sitgreaves and Tonto National Forests [USFS 2002]. Approximately 1,300 miles of road and 107 miles of trails were impacted to some degree [USFS 2002d]. The Rodeo-Chediski Fire Burned Area Emergency Rehabilitation Team inventoried the Forests. The team reported that 201 structures consisting of corrugated metal pipes, concrete box culverts, low water crossings, and one bridge in the Black Canyon drainage needed protection, and that public access will be impaired during and immediately after even light to moderate precipitation events [BAER 2002].

Canyon Creek, located south of Forest Lakes, one of the Southwest's finest trout-fishing streams, was destroyed, not by the flames but by subsequent monsoon rains that flushed the stream with silt and ash, physically washing fish from the stream and clogging their gills. Aquatic creatures were either left high and dry on the banks or choked in the debris-laden water [AZ-NM Chapter American Fisheries Society 2002]. Arizona Game and Fish Department biologists estimate that nearly 99% of the fish population has disappeared from the stream. Black Canyon Lake near Heber-Overgaard also experienced a complete fish kill due to ash runoff in August 2002. Phytoplankton growth and oxygen returned in November, 2002, allowing the lake to be stocked with rainbow trout.

Roosevelt Lake has been a focal point for the Rodeo-Chediski fire's effects on water quality. Its location as the basin below the burned watershed, its importance as a water supply reservoir, and the possible impact on its wildlife resources make Roosevelt Lake an accurate fire damage indicator. Fish managers have observed fire ash and debris flowing down the Salt River into Roosevelt Lake, turning the river black with contaminants that could kill the fish in the reservoir and leave the ecosystem lifeless for months. Fortunately, there has been no immediate detrimental effect to lake fish. However, the Arizona Game and Fish Department continues to observe the lake to determine whether fish will suffer a delayed effect due to the breakdown in the silt and ash and resultant increase in the bioavailability of the nutrients [Marc Dahlberg, Arizona Game and Fish Department, personal communication, 2003]

## Child Health Considerations

ATSDR's Child Health Considerations program recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contaminants in air. Children are more likely than adults to be exposed because they play outdoors. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages.

Furthermore, children—even those without pre-existing illness or chronic conditions—are susceptible to air pollution. Their lungs are still developing, and they are often engaged in vigorous outdoor activities, making them more sensitive to pollution than are

healthy adults. Studies have shown that in children, particulate pollution is associated with increased episodes of coughing, breathing difficulties, and decreased lung function. Children, particularly those with asthma, were likely among the most affected by the fire.

## Conclusions

- Air quality data and community health survey information suggest that smoke from the Rodeo-Chediski fire caused an increase in respiratory problems in area residents consistent with wood-smoke inhalation. These data suggest that the fire represented an acute (short-term) public health hazard.

- Community members in areas impacted by the smoke who were not evacuated experienced fire-related respiratory symptoms. Evacuated community members experienced fewer respiratory problems but experienced more stress and anxiety than did community members who were not evacuated.

- Community members at evacuation centers sought health care services for both physical and mental health needs. Significantly more community members requested mental health support than requested physical health care treatment.

- Major stressors included smoke exposure, evacuation or loss of home (or both), and temporary or permanent job loss. Other major stressors included assisting in the response phase of the fire and pre-existing physical/mental disability or substance disorder. For the Apache people, destruction of generational lands and religious sites and strained relations with nearby non-Indian communities are additional stressors. In the months after the fire, those exposed to multiple stressors had, and will continue to have, an increased likelihood of post-disaster mental health support.

## Recommendations

The Arizona Department of Health Services and Arizona Department of Environmental Quality should work together to establish joint air quality criteria for issuing public health advisories and evacuation orders due to smoke. Additionally, the Arizona Department of Health Services and Arizona Department of Environmental Quality's Hazardous Assessment Response Team (emergency air monitoring team) should evaluate their joint activities during the Rodeo-Chediski fire to identify and implement any suggested improvements for the upcoming fire season.

## Public Health Action Plan

The public health action plan (PHAP) for the Rodeo-Chediski fire describes actions taken and those to be taken at and near the site by ATSDR, the Arizona Department of Environmental Quality, and the Arizona Department of Health Services. Future actions will be taken during and after the completion of this public health assessment. The purpose of the public health action plan is to identify potential and ongoing public health hazards and to provide a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The public health actions that are completed, currently implemented, or planned are as follows:

**Completed Actions:**

- During the fire the Arizona Department of Environmental Quality completed measurements of $PM_{10}$ in the communities of Snowflake, Show Low, Holbrook, and Springerville from June 20 to 27, 2002, and $PM_{2.5}$ in the communities of Snowflake, Show Low, Holbrook, Forest Lakes, Heber, St. Johns, and the Ponderosa Fire Camp from June 28, 2002 to July 10, 2002.

- Based on the measured levels of particulates, the Arizona Department of Emergency Management and the Arizona Department of Health Services issued public health advisories for smoke from June 21, 2002, through the duration of the fire.

- The Arizona Department of Health Services completed a pamphlet entitled, "*What to Do After a Fire*" and distributed 20,000 copies in shelters and to evacuees as they returned to the fire area.

- Arizona Department of Health Service sanitarians worked with the Navajo County Health Department to ensure good sanitation and monitor food safety at evacuation shelters, to monitor infectious diseases and food borne illnesses at shelters, and to ensure adequate vaccine supplies.

- Arizona Department of Environmental Quality water quality staff inspected regulated water systems in the fire area, assisted regulated water system owners in restoring service while identifying possible compromises in system integrity that

might adversely affect the health of the users, and provided assistance to non-regulated private well owners. "Boil Water" notices were issued for eight regulated systems in the fire area.

- The Arizona Department of Health Services, with assistance from the U.S. Centers for Disease Control, conducted a community survey to identify the public health impacts of the fire. Rates of pulmonary symptoms and stress were surveyed for 416 participants in the evacuated communities of Show Low/Lakeside/Pinetop and in the non-evacuated communities of Snowflake and Taylor.

- The U.S. Centers for Disease Control and Prevention reviewed and reported on the clinical and mental health encounters at the two largest American Red Cross shelters (Eager and Holbrook) housing fire evacuees.

- Between June 27, 2002 and July 1, 2002, community forums and interviews with Red Cross representatives, local service providers, clergy, mental health agencies, and county and tribal officials, identified immediate and long-term mental health crises intervention and support services needs.

- The Arizona Department of Health Services received $403,000 from the Federal Emergency Management Agency to develop behavioral health programs and counseling services in the fire-affected communities. The White Mountain Recovery Partnership provided services to the Rim communities and the Apache Behavioral Health Services provided services to the Fort Apache Indian Reservation from July 12, 2002 to November 18, 2002.

**Ongoing Actions:**

- The Arizona Department of Health Services has received $1,106,320 from the Federal Emergency Management Agency for a "Regular Services Program" behavioral health program to be conducted in the fire area from November 18, 2002 to August 18, 2003. During this phase of the program the White Mountain Recovery Partnership is providing services to both the Rim communities and the Fort Apache Indian Reservation.

**Planned Actions:**

- The Arizona Department of Health Services and the Arizona Department of Environmental Quality will work together to establish joint air quality criteria for issuing smoke-realted public health advisories and evacuation orders.

- To identify and implement improvements for the upcoming fire season, the Arizona Department of Health Services and Arizona Department of Environmental Quality's Hazardous Assessment Response Team will evaluate their joint activities undertaken during the Rodeo-Chediski fire.

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# Appendix A

**Populations of Communities in the Fire Area*[8]**

| | | |
|---|---|---|
| **Navajo County** | 101,615 | |
| Aripine | 70 | |
| Cibecue | 1,331 | (Fort Apache Indian Reservation) |
| Clay Springs | 550 | |
| Heber-Overgaard | 2,722 | |
| Linden | 1,200 | |
| Pinedale | 550 | |
| Pinetop-Lakeside | 3,750 | |
| Show Low | 8,295 | |
| Snowflake | 4,700 | |
| Taylor | 3,590 | |
| Whiteriver | 5,220 | (Fort Apache Indian Reservation) |
| Winslow | 9,450 | |
| **Apache County** | 70,105 | |
| Eager | 4,105 | |
| McNary | 349 | (Fort Apache Indian Reservation) |
| Springerville | 1,990 | |
| St. Johns | 3,545 | |
| **Gila County** | 53,015 | |
| Payson | 14,510 | |
| **Coconino County** | 125,420 | |
| Forest Lakes | N/A | |

[8] Population data are 2002 estimates from the County Profiles, Arizona Department of Commerce. Population data for Cibecue, Heber-Overgaard, Whiteriver, and McNary are 2000 estimates from the U.S. Bureau of the Census. Population estimates for Aripine, Clay Springs, Forest Lakes, Linden, and Pinedale are from Web sources