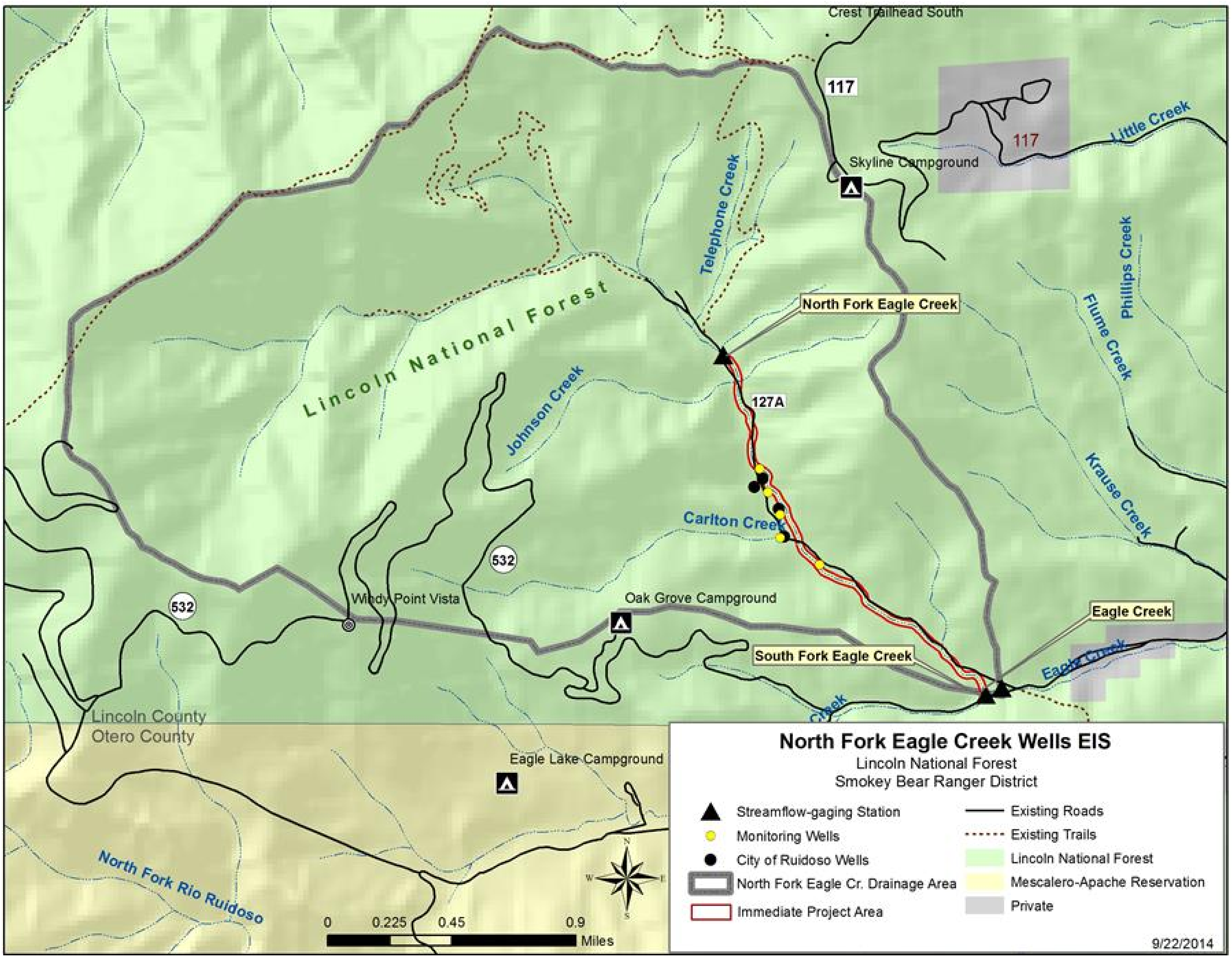
United States Department of Agriculture

Supplemental Draft Environmental Impact Statement

North Fork Eagle Creek Wells Special Use Authorization



Forest Service

Southwestern Region

Lincoln National Forest

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Supplemental Draft Environmental Impact Statement for the North Fork Eagle Creek Wells Special Use Authorization Project

Lincoln National Forest, Lincoln County, New Mexico

Lead Agency:	USDA Forest Service
Responsible Official:	Travis G. Moseley, Forest Supervisor 3463 Las Palomas Road Alamogordo, NM 88310
For Information Contact:	Dave Warnack, District Ranger 901 Mechem Drive Ruidoso, NM 88345 (575) 257-4095

Abstract: The Lincoln National Forest proposes to authorize, under a new special use permit, the operation of four municipal supply water wells (and their associated facilities as described in more detail in chapter 1) located on National Forest System land in the North Fork Eagle Creek drainage. This proposal addresses the need for: (1) authorizing, under a special use permit, the Village of Ruidoso's ability to access and divert groundwater from its North Fork Eagle Creek wells on National Forest System land, as a substantial component of the municipal water supply system that the Village of Ruidoso, New Mexico, residents and visitors rely upon; and (2) protecting natural resources on the national forest by maintaining adequate surface and groundwater flows to sustain or improve the riparian and aquatic ecosystems that may be affected by groundwater drawdown from pumping of these wells. The new permit would include additional terms and conditions reflecting current adaptive management strategies which both respond to the purpose and need for action, and mitigate potential adverse impacts to surface water and groundwater resources from well operations. This supplemental draft environmental impact statement (SDEIS) compares environmental effects of implementing three alternatives, including (1) continuation of pumping; (2) no pumping; and (3) the proposed action.

We (USDA Forest Service, Lincoln National Forest) released the North Fork Eagle Creek Wells Special Use Authorization Project Draft Environmental Impact Statement (DEIS) on May 25, 2012 for public comment. The Little Bear Fire started on June 4, 2012 and encompassed approximately 99 percent of the project area. Because of the substantial impact this wildfire had on the project area and resources analyzed in the DEIS, we stopped the comment period on the DEIS and proceeded with preparing a supplemental information report to document the extent of the changed conditions and the need for a SDEIS. A Notice of Intent to prepare a supplemental DEIS was published in the Federal Register on July 20, 2012. We have prepared this SDEIS using public comments we received on the DEIS prior to the end of the comment period, multiple

interdisciplinary team discussions, coordination with project stakeholders (Village of Ruidoso, Eagle Creek Conservation Association, and the U.S. Geological Survey), literature review, and resource analyses of changed conditions in the project area since the Little Bear Fire.

We encourage your review of this document. It is important that reviewers provide their comments at such times and in such a way that they are useful to the USDA Forest Service's preparation of the final EIS. Therefore, comments should be provided prior to the close of the comment period and should clearly articulate the reviewer's concerns and contentions. Comments must be received within 45 days from the date of the Notice of Availability in the Federal Register. Failing to submit timely and specific comments can affect a reviewer's ability to participate in subsequent administrative review or judicial review. Comments received in response to this solicitation, including names and addresses of those who comment, will be part of the public record for this proposed action. Comments submitted anonymously will be accepted and considered; however, anonymous comments will not provide the respondent with standing to participate in subsequent administrative review or judicial review.

Once the final EIS is prepared, it and the associated draft decision document (Record of Decision) are subject to the predecisional administrative review process (objection process) pursuant to 36 CFR 218, subparts A and B. Objections will only be accepted from those who have previously submitted specific written comments regarding this proposed project during scoping or other designated opportunity for public comment in accordance with §218.5(a). Issues raised in objections must be based on previously submitted, timely, specifically written comments regarding this proposed project unless based on new information arising after the designated comment opportunities.

Send Comments to:

Dave Warnack, District Ranger
901 Mechem Drive
Ruidoso, NM 88345

Date Comments Must Be Received:

Summary

We (the USDA Forest Service, Lincoln National Forest) propose to authorize, under a new special use permit, the operation of four municipal supply water wells (three equipped and one unequipped) and associated monitoring wells; well house control station; underground pipelines and power lines; and road access located on National Forest System land in the North Fork Eagle Creek (North Fork) drainage. The new permit would be authorized for up to 20 years, with stipulations for frequent review and verification of the permit terms and conditions. These could occur as often as every year but would occur at least every 5 to 10 years. The new permit would include terms and conditions reflecting current adaptive management strategies which both respond to the purpose and need for action, and mitigate potential adverse impacts to surface water and groundwater resources from well operations.

North Fork Eagle Creek is located in the Sacramento Mountains of south-central New Mexico in Lincoln County north of the Village of Ruidoso and approximately 2.5 miles west of Alto, New Mexico (figure 1). The project area consists of approximately 5 acres of National Forest System land occupied by the Village of Ruidoso's four wells and surrounding National Forest System land upstream from the Eagle Creek gaging station. This area is within the North Fork Eagle Creek drainage, which totals 5.3 square miles, or approximately 3,400 acres. The North Fork Eagle Creek between the North Fork stream gage and the Eagle Creek stream gage, totaling approximately 2 stream miles, is the emphasis of this environmental analysis (figure 2).

Eagle Creek Conservation Association, Inc., Gerald Ford, and Dr. William S. Midkiff filed a lawsuit in 2005 based on concerns that operating these wells could be affecting streamflow in Eagle Creek. The case was dismissed in 2006 after all parties to the lawsuit signed a Stipulation Agreement, in which the Lincoln National Forest agreed to complete an environmental analysis before a new permit can be issued to the Village of Ruidoso. As part of that analysis, the agreement also requires that an independent watershed and geohydrologic study of Eagle Creek and the North Fork wells be undertaken by an entity not previously involved in the lawsuit.

We have studied the environmental effects of authorizing, under a special use permit, the operation of the existing wells and their associated pipeline, underground power cable, well control house, and road access in this SDEIS. These wells supply a substantial amount of the Village of Ruidoso's municipal water system. They provide, on average, a direct contribution to the Village of Ruidoso water supply ranging from 24 to 29 percent. When indirect annual contributions are added to direct contributions (based on factoring in diversions from return flow credits, described in more detail in chapter 1 and in chapter 3), this increases to 36 to 43 percent. During the summer months, data show that 57 to 87 percent of total direct and indirect annual diversions can be attributable to the North Fork wells). There is a need for: (1) authorizing, under a special use permit, the Village of Ruidoso's ability to access and divert groundwater from its North Fork wells on National Forest System land, as a substantial component of the municipal water supply system) that Ruidoso residents and visitors rely upon; and (2) protecting natural resources on National Forest System lands by maintaining adequate surface and groundwater flows to sustain or improve riparian and aquatic ecosystems that may be affected by groundwater drawdown from pumping of these wells.

We published a Notice of Intent to prepare an environmental impact statement in the Federal Register on February 3, 2011, initiating the public scoping period for this project. We held a public meeting on February 17, 2011, in Ruidoso to answer questions from the public and discuss the project and process. We received a total of 102 comment letters from the public—including agencies, organizations, individuals, and elected officials—in response to our request for input. We analyzed all of these scoping comments to identify issues and information that have been

addressed in this SDEIS. Based on public and internal scoping results, we identified five significant issues. These significant issues include effects of well pumping on water resources, aquatic habitat and fish, riparian vegetation, water rights, and socioeconomics. These issues were used to develop alternatives to the proposed action including:

- **No Change (Continue Current Management) Alternative**: The USDA Forest Service would issue a new permit with no change in existing well pumping operations. Pumping would continue at historic levels with no new restrictions on use, in accordance with the Village of Ruidoso's water rights. The new permit would be issued with similar terms, conditions, and history of water use that has been in operation since 1988.
- **No Action (No Pumping) Alternative**: The USDA Forest Service would not issue a new permit for the Village of Ruidoso's North Fork well operations and maintenance; the use of these wells would not be authorized and would be discontinued.

We released the DEIS for public comment on May 25, 2012. The Little Bear Fire started on June 4, 2012 and encompassed approximately 99 percent of the project area. Because of the substantial impact this wildfire had on the project area and resources analyzed in the DEIS, we stopped the comment period on the DEIS and prepared a supplemental information report to document the extent of the changed conditions and the need for a supplemental DEIS. A Notice of Intent to prepare a supplemental DEIS was published in the Federal Register on July 20, 2012. We received 19 comments between June and September 2012 (email, letters, or phone calls) that were either related to the content of the DEIS prior to suspension of the comment period or on our request for information on changed conditions due to the Little Bear Fire.

This SDEIS is similar to the May 2012 DEIS but documents changes necessary due to the Little Bear Fire and in response to the Notice of Intent previously mentioned. It was prepared using public comments we received on the DEIS prior to the end of the comment period, multiple interdisciplinary team discussions, coordination with project stakeholders (Village of Ruidoso, Eagle Creek Conservation Association, and the U.S. Geological Survey), literature review, and resource analyses of changed conditions in the project area. A listing of the specific changes between the DEIS and this SDEIS is provided at the beginning of chapter 1.

Based upon effects of the alternatives, the Lincoln National Forest Supervisor must decide whether to issue a new permit to re-authorize the Village of Ruidoso's North Fork well operations on National Forest System lands, and if so, under what permit terms and conditions, including adaptive management requirements.

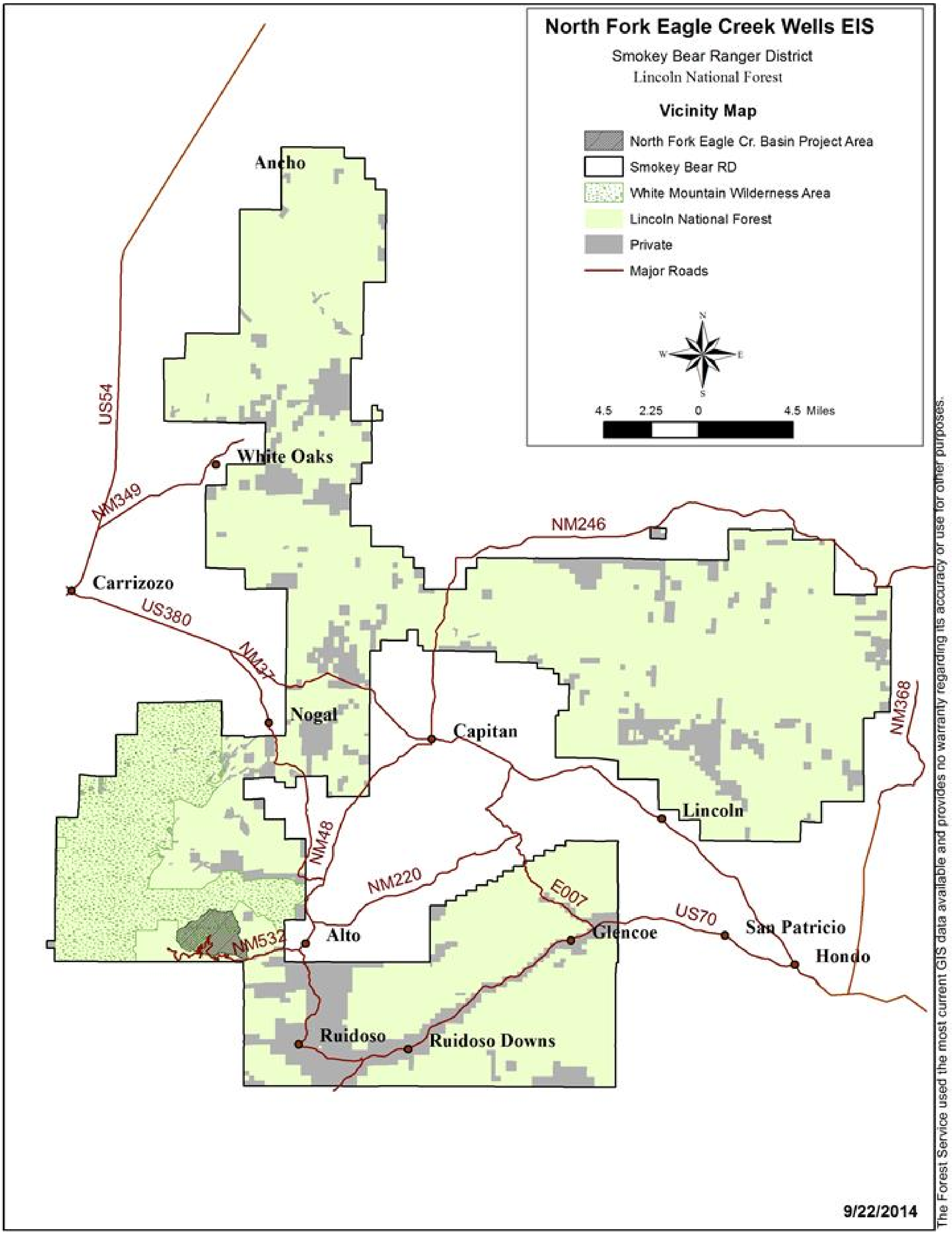

Figure 1. Project vicinity

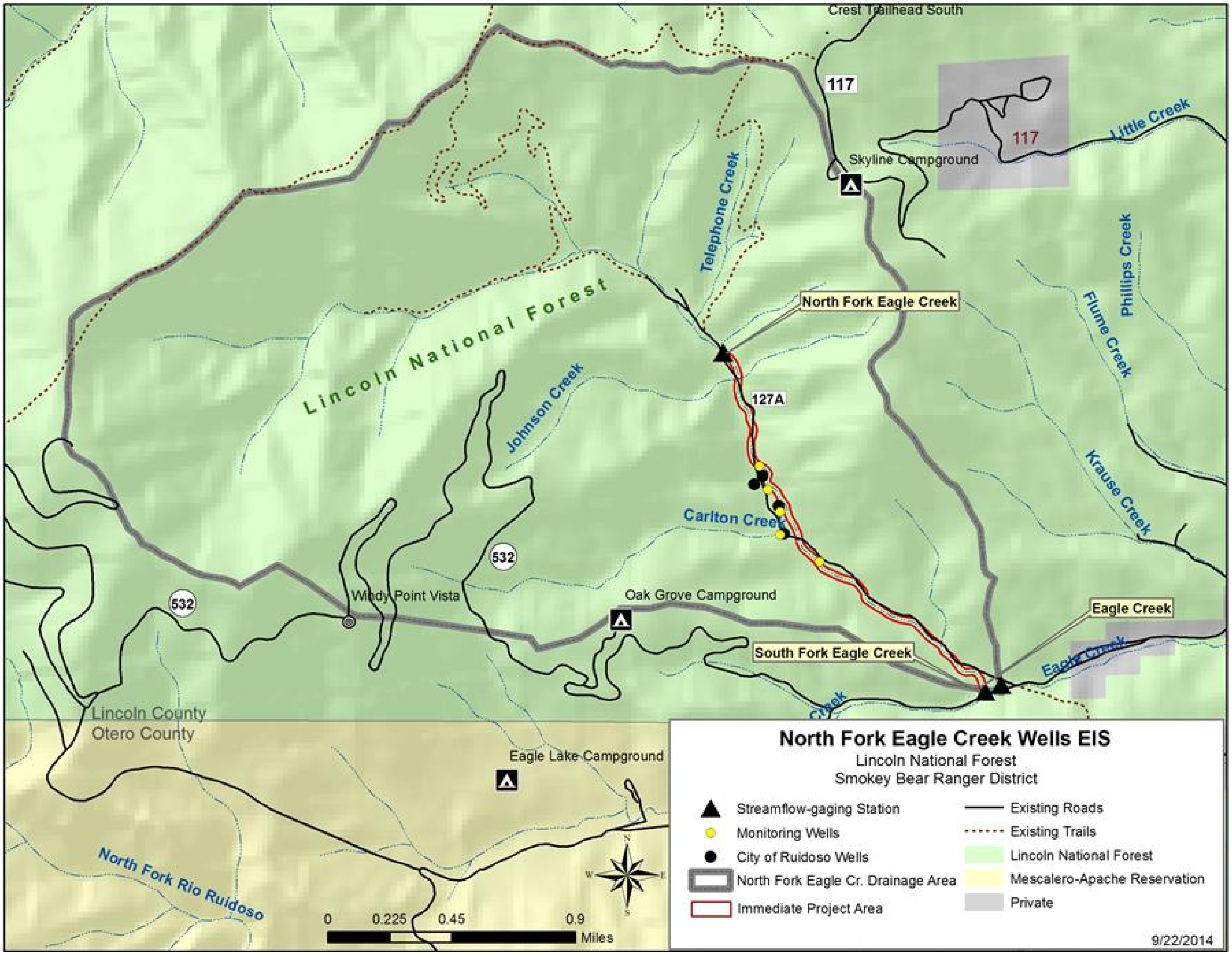

Figure 2. Project area

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Chapter 1. Purpose of and Need for Action

We (the USDA Forest Service, Lincoln National Forest) propose to authorize, under a new special use permit, the operation of four municipal supply water wells located on National Forest System land in the North Fork Eagle Creek (or North Fork) drainage. The new permit would be authorized for up to 20 years, with stipulations for frequent review and verification of the permit terms and conditions. These could occur as often as every year but would occur at least every 5 to 10 years. The new permit would add terms and conditions to the permit reflecting current adaptive management strategies which both respond to the purpose and need for action, and mitigate potential adverse impacts to surface water and groundwater resources from well operations.

Background

The Village of Ruidoso drilled four production wells on National Forest System land along the North Fork of Eagle Creek. Three of these wells were put into service in 1988 and remain in use. The permit for the operation of these wells expired on December 31, 1995. Between 1996 and 2005, the Forest Service began discussions with the Office of the State Engineer, the Village of Ruidoso, and the Eagle Creek Conservation Association concerning permit renewal. Since 2005, well operations have continued under annual operating plans while the environmental analysis and decisionmaking process for issuing a new permit is being conducted.

Urban and resort development and drought conditions have placed increasing demands on surface water and groundwater resources within the Eagle Creek basin. These wells supply a substantial amount of the Village of Ruidoso's municipal water system. They provide, on average, a direct contribution to the Village of Ruidoso water supply ranging from 24 to 29 percent. When indirect annual contributions are added to direct contributions (based on factoring in diversions from return flow credits, described in more detail in the next section and in chapter 3), this increases to 36 to 43 percent. During the summer months, data show that 57 to 87 percent of total direct and indirect annual diversions can be attributable to the North Fork wells.

The U.S. Geological Survey conducted an independent study from 2007 to 2009 to determine potential effects of the North Fork Eagle Creek well field on streamflow in the Eagle Creek basin and to provide data for this SDEIS. The final report was released on October 21, 2010, and subsequently revised in November 2010 and November 2011 (Matherne, Myers and McCoy 2011). Findings show that:

- North Fork Eagle Creek is a perennial stream maintained by base flow from groundwater in its upper reaches and becomes intermittent in the 2 miles upstream from the Eagle Creek gage (figure 26, page 55 in Matherne, Myers and McCoy 2011); see figure 2 on the previous page. Without pumping, North Fork Eagle Creek would still be intermittent below the wells. About 1,600 feet downstream of the North Fork stream gage the creek's water sinks into the stream channel alluvium and bedrock aquifer, so this reach remains dry during dry periods, although water resurfaces from the alluvium in some downstream reaches (stretches ranging from 10 to 50 feet long). Streamflow, when present, tends to occur in reaches where there are bedrock outcrops in the channel or the alluvium is thin. There are three gaging stations; one each for the South Fork, North Fork, and Eagle Creek.

- When groundwater is pumped from the North Fork wells, a temporary decline in the water table results and creates a cone of depression around the wells.
- Pumping and streamflow are related, and pumping near a stream (generally) will cause streamflow depletion. However, the degree of connection and the nature of groundwater flow paths is complex in this area and has not been fully characterized.
- During the U.S. Geological Survey study period there was less available sustained base flow than there was before the wells began pumping in 1988. Annual discharge, direct runoff, and base flow were lower during the study period (2007–2009) than before 1988 (1969–1980). Although years of below average precipitation were recorded during both time periods, there were no days of zero flow recorded at the Eagle Creek gage from 1969–1980. No-flow days were recorded in 11 years (totaling 789 days) of the 20 years analyzed after 1988, with 8 of the last 10 years having no-flow days. No-flow days occurred during periods of both below and above average precipitation during the study period but no-flow days did not occur during periods of below average precipitation before 1988. It is important to note that the Eagle Creek gage measures flow from both North Fork and South Fork, and that the Eagle Creek gage used to be (1969–1980) at a different location further downstream along Eagle Creek. The exact position of this prior location is not known with certainty (this is described in more detail in the water resources section of chapter 3).
- Average annual groundwater recharge was estimated to average 490 acre-feet, or about 4 percent of precipitation (1970–1980). Groundwater flow out of the basin (552 acre-feet) was estimated to represent about 16 percent of basin yield (1970–1980), and mean annual groundwater pumping (578 acre-feet for 1988–2000) was estimated to be about 17 percent of basin yield.
- The streambed has a capacity to transmit water at a threshold rate of about 0.7–1 cubic feet per second. The amount of water needed to saturate the alluvium to the bottom of the stream channel at its greatest cross-sectional area between the North Fork and Eagle Creek gages was estimated using Darcy's law to range from 0.6 to 1.2 cubic feet per second. Sustained flows greater than 2.2 cubic feet per second (threshold rate of 1.0 cubic feet per second loss to bedrock plus 1.2 cubic feet per second) are needed to both saturate the alluvium and maintain continuous flow in the North Fork. From September 2007 through March 2009, 2.2 cubic feet per second of discharge was equaled or exceeded at the North Fork gaging station 2 percent of the time. During the study period, a discharge of 1.2 cubic feet per second was equaled or exceeded at the North Fork gaging station 8 percent of the time.

These results are consistent with other studies conducted in this area. For instance, Balleau (2004) used the Glover-Balmer (1954) approximation to estimate streamflow loss caused by pumping of the North Fork wells at Eagle Creek of between 0.5 and 0.8 cubic feet per second. Finch et al. (2004) determined by a mass balance analysis of the Balleau groundwater model that about 70 percent of the water pumped by the North Fork wells was derived from surface water and 30 percent from groundwater storage.

If the cone of depression continues to expand, it could impact water-dependent resources outside the stream corridor. This situation is exacerbated by the location of the wells within the stream channel, together with the low storage capacity of the aquifer.

The June 2012 Little Bear Fire, started by lightning, burned approximately 35,300 acres within the Smokey Bear Ranger District. It affected the North Fork Eagle Creek drainage area where it burned approximately 3,380 acres of the 3,400-acre project area (or 99 percent). It burned with a mix of severities as follows:

- 26 percent high burn severity
- 26 percent moderate burn severity
- 27 percent low burn severity
- 21 percent unburned or very low severity

Wildfire is widely acknowledged to be a major watershed disturbance, which potentially creates substantial changes in watershed dynamics and water balance factors. These changes are often more pronounced when these extensive, severe fires occur in coniferous mountain watersheds such as the Eagle Creek headwaters. As summarized in the following “Existing Condition” description and described in more detail in the “Water Resources” section of chapter 3, several hydrological aspects of the North Fork Eagle Creek watershed have been changed or are expected to change over time because of the Little Bear Fire.

Water Rights

As described in more detail in chapter 3, the Village of Ruidoso (the applicant; the entity that is applying for a special use permit) owns water rights in Eagle Creek basin. The applicant was originally adjudicated a total of 5,648 acre-feet per annum from the North Fork wells subject to beneficial use. In June 2007, the Village of Ruidoso filed Proof of Beneficial Use with the State Engineer which was used as a basis for a 2010 consent order adjudicating a total of 2,539.34 acre-feet per annum with an additional 846.46 acre-feet per annum subject to beneficial use to be filed on or before December 31, 2024. The 2010 Consent Order also adjudicated the North Fork wells authorizing supplemental well diversion up to 761.12 acre-feet per annum for the Village of Ruidoso surface water rights on Eagle Creek.

The Village of Ruidoso and Rio Hondo Land and Cattle Company, L.L.P., entered into a memorandum of agreement on July 26, 2011, regarding Village of Ruidoso water rights in the Eagle Creek basin. To our knowledge as of April 2014, this agreement between the two parties has not been acknowledged by the Office of the State Engineer. If an updated consent order from the Office of the State Engineer including this agreement is issued, we will recognize the updated consent order as the most current description of the Village of Ruidoso’s water rights. Until that time, we will use the 2009 final adjudication as the Village of Ruidoso’s water rights in the North Fork Eagle Creek. More details regarding this memorandum are included in the “Water Rights” section of chapter 3. The alternatives presented in this document for analysis would not be affected by implementation of this memorandum of agreement.

Except for Federal reserved water rights, in New Mexico, the Office of New Mexico State Engineer has authority to administer water rights, even on Federal land. The Forest Service has authority to allow or deny use of National Forest System lands and to determine what is reasonable access, (e.g. conditions of use of National Forest System land).

Changes between DEIS and SDEIS

This document is similar to the May 2012 DEIS that was provided for public comment. The primary differences between the content of the DEIS and this SDEIS is in reference to the Little

Bear Fire. We have carefully reviewed each section of the document to ensure that any anticipated changes in the project area due to the wildfire are accurately described and that any changes anticipated to the alternatives, analysis or conclusions are accurately reflected as well. We also reviewed public comments received on the DEIS and used this in preparing this SDEIS. Changes include:

- Minor adjustments to the “Purpose and Need” and “Management Objectives” sections in chapter 1 to reflect the most current information on the Village of Ruidoso’s water system
- Minor adjustments to the Desired Condition description in chapter 1 to recognize changes in the way streamflow would likely be measured in the future
- Additions to the Existing Condition description in chapter 1 to reflect changed baseline conditions
- Additions to the Public Involvement section in chapter 1 to reflect the public comment period on the DEIS and the decision to prepare this SDEIS
- Minor adjustments to the “Measurement Indicators” described in the “Issues” section of chapter 1 to more accurately reflect differences in how resources can be measured in the future due to changes from the Little Bear Fire. The water quality indicator under water resources was removed.
- Minor adjustments to the descriptions of alternative 1 (no change/continue current management) and alternative 2 (no action/no pumping); these changes are described in more detail in chapter 2
- Revisions to some aspects of the adaptive management triggers of alternative 3 (proposed action) in chapter 2. These are described in more detail in chapter 2.
- Adjustments to alternative 3 (proposed action) and the adaptive management strategy proposed to reflect changes due to the Little Bear Fire. These are described in more detail in chapter 2.
- Adjustments to mitigation measures and monitoring for the alternatives analyzed in detail in chapter 2
- Updated affected environment resource descriptions in chapter 3
- Updated environmental consequences sections for each resource area to reflect revised alternative descriptions and changed baseline conditions
- Added appendix C to summarize public comments received on the DEIS
- Added appendix D with photographs of the project area post-Little Bear Fire

Purpose and Need for Action

The USDA Forest Service’s purpose of taking action at this time is to respond to a request by the Village of Ruidoso for authorization to access their existing wells on National Forest System lands.

There is also an equal need to provide for protection of forest resources on National Forest System lands in the project area.

To develop the purpose and need, we compared desired conditions to existing conditions.

Desired Condition

We developed the following desired condition description based on a review of the 1986 "Lincoln National Forest Land and Resource Management Plan," as amended (forest plan); applicable USDA Forest Service management direction in laws, regulations, Forest Service Manual and Handbooks (summarized later in this chapter under "Management Direction"); studies and reports pertinent to the project area; and input from USDA Forest Service personnel and stakeholders. We also considered the changes in condition in the project area due to the Little Bear Fire.

> Adequate surface flows between the North Fork gage and the Eagle Creek gage are maintained in order to provide streamflow (consistent with an intermittent stream). North Fork and South Fork tributaries provide streamflow to the Eagle Creek gage, measured either at the gage and/or measured at associated monitoring wells, during dry periods, and no-flow days average 20–30 days or less per year, or their equivalent measured at associated monitoring wells, roughly half of the average number of no-flow days experienced between 1989 and 2011.
>
> Groundwater discharge sustains base flows in North Fork Eagle Creek and is a source of water for springs and seeps and water-dependent ecosystems. Riparian habitat along North Fork Eagle Creek is present and provides ecological diversity and wildlife habitat and functions to aid in restoration of watershed conditions affected by the Little Bear Fire. Water quality in North Fork Eagle Creek is maintained, recognizing that short-term adverse impacts due to the Little Bear Fire are likely, but that these effects will diminish over the long-term.
>
> North Fork Eagle Creek provides streamside recreation and wildlife viewing. The thresholds for average or median water table depth annually or seasonally (based on monitoring) is maintained.
>
> The Village of Ruidoso's North Fork wells are authorized under an existing special use permit and provide an important source of water to the Village of Ruidoso; these wells provide water to the Village of Ruidoso, but with a focus on water conservation, management flexibility, and seeking opportunities for transferring water rights to locations off of National Forest System land.

Existing Condition

We developed the following existing condition description based on the best available information at the time of this writing regarding conditions and uses along North Fork Eagle Creek. Information used is listed in the references section later in this document, included in the project record, and discussed in more detail in each resource section of chapter 3.

> North Fork Eagle Creek is a perennial stream maintained by base flow from groundwater in its upper reaches (above the North Fork gage) and an intermittent stream below the North Fork gage for approximately 2 miles downstream to the Eagle Creek gage. Streamflow below the wells, when present, occurs in reaches where bedrock outcrops into the channel or where bed load (sand and gravel) deposits are thinner. North Fork Eagle Creek has less available sustained base flow than it did before the wells began pumping in 1988. Annual discharge, direct runoff, and base flow were lower during the U.S. Geological Survey study period (2007–2009) than before 1988 (1969–1980). No-flow days average approximately 46 days per year (1988–2011).

Several hydrological aspects of North Fork Eagle Creek watershed have been changed or are expected to change because of the Little Bear Fire, as described in more detail in chapter 3 and in the Water Resources Report in the project record (AECOM 2014). These include:

- Changes in upland vegetation and reduced canopy interception, which can modify moisture availability, lead to greater runoff from storms and snowmelt, and temporarily increase surface water yield.
- Reduced storage of water in litter which can increase overland water flow.
- Reduced transpiration which can increase soil moisture, increase streamflow and possibly increase recharge from large monsoonal events.
- Reduced infiltration which can increase overland flow and erosion.
- Changed surface streamflow resulting in temporary increases in 'flashy' responses to rainfall and rapid snowmelt, seasonal changes in snowmelt and altered water quality.
- Reduced infiltration and recharge resulting in short-term decreases in baseflow. Over the long-term, there could be a return to pre-burn baseflow conditions, or increased baseflow due to tree and shrub densities, reduced evapotranspiration and monsoonal recharge.
- Increased stormflow and sediment/debris yields resulting from greater peak flow rates, greater volumes of sediment and debris, greater flash flood frequency, increased erosive power, and modified channel conditions.
- Increased snow accumulation (due to reduced canopy cover), which can be offset by increased or accelerated evaporation, sublimation, and melt.
- Vegetation within the project area riparian corridor consists primarily of ponderosa pine and boxelder in the overstory and grass in the understory. Obligate wetland species are generally not supported by this stream based on the results of surveys conducted in 2010–2011; willows and sedges were only occasionally observed. North Fork Eagle Creek provides streamside recreation and wildlife viewing.

As described in more detail in chapter 3 and in the "Riparian Vegetation Report" in the project record (Miller 2014), the Little Bear Fire affected vegetation in the project area, including the riparian corridor (200 feet on either side of North Fork Eagle Creek). However, the wildfire burned primarily at or below low intensity in this corridor; only 1 acre (or less than 1 percent) burned at moderate intensity and there was no high intensity fire. There was little loss of vegetation in the riparian corridor due to the wildfire but some areas showed signs of sediment flow where vegetation was covered in sediment, bank scouring and deep cobble deposits near the confluence of the North Fork and South Fork of Eagle Creek.

The Village of Ruidoso's North Fork wells provide an important source of water to the municipal water supply system, but are currently operating under an expired special use permit. Estimates of their contribution to the municipal water supply varies (as described in more detail in the "Socioeconomics" section of chapter 3), but when both direct and indirect contributions are factored in, they supply up to an average of 43 percent annually and up to 87 percent during the summer months (Wilson and Company 2005; AECOM 2012 and 2014; Hennighausen and Olsen 2012 and Atkins Engineering Associates, Inc. 2014).

The Village of Ruidoso's methods for managing water supplied by the North Fork Eagle Creek wells were affected by the Little Bear Fire, in combination with continued drought conditions. This is described in an updated summary of "water rights, return flow and conditions resulting from the Little Bear Fire and drought" prepared by Atkins Engineering Associates (2014). Due to the wildfire, the Village of Ruidoso lost their ability to use Eagle Creek surface water because of poor water quality and debris flows. Groundwater availability was also reduced due to damage to aquifer recharge. Since the 2012 Little Bear Fire, the Village of Ruidoso has been diverting more surface and groundwater from the Rio Ruidoso to meet the demand for municipal water. Water storage in Grindstone Reservoir by diversion from the Rio Ruidoso has declined to historic lows. The Village of Ruidoso anticipates the effects of the wildfire on water quality and aquifer recharge in Eagle Creek will stabilize over a period of years so that resumption of their normal operations would be possible in the future.

Need for Action

Using the model Desired Condition – Existing Condition = Need for Change, there is a need for:

- Authorizing, under a special use permit, the Village of Ruidoso's ability to access and divert groundwater from its North Fork wells on National Forest System land, as a substantial component of the Ruidoso municipal water supply system that residents and visitors rely upon; and
- Protecting natural resources on the national forest by maintaining adequate surface and groundwater flows to sustain or improve riparian and aquatic ecosystems that may be affected by groundwater drawdown from pumping these wells.

Management Objectives

We are responding to the Village of Ruidoso's application for a new permit to access their wells on National Forest System land as required by law, regulation and policy. The above needs and the following management objectives will be used to guide implementation of this project.

- Recognizing the importance of the well field to municipal water supply by providing water to the Village of Ruidoso while also encouraging water conservation, management flexibility, and opportunities for transferring water rights to locations off of National Forest System land; and
- Minimizing impacts of groundwater drawdown from well field pumping by maintaining adequate surface and groundwater flows and protecting water dependent ecosystems.

The Little Bear Fire has affected watershed conditions in the project area and is likely to result in altered conditions in both the short- and long-term as described in more detail in chapter 3. We recognize the importance of watershed stabilization post-Little Bear Fire and the importance of adequate surface and groundwater, and upland and riparian vegetation in this stabilization.

This need for action and these management objectives are consistent with USDA Forest Service policy and direction, as described in more detail in the "Consistency with Management Direction" section later in this chapter. In summary, the Lincoln National Forest is to be managed to provide a favorable flow of water for users by maintaining watersheds in satisfactory condition. Standards and guidelines in the forest plan include that riparian areas and fish habitat are to be maintained and enhanced and existing water rights are to be maintained and protected. Forest Service Manual and Handbook direction also applies to special use authorizations and water uses and development and requires that ‘thoughtful and prudent’ management be applied to groundwater beneath National Forest System lands as a valuable resource.

Proposed Action

To begin moving the project area toward desired conditions and to address the purpose and need for action and management objectives, we propose to authorize, under a new special use permit: operation of four municipal supply water wells (three equipped and one unequipped) and associated monitoring wells; well house control station; underground pipelines and power lines; and road access located in the North Fork Eagle Creek drainage on National Forest System land. The new permit would be authorized for up to 20 years, with stipulations for frequent reviews and verification of the permit terms and conditions. These could occur as often as every year but would occur at least every 5 to 10 years. The new permit would include an operating plan with new requirements reflecting current adaptive management strategies which both respond to the purpose and need for action, and mitigate potential adverse impacts to surface water and groundwater resources from well operations.

The adaptive management strategy would take into consideration the dynamic nature of groundwater systems by establishing a feedback process to guide management of groundwater withdrawal rates over time. The North Fork Eagle Creek drainage is characterized as highly transmissive (water moves through it easily); yet with a relatively low groundwater storage capacity. These two characteristics make it sensitive to variations in precipitation patterns and intensity.

Thresholds would be established for streamflow volume and alluvial water depth, water table depths, and riparian vegetation, as described in more detail in chapter 2. Exceeding these thresholds would trigger implementation of adaptive management strategies to mitigate impact to surface resources. Adaptive management strategies currently under consideration include limiting groundwater withdrawal rates and stopping pumping for short periods. In addition, a threshold would be established for the total volume of water withdrawn from the Village of Ruidoso’s wells over a consecutive 3-year period, where exceeding the threshold would trigger a review of the other thresholds and mitigations to prevent degradation of surface resources.

The proposed action would require the Village of Ruidoso to be responsible for the cost and implementation of any identified monitoring and adaptive management of groundwater and surface water resources, once finalized in a Record of Decision and included in the operating plan, which is part of the special use permit. The USDA Forest Service, with assistance from the U.S. Geological Survey, if possible, may also assist with certain aspects as mutually agreed upon by all parties. Four key monitoring indicators would be used to evaluate effectiveness of this management strategy. This adaptive management strategy would be incorporated into the operating plan that is part of the permit.

We described the details of the monitoring indicators and how we would use them more fully in chapter 2.

Decision Framework

The Lincoln National Forest Supervisor must decide whether to issue a new permit to re-authorize the Village of Ruidoso's North Fork well operations on National Forest System lands, and if so, under what terms and conditions, including adaptive management requirements.

Public Involvement

We released the "North Fork Project Notice of Intent to Prepare an EIS and Proposed Action" on February 3, 2011, for a 45-day scoping period. We continue to accept comments throughout the process. We mailed a scoping letter with a detailed purpose and need and proposed action description to 174 stakeholders including private landowners, agencies, organizations, and tribes. We also posted information on the Lincoln National Forest web site and published a news release in the Ruidoso News on February 15, 2011. We held a public open house at the Ruidoso Middle School on February 17, 2011, to provide project information and answer questions. As of January 2012, we received a total of 102 comment letters from you, the public—including agencies, organizations, individuals, and elected officials—in response to our request for input. Appendix A displays all those who provided comments prior to January 2012 and the completion of the DEIS, the consolidation of all these comments, and how these comments were addressed in the DEIS.

We released the North Fork Eagle Creek Wells Special Use Authorization Project Draft Environmental Impact Statement (DEIS) on May 25, 2012. The notification of its availability for public comment was published in the Federal Register, a legal notice was published in the Ruidoso News, and email and letter notifications were distributed to all those on the project mailing list. We requested comments by July 9, 2012. We received several requests for extensions to the comment period and Lincoln National Forest Supervisor Trujillo granted an additional 60-day extension, requesting all comments be submitted no later than September 9, 2012.

The Little Bear Fire started on June 4, 2012. Because of the substantial impact this wildfire had on the project area analyzed in the DEIS, Lincoln National Forest Supervisor Trujillo decided to stop the comment period on the DEIS and begin the process to prepare a supplemental DEIS that would address the changed conditions in the project area. This was published in the Federal Register on July 20, 2012. While we discontinued the formal comment period on the DEIS, we did invite any comments on the changed conditions in the project area by September 7, 2012. We also received comments on initial drafts of chapters 1 and 2 of this SDEIS from stakeholders and these comments were also considered in development of this document. Appendix B includes a summary of the comments that were received and how they were used in preparation of this SDEIS.

Significant Issues

Based on the content analysis process, we have identified five significant issues for the North Fork project. We used the significant issue measurement indicators described below to identify and compare differences in effects among alternatives in chapter 3. Where necessary, these have been updated since the DEIS to reflect changed conditions since the Little Bear Fire.

Water Resources

Well pumping results in changes in dynamics of groundwater (groundwater drawdown and water table) and surface water (streamflows, wetlands, springs, and seeps). Surface water and groundwater availability are linked and limited by accessible available quantities of water. Water resources over time can also be affected by climate change.

Measurement Indicators

Well pumping may affect the quantity and quality of streamflow, groundwater, wetlands, springs, and seeps. Effects of climate change may affect well pumping alternatives over time. Alternatives will be compared using the following indicators:

- **Streamflow Quantity**: Compare estimated durations of no surface flow conditions anticipated to occur at the Eagle Creek gage during a year of average precipitation. No-flow conditions are defined as anything less than 0.01 cubic feet per second in the stream at the gage.
- **Streamflow Quantity**: Compare estimated occurrence of flows equal to or greater than 1.2 cubic feet per second at the Eagle Creek gage during a year of average precipitation.
- **Springs and Seeps**: Identify springs and seeps that may be affected by pumping as those within the projected drawdown (see figure 7 and figure 8 in chapter 3).
- **Domestic Wells**: Identify domestic wells that may be affected by pumping as those within the projected drawdown (see figure 7 and figure 8 in chapter 3).
- **Success of the Alternatives Over Time Considering Climate Change**: This indicator involves a qualitative analysis without significance determination, based on a general review of the indicators above under possible climate change effects. Potential effects on water resources from climate changes may include reduced basin yield and recharge from changes in rainfall, reduced snowpack accumulation, and evapotranspiration; more frequent early season snowmelt; and reduced seasonal peak flows and/or shorter flow durations.

Aquatic Habitat and Fish

Well pumping results in changes in the water table which may affect streamflow to varying degrees. Lowering streamflow may increase temperatures and temperature related fish mortality. Quantity, quality, and waterflow availability that mirrors natural flow patterns are important for aquatic habitat and fish. Suitable water quality and temperatures, which are partially based on water depth and channel conditions, are necessary to support fish populations. Sufficient water supplies must also be available during summer months to provide water temperatures needed for survival of aquatic species.

Measurement Indicators

Well pumping may affect the quantity and quality of aquatic habitat; including temperature, (salmonids require summer water temperatures at or below 68 degrees Fahrenheit), and waterflow availability and seasonality (seasonal and year-long flows compared to expected flows without pumping). Alternatives will be compared using the water resource streamflow quantity indicator. While water quality, particularly related to temperature, is important for assessing impacts to fish, the former streamflow quality indicator that was used in the 2012 DEIS as part of the water resources analysis has been removed. This is because this indicator is not likely to apply either to short-term or long-term post-wildfire conditions, since the North Fork Eagle Creek channel will transport and re-work sediment and debris for a considerable number of years. This is described in more detail in the Water Resources Report (AECOM 2014). However, water quality will be used in a general sense to compare the alternatives in chapter 3 qualitatively.

Riparian Vegetation

Well pumping results in changes in the water table which may affect streamflow to varying degrees. These water quantity changes could indirectly affect quantity and quality of riparian vegetation along the stream corridor.

Measurement Indicators

Well pumping may affect riparian vegetation canopy cover, species composition, and overall riparian condition. Alternatives will be compared using the following indicators:

- **Canopy Cover**: Predicted qualitative shifts in canopy cover for trees over time, based on implementing each alternative.
- **Species Composition**: Predicted qualitative shifts in plant communities over time, based on implementing each alternative.

Socioeconomics

Effects on water available for diversion have potential to affect local social and economic conditions. Well pumping may result in changes in groundwater and surface water availability. Limiting access to groundwater pumping has potential to alter municipal water supply, affect streamside recreational use (public use of streams for streamside recreation, fishing, and wildlife viewing), and affect private land (availability of water for domestic wells).

Measurement Indicators

Well pumping may affect municipal and private land water available for diversion based on information presented in the water resources specialist report. Well pumping may also affect streamside recreational use based on potential effects to surface water used for recreation. Alternatives will be compared using the following indicators:

- **Municipal Water Supply**: Estimates of potential forgone water diversion from groundwater withdrawal limitations are used to measure the potential for change to historic North Fork well diversion. Effects of groundwater withdrawal limitations will be examined on historic North Fork well diversion (average annual), diversion for Alto Creek and Grindstone Reservoirs (average annual) and projected demands from the 40-year water plan. In addition, effects of groundwater withdrawal limitations will be examined on historic North Fork well diversion during the 5-month summer resort period (high demand on water use) from May to September.
- Av**ailability of Domestic Well Water and Water for Irrigation (private land water supply)**: Availability of domestic well water indicators will be used to measure potential for change to private land water supply using an estimate of water drawdown similar to the springs and seeps (as described in the “Water Resources” section earlier in this chapter).
- **Streamside Recreational Use:** Streamside recreational use indicators will be used to measure potential for change to quality of recreation experience from streamflow quantity, streamflow quality, and riparian vegetation associated with springs and seeps (as described in the “Water Resources” section earlier in this chapter).
- **Values, Beliefs and Attitudes**: Where economic or other effects on area communities cannot be quantified, a qualitative discussion of nonmarket and social values will be

used. Accordingly, values, beliefs, and attitudes of area communities are presented to address social considerations.

- **Environmental Justice**: Executive Order 12898, issued in 1994, orders federal agencies to identify and address environmental justice effects, which are any adverse human health and environmental effects of agency programs that disproportionately impact minority and low income populations.

Water Rights

Well pumping results in changes in dynamics of groundwater and surface water. Surface water and groundwater availability are linked and are limited not only by accessible available quantities of water, but also by available water rights. Limiting access to groundwater pumping has potential to alter municipal water supply and affect beneficial use of the Village of Ruidoso's total adjudicated water rights.

Measurement Indicators

Well pumping may affect available water rights and beneficial use of the Village of Ruidoso's total adjudicated water rights. Alternatives will be compared using the following indicator:

- Beneficial use of Village of Ruidoso's adjudicated water rights.

Nonsignificant Issues

Nonsignificant issues are sometimes important for understanding the full context of alternatives. Mitigation measures are generally used to mitigate these types of concerns which we will discuss in chapter 2. Unlike significant issues, these nonsignificant issues are not usually subject to detailed analysis, so these will be addressed more briefly in chapter 1 or chapter 3 of the SDEIS. We have identified the following six for the North Fork project:

Soil Quality

There is little potential for measurable effects to soil quality based on implementation of the alternatives. New ground disturbance is not proposed (except under the no pumping alternative); we have identified mitigation measures (chapter 2) that would be used to ensure any potential for effects are minimized. Therefore, soil quality will not be discussed in chapter 3.

Vegetation

Besides riparian vegetation (which is a significant issue), there is some potential for effect to other types of vegetation such as invasive plant occurrence, sensitive plants, and, to a limited extent, upland vegetation. The possible effect of conifer density on water yield in the drainage was also identified during scoping as a concern. This will be discussed briefly in chapter 3.

Wildlife

Besides aquatic habitat and fish (which is a significant issue), other types of wildlife such as federally listed and sensitive species, management indicator species, and migratory birds are discussed in chapter 3; these nonaquatic wildlife species are not significant to this project and are, therefore, only discussed briefly in chapter 3.

Cultural Resources

There is little potential for measurable effects to cultural resources based on implementation of the alternatives; archaeological surveys have been conducted in the project area and there are no known sites within the vicinity of the wells. Only minimal new ground disturbance is proposed under any of the alternatives and the impacts of this disturbance would be adequately minimized by implementation of mitigation measures as described in chapter 2. These measures would require that the forest archaeologist be notified before any ground-disturbing activities to ensure surveys are up to date and no protection measures are needed. Therefore, this project would not affect cultural resources, and cultural resources are not discussed in chapter 3.

Recreation and Scenery

Besides streamside recreational use (which is a significant issue) there are no other types of recreation or visual resources within or near the project area with potential to be affected by proposed actions due to the limited nature of effects from well pumping, as summarized below. Therefore, this project would not affect recreation and scenery and these topics are not discussed in chapter 3.

There are no wild and scenic rivers within or near the project area.

White Mountain Wilderness is approximately 2 miles from the project area upstream from the North Fork gage and would not be affected by implementation of alternatives downstream.

There are no inventoried roadless areas in or near the project area.

There are several streams in the White Mountain Wilderness designated in the State of New Mexico as Outstanding National Resource Waters (New Mexico Environment Department 2011) but these are all upstream from the project area and do not have potential to be affected by proposed actions.

There would be no changes in access (roads and trails) to or within the project area, including access for outfitter/guides or other special use permit holders.

The Eagle Creek Summer Home area occurs upstream of the North Fork Eagle Creek wells. Effects to this area are evaluated as part of domestic water supply under “Water Resources.”

North Fork Eagle Creek primarily provides opportunities for dispersed recreation; there are no developed recreation sites along the North Fork Eagle Creek between the North Fork gage and Eagle Creek gage; the nearest developed recreation site is Oak Grove Campground, greater than 1 mile from the North Fork Eagle Creek well field. Dispersed recreation, as defined in the forest plan, is recreation use that occurs outside of developed sites and requires few, if any, facilities other than roads and trails. In the project area, dispersed recreation activities primarily including hiking, backpacking, and camping. The only aspects of dispersed recreation with potential to be affected by the alternatives are streamside recreational use and fishing opportunities. Since these recreation aspects are discussed in other sections of chapter 3 (under “Aquatic Habitat and Fish” and “Socioeconomics”), dispersed recreation is not discussed further.

There are no active livestock grazing allotments in the project area, so grazing will not be addressed in chapter 3 of the SDEIS. However, depending on results of the water resources analysis and the possibility of effects to springs and seeps in the larger drainage, there is potential for a cumulative effect. Monitoring measures are identified for springs to determine if any effects are occurring; the likelihood is small as discussed in the “Water Resources” section of chapter 3.

Most of the project area is in the recreation opportunity spectrum class of roaded natural. Changes in pumping levels would not result in any changes to this recreation opportunity spectrum class and is consistent with management direction for Management Area 1I and this recreation opportunity spectrum class. The scenic integrity of project area is classified primarily as high with a high sensitivity level. These recreation and scenery classifications would not be directly or indirectly affected by North Fork Eagle Creek well pumping.

Public Safety and Well Security

Any potential effects to public safety and security of well facilities would be mitigated by following safety standards and requirements. Because it is the responsibility of the Village of Ruidoso to ensure safe and secure facilities, public safety and security will not be addressed in chapter 3. Each wellhead is secured and locked. As stated in the description of alternative 1 (no change) and alternative 3 (proposed action), the Village of Ruidoso may install security fencing around each well, if needed, and this would be captured in an operating plan that is a component of the permit.

Regulatory Framework and Consistency with Management Direction

Several important laws and policies form the regulatory framework applicable to managing the Lincoln National Forest. These include, but are not limited to, the: Endangered Species Act, National Historic Preservation Act, Clean Water Act, National Environmental Policy Act, National Forest Management Act, and various Executive Orders. Chapter 3 of this document (and in more detail in resource reports in the project record) identifies the regulatory framework that is applicable to each resource analysis.

NEPA at 40 CFR 1502.25(a) directs “to the fullest extent possible, agencies shall prepare draft environmental impact statements concurrently with and integrated with …other environmental review laws and executive orders.”

The proposed action is consistent with applicable management direction in laws, regulations, Forest Service manuals and handbooks, and the forest plan, as described in more detail below. No forest plan amendments are needed for this particular project. The forest plan is incorporated by reference and key sections applicable to this project are summarized below. Best management practices, other additional specific mitigating measures, and adaptive management options have been developed so that forest plan consistency can be assured.

Lincoln National Forest Land and Resource Management Plan (1986, as amended)

The mission of the Lincoln National Forest is to manage resources under multiple use and sustained yield principles in a way that maximizes long-term net public benefits consistent with resource integration, environmental quality, and management considerations (p. 11 of the forest plan).

The forest plan goals for water resource management on the Lincoln National Forest include (pp. 12-13 of the forest plan):

- Provide support to resource management activities with emphasis on maintaining water quality and quantity.
- Secure and provide an adequate supply of water for the protection and management of the forest; contribute to the forest's estimated 123,000 acre-feet per year (acre-feet per year) of water yield (p. 9 and p. 217 of the forest plan).
- Manage for a favorable flow of water for users by improving or maintaining all watersheds to a satisfactory or higher condition (the 2011 Watershed Condition Classification Technical Guide (USDA Forest Service 2011) would be used to determine satisfactory conditions).
- Manage riparian areas to provide optimum vegetation and ecological diversity (the 2011 Watershed Condition Classification Technical Guide (USDA Forest Service 2011) would be used to determine these conditions).

The project area occurs within forest plan management area 1I – Upper Ruidoso. This management area is managed primarily for recreation (p. 78 of the forest plan). There are no specific standards and guidelines for this management area that apply to special use permit authorizations or water resources. The project area is not within lands identified as base-in-exchange.

Standards and guidelines applicable to all management areas (p. 28 of the forest plan) relevant to this project include:

- Protect and enhance riparian habitat.
- Maintain and enhance fish habitat. Avoid causing disturbances to existing habitats.
- Update water rights inventory, maintain and protect existing water rights.
- Limit special use permits to only necessary public utilities on land identified as base-in-exchange.

Agency Direction

Forest Service Manual (FSM) directives for groundwater resource management include:

FSM 2500, Chapter 2530 – Water Resource Management

- Objectives include: (1) produce water of a quality suitable for the beneficial uses identified in the land and resource management planning process (FSM 1920) and (2) ensure safe drinking water subject to public use on national forests, whether the source is a natural or developed water supply (FSM 7420). Where State standards do not exist, observe Environmental Protection Agency (EPA) water quality criteria (FSM 2532.02).
- Include a water quality evaluation for all environmental analyses (FSM 1950). Identify the water quality implications of proposed and alternative land management practices (FSM 2532.03).

FSM 2500, Chapter 2540 – Water Uses and Development –

FSM 2541.04c Region 3 Supplement – National Forest System Water Rights – Forest Supervisors

- Maintain and update annually the forest's water uses, requirements, and rights inventory. Assure that wells and pipelines proposed by the Forest Service are evaluated with the same criteria established below for entities other than the Forest Service. A state water permit is not needed for water use under the reservation doctrine. All other Federal water uses, however, must be in compliance with applicable state law and pursuant to state-based water right or permit. Whether a water right is based on state or Federal law, water development by the Forest Service requires NEPA compliance.

FSM 2541.34 - Water Uses and Development – National Forest System Water Rights - Water Rights and Uses for Other Purposes

- Evaluate projected water requirements of uses of National Forest System lands for purposes such as hotels, power developments, and transmission lines not directly related to Forest Service programs. Assess environmental effects of the use before authorizing the use. If the projected water requirements conflict with existing or potential Forest Service uses and rights or will adversely affect national forest resources, the potential permittee must seek alternative water sources or develop mitigation plans acceptable to the Forest Service.

FSM 2541.35 Region 3 Supplement

- Groundwater beneath National Forest System lands in the region is a valuable resource that requires thoughtful and prudent management. Understanding ground and surface water interactions facilitates the protection of surface water rights. Where surface and groundwater are connected, groundwater discharge sustains base flows in National Forest System streams and is the source of water for springs and seeps. This groundwater discharge may be critical for sustaining aquatic and riparian ecosystems along with the numerous resources and activities dependent upon them. Data describing ground and surface water interactions are valuable information for State agencies to have as they fulfill their responsibilities for the administration of water rights (FSM 2541.35).
- If water supplies in sufficient quantities to meet the Village of Ruidoso's needs are located in existing wells or found through exploration, a detailed plan to determine impacts should be required. This plan will be site specific and designed to identify potential impacts to forest resources and neighboring water supplies, and must be approved by the Forest Service before testing for impacts.
- In considering requests to use water from a known aquifer underlying National Forest System lands, modeling drawdown and resultant impacts may be sufficient provided that there is adequate information available regarding key aquifer parameters such as transmissivity, storativity (capacity), recharge rate, saturated thickness, etc. Modeling shall be conducted using a groundwater flow model approved by the Forest Service in consultation with the appropriate state agencies. In the absence of sufficient information to model impacts, an aquifer test such as long-term pumping of existing and/or exploratory well(s) may be required. The purpose of the test is to evaluate the potential impacts of removing water at production levels from the well(s) under consideration. As testing occurs, there should be simultaneous measurements of water levels and/or

pressures in other wells within the vicinity and of flows in adjacent surface waters. Any aquifer test(s) should be conducted during periods of appropriate flows in adjacent surface waters so that impacts can be identified and used to support modeling of drawdown characteristics and/or impacts to surface water resources over time. Chemical characterization may be necessary to further evaluate the potential connection between ground and surface water sources. If the proposal involves the transport of groundwater pumped from nearby non-National Forest System lands across National Forest System lands, the above testing may still be required to evaluate impacts of the groundwater withdrawal (40 CFR § 1508.25 Scope, 40 CFR § 1508.7 Cumulative impact). Note that in the analysis of impacts, the state may play a pivotal role in the determination of impact based on state law and priority dates. For example, the state may find that a negative impact to a junior appropriator is acceptable to meet the needs of a senior water rights holder. In the documentation and decision process, consider the statement in 40 CFR § 1508.14 Human environment: "economic or social effects are not intended by themselves to require preparation of an environmental impact statement" (Sec. 3(b)).

- All monitoring or mitigation measures necessary to ensure protection of forest resources during the construction of water pumping, storage, or transport facilities, and during the long-term removal of groundwater should be included in annual plans of operation attached to and made a part of the permit(s). Mitigation measures such as not pumping during critical times of the year or returning water to streams and springs will be considered only if they have been granted all applicable state authorizations and if forest resources can be protected over a long-term period.
    - The holder should be required to bear the costs of monitoring and mitigation either directly through permit language or indirectly through the use of a collection agreement that funds the Forest Service to accomplish the work.
    - If long-term monitoring detects additional or unforeseen adverse impacts to forest resources, or if mitigation measures do not adequately protect forest resources, the permit shall be suspended or revoked as appropriate (36 CFR § 251.60 (a)(2)(D)). To reverse or prevent a suspension, the holder shall undertake such efforts as are necessary to eliminate adverse impacts (sec. 5).
    - Applicable laws and regulations governing wells and water rights shall be adhered to for all proposals. This includes state requirements for notifications, drilling permits, well abandonment procedures, and water rights; and Federal (for example, Environmental Protection Agency) requirements and recommendations for monitoring wells, construction, sampling, and abandonment.
- In the event that testing, modeling, or monitoring indicates a possibility that appropriable waters are or may be impacted, the Forest Service shall follow the procedures appropriate for the state(s) in which the development is located. If an appropriate state remedy is not available, the Forest Service may seek remedy in any court of jurisdiction. The Forest Service shall not issue a permit for construction or issue/reissue a permit for production unless the applicable state authorization has been granted for the proposed development. In the event that a state withholds authorization for a water development proposed by the Forest Service, the requesting Forest Service official is advised to consult with the Office of General Counsel. Permits issued by the Forest Service for exploration, evaluation, construction, and/or production do not convey a water right to the holder (sec. 6).

FSM and Forest Service Handbook (FSH) directives for special use permitting include:

FSH 2709.11, 52.3 – Special Uses – Standard Forms and Supplemental Clauses

- C-8. Operating Plan. The holder shall provide an operating plan [optional - and revise the plan every (year(s)/month(s)]. The plan shall be prepared in consultation with the authorized officer or designated representative and cover operation and maintenance of facilities, dates or season of operations, and other information required by the authorized officer to manage and evaluate the occupation and/or use of National Forest System lands. The provisions of the operating plan and the annual revisions shall become a part of this authorization and shall be submitted by the holder and approved by the authorized officer or their designated representative(s). This operating plan is hereby made a part of the authorization.

FSM 2716.12 - Special Use Authorizations - Review before Reissuance

- Before approving the issuance of a new special use permit for an established use, an analysis of the conditions of the use shall be made to determine whether changes in permit conditions are needed. Every opportunity should be taken to correct deficiencies and bring older facilities and permit areas up to standard. New requirements must be reasonable and defensible. To ensure an orderly and planned accomplishment of objectives, a schedule of completion dates shall be made a part of the permit.
- When an existing use is no longer desirable, or when the area is needed for uses of higher priority, the permittee should be given written notice that a request for a new permit will not be approved if the improvements are transferred. This notice will allow the permittee to make the most satisfactory arrangements possible, and is to be given at the earliest possible date.

FSM 2800, Chapter 2880 – Geologic Resources, Hazards and Services

- In analyzing land management activities, consider: (1) location, function, and value of groundwater-dependent resources; (2) value of groundwater-dependent vegetation to provide fish and wildlife habitat, control sediment, and maintain stream temperatures and stream channel stability; (3) groundwater recharge and discharge areas and effluent and influent stream channel conditions; (4) water quality and deposition or buffering of potential water pollutants; (5) fluctuations in groundwater levels, discharge quantities, and timing of flow; and (6) cumulative effects of management activities on groundwater resources (FSM 2881.2).
- The objectives of geologic resources activities are to protect, manage, and improve groundwater and groundwater-dependent ecosystems, recognizing their unique values, while implementing land management activities (FSM 2882.02).
- Manage groundwater dependent ecosystems in relation to legal mandates, including but not limited to those associated with flood plains, wetlands, water quality, dredge and fill material, endangered species, and cultural resources (FSM 2882.03).

Title 36, Code of Federal Regulations, Part 251, Subpart B, Special Uses

Section 251.50 - Scope

- All uses of National Forest System lands, improvements, and resources, except those authorized by the regulations governing sharing use of roads (§212.9); grazing and livestock use (part 222); the sale and disposal of timber and special forest products, such as greens, mushrooms, and medicinal plants (part 223); and minerals (part 228) are designated “special uses.” Before conducting a special use, individuals or entities must submit a proposal to the authorized officer and must obtain a special use authorization from the authorized officer, unless that requirement is waived….

Section 251.51 – Definitions

- Permit—a special use authorization which provides permission, without conveying an interest in land, to occupy and use National Forest System land or facilities for specified purposes, and which is both revocable and terminable.

§251.54 Proposal and application requirements and procedures.

- Pre-application actions—(1) Initial screening. Upon receipt of a request for any proposed use other than for noncommercial group use, the authorized officer shall screen the proposal to ensure that the use meets the following minimum requirements applicable to all special uses: (i) The proposed use is consistent with the laws, regulations, orders, and policies establishing or governing National Forest System lands, with other applicable Federal law, and with applicable State and local health and sanitation laws. (ii) The proposed use is consistent or can be made consistent with standards and guidelines in the applicable forest land and resource management plan prepared under the National Forest Management Act and 36 CFR part 219. (iii) The proposed use will not pose a serious or substantial risk to public health or safety. (iv) The proposed use will not create an exclusive or perpetual right of use or occupancy. (v) The proposed use will not unreasonably conflict or interfere with administrative use by the Forest Service, other scheduled or authorized existing uses of the National Forest System, or use of adjacent non-National Forest System lands. (vi) The proponent does not have any delinquent debt owed to the Forest Service under terms and conditions of a prior or existing authorization, unless such debt results from a decision on an administrative appeal or from a fee review and the proponent is current with the payment schedule. (vii) The proposed use does not involve gambling or providing of sexually oriented commercial services, even if permitted under State law. (viii) The proposed use does not involve military or paramilitary training or exercises by private organizations or individuals, unless such training or exercises are federally funded. (ix) The proposed use does not involve disposal of solid waste or disposal of radioactive or other hazardous substances.

Section 251.61 Applications for new, changed, or additional uses or area

- Holders shall file a new or amended application for authorization of any new, changed, or additional uses or area, including any changes that involve any activity that has an impact on the environment, other uses, or the public. In approving or denying new, changed, or additional uses or area, the authorized officer shall consider, at a minimum, the findings or recommendations of other affected agencies and whether to revise the terms and conditions of the existing authorization or issue a new authorization. Once approved, any new, changed, or additional uses or area must be reflected in the existing or a new authorization.

Section 251.64 - Renewals

- When a special use authorization provides for renewal, the authorized officer shall renew it where such renewal is authorized by law, if the project or facility is still being used for the purpose(s) previously authorized and is being operated and maintained in accordance with all the provisions of the authorization. In making such renewal, the authorized officer may modify the terms, conditions, and special stipulations to reflect any new requirements imposed by current Federal and state land use plans, laws, regulations or other management decisions. Special uses may be reauthorized upon expiration so long as such use remains consistent with the decision that approved the expiring special use or group of uses. If significant new information or circumstances have developed, appropriate environmental analysis must accompany the decision to reauthorize the special use.

- When a special use authorization does not provide for renewal, it is discretionary with the authorized officer, upon request from the holder and prior to its expiration, whether or not the authorization shall be renewed. A renewal pursuant to this section shall comply with the same provisions contained in the paragraph above.

Chapter 2. Alternatives, Including the Proposed Action

Introduction

This chapter describes and compares alternatives considered for the North Fork project, and includes updates made since we released the DEIS for public comment and the Little Bear Fire occurred. It includes a description of each alternative considered in detail, as well as those alternatives that were initially considered but not developed for further analysis. Alternatives considered in detail are compared based on alternative components, measurement indicators, and how well they achieve the purpose and need for action and address the significant issues. A summary table of the environmental effects of each alternative is included at the end of this chapter.

Alternatives Analyzed in Detail

The USDA Forest Service developed three alternatives for detailed analysis, considering public comments, USDA Forest Service direction, internal scoping, and changed conditions resulting from the Little Bear Fire. These include a 'no change' alternative that would continue pumping at historic levels with no change in current management, a 'no action' alternative that would discontinue pumping, and the proposed action alternative. The no action alternative sets the baseline against which the effects of pumping are compared. A no action alternative is required in an EIS (40 CFR 1502.14(c)).

Alternative 1 - No Change - Continue Pumping at Historic Levels

Alternative 1 is the Village of Ruidoso's proposal as reflected in their request for a new special use permit. It reflects continued pumping from the North Fork well field, with no new restrictions, a continuation of current management, reflected under a new special use permit.

The USDA Forest Service would authorize, under a new special use permit, the operation and maintenance of four municipal supply water wells (three equipped and one unequipped) and associated monitoring wells; well house control station; underground pipeline and power line; and road access located in the North Fork Eagle Creek drainage on National Forest System land. The new permit would be authorized for up to 20 years, with stipulations for frequent reviews and verification of the permit terms and conditions. These could occur as often as every year but would occur at least every 5 to 10 years. The permit term would be shortened if necessary, based on the results of these more frequent reviews and verifications of permit terms and conditions.

The existing municipal water supply system is composed of these four wells (three equipped and one unequipped) and the following associated facilities and structures which were, except for the monitoring wells, previously approved by the USDA Forest Service and constructed and installed in 1985-1986:

- Approximately 1.4 miles of 14-inch diameter underground ductile iron pipeline
- One cinder block pump control house (6 foot by 8 foot)
- Approximately 1.3 miles of underground electric power cable
- Four alluvial monitoring wells (MW-1A, MW-2A, MW-3A, and MW-5A) and one nested bedrock monitoring well (MW-1B and MW-1C) which were previously installed

by the U.S. Geological Survey along the North Fork in the area of the North Fork well field to measure groundwater (figure 2).

The Village of Ruidoso would conduct periodic routine repair/maintenance to these structures as needed. Prior to any maintenance or repair, the Village of Ruidoso would contact us for approval and scheduling prior to performing the work. For this analysis, it is assumed that any ground disturbance necessary for anticipated maintenance or repair of the pipeline, control house, well, monitoring wells, or underground electric cable would be minimal. Prior review and approval of any maintenance or repair activities would ensure any needed mitigations would be applied to minimize any potential for adverse impacts due to ground disturbance or noise (see "Mitigation Measures" section later in this chapter).

The Village of Ruidoso would also maintain National Forest System Road 127A from State Road 532 to the North Fork well sites. Any maintenance activities performed by the Village (including the low water crossing of National Forest System Road 127A across North Fork Eagle Creek) would only occur following review and approval by the Forest Service. Security fencing may be installed around each wellhead; the Village of Ruidoso would contact the Forest Service for approval and scheduling prior to this work being performed to ensure that any needed mitigations would be applied to minimize any potential for adverse impacts due to this ground disturbance or noise (see "Mitigation Measures" section later in this chapter).

We would issue a new permit with no change in existing well pumping operations. This means that pumping would continue at historic levels[1] with no new restrictions on use, in accordance with the Village of Ruidoso's water rights. The new permit would be issued with similar terms, conditions, and history of water use that has been in operation since 1988, as described below. While the terms and conditions of the permit would be similar to the expired permit, the new permit would adhere to the most current special use permit templates.

Water use would likely average approximately 740 acre feet per year, with highest use between March and September (ranging from a combined total of 60 to 117 acre feet per month); between 2002 and 2010, use averaged 569 acre-feet per year and ranged between 433 and 807 acre-feet per year. As discussed in the "Background" section of chapter 1 and in more detail in the "Socioeconomics" and "Water Rights" sections of chapter 3, from 2001 to 2006, the Village of Ruidoso obtained approximately 31 percent of its water supply from the North Fork well field. Based on recent information from the Village of Ruidoso, 46 to 75 percent of its water supply can be attributed to North Fork Eagle Creek well diversions (Village of Ruidoso 2012). In 2010, this was estimated at 77 percent (Atkins Engineering Associates, Inc. 2014).

As part of the special use permit, the authorization would include an annual operating plan that the Village of Ruidoso would prepare in consultation with us. We would require the Village of Ruidoso to prepare monthly reports, with electronic reports in spreadsheet format, with the following information:

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[1] These estimates of historic water use are based on the best available information at the time of preparation of this document. We recognize that the applicant has instituted some changes in the way in which the North Fork well field is managed in conjunction with its Eagle Creek surface diversion and its water rights from the Rio Ruidoso due to the changes caused by Little Bear Fire. We recognize that these recent management adjustments are not typical and that the applicant anticipates resumption of pumping levels from the North Fork well field in a period of years when the effects of the Little Bear Fire are reduced (Atkins Engineering Associates, Inc. 2014).

- **Well Static/Pumping Water Levels**: Water levels (static and pumping) would be collected at least once a month from the following wells within and upstream of the project area: MW-1A, B, C; MW-2A; MW-3A; and MW-5A (see figure 7 and figure 8, chapter 3). Where possible, data would be collected electronically via transducers and data loggers that would provide daily measurements.
- **Well Pumping Reports**: Daily pumping quantities of water from each of the North Fork wells would be reported in gallons per minute (summarized for the month).

The Village of Ruidoso would be responsible for daily operations, facilities and road maintenance (National Forest System Road 127A maintenance is the responsibility of the Village of Ruidoso from NM 532 to the gate below the summer homes) and coordinating with us on maintenance/repair projects or data collection activities.

The Village of Ruidoso would be required to notify us if they implement stage 5 water restrictions (stringent water conservation measures). This would prompt a joint Forest Service and Village of Ruidoso review of the annual operation plan and development of an agreement to temporarily modify well pumping if needed to address a critical water situation.

While alternative 1 (no change) is essentially continuing the Village of Ruidoso's current well operations, it does include added mitigation and monitoring measures that are not currently being conducted as part of the Village of Ruidoso's annual operating plan. These would not constitute new restrictions on water availability and use but would provide necessary protections related to ground disturbance activities for wildlife and water quality and improved monitoring information. These measures would become part of a new annual operating plan under this alternative and are described under the "Mitigation Measures" and "Monitoring" headings later in this section. With these added mitigations and monitoring, alternative 1 (no change) addresses some aspects of the purpose and need and the significant issues, as shown in the analysis in chapter 3 (and summarized in table 2 and table 3).

An implementation plan (with schedule, tasks, responsible parties, reporting requirements, quality control measures and costs) would also be developed.

Alternative 2 – No Action (No Pumping) - Discontinue All Pumping

The USDA Forest Service would deny a new permit for the Village of Ruidoso's North Fork well operations and maintenance. Using these four municipal water supply wells and associated monitoring wells; well house control station; underground pipeline and power line; and road access located on National Forest System land would not be authorized and would be discontinued, except those identified for future monitoring. These wells and associated facilities would be removed from service and from National Forest System lands within approximately 6–12 months of notifying the Village of Ruidoso their permit would not be reissued. National Forest System road 127A would no longer be maintained by the Village of Ruidoso.

If this alternative were selected, the Village of Ruidoso would have the option to file an application with the Office of the State Engineer to transfer the point of diversion of their water rights to location(s) off National Forest System land, as described in the "Water Rights" section of chapter 3. The Village of Ruidoso would no longer be able to access and put to beneficial use their adjudicated water rights at this current location, and would be required to move them, subject to approval by the Office of the State Engineer.

While this is outside the scope of this analysis, we anticipate that the existing North Fork stream gage would be removed at some point in the future if this alternative were selected, but the Eagle Creek and South Fork Eagle Creek gages may remain in place for future monitoring. These gages are the property of the U.S. Geological Survey and this would be a decision they would make if their use were no longer needed.

If the gages remain and if funding were provided through the U.S. Geological Survey or other parties, surface water monitoring may continue at the existing Eagle Creek below South Fork gage (U.S. Geological Survey 08387600), even if pumping were no longer authorized. Water levels may be monitored at selected locations in or near the well downstream of the existing well field in the vicinity of MW-5. Recording devices or methods, measurement frequencies, and reporting provisions would be determined and implemented cooperatively between the USDA Forest Service and the U.S. Geological Survey.

Alternative 2 (no pumping) includes some additional mitigation and monitoring measures as described in the “Mitigation Measures” and “Monitoring” sections later in this section. Alternative 2 (no pumping) addresses some aspects of the purpose and need and the significant issues, as shown in the analysis in chapter 3 (and summarized in table 2 and table 3). The Village of Ruidoso would not be responsible for any aspects of stream gage- or monitoring well-operation or maintenance or any mitigation or monitoring measures if this alternative were selected.

Alternative 3 - Proposed Action - Adaptive Management

This alternative was developed to address the purpose and need for action and management objectives and provides a balance between providing municipal water to the Village of Ruidoso while also ensuring maintenance or improvement of water-dependent resources. It incorporates revisions necessary to reflect the changed conditions in the project area from the Little Bear Fire.

The Forest Service would authorize, under a new special use permit, the operation of four municipal supply water wells (three equipped and one unequipped) and associated monitoring wells; well house control station; underground pipeline and power line; and road access located in the North Fork Eagle Creek drainage on National Forest System land. The new permit would be authorized for up to 20 years, with stipulations for frequent reviews and verification of the permit terms and conditions. These could occur as often as every year but would occur at least every 5 to 10 years. The permit term would be shortened if necessary, based on the results of these more frequent reviews and verifications of permit terms and conditions.

All existing associated facilities (underground pipeline, power line, well control house and monitoring wells) that are described for alternative 1 (no change) would also be approved as part of the permit under alternative 3 (proposed action). As stated for alternative 1 (no change), the Village of Ruidoso would conduct periodic routine repair/maintenance to these structures as needed. Prior to any maintenance or repair, the Village of Ruidoso would contact us for approval and scheduling prior to performing any work. For this analysis, it is assumed that any ground disturbance necessary for anticipated maintenance or repair of the pipeline, control house, well, monitoring wells, or underground electric cable would be minimal. Prior review and approval of any maintenance or repair activities would ensure any needed mitigations would be applied to minimize any potential for adverse impacts due to ground disturbance or noise (see “Mitigation Measures” section later in this chapter).

Security fencing may be installed around each wellhead; the Village of Ruidoso would contact the Forest Service for approval and scheduling prior to this work being performed to ensure that any needed mitigations would be applied to minimize any potential for adverse impacts due to this ground disturbance or noise (see “Mitigation Measures” section later in this chapter).

As under alternative 1 (no change), the Village of Ruidoso would also maintain National Forest System Road 127A from State Road 532 to the North Fork well sites, following review and approval by the Forest Service prior to performing any maintenance work, including the low water crossing of National Forest System Road 127A across North Fork Eagle Creek.

The new permit would include an annual operating plan that would reflect current adaptive management strategies which both respond to the purpose and need for action, and mitigate potential adverse impacts to surface water and groundwater resources from well operations. Water use would equal approximately 900 cumulative acre feet or less over any 3 consecutive water years (300 acre-feet per year or less). This could vary based on monitoring results of the adaptive management triggers described in more detail below. This water use threshold would be implemented as a starting point only and could be adjusted (up or down), depending on the results of monitoring.

The Village of Ruidoso would prepare an annual operating plan in consultation with us. We would require the Village of Ruidoso to prepare monthly reports, electronic reports in spreadsheet format, with the following information:

- **Well Static/Pumping Water Levels**: Water levels (static and pumping) would be collected at least once a month from the following wells within and upstream of the project area: MW-1A, B, C; MW-2A; MW-3A; and MW-5A (see figure 3). Where possible, data would be collected electronically via transducers and data loggers that would provide daily measurements.
- **Well Pumping Reports**: Daily pumping quantities of water from each of the North Fork wells would be reported in gallons per minute (summarized for the month).

The Village of Ruidoso would be responsible for costs associated with the adaptive management strategy and monitoring, daily operations, facilities, and road maintenance (National Forest System Road 127A maintenance is the responsibility of the Village of Ruidoso from NM 532 to the gate below the summer homes), and coordinating with us on maintenance/repair projects or data collection activities. The Village of Ruidoso would be required to notify us if they implement stage 5 water restrictions (stringent water conservation measures). This would prompt a joint Forest Service and Village of Ruidoso review of the annual operation plan and development of an agreement to temporarily modify well pumping if needed to address a critical water situation.

The adaptive management strategy would take into consideration the dynamic nature of groundwater systems by establishing a feedback process to guide management of groundwater withdrawal rates over time. The North Fork Eagle Creek basin is characterized as highly transmissive - (water moves through it easily); yet with a relatively low groundwater storage capacity. These two characteristics make it sensitive to variations in precipitation patterns and intensity.

An implementation plan (with schedule, tasks, responsible parties, reporting requirements, quality control measures, and costs) would also be developed.

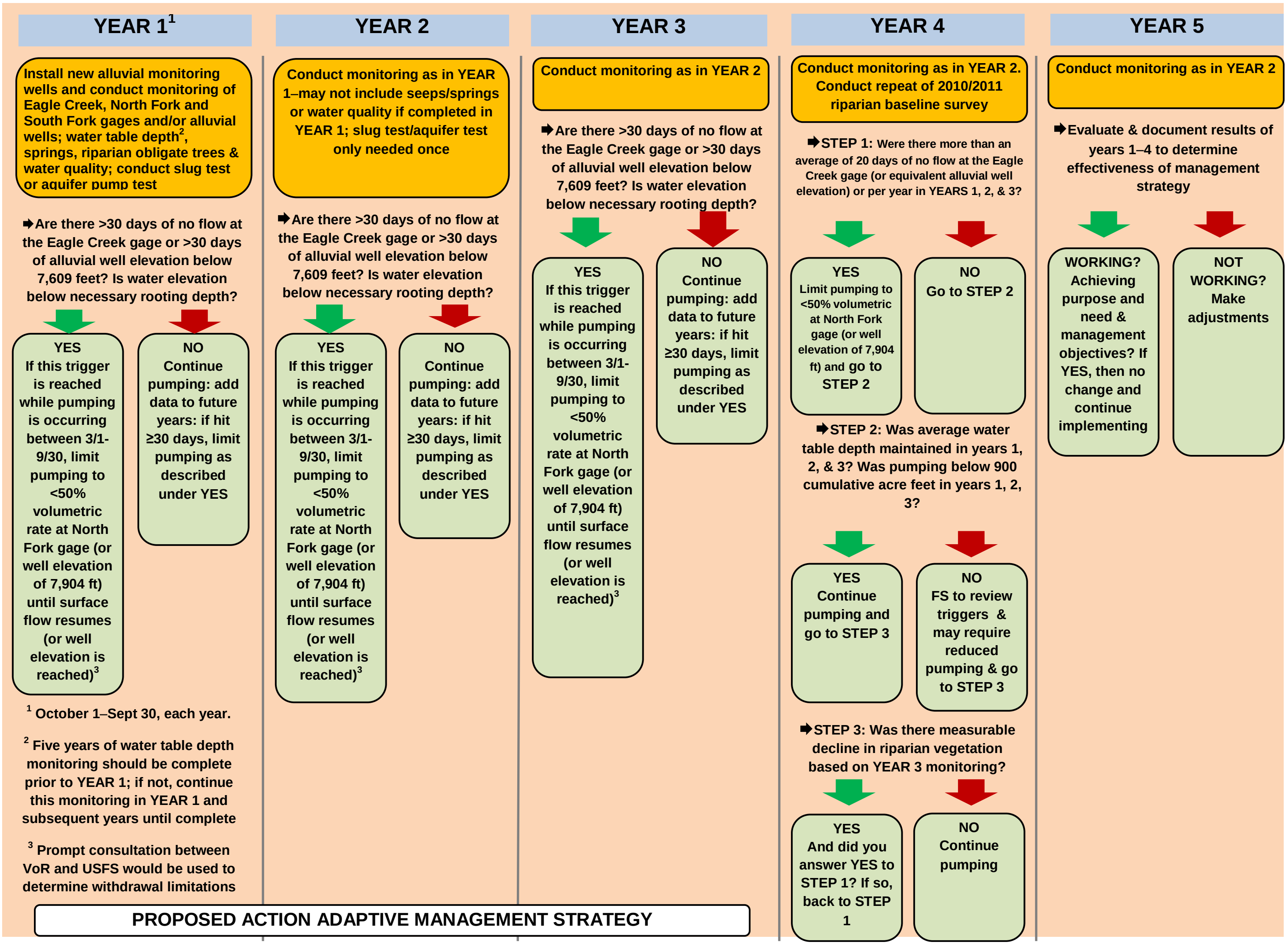

Figure 3. Flowchart of proposed adaptive management strategy

Thresholds would be established for streamflow and alluvial water depth, water table depths, and riparian vegetation as described below. Exceeding these thresholds would trigger implementation of adaptive management strategies to mitigate the impact to surface resources (figure 3). If thresholds are not exceeded, there would be no restrictions on pumping. Adaptive management strategies currently under consideration, if thresholds are exceeded, include limitations on groundwater withdrawal rates and cessation of pumping for short periods. In addition, a threshold would be established for the total volume of water withdrawn from the Village of Ruidoso's wells over a consecutive 3-year period, where exceeding the threshold would trigger a review of the other thresholds and mitigations to prevent degradation of surface resources.

The proposed action would require the Village of Ruidoso and USDA Forest Service to work in partnership, with assistance from the U.S. Geological Survey, if possible, to conduct monitoring and adaptive management of groundwater and surface water resources. Generally, direct costs associated with adaptive management and monitoring would be the responsibility of the Village of Ruidoso. Four key adaptive management triggers (monitoring thresholds) would be used, as described below, to evaluate effectiveness of this management strategy. This adaptive management strategy would be incorporated into the operating plan for the permit.

Adaptive Management Triggers (Monitoring Indicators)

Trigger #1 - North Fork Surface Flow Volume and Alluvial Water Depth

This trigger would act as an indicator of surface and subsurface flows necessary to maintain or improve existing riparian and aquatic ecosystems along the North Fork Eagle Creek below the existing well field. The Village of Ruidoso would be responsible for continued collection of alluvial water depth measurements collected at new wells located at the Eagle Creek gage (U.S. Geological Survey 08387600) and the North Fork gage (U.S. Geological Survey 08387550), at existing or rehabilitated monitoring wells at the MW-1A and MW-5A well locations along the North Fork Eagle, and existing pumping wells. The Eagle Creek stream gage, located just below the confluence of the North Fork and South Fork tributaries, records surface flow volume rates (quantities) in cubic feet per second. These data are currently collected and stored by the U.S. Geological Survey, and available to the USDA Forest Service and public on the U.S. Geological Survey water data web site (http://waterdata.usgs.gov/nwis).

Because these data may no longer be reliable due to the Little Bear Fire and subsequent debris loading in the Eagle Creek drainage, this adaptive management trigger would use these Eagle Creek gage streamflow data (if deemed available and reliable), in conjunction with water depth measurements from monitoring wells along North Fork Eagle Creek including new monitoring wells to be located at the North Fork and Eagle Creek stream gages. Common elevation datums and transects would be established by surveys and permanently located in the field at the North Fork gage and its new monitoring well, at MW-1A and MW-5A, and at the Eagle Creek gage and its new monitoring well. These surveys would relate historic and current streamgage stages to benchmark water levels in monitoring wells and to elevations of the streambed and banks. If stream gage data are deemed unavailable or unreliable, water level data from alluvial monitoring wells would be used instead as adaptive management benchmarks. Flows and/or water levels in wells would be monitored on at least a daily basis, and transformed at least monthly into elevations based on a common established datum.

If there are more than 20 days per year of no surface flow (less than 0.01 cubic feet per second or an equivalent monitoring well elevation) over a period of 3 consecutive water years at the Eagle

Creek gage, or more than 30 no-flow days within any single water year (October 1–September 30), the Village of Ruidoso would reduce groundwater withdrawal rates from pumping wells. Based on recent pre-wildfire streamgaging data, this flow trigger (0.01 cubic feet per second) has historically corresponded to an equivalent water surface elevation of 7,609.0 feet at the Eagle Creek gage. (This value is accurate to approximately 0.2 feet.)

If either of these adaptive management triggers (streamflow or water level thresholds) is activated while pumping is occurring between March 1 and September 30, then groundwater withdrawals from the North Fork pumping wells would be limited. Prompt consultation between appropriate Village of Ruidoso and USDA Forest Service staff would be required and the conclusive results of this consultation would determine groundwater withdrawal limitations. Groundwater withdrawals would be limited to 50 percent of the volumetric rate of surface flow at the North Fork gage (or a monitoring well elevation of 7,904 feet at the North Fork gage upstream from the pumping wells) until: 1) surface flow at the Eagle Creek gage resumes, or 2) the water level elevation in a new monitoring well at the current Eagle Creek gage location reaches at least 7,609 feet; or 3) other criteria determined by the USDA Forest Service staff at the time of consultation on this trigger are met.

The following parameters and assumptions form the basis on which the North Fork Eagle Creek surface flow and alluvial water depth trigger would be modeled and managed:

- Using a 3-year running average allows for natural fluctuations in precipitation and snowmelt runoff, and periodic short-term drought cycles, considering historic trends.
- The 3-year threshold of 20 no-flow days is equal to about half the average number of no-flow days experienced since pumping began (1988-2011), and should result in an improved trend in surface flows and moisture regimes in the North Fork tributary and its associated riparian area. The number of no-flow days and alluvial water depth measurements would be evaluated based on real time daily recordings from the Eagle Creek stream gage (if deemed reliable and available) in conjunction with a new monitoring well near the Eagle Creek with daily measurements taken.
- If we identify additional criteria for groundwater withdrawals in response to trigger activation and required consultation, the criteria would be documented in writing and distributed appropriately. Such criteria may be provisional if needed, and could be based on pumping volumes, durations, or other monitored parameters. There are naturally-occurring monthly, seasonal, and annual variations in precipitation, evapotranspiration, runoff, and groundwater recharge. Eagle Creek watershed characterizations have been based on historical data. Contrasting dry, average, or wet periods exist in these historic data. Similar natural moisture swings will occur in the future. Also, the long-term regional climate may change, creating local effects. Therefore, flexibility in the adaptive management response to flow or water level triggers is needed. Monitoring and mitigation measures are recommended for the purpose of enhancing multiple-resource management in the project area. In particular, using information gathered from monitored snowpack, precipitation, and water levels would allow site-specific responses to adaptive management triggers to be tailored to existing conditions, forecasted or reasonably expected conditions, or other considerations.
- We recognize that the Eagle Creek stream gage includes flow contributions from the South Fork tributary. For consistency with data gathered since 1969, the Eagle Creek stream gage location would continue to be used, assuming there are no measurable

changes in human development or water use within the North or South Fork drainages. The South Fork and North Fork stream gages or the new monitoring well located at the North Fork gage location (U.S. Geological Survey 083875550) would also continue to be used in long-term monitoring, but have insufficient historical data to initially be used as an effective trigger. Additional surveying and monitoring will allow these locations to be incorporated into the adaptive management framework. The relationship between the current Eagle Creek gage location and its previous location is discussed in more detail in the water resources section of chapter 3.

- Alluvial water level elevation triggers in new monitoring wells at the current Eagle Creek and North Fork gage locations (U.S. Geological Survey 08387600 and 08387550, respectively) are based on historical elevations for the 0.01 cubic feet per second ("no flow") condition at those sites. As of October 2012, post-wildfire streambed surface elevations at the North Fork gage are approximately 3 feet higher than the pre-wildfire condition, and substantial channel disturbance also has occurred at the Eagle Creek gage due to sediment accumulation and site repair.
- An initial survey traverse with appropriate closure would be conducted at the start of the monitoring program to correlate channel and bank elevations, gage datums and stages, and monitoring well water level elevations between the North Fork gage location (U.S. Geological Survey 08387550), all monitoring wells, and the Eagle Creek gage location (U.S. Geological Survey 08387600). Cross-sectional elevation surveys would be conducted annually at the permanently-located transects (at the North Fork gage, MW-1A, MW-5A, and the Eagle Creek gage locations) to identify ongoing modifications in streambed and bank levels and locations.

This trigger is different than that described in the DEIS and incorporates modifications as a result of the anticipated changes in the project area along the North Fork Eagle Creek following the Little Bear Fire. Even as hillslope conditions eventually restore to reasonably stable post-Little Bear Fire conditions, a substantial amount of deposited sediment and debris is expected to move through the drainage system for decades. This will modify channel and bank conditions, streamflow occurrence and water levels, and gaging conditions. By tying adaptive management streamflow triggers to water level elevations, and by connecting monitoring locations to established elevation benchmarks, these flows, water levels and alluvial conditions can be more successfully tracked over time.

Trigger #2 - Water Table Depth

This trigger would provide a continuous indicator of the status of groundwater storage along the North Fork Eagle Creek. The Village of Ruidoso would continue to maintain monitoring well MW-1B and other selected wells in or near the North Fork Eagle Creek well field, using them to retrieve daily data on water table levels. Data for pumping rates from individual pumping wells would also be retrieved. Water table depth data (feet below ground surface) have been collected by U.S. Geological Survey and stored in the acre-feet database. These data and the values additionally collected would be continuously reported to the Forest Service and public on a water data web site maintained by the Village of Ruidoso as real time and historic daily averages. The U.S. Geological Survey water data Web site or a database maintained by the New Mexico Office of the State Engineer may be used for these reporting purposes, pending an agreement with either agency. The reporting frequency (e.g., daily or weekly) would be determined through further interactions between the USDA Forest Service, the Village of Ruidoso, and other interested parties.

Using the sum of all monitoring data collected prior to implementation (2 years of data collected by U.S. Geological Survey during their study plus the data collected by the Forest Service during the EIS process, estimated at approximately 5 years of data), the Forest Service would evaluate these data to establish an adaptive management trigger (threshold) for average or median water table depth. For example, if the water level in monitoring well MW-1B declines to more than 75 feet below ground surface, then pumping shall cease until the water level recovers to 65 feet below ground surface. The water table depth threshold may be established on an annual or seasonal basis (e.g. growing season, or spring, summer and fall), and would be based on interpretation of data representing periods of no pumping and pumping. If selected, the seasonal orientation would consider water table fluctuations under conditions of snow accumulation, snowmelt, low precipitation, and monsoonal moisture. Upon data collection and interpretations, individual thresholds may be established for different wells monitored at different locations along the North Fork Eagle Creek. To avoid extreme conditions, 10 percent of the values would be trimmed from both the highest and lowest portions of the dataset(s).

The Village of Ruidoso would be required to maintain a corresponding average water table depth that is equal to or above these thresholds over 3 consecutive water years. If groundwater pumping of North Fork wells results in a declining trend in the average water table depths over any 3-year period, the Village of Ruidoso would reduce diversions from the wells until the average water table depth is reestablished and the Forest Service determines that pumping may resume without creating further departures over a 3-year period.

In addition, the unnamed spring on the right bank of the North Fork upstream from the North Fork gage (UTM coordinates of 430344.177, 3697589.137 meters) would be monitored monthly for continued flow. Water chemistry at this spring would be characterized to ascertain its source (e.g., deep bedrock). After at least two years of monthly monitoring, changes or cessation of flow rates at this spring would be used to further inform potential adaptive management actions.

Trigger #3 - Riparian Vegetation

This trigger would provide an indicator of the effects of groundwater withdrawal on the condition and trend of surface resources in and downstream from the North Fork Eagle Creek basin and was developed to complement the surface flow and alluvial water depth trigger.

The riparian inventory conducted in 2010-2011 would be used as a baseline so that any future changes in riparian vegetation in the project area would be apparent with future monitoring. Short-term and long-term trends in riparian vegetation canopy cover, composition, and conditions would be evaluated and documented by repeating the riparian inventory annually between June 1 and July 15. This will provide an opportunity to examine any noticeable shifts in riparian vegetation at a community level. This inventory would be coordinated with stream geometry monitoring along the North Fork Eagle Creek, as further detailed under “Monitoring, Water Resources and Fisheries” below.

We would conduct annual monitoring of riparian obligate tree species (e.g. willows, boxelder) and other facultative wetland species in the project area in order to detect short-term changes in condition and canopy cover. Individual baseline monitoring plots known to contain facultative wetland vegetation would be examined annually for continued presence/absence of these species.

Trigger #1 for streamflow and alluvial water depth would be used to determine when pumping would be reduced. As a guideline for trigger #1, we chose the minimum rooting depth of 30 inches for shining willow (*Salix lucida*) and 34 inches boxelder (*Acer negundo*) to define the inner and outer edge of the riparian area, respectively and their growing season (March 1 through September 30). If water level elevations in monitoring wells used for trigger #1 decline greater than these depths below their benchmark elevations [currently 7,609 feet above mean sea level NAVD88 at the Eagle Creek gage location, 7,904 feet above mean sea level NAVD88 at the North Fork gage location, or other benchmark elevations to be identified at monitored wells], then pumping would be reduced until water level elevations are within 30 to 34 inches of the water level benchmark or other mitigating arrangements are made and implemented with the Village of Ruidoso. If riparian conditions are adversely affected by stream channel or bank instabilities, monitoring locations and/or trigger activation would be modified as deemed necessary by qualified agency riparian specialists.

If annual monitoring of riparian obligate or other facultative wetland species detects substantial reductions in condition or canopy cover, or if the 5-year re-reading of the baseline riparian inventory detects measurable declines in canopy cover or composition, the Forest Service may require diversions from the wells to be reduced to below 50 percent of the annual average well diversions (in acre-feet per year or acre-feet per year), or may modify benchmark water level elevations in monitoring wells that serve as the baseline for other triggers, to help restore riparian vegetation. This trigger would be used in conjunction with the streamflow and alluvial water depth trigger to determine if reductions in pumping are necessary.

The following parameters and assumptions form the baseline on which the North Fork Eagle Creek riparian trigger would be managed:

- Annual monitoring would be relatively fast and inexpensive while still providing a method to detect rapid changes in keystone obligate and facultative wetland plants that occur in the project area and upstream of the current baseline monitoring area.
- Because the riparian corridor was not substantially affected by the Little Bear Fire and experienced primarily low intensity fire only, using the pre-wildfire riparian inventory baseline survey conducted in 2010-2011 is still appropriate and would provide an important method for gaging change in riparian conditions over time. Changes in alluvial deposits, soil deposition and bank shearing observed in some areas post-wildfire will be noted and documented.

Well Pumping Volume

The Village of Ruidoso would continue daily monitoring and recording of groundwater withdrawals through the North Fork Eagle Creek wells (pumping volumes in acre feet). Combined with precipitation and streamflow records over time, this metric would be used to develop an additional reliable indicator for modeling anticipated effects of groundwater withdrawals on surface resources within the North Fork Eagle Creek basin by accurately modeling the cone of depression.[2]

[2] The cone of depression is based on Figure 16 of Matherne and others (2011). Bedrock water level at piezometers MW-1B and MW-1C are measured halfway between the pumping center and the North Fork gage. In March of 2009, MW-1B showed a drawdown of 75 feet at a time when the pumping rate was approximately 600 acre feet per year. At 75 feet of drawdown, Figure 16 shows that the cone of depression has negligible effect in the vicinity of the North Fork gage. If drawdown at MW-1B or MW-1C is limited to 75 feet, then effects to the upper reaches of the North Fork would be minimized. This water level maintenance would be independent of wet or dry periods, as the cone of depression would have the same shape whatever the pumping rate is to achieve it. However, Figure 16 makes note that the alluvial wells were dry in March of 2009, which will also need to be considered in the adaptive management for riparian areas.

An initial adaptive management trigger (threshold) of 900 cumulative acre feet over any 3 consecutive water years (300 acre-feet per year) would trigger a review by the Forest Service of the current thresholds and mitigations at maintaining or improving surface resource conditions. This threshold is based on 500 acre-feet per year recharge for the North Fork basin as determined by the chloride balance method described in the U.S. Geological Survey report (Matherne et al. 2011). If the water level elevations in the alluvial wells or at MW-1B are shallower than related adaptive management triggers, then greater pumping volumes may be allowed. If analysis results indicate that current thresholds and mitigations are not sufficient to maintain surface resource conditions, management of groundwater withdrawals would be adjusted to provide additional protections against further degradation of riparian and other surface resources within the North Fork Eagle Creek basin.

Adjustments in Management of Water Withdrawals

As time and funding allow, we would conduct periodic North Fork project area site visits to observe facility operations, gages and wells, streamflow, and riparian conditions. Notes and photographs (if applicable) would be taken and added to the project file. Every 5 years that the permit is in effect, or when triggered by exceeding the water withdrawal threshold described above, the Forest Service would evaluate and document monitoring results to determine effectiveness of the adaptive strategy and determine whether an adjustment to the parameters of this adaptive management strategy are warranted. These 5-year evaluations would correspond with the New Mexico Office of the State Engineer (Office of the State Engineer) (Roswell District) 5-year water accounting periods. For water accounting purposes, the Office of the State Engineer water year runs from November 1 through October 31, and the year is numbered by the October date (e.g., Office of the State Engineer Water Year 2014 begins on November 1, 2013 and ends October 31, 2014). Forest Service 5-year adaptive management evaluations would be conducted on a schedule that coordinates with the Office of the State Engineer accounting periods.

- Even as hillslope conditions eventually restore to reasonably stable post-Little Bear Fire conditions, a substantial amount of deposited sediment and debris is expected to move through the drainage system for decades. This will modify channel and bank conditions, streamflow occurrence and water levels, and gaging conditions. By tying adaptive management streamflow triggers to water level elevations, and by connecting monitoring locations to established elevation benchmarks, these flows, water levels and alluvial conditions can be tracked over time.
- Based on the 5-year evaluations of the special use permit, the Forest Service may relax or further restrict specific parameters of this adaptive management strategy, with modification to the operating plan of the permit. These 5-year evaluations would coincide, if possible, with the State Engineer 5-year accounting periods for the Hondo Basin.
- Adjusting these parameters would be based on USDA Forest Service determinations of the extent to which the North Fork well operations are consistent with the purpose and need and identified management objectives.

Adaptive management adjustments include limitations on groundwater withdrawal rates and cessation of pumping for short periods; increases in withdrawal rates could also occur depending on the results of monitoring.

Alternative 3 (proposed action) includes some additional mitigation and monitoring measures as described in the “Mitigation Measures” and “Monitoring” sections (below). Alternative 3 (proposed action) addresses the purpose and need and the significant issues, as shown in the analysis in chapter 3 (and summarized in table 2 and table 3).

Mitigation Measures

Forest Service staff have developed the following mitigation measures that would apply to implementation of the alternatives. Some would differ by alternative, as indicated below.

Wildlife and Fish

- **All Alternatives**: In the event that any mechanized equipment use that may be necessary for implementing repair, maintenance or operation activities of the wells/associated facilities, fencing activities around the wells, or for monitoring or adaptive management (or for well and facility removal under alternative 2 (no pumping)), this activity would not occur within 0.25 mile of the northern goshawk post-fledging area from March 1 to September 30 to minimize disturbance during the breeding season. The Village of Ruidoso would contact the Smokey Bear Ranger District for this location.
- **All Alternatives**: In the event that any mechanized equipment use that may be necessary for implementing repair, maintenance or operation activities of the wells/associated facilities or for monitoring or adaptive management (or for well and facility removal under alternative 2 (no pumping)), this activity would not occur within 0.25 mile of the adjacent protected activity center during the Mexican spotted owl breeding season (March 1–August 31).

Water, Soil, and Vegetation

- **All Alternatives**: USDA Forest Service Southwestern Region best management practices (USDA Forest Service 1982) for water quality management would be applied to any ground-disturbing activities under any of the alternatives related to maintenance and operation of the wells/associated facilities or for monitoring (or for well and facility removal under alternative 2 (no pumping)). These practices would ensure that any potential for increased soil erosion or vegetation disturbance would be minimized.
- **Alternative 3 (proposed action):** The adaptive management triggers (monitoring indicators) described for this alternative serve as measures that would minimize the potential for adverse impact to water, soil, and vegetation resources.
- **Alternatives 1 (continue current management) and alternative 3 (proposed action)**: The Village of Ruidoso would be required to develop and implement a water conservation strategy as part of the terms and conditions of their special use permit.

Cultural Resources

- **Alternative 2 (no pumping):** The Lincoln National Forest archaeologist would be consulted prior to removal of any wells and associated facilities in order to ensure cultural resource protections are provided, as needed. No impacts are expected at this time since no known sites are located within the area of potential effect.
- **All Alternatives**: If any human remains or artifacts determined to fall under the Native American Graves Protection and Repatriation Act guidelines are unearthed during project activities, we would consult with all appropriate tribes.

Public Safety and Health

- The Village of Ruidoso is responsible for ensuring all wells and associated facilities are safe and do not pose a danger to public health or safety.

Monitoring

The first eight monitoring measures described below for water resources and fisheries would be implemented for either alternative 1 (no change) or alternative 3 (proposed action) (adaptive management). Monitoring is also recommended for alternative 2 (no pumping) and is described below as monitoring measure nine.

These measures would be used in conjunction with those already identified as part of the alternative descriptions provided earlier in this chapter, including those discussed as part of adaptive management under alternative 3 (proposed action).

Water Resources and Fisheries

1. Under alternative 1 (no change) or alternative 3 (proposed action): The Village of Ruidoso would rehabilitate existing monitoring wells, or construct new ones upstream and downstream of the well field, to ensure that only one individual water-bearing zone of interest is monitored within each screened zone. New alluvial monitoring wells would be constructed by the Village of Ruidoso adjacent to the North Fork of Eagle Creek, at the locations of the existing North Fork streamgage (U.S. Geological Survey 08387550) and Eagle Creek below South Fork streamgage (U.S. Geological Survey 08387600). In order of increasing depth, the individual groundwater zones of interest in the well field area include the stream alluvium, shallower fractured and weathered zones within volcanic bedrock, and deeper bedrock zones within the same volcanic aquifer system. Well rehabilitation can include sealing off multiple completions with bentonite and/or grout as appropriate; or other means of isolating a source zone by adaptations of the wells already in place. In addition, if a pumping alternative is selected, deep, long-screen wells would be selected or newly constructed and monitored both upstream and downstream of the well field to track water table depths as part of monitoring. The screened portions of these two wells would be the same as the elevation range of the screened or open zones of the pumping wells. The results of this monitoring would be used (along with proposed riparian monitoring) to assist in determining potential effects to riparian vegetation by comparing to minimum rooting depths of facultative wetland species.
2. Under alternative 1 (no change) or alternative 3 (proposed action): Using the re-configured as well as new monitoring wells completed from Monitoring Measure 1, the Village of Ruidoso would conduct slug tests or aquifer pumping tests of the individual water-bearing zones of interest at the well field. The choice of tests would ultimately depend on the time and resources available, and on conclusions reached during coordinating efforts that would be completed between the Village of Ruidoso and USDA Forest Service. Comparable and contemporaneous tests would be completed for each water-bearing zone of interest, so that comparisons can be made between appropriate test results and a greater understanding of the hydrogeologic nature of the well field can be gained. Surface flow observations would also be made before, during, and after the groundwater tests at selected locations along North Fork Eagle Creek.
3. Under alternative 1 (no change) or alternative 3 (proposed action): Monthly water quality field measurements would be made by the Village of Ruidoso at all three existing surface

flow gages on the North Fork, South Fork, and Eagle Creek. An additional streamflow sampling location would be determined and marked or monumented immediately below the well field, at or near existing monitoring well MW-5 or wherever surface flow frequently occurs downstream. Field sampling constituents would include water temperature, air temperature, pH, turbidity, dissolved oxygen, and specific conductance. If approved in writing by the USDA Forest Service, the frequency of sampling could be reduced to a quarterly basis after 1 year. All data records would be filed with the Lincoln National Forest Supervisor's office on a quarterly basis.

4. Under alternative 1 (no change) or alternative 3 (proposed action): Daily mean flow and/or water level measurements would continue to be recorded by the Village of Ruidoso at the three stream gages or new monitoring wells, and at monitoring wells used in the U.S. Geological Survey program. Foundation conditions at the Eagle Creek stream gage would be ascertained, and if significant alluvial underflow occurs, then modifications would be implemented to either minimize or measure alluvial underflow past the gage. Rehabilitated or newly constructed wells described in measure #1 above may be substituted for existing monitoring wells as needed, and may be used to substitute for surface flow gages. Recording devices or methods, and measurement frequencies, would be determined cooperatively between the USDA Forest Service and Village of Ruidoso. Adding a transducer that would record hourly so diurnal variations could be accounted for would be considered. Flow or water level measurements would correspond to water quality field data collection efforts if conducted under Water Resources Monitoring Measure 3. Data would be reported on a monthly basis to the USDA Forest Service, U.S. Geological Survey, and the New Mexico Office of the State Engineer, and stored in a publically available database maintained by one of these agencies as determined through further coordination and decisionmaking. Quarterly and annual data summaries and conclusions would be developed and made publically available by the Village of Ruidoso, with the USDA Forest Service acting in an agency review and approval capacity.

5. Under alternative 1 (no change) or alternative 3 (proposed action): Eight springs and seeps in the North Fork Eagle Creek drainage would be identified and monitored by the Village of Ruidoso on a monthly basis for 1 year: priority locations would be such features alongside or in the channels in the upper North Fork Eagle Creek and Carlton Canyon. Locations are indicated on figure 2. Monitoring constituents would include flow rate, temperature, pH, and specific conductivity. Additional water quality constituents (e.g., carbonate, bicarbonate, chloride, sulfate) would be included if specified by the USDA Forest Service, and samples would then be retrieved and handled for laboratory analyses of those constituents if they were deemed necessary.

6. Under alternative 1 (no change) or alternative 3 (proposed action): Stream gradient, planform, and stability indicators would be monitored and documented annually by the Village of Ruidoso between June 1 and July 15 at selected and benchmarked cross-section locations along the North Fork Eagle Creek for the first 5 years during the term of the permit. Cross-sections would be located a minimum of every 1,000 feet downstream from the existing North Fork Eagle Creek streamgage location to the Eagle Creek below South Fork streamgage location, below major tributary junctions, and at selected sharp bends. Stream channel width, bank height and angle, aggradation or degradation of sediment or debris, longitudinal profile, flow estimates, pool locations, and other selected geomorphic characteristics would be documented in the field by the Village of Ruidoso and submitted in an annual summary report to the USDA Forest Service that includes data forms, summary

tables, photographs and figures, and interpretations. After the first 5 years of the term of the permit, The Village of Ruidoso would measure these parameters at these same locations every 3 years (instead of every year), between June 1 and July 15.

7. Under alternative 1 (no change) or alternative 3 (proposed action): Snowpack on Sierra Blanca would be monitored by the Village of Ruidoso for the permit duration through access to the Natural Resources Conservation Service data portal. Anticipated dry, average, or wet spring seasonal moisture conditions will be ascertained monthly and documented by monthly memoranda to the Forest Service for the months of January, February, March, and April every year. At least one precipitation gage along the North Fork Eagle Creek watershed divide would be maintained by the Village of Ruidoso for the permit duration in cooperation with the U.S. Geological Survey, and monthly total precipitation accumulations would be reported to the USDA Forest Service on a quarterly basis every year.
8. Under alternative 1 (no change) or alternative 3 (proposed action): The Village of Ruidoso would develop and calibrate a site-specific groundwater computer model in cooperation with the USDA Forest Service and other selected, qualified parties representing appropriate stakeholder interests along the North Fork of Eagle Creek. The model will be developed and calibrated during the initial three years of the term of the permit, and used through the continuation of the permit term to further inform adaptive management of surface and groundwater relationships along the North Fork Eagle Creek.
9. Under alternative 2 (no pumping): Surface water monitoring would continue at the existing Eagle Creek below South Fork gage (U.S. Geological Survey 08387600), and water levels would be monitored at a selected well downstream of the existing well field in the vicinity of MW-5. Recording devices or methods, measurement frequencies, and reporting provisions would be determined cooperatively between the USDA Forest Service and U.S. Geological Survey. Adding a transducer that would record hourly so diurnal variations could be accounted for would be considered; this monitoring would be conducted as time and funding allowed and would be used to determine possible changes in flow due to discontinuation of pumping.

Riparian Vegetation

1. Under alternative 1 (no change) or alternative 3 (proposed action): The 2010 baseline riparian vegetation survey would be repeated every 5 years, as described in the adaptive management strategy description of alternative 3 (proposed action) earlier in this chapter. Annual monitoring of riparian obligate tree species (e.g. willows, boxelder) and other facultative wetland species within the project area would also be used to detect short-term changes in condition and canopy cover. This monitoring would be coordinated with stream geometry and stability monitoring as described above for “Water Resources and Fisheries”.
2. Under alternative 2 (no pumping): The 2010 baseline riparian vegetation survey would be repeated at 5-year intervals, as time and funding allows.

Alternatives Considered but Eliminated from Detailed Study

Federal agencies are required by the NEPA to rigorously explore and objectively evaluate all reasonable alternatives and to briefly discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR 1502.14).

We received comments from the public on our proposed action during the scoping period and many of these offered suggestions for alternative methods for achieving the purpose and need. For an alternative to be analyzed in detail in an EIS, it should meet the purpose and need for action, address one or more significant issues, and reduce the potential for significant impacts. Reasonable alternatives include those that are practical or feasible from a technical and economic standpoint; they do not necessarily have to be within USDA Forest Service jurisdiction to implement. Alternatives not considered in detail in an EIS may include, but are not limited to, those that fail to meet the purpose and need, are technologically infeasible or illegal, or would result in unreasonable environmental harm. We also considered applicable USDA Forest Service direction as summarized in chapter 1.

The following sections describe the comments we received form the public related to alternatives and why these were not carried forward for detailed analysis in this document.

Suggestions for Changes to the Proposed Action – General

No-flow days (days where there is zero flow in North Fork Eagle Creek) should be eliminated entirely from the proposed action - assure that the stream flows every day.

The no pumping alternative will be analyzed in detail and is the alternative with the best potential to eliminate no-flow days. This alternative would "leave downstream flows in the same state that they would be absent the pumping of the North Fork Eagle Creek wells" which is required for the EIS analysis as part of the stipulation agreement.

As stated in the U.S. Geological Survey report and summarized in chapter 2 of the EIS, although years of below average precipitation were recorded during the time period before the wells began pumping and after the wells began pumping, there were no days of zero flow recorded at the Eagle Creek gage from 1969-1980. A total of 789 no-flow days were recorded in 11 years of the 20 years analyzed after 1988, with 8 of the last 10 years having no-flow days. No-flow days occurred during periods of both below and above average precipitation during the study period but no-flow days did not occur during periods of below average precipitation before 1988. It is important to note that the Eagle Creek gage measures flow from both the North Fork and South Fork.

The "Manual Direction Summary" document (USDA Forest Service 2011) and Thompson (2014) illustrates that we do not have the authority in New Mexico to establish a minimum instream flow and that certain Forest Service manual direction related to instream flow does not apply to this particular project. Requiring zero no-flow days as part of the proposed action would not be consistent with these conclusions or our interpretation of New Mexico state law.

The purpose and need for taking action and the management objectives outlined for this project would not be achieved with eliminating no-flow days completely. The proposed action proposes to reduce the number of no-flow days to an average of 20–30 days or less per year, roughly half of the average number of no-flow days experienced between 1989 and 2011. This would allow pumping to occur under a closely monitored adaptive management strategy designed to ensure protection of forest resources while providing needed municipal water to the Village of Ruidoso.

For these reasons, this suggestion to eliminate no-flow days completely was not added to the proposed action, but will be addressed by the no pumping alternative. However, the predicted number of no-flow days per year may be used as an indicator in the "Water Resources" section of chapter 3 in order to compare and contrast alternatives in the EIS.

The term of the permit should be 10 years with an option to renew (instead of the stated 30 years). There should be a review of the permit every 4 years, not every 5 or 10 years as stated.

The term of the permit has been revised slightly in the description of the proposed action since public scoping, as follows: "The new permit could be authorized for up to 20 years, with stipulations for frequent reviews and verification of the permit terms and conditions. These could occur as often as every year, but would occur at least every 5 to 10 years."

We changed the term of the permit from 30 years as originally stated to 20 years and also added in a provision for annual reviews based on a review of Forest Service manual and handbook direction regarding special use permitting.

Stipulations for review and verification of the operating plan of the permit are important at regular intervals during the administration of a permit; this is stated in the description of the proposed action. Keep in mind that the alternative that is ultimately selected for implementation in the record of decision would be inserted into the new permit authorization. One of the terms will be an operating plan which would include mitigation measures, monitoring, and adaptive management details. The USDA Forest Service and the Village of Ruidoso would develop an operating plan each year to guide management for that year. As also stated in the proposed action, the permit and its operating plan would go through frequent reviews possibly as often as every year, but at least every 5 to 10 years. Changes to the permit's annual operating plan (including any need for changes in adaptive management monitoring) could be made as a result of these reviews to ensure forest resource protection is being achieved.

Therefore, this alternative was dismissed from further detailed analysis since it is very similar to the revised proposed action.

Don't authorize well #2 and decommission it since it is not being used and never has – this is required by the State Engineer Office water regulations.

The Village of Ruidoso does not use well #2 because it is not equipped, is not tied into the main line, and does not have power. However, the proposed action includes mention of this well in the Village of Ruidoso's permit in order to authorize its presence on National Forest System land. If we did not mention this well in the permit, the Village of Ruidoso would be required to cap it or remove it from National Forest System land. Removal of an existing well also has the potential to impact water rights associated with the well. Removal of an existing well would result in ground disturbance and additional environmental impacts that would need to be carefully evaluated. Capping the well permanently would preclude its use in the future for other management needs such as monitoring.

If the Village of Ruidoso proposed to begin pumping water from well #2 at some point in the future, this use would still be guided by all the parameters established for the well field as a whole. If any new impacts not analyzed in the EIS would result from this new use of well #2, new or additional environmental analysis may be necessary at that time.

For these reasons, we feel permitting well #2 is appropriate in the proposed action and would provide the most flexibility for future management without resulting in any additional environmental impacts. This alternative was dismissed from further detailed analysis.

Don't authorize well #3 since it is damaged and is not currently being used.

As stated above, the proposed action includes mention of this well in the Village of Ruidoso's permit in order to authorize its presence on National Forest System land. If we did not mention this well in the permit, the Village of Ruidoso would be required to cap it or remove it from National Forest System land. Removal of an existing well also has the potential to impact water rights associated with the well. Removal of an existing well would result in ground disturbance and additional environmental impacts that would need to be carefully evaluated. Capping the well permanently would preclude its use in the future for other management needs such as monitoring.

If the Village of Ruidoso proposed to begin pumping water from well #3 at some point in the future, this use would still be guided by all the parameters established for the well field as a whole. If any new impacts not analyzed in the EIS would result from this new use of well #3, new or additional environmental analysis may be necessary at that time.

For these reasons, we feel permitting the presence of well #3 is appropriate in the proposed action and would provide the most flexibility for future management without resulting in any additional environmental impacts. This alternative was dismissed from further detailed analysis.

Suggestions for Changes to the Proposed Action – Monitoring and Adaptive Management

Install a bedrock saturation switch instead of using a depth to water threshold.

We developed the depth to water threshold as described in the proposed action in order to define water table depth based on an average over several years so as to allow for natural fluctuations in precipitation and runoff. Once the average is identified, the monitoring wells would be used to provide water table depth indicators; these wells would provide this information nearly as quickly as a bedrock saturation switch.

Using this switch to shut off the pumps whenever the bedrock is not saturated is very similar to the suggestion to not allow any no-flow days under the proposed action. The aquifer in communication with the stream needs to remain saturated, or the stream will lose flow to the aquifer. For the reasons described above for not eliminating no-flow days from the proposed action, we do not feel that the requirement for saturated bedrock before any pumping can occur meets the purpose and need for action or the management objectives for this project.

Under the proposed action, the Village of Ruidoso would be required to maintain water table depth at or above the identified threshold (threshold would be identified after 5 years of data are collected) over 3 consecutive water years. If groundwater pumping of the North Fork Eagle Creek wells results in a declining trend in the average water table depth over any 3-year period, the Village of Ruidoso would be required to reduce pumping until the average water table depth is reestablished and the USDA Forest Service determines that pumping may resume without creating further departures over a 3-year period. Use of this threshold would allow pumping to occur under a closely monitored adaptive management strategy designed to ensure protection of forest resources while providing needed municipal water to the Village of Ruidoso.

For these reasons, this suggestion to maintain saturated bedrock and to use a switch to detect this condition so that pumps are turned off when it is not achieved was not added to the proposed action, but will be addressed by the no pumping alternative. Detailed prescriptions from the alternative (identified in the record of decision) which is ultimately selected for implementation would be inserted into the operating plan for the permit. This includes mitigations, monitoring, and adaptive management actions. The USDA Forest Service and the Village of Ruidoso would develop an annual operating plan each year based on the terms and conditions of the permit to guide management for that year. As also stated in the proposed action, the permit would go through a review and renewal at least every 5 to 10 years. Changes to the operating plan of the permit (including any need for changes in adaptive management monitoring) could be made during any of these steps to ensure forest resource protection is being achieved; they may require additional environmental analysis.

All monitoring information should be relayed electronically to the Forest Service and then made available to the public via the Web.

Having all monitoring information available electronically would be beneficial for management and would make it easier to disseminate this information to those who are interested. However, the specifics regarding how monitoring information is collected, stored, analyzed, and otherwise made available is outside the scope of this environmental analysis. The EIS will evaluate the effects of various well pumping alternatives on forest resources and socioeconomics; how data are relayed and made available for any of the alternatives would not result in any differences in effects to forest resources or socioeconomics.

For these reasons, this suggestion was dismissed from further detailed analysis. However, the USDA Forest Service will consider this suggestion when deciding how best to implement whatever alternative is ultimately selected in the record of decision.

All monitoring should be conducted by the Forest Service or the Office of State Engineer and not the Village of Ruidoso.

As discussed above, the specifics regarding how monitoring is conducted is outside the scope of this environmental analysis. The EIS will evaluate the effects of various well pumping alternatives on forest resources and socioeconomics. While monitoring is a large component of the proposed action and has the potential for some effects (i.e. primarily labor implications and cost), exactly who would conduct the monitoring is not relevant to the environmental analysis.

For these reasons, this suggestion was dismissed from further detailed analysis. However, the USDA Forest Service recognizes the importance of monitoring to this project and the desire for objective evaluations and adherence to whatever monitoring plan is ultimately selected in the record of decision. Any actions included in the operating plan of the USDA Forest Service special use permit must be authorized and approved by the USDA Forest Service. It is common practice for certain special use permit terms and conditions or the operating plan provisions (such as monitoring) to be conducted by the USDA Forest Service or an approved contractor or third party and paid for by the Village of Ruidoso.

Adaptive management monitoring should be on a 5-year rotation/ Adaptive management monitoring should be on a 4-year rotation.

The proposed action includes verifying the success of the adaptive management strategy every 5 years, so that adjustments would be made within 5 years if needed to ensure protection of forest resources. Therefore, the suggestion for a 5-year rotation is achieved by the proposed action.

Shifting this verification to every 4 years instead of every 5 years would not likely result in any measurable difference in "on-the-ground" effects to forest resources due to the similarity between a 4-year review and a 5-year review and the variability in forest resource measurements over a 1-year period. As described previously, special use permits are to be managed with multiple levels of review and adjustment. Detailed prescriptions from the alternative (identified in the record of decision) which is ultimately selected for implementation would be inserted into the permit. The USDA Forest Service and Village of Ruidoso would develop an annual operating plan each year based on the mitigation measures of the permit. As also stated in the proposed action, the permit would go through a review at least every 5 to 10 years. Changes to the terms and conditions of the permit (including any need for changes in adaptive management monitoring) could be made during any of these steps to ensure forest resource protection is being achieved; they may require additional environmental analysis. For these reasons, this suggestion was dismissed from further detailed analysis.

Depth to water threshold should be based on a pre-well baseline and not on a post-well baseline, as is currently described.

The USDA Forest Service developed the depth to water threshold as described in the proposed action in order to define water table depth based on an average over several years so as to allow for natural fluctuations in precipitation and runoff. Once the average is identified, the monitoring wells would be used to provide water table depth indicators. However, we recognize that any post pumping water table surface is curved (within the cone of depression) and is transitory and is not the same as the pre-well pumping baseline.

Using a pre-well baseline for average water table depth instead of the 5-year post-well average is very similar to the suggestion to not allow any no-flow days under the proposed action or to use a bedrock saturation switch. The pre-well average water table depth was likely close to the stream channel, but we have no way of knowing exactly what the water table depth was before pumping began; this can only be inferred based on Eagle Creek gage information and some other factors as described in the U.S. Geological Survey report. For the reasons described above (for not eliminating no-flow days from the proposed action and not requiring bedrock saturation) in the proposed action, we do not feel that establishing a water table depth based on pre-well conditions meets the purpose and need for action or the management objectives for this project. We intend to use the average water table depth threshold as a baseline for comparison; a datum by which current conditions are compared. It is a method for measuring relative change.

Under the proposed action, the Village of Ruidoso would be required to maintain water table depth at or above the identified threshold (threshold would be identified after 5 years of data are collected) over 3 consecutive water years. If groundwater pumping of the North Fork Eagle Creek wells results in a declining trend in the average water table depth over any 3-year period, the Village of Ruidoso would be required to reduce pumping until the average water table depth is reestablished and the Forest Service determines that pumping may resume without creating further departures over a 3-year period. Using this threshold, in combination with the other identified indicators, would allow pumping to occur under a closely monitored adaptive management strategy designed to ensure protection of forest resources while providing needed municipal water to the Village of Ruidoso. For these reasons, this suggestion to use a pre-well baseline for water table depth was not added to the proposed action, but will be addressed by the no pumping alternative.

There should be no limit on pumping during drought – you should use precipitation and projected streamflow instead.

Not instituting any control over pumping during drought situations would not meet the purpose and need for action. The thresholds for water table depth, streamflow, riparian conditions, and pumping volumes in the proposed action include using 3-year running averages. This considers historic trends and allows for natural fluctuations in precipitation and snowmelt runoff, and periodic short-term drought cycles. While we recognize that water demand may be highest during times of below average precipitation, this is also the time when water-dependent resources are also stressed. Use of the thresholds identified in the proposed action would allow pumping to occur under a closely monitored adaptive management strategy designed to ensure protection of forest resources while providing needed municipal water to the Village of Ruidoso. For these reasons, this suggestion was not added to the proposed action but will be addressed by the no action (no change) alternative.

The 5-year monitoring requirement for water table depth before making adjustments is too long.

The proposal to base the water table depth threshold on the average depth based on 5 years of data collection was developed to allow for natural fluctuations in precipitation, snowmelt runoff, recharge, and periodic short-term drought cycles. We do not think that using 5 years of data is too long since it is important to ensure the average depth is based on a long enough time period to capture these natural fluctuations. However, we recognize that waiting until a decision is made on this project to initiate the last 3 years of this needed monitoring is not ideal at present, it appears feasible for the USDA Forest Service to conduct monthly water table depth monitoring on monitoring well MW-1B beginning immediately. If this occurs, this means that the average water table depth could be determined prior to a decision on this project.

This statement in the proposed action has been revised slightly to capture this.

Using the 5-year water level average is not accurate. This should be removed since it is not supported by the U.S. Geological Survey study.

Please see the response above regarding use of the average water table depth based on 5 years of data. We do not agree that developing an average water table depth based on multiple years of data (and not just the 2 years collected during the U.S. Geological Survey study) is in conflict with the findings of the U.S. Geological Survey study. The U.S. Geological Survey study used a 5-year moving average to analyze the precipitation trend, so it is consistent with that approach, especially since we are concerned about the relationship between drought and water table depth.

Groundwater withdrawals should be based on 50 percent of the streamflow measured at the North Fork gage.

The proposed action includes monitoring streamflow as follows: “If there are more than 20 days per year of no surface flow (less than 0.01 cubic feet per second) over a period of 3 consecutive water years at the Eagle Creek gage, or more than 30 no-flow days within any single water year (October 1–September 30), the Village of Ruidoso must reduce groundwater withdrawal rates from these wells. If either of those thresholds is exceeded, then groundwater withdrawals from the North Fork wells would be limited to 50 percent of the volumetric rate of surface flow at the North Fork gage (which is upstream from the wells) until surface flow at the Eagle Creek gage resumes.”

The proposed action includes basing groundwater withdrawals on 50 percent of the flow measured at the North Fork gage, as you suggest, if the thresholds for no-flow days is reached.

Weekly field checks should be added to the monitoring strategy.

We recognize the value in periodic visual inspections during the course of implementation of any adaptive management strategy. While visual observations would not contribute to the data needed to verify the adaptive management triggers (monitoring indicators), it could provide anecdotal information on flow patterns, flood events, gage and well conditions, and vegetation condition and recreational use, to name a few. Conducting periodic visual observations has been added to the proposed action under the adaptive management strategy. However, we do not agree that mandatory weekly field checks are necessary to ensure an effective monitoring strategy. With limited funding and personnel, this would be difficult to implement.

If there are violations to the stipulations, immediate actions should be taken until artesian flow regimes are regained.

We recognize that in successfully implementing the new permit, there must be consequences in the event the Village of Ruidoso does not comply with the terms and conditions. However, this is outside the scope of this environmental analysis. This EIS evaluates the effects of various well pumping alternatives on forest resources and socioeconomics. Effects are analyzed on the assumption that all the components of any alternative (including mitigations, monitoring, and adaptive management strategies) are implemented as described. In other words, it assumes full compliance. If the Village of Ruidoso is in noncompliance with applicable statutes or regulations or the terms and conditions of the authorization, the USDA Forest Service would handle it administratively per Federal Regulations. 36 CFR 251.60 (B). For these reasons, this alternative was dismissed from further detailed analysis.

The water table depth monitoring should be based on information from NF-1, NF-3 and NF-4 and MW-1B, not just MW-1B as is currently stated.

We agree that the wording in the explanation of how monitoring well MW-1B would be used for monitoring water table depth is not entirely accurate. We agree that all available information should be used and this may include data from the other monitoring wells and water supply wells. This clarification has been added to the proposed action.

Comments on Stream Augmentation

Drop stream augmentation from any further consideration. It does not address the purpose and need and could result in adverse impacts by expanding the cone of depression and exacerbating these effects to forest resources and by introducing chemical properties of groundwater above the surface.

Stream augmentation has been proposed by the Village of Ruidoso as a way to mitigate the potential for adverse effects to streamflow due to well pumping. We recognize that there are advantages and disadvantages to the use of stream augmentation and that there is literature available on this topic.

Stream augmentation with groundwater is sometimes used to provide surface flow where there would otherwise be little or none. This may be beneficial, as in the case of saving an endangered species; or it can create other issues. The most obvious of these being added lowering of the water table and the potential for surface water degradation. We considered the following factors in determining whether or not stream augmentation should be carried forward for detailed analysis:

- Sommer and Horwitz (2009) made the observation that ". . . artificial augmentation will inevitably change the system in another direction, i.e. the 'recovered' state will be slightly different to the original state. In addition, it will require ongoing care, will use a valuable resource relatively inefficiently, and will not address the root causes of the problem, namely overextraction of groundwater and declining rainfall."
- Parasiewicz (2008) emphasized the importance of simulating the natural variable discharge that any stream will have throughout the year, minus the extreme spikes. Lowering the stream temperature in the summer or raising temperature in the winter by addition of groundwater may be detrimental to fisheries (Cowx 2004). Lower dissolved oxygen content of augmenting groundwater could also lead to asphyxiation of fish and invertebrate species (ibid.).
- Constituents generally not present or in very low concentrations in surface runoff may be highly enriched in groundwater which has equilibrated with the host aquifer. Utilizing groundwater to augment lakes in Florida resulted in significant increases in radium activity. The radium in this case was from the Floridian aquifer (Brenner et al. 2006). Water of high ionic strength potentially being released from aquifer storage and recovery projects for Everglades restoration was recognized as representing a "major ecological change" (National Research Council 2002).
- Additional pumping near a stream that is disconnected, or above the water table, can increase the length of the stream that is disconnected, resulting in more flow reduction (Brunner et al. 2011).

Any withdrawal of groundwater to augment the creek at any point would result in a cone of depression that would be in addition to whatever drawdown is being caused by water supply pumping. As documented in more detail in the project record, we evaluated two scenarios. For the first, the transmissivity was set at 2,941 square feet per day and the storage coefficient was set at 0.0014 (these numbers were taken from Atkins-Landfair, Inc. 1985). Based on this rough calculation under this scenario, water table drawdown would be approximately 2 feet within 50 feet from the pumping well after 1 year. For the second, the transmissivity was set at 1,250 square feet per day and a storage coefficient was set at 0.002 (these numbers were taken from Balleau

Groundwater, Inc. 2004). Based on this rough calculation under this second scenario, drawdown would roughly be 4 feet within 50 feet from the pumping well after 1 year.

These two simulations assume the aquifer is homogenous. Any barriers, such as faults or areas of lower hydraulic conductivity would serve to increase these drawdown effects. And again, these estimated drawdowns would be additive to any drawdown resulting from water supply pumping. The deeper the cone of depression formed due to water supply pumping or stream augmentation, the longer it would take for the water table to recover.

Another aspect of evaluating this alternative is ensuring that we can describe it in enough detail so it can be meaningfully evaluated and compared to the other alternatives. In order to determine these specific parameters (e.g. When would we decide to augment flow? How long would it be used? How would we decide to stop augmenting flow?), the Village of Ruidoso proposed a pilot study to us and the New Mexico Surface Water Quality Bureau. The Surface Water Quality Bureau stated that this type of study falls under the jurisdiction of the Environmental Protection Agency and requires a National Pollutant Discharge Elimination System permit. The Environmental Protection Agency stated that the use of groundwater is inconsistent with surface water and that North Fork Eagle Creek needs to be managed for aquatic systems and the Surface Water Quality Bureau considers it swimmable/fishable. This implies that this action could result in adverse effects to water quality and aquatic ecosystems. Because of these factors, the Village of Ruidoso would need to go through a lengthy permitting process with the Environmental Protection Agency, effectively eliminating the opportunity to conduct a pilot study in time to inform the EIS.

The Village of Ruidoso initially filed a National Pollutant Discharge Elimination System permit application to conduct a pilot test to the Environmental Protection Agency Region 6 office on October 27, 2011, with the final filing occurring on November 28, 2011. The Village of Ruidoso is currently awaiting action on this application (Atkins Engineering Associates 2014).

Without a pilot study, we do not have any measurable parameters for how, specifically, this alternative would be implemented. Using the adaptive management triggers from the proposed action would be unrealistic since these are based on groundwater maintenance. The pilot study was to be used to assist in determining some of these parameters and to see if streamflow could be maintained. We would need these parameters in order to effectively analyze this alternative in the EIS.

Implementing stream augmentation would not meet the purpose and need for taking action or the management objectives for this project because of the potential for adverse impacts to forest resources, expansion of the cone of depression, and lack of detail regarding how stream augmentation would be used on North Fork Eagle Creek. It also would not address any of the significant issues for analysis. For these reasons, this alternative was dismissed from further detailed analysis.

Add a pilot test of the stream augmentation adaptive management option to the proposed action so this can be tested for feasibility early on in the permit.

We removed stream augmentation as a potential adaptive management adjustment in the proposed action upon further examination of the range of alternatives and the desire for each alternative to stand alone. As discussed above, stream augmentation was initially considered as a stand-alone alternative and we recognized at that time the value of conducting a pilot test. After the Little

Bear Fire we reevaluated this option to see if changes due to the fire would allow us to test stream augmentation without negatively affecting other resources. However, as stated above, because of the potential for adverse impacts to forest resources, possible expansion of the cone of depression, and the lack of detail regarding how stream augmentation would be used on North Fork Eagle Creek, stream augmentation would not meet the purpose and need for taking action or the management objectives for this project. It also would not address any of the significant issues for analysis. For these reasons, this alternative was dismissed from further detailed analysis.

Keep stream augmentation. It will enhance riparian vegetation.

See responses above.

The current description of the stream augmentation alternative does not make sense. How will thresholds for groundwater maintenance be used to determine when to augment streamflow?

Following the release of the notice of intent, the interdisciplinary team realized that the way in which the stream augmentation alternative was described may not be implementable. There is a disconnect between how the monitoring thresholds would be used to decide when to augment streamflow. As currently written, exceeding the thresholds for streamflow, water table depth, and riparian vegetation would trigger augmentation of streamflow by pumping groundwater into the North Fork of Eagle Creek stream channel to mitigate adverse impacts to surface resources.

As we explained in the responses above, we do not have information on what thresholds could be used to determine when to augment streamflow. Initially, a pilot test was proposed to identify these parameters and thresholds. However, there is not enough time to complete a pilot test within a reasonable timeframe for this EIS analysis. Because of this and the other reasons described above, this alternative has been dismissed from further detailed analysis.

Suggestions for New Alternatives

Ensure that the range of alternatives includes all reasonable alternatives (and no less than one) that leave downstream flows in the same state they would be absent pumping, to be in compliance with the stipulation agreement.

This is addressed by alternative 2 (no pumping). The no pumping alternative would leave downstream flows in the same state they would be absent pumping and is currently in the range of alternatives for detailed analysis. This alternative will provide a very valuable comparison to the other alternatives to show the effects well pumping has on forest resources and economics. It is within the discretion of the decision maker for this project to select this alternative following their review of the final EIS and all public comments received.

We could not identify any other reasonable alternatives besides the no pumping alternative that would also meet the purpose and need for action, the management objectives, and be consistent with our manual direction, as summarized in the separate “Manual Direction Summary” document (USDA Forest Service 2011) and in chapter 1. For these reasons, no additional alternatives were developed to meet this criterion. We feel this is consistent with the stipulation agreement.

Build a water purification plant.

This suggestion is outside the scope of this project. While we recognize the value in reclaiming and reusing wastewater for municipal water needs, the specifics of how, when, and where this is done is outside the jurisdiction of the USDA Forest Service. However, we will ensure the Village of Ruidoso is aware of this suggestion. For these reasons, this alternative was dismissed from detailed analysis.

Add more storage capacity to the system.

This suggestion is outside the scope of this project. While we recognize the value in additional water storage, the specifics of how much, when, and where this is done is outside the jurisdiction of the USDA Forest Service.

Having additional water storage would allow the Village of Ruidoso to pump water from the North Fork of Eagle Creek during high flow periods and store the water so it could then be used during dry periods. Removing excess water from the system during high flow periods and limiting pumping during low flow periods would provide for forest resource needs and municipal water. It could also minimize the need for extensive mitigations, monitoring, and adaptive management actions. However, adding more storage to the system would be difficult due to the high volume of storage needed to meet demand and the logistics and cost this would entail.

Based on some rough calculations, the Village of Ruidoso requires approximately 41–42 million gallons of water during the typical dry season to meet the demand for municipal water.

A household's average water use was estimated to be 0.5 acre feet per year. This is 163,000 gallons of water per household. According to the census Web site, the Ruidoso/Ruidoso Downs metropolitan area has the equivalent of 4,600 households needing 2,300 acre feet (750 million gallons) per year. Three weeks of storage would amount to about 42 million gallons. The largest storage tanks are about 2 to 3 million gallon capacity, which would require 14 to 21 of the largest tanks, or a 13-acre surface reservoir with an average 10-foot depth.

In speaking with one company that supplies water storage tanks (Aquastore tanks and domes), each tank would cost about 2.8 million dollars, for a total cost of approximately 40 million dollars. Besides the cost, there is added difficulty in determining if there is a feasible location.

Constructing a new dam impounding 50 acre feet (about 16 million gallons) would cost from 2.5 to 3.5 million dollars, based on some rough estimates. A new dam in this area would be considered "high hazard" since it is most likely that people would be living downstream of it. Expansion of an existing dam, such as Alto Reservoir, is a complex undertaking. A 50-acre-foot dam would typically be about 25 feet high. An alternative to a single large reservoir could be a series of smaller dams, which would lessen the hazard, but would cost about the same.

Adding more storage capacity to the system to address water shortage during times of drought is typically not feasible due to economic considerations. During times of drought, source production would be the main limiting factor for water quantity. If the source cannot produce enough water, it is not economical to add additional water storage capacity if demand does not change during times of drought.

Water storage capacity for a drinking water system is based upon several calculations such as pressure requirements, maximum flow velocities within the piping, piping sizes, and most important, peak hourly demand, and maximum fire flow requirements. These are specific to the water system design. The need for additional storage during dry periods is not typically incorporated into the calculations for a water system because of the economic factors of overbuilding. The water system would need to be evaluated to determine capacity, if additional water treatment methods would be necessary (per New Mexico Environment Department regulations), and if the water system infrastructure would have the capacity to distribute the additional water. This evaluation would need to consider additional engineering, design, and construction implications for the water system infrastructure. Environmental impacts related to the ground disturbance associated with added infrastructure would also need to be considered.

For these reasons, this alternative was dismissed from further detailed analysis. We will ensure the Village of Ruidoso is aware of this suggestion.

Clear vegetation on private land to improve the water table and increase fire protection.

How vegetation is managed on private land is outside the jurisdiction of the USDA Forest Service and outside the scope of this project. However, we recognize that upland vegetation can influence the water table. The EIS includes an evaluation of the effects of forest density (and any changes in forest density over time, if known) within the North Fork Eagle Creek drainage to water availability, as a component of the cumulative impacts analysis. For these reasons, this alternative was dismissed from detailed analysis.

Don’t build any more golf courses or other new developments.

This suggestion is outside the jurisdiction of the USDA Forest Service and outside the scope of this project. While we recognize the value in reducing future demands on the municipal water supply through limiting new development, the specifics of how, when, and where this is done is outside the jurisdiction of the USDA Forest Service. However, we will ensure the Village of Ruidoso is aware of this suggestion. For these reasons, this alternative was dismissed from detailed analysis.

Minimum Instream Flow Alternative

The components of this suggested alternative are included below:

- Install new gage on North Fork Eagle Creek above the confluence with South Fork Eagle Creek
- Install electronic monitoring switches on pumps and gages
- Establish a minimum instream flow (we suggest 1.2 cubic feet per second based on the U.S. Geological Survey study)
- When flows are below the minimum instream flow measured at the new gage, stop pumping (the switches on the pumps will automatically shut off)
- When flow is greater than the minimum instream flow, continue pumping
- Add storage capacity to the system so that more water can be pumped and stored during high flows
- Authorize a 10-year permit term with options for renewal

The basis for this alternative is in establishing and then managing for a minimum instream flow at all times. The flow suggested (1.2 cubic feet per second) is supported by the U.S. Geological

Survey study if our desired condition is continuous flow. Here is the excerpt from the U.S. Geological Survey Report Abstract:

> If it is assumed that, without pumping, the bedrock aquifer would be saturated to the base of the alluvium, then a discharge of only 1.2 cubic feet per second required to saturate the alluvium in its thickest and widest reach would be needed to sustain continuous flow in the stream. During the study period, a discharge of 1.2 cubic feet per second was equaled or exceeded at the North Fork gaging station 8 percent of the time. Based on the discharge record at the Eagle Creek gage, given alluvium and channel configurations similar to those described in this study, streamflow in some part of the stream channel between the North Fork and Eagle Creek gages was likely discontinuous during part of the year during both time periods.

We compared the number of months per year when flow was less than 1.2 cubic feet per second during the early period (August 1969 through December 1980) and after pumping began (April 1988 through 2011), as shown in table 1.

Before pumping began, flow measured at the Eagle Creek gage was greater than 1.2 cubic feet per second about 54 percent of the time, or for approximately 6.5 months out of every year. Since pumping began, flow has been greater than 1.2 cubic feet per second about 30 percent of the time or for approximately 3.5 months out of every year. To manage pumping to maintain this minimum instream flow continuously would mean that we would be managing for a condition that did not exist before the wells began pumping.

We recognize flow has changed since pumping began and that dry periods have increased. We reanalyzed this data to make interpretations regarding all available data, which is presented in the water resources section of chapter 3.

Table 1. Streamflow before 1980 and after 1988, measured at the Eagle Creek gage

Flow Measured at Eagle Creek Gage	Percent of Time	Months per Year
Early Period (1969-1980)[a]		
Time dry	0.0 percent	0.0
Flow greater than 0.12 to 1.2 cubic feet per second	46.1 percent	5.5
Flow greater than 1.2 cubic feet per second	53.9 percent	6.5
Late Period (1989-2011)[b]		
Time dry	12.3 percent	1.5
Flow greater than 0.01 to 1.2 cubic feet per second	57.2 percent	6.9
Flow greater than 1.2 cubic feet per second	30.5 percent	3.7

a - Data used for this calculation came from 1969-1980; this results in slightly different figures than that reported in table 5 because 2 additional years were used (1969 and 1970); however the results are similar.

b - Data used for this calculation came from 1989-2011; this results in slightly different figures than that reported in table 5 because 2005 data were used; however the results are similar.

As stated in our response to the suggestion to eliminate no-flow days completely from the proposed action, the USDA Forest Service does not have the authority in New Mexico to establish a minimum instream flow and the relevant sections of our Forest Service Manual do not apply to this project since North Fork Eagle Creek does not meet certain criteria (see separate "Manual Direction Summary" document (USDA Forest Service 2011) for further information). Therefore, requiring the Village of Ruidoso to manage for a continuous minimum instream flow is not consistent with these conclusions and is outside the jurisdiction of the USDA Forest Service in New Mexico.

As stated in the purpose and need for taking action, the management objectives outlined for this project, and the desired conditions for the project area, we are not striving to attain continuous flow in North Fork Eagle Creek. Rather we are striving to: (1) attain increased flow (measured by a reduction in no-flow days), consistent with the intermittent nature of North Fork Eagle Creek in the project area; (2) ensure groundwater discharge sustains base flows and is a source of water for springs and seeps and water-dependent ecosystems; and (3) ensure riparian vegetation is maintained or improved and that streamside recreation opportunities are available.

We recognize the value in having a separate stream gage for North Fork Eagle Creek. This would simplify the necessary calculations between the Eagle Creek gage and the South Fork gage and would provide easily obtainable flow measurements continually for North Fork Eagle Creek flows in the project area. However, there are already three gages installed on this system; installing a fourth would require additional funding (estimated between $18,000 and $100,000 in addition to annual maintenance costs; the North Fork gage cost $32,608 to install), additional time and labor, additional manpower for monitoring, and added stress to the system. Gages have impacts on stream habitat. While these effects can be minimized, they need to be considered before installing any new structures in streams. As one example, they can result in barriers to fish movement. There is already concern that the various gages and road crossings on North Fork Eagle Creek are limiting the ability for fish passage and movement within and upstream from the project area. Finally, finding a suitable location for a gage upstream from the confluence with the South Fork would be difficult due to the width of the channel here and the depth of the alluvium.

The USDA Forest Service agrees that using electronic monitoring switches would be beneficial for management and would minimize monitoring efforts. This type of system would only work with establishing a minimum instream flow, and as stated above, this is outside the jurisdiction of the Forest Service and would not meet the purpose and need for action.

Adding additional storage capacity to the system and evaluating different permit term lengths have been addressed in previous responses. For these reasons, the minimum instream flow alternative was dismissed from further detailed analysis.

Limited Restrictions Alternative

The components of this suggested alternative are included below:

- Instead of using the 300 acre-feet per year threshold per year, use the 2009-2010 pumping volume of 738 acre-feet per year. The 300 acre-feet per year threshold (which is based on 490 acre-feet per year annual recharge rate from the U.S. Geological Survey study based on the chloride mass balance method). This should instead be based on 1,950 acre-feet per year (which is the mid-range based on the annual groundwater recharge rate computed by U.S. Geological Survey using the basin yield method and acknowledges the range of error). Using 738 acre-feet per year is more in keeping with the 1,950 number.

- Do not apply the requirement for no more than 20–30 no-flow days per year during times of drought. Instead use measured annual precipitation and projected streamflow.
- Allow stream augmentation during drought conditions to benefit riparian vegetation.
- Do not use the 5-year average water table depth as a monitoring indicator as it does not take into account the fluctuating nature of the aquifer during drought and subsequent recharge during precipitation events. There is no evidence of an expanding cone of depression outside of National Forest System lands. Remove the riparian monitoring threshold.
- Allow groundwater diversions to continue at 2009-2010 water year levels at least until the Village of Ruidoso has been granted approval to move their water rights and allow sufficient diversion of municipal water rights off of National Forest System lands.
- Account for Office of the State Engineer required reporting per the Hondo Basin duty of water special master report.

The 300 acre-feet per year threshold per year was based on the 500 acre-feet per year recharge for the North Fork basin as determined by the chloride balance method described in the U.S. Geological Survey report. The recharge rate from the chloride balance method was used instead of the rates calculated using the basin yield because of less certainty in evapotranspiration estimation. The chloride balance method also gives a maximum value for recharge because the rocks may contribute chlorine. We do not agree that calculating the recharge rate and then the acceptable well pumping threshold based on the basin yield method is appropriate since the proposed action includes adaptive management to achieve the desired conditions. The use of the recharge rate determined by chloride balance is a safe starting point because it should represent a maximum groundwater recharge rate method.

That being said, the initial threshold of 900 cumulative acre feet over any 3 consecutive water years (300 acre feet per year) is not a stand-alone threshold. As stated in the proposed action, hitting this threshold would trigger a review by the USDA Forest Service of the other current thresholds and mitigations at maintaining or improving surface resource conditions. We would decide, based on evaluation of all monitoring indicators, if changes would be needed.

We are also unclear regarding the suggestion to use 1,950 acre-feet per year; this amount would exceed the current water right for 1,692 acre-feet per year (based on the 2010 Consent Order) which is based on maximum pumping.

We recognize that the 300 acre-feet per year threshold was only a starting point based on the best available information at the time the proposed action was developed. We have since re-evaluated this number based on additional reanalysis of all available information (as recently discussed at the hydrologist technical meeting held in April 2011 and the results of which are documented in chapter 3) and conclude that it still valid based on the best available science. However, the proposed action includes adaptive management strategies that would allow for additional monitoring results to be used to continually review and refine these thresholds based on new information.

For these reasons, the suggestion to use the 2009-2010 pumping volume of 738 acre-feet per year as the well pumping volume threshold was dismissed from further detailed analysis but will be addressed by the no action (no change) alternative.

The other suggestions for removing the no-flow day thresholds, removing the average water table depth threshold, removing the riparian thresholds, and allowing groundwater diversions to continue at 2009-2010 levels are essentially a description of the no action (no change) alternative. The no action (no change) alternative will be analyzed in detail in chapter 3.

The suggestion to use stream augmentation is addressed in the previous responses to stream augmentation earlier in this document.

In regards to the request for Office of the State Engineer reporting, we defer to them in the allocation, adjudication, and transferability of water, even on public lands. The USDA Forest Service as a federal entity recognizes fully adjudicated basins and the apportionment of waters of a designated district by a Water Master.

The Village of Ruidoso would be allowed to pump up to 50 percent of the volumetric rate of surface flow greater than 1.2 cubic feet per second, up to a total of 300 acre-feet per year, measured at the North Fork gage upstream of the wells.

We considered whether this alternative would meet the purpose and need for action. While it would likely meet the second need statement (protecting natural resources on the national forest by maintaining adequate surface and groundwater flows to sustain or improve the riparian and aquatic ecosystems that may be affected by groundwater drawdown from the pumping of these wells) it would not likely meet the first need statement (authorizing, under a special use permit, the Village of Ruidoso's ability to access and divert groundwater from its North Fork Eagle Creek wells on National Forest System land, as a substantial component of the municipal water supply system (attributable, at times, to providing up to 75 percent of the municipal water supply) that Village of Ruidoso residents and visitors rely upon). While this alternative would continue to provide the Village of Ruidoso with water access, it would not likely continue to contribute substantially to the municipal water supply.

The occurrence of flows greater than 1.2 cubic feet per second at the North Fork gage is quite limited (often occurring less than 4 percent of the time). Calculations based on a cutoff of 1.2 cubic feet per second at the North Fork gage from September 2007 through November 2011 data, show that:

- The Village of Ruidoso would be able to divert 300 acre-feet per year (or more, if allowed) during average or wetter years under this alternative. The ability to divert, however, would be much more severely limited during dryer years. It is possible that in some years, the well field would produce less than 10 acre-feet per year under these proposed criteria.
- The average available water for pumping would be approximately 152 acre-feet per year (based on these 4 years of available data only), which would be substantially less than the Village of Ruidoso's current average (569 acre-feet per year based on data from 2002-2010).

Thus, this suggested alternative is very narrow and does not provide the needed flexibility to respond to the first need statement; it could result in an immediate and significant reduction in current levels of use.

The basis for this alternative is in establishing and then managing for a minimum instream flow at all times, measured at the North Fork gage. The flow suggested (1.2 cubic feet per second) is supported by the U.S. Geological Survey study if our desired condition is continuous flow. As stated in our response to the suggestion to eliminate no-flow days completely from the proposed action and to our response to the minimum instream flow alternative (see previous responses to these suggested alternatives earlier in this section), the USDA Forest Service does not have the authority in New Mexico to establish a minimum instream flow. Certain sections of our Forest Service Manual do not apply to this project since North Fork Eagle Creek does not meet certain criteria (see separate “Manual Direction Summary” document (USDA Forest Service 2011) for further information). Therefore, requiring the Village of Ruidoso to manage for a continuous minimum instream flow is not consistent with these conclusions and is outside the jurisdiction of the USDA Forest Service in New Mexico.

For these reasons, this alternative was dismissed from further detailed analysis.

Alternative 3 (Proposed Action) Described in the DEIS

Alternative 3 (proposed action) described in this document is not exactly the same as the proposed action that was described in the DEIS and distributed for public comment, although they are quite similar. Since the distribution of the DEIS we have made a few adjustments to address anticipated conditions due to the Little Bear Fire and the ability for successful adaptive management and monitoring into the future, as well as public input on the DEIS. The intent of the proposed action, however, is the same and it includes similar adaptive management triggers and monitoring to the proposed action described in the DEIS.

Comparison of Alternatives

This section provides a summary of the primary alternative components and how well the alternatives achieve the purpose and need (table 2) and summarizes the effects of implementing each alternative (table 3). The effects of implementing each alternative are described in detail in chapter 3.

Table 2. Summary of alternative components

Components	Alternative 1 – No Change (Continue Pumping)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Permit	New permit issued and authorized for up to 20 years, with stipulations for frequent reviews and verification of the permit terms and conditions. These could occur as often as every year, but would occur at least every 5 to 10 years.	No permit issued; wells and associated facilities would no longer be authorized and all use would be discontinued.	Same as alternative 1.
Wells Used	Four wells authorized under permit (three equipped and one unequipped); wells #1 and #4 would typically be used. If the Village of Ruidoso proposed to begin pumping water from wells #2 or #3, permit terms and conditions would be reviewed; new environmental analysis may be necessary.	None - wells would be removed from National Forest System land within 6-12 months	Same as alternative 1.
Associated Facilities	Permit includes operation and maintenance of existing monitoring wells, well house control station, underground pipeline and power line, and National Forest System Road 127A road maintenance between NM 532 and gate below summer home area.	None – associated facilities would be removed from National Forest System land within 6-12 months.	Same as alternative 1.
Annual Well Pumping Volumes	Approximately 740 acre feet per year, with highest use between March and September (ranging from a combined total of 60 to 117 acre feet per month); between 2002-2010, use averaged 569 acre-feet per year and ranged between 433 and 807 acre-feet per year.	None	Approximately 900 cumulative acre feet or less over any 3 consecutive water years (300 acre feet per year or less). May vary based on monitoring results of other adaptive management triggers. This would be implemented as a starting point only and could be adjusted (up or down), depending on the results of monitoring.
Gages	It is assumed that the North Fork, South Fork and Eagle Creek U.S. Geological Survey gages would remain in place and would continue to be periodicaly monitored by the U.S. Geological Survey.	North Fork gage would possibly be removed; South Fork and Eagle Creek gages would possibly remain and would be monitored by the U.S. Geological Survey.	Same as alternative 1. However, the adaptive management strategy also identifies the use of new alluvial monitoring wells as an integral component of this alternative.

Components	Alternative 1 – No Change (Continue Pumping)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Monitoring	The Village of Ruidoso would provide monthly reports to the USDA Forest Service including bimonthly static and pumping water levels, well operation schedules, and daily pumping quantities (summarized for the month) for the month in acre-feet. As described in more detail in the monitoring section (beginning on page 34) in this chapter, several monitoring measures would be implemented for alternative 1: **#1:** Existing monitoring wells would be rehabilitated or new ones constructed upstream and downstream of the well field. New alluvial monitoring wells would be constructed by the Village of Ruidoso adjacent to North Fork Eagle Creek, at the locations of the North Fork stream gage and Eagle Creek stream gage. **#2:** Using the reconfigured and new monitoring wells from measure #1, the Village of Ruidoso would conduct slug tests or aquifer pumping tests of the individual water-bearing zones of interest at the well field. **#3:** The Village of Ruidoso would take monthly water quality field measurements at all three existing surface flow gages on the North Fork, South Fork, and Eagle Creek, and one additional streamflow sampling location immediately below the well field or wherever surface flow frequently occurs downstream. **#4:** The Village of Ruidoso would continue to record daily mean flow and water level measurements at the three stream gages or new monitoring wells and monitoring wells used in the U.S. Geological Survey program. **#5:** The Village of Ruidoso would identify and monitor eight springs and seeps in the North Fork Eagle Creek drainage on a monthly basis for 1 year.	Surface water monitoring would continue at the existing Eagle Creek below South Fork gage (U.S. Geological Survey 08387600), and water levels would be monitored at a selected well downstream of the existing well field in the vicinity of MW-5. Recording devices or methods, measurement frequencies, and reporting provisions would be determined cooperatively between the USDA Forest Service and U.S. Geological Survey. Adding a transducer that would record hourly so diurnal variations could be accounted for would be considered. The 2010 baseline riparian vegetation survey would be repeated at 5-year intervals, as time and funding allows.	Same as alternative 1, but with the following additional monitoring indicators which would be used to inform the adaptive management triggers described under alternative 3 (beginning on page 27): Baseline: An initial survey traverse with appropriate closure would be conducted at the start of the monitoring program to correlate channel and bank elevations, gage datums and stages, and monitoring well water level elevations between the North Fork gage location (U.S. Geological Survey 08387550), all monitoring wells, and the Eagle Creek gage location (U.S. Geological Survey 08387600). Cross-sectional elevation surveys would be conducted annually at the permanently-located transects (at the North Fork gage, MW-1A, MW-5A, and the Eagle Creek gage locations) to identify ongoing modifications in streambed and bank levels and locations. #1: Surface flow volume would be measured at the Eagle Creek gage and North Fork gage and/or alluvial water elevations measured at new wells located at the Eagle Creek gage and North Fork gage. #2: Water table depth in monitoring wells and water wells would be measured monthly and reported. #3: Annual monitoring of riparian obligate species (e.g. willow and boxelder) would occur. Trends in riparian condition, vegetation canopy cover, and composition would be evaluated and documented at least every 5 years.

Components	Alternative 1 – No Change (Continue Pumping)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
	#6: The Village of Ruidoso would monitor and document stream gradient, planform, and stability indicators annually between June 1 and July 15 at selected and benchmarked cross-section locations along the North Fork Eagle Creek for the first five (5) years of the permit term. After the first five years of the permit term, these parameters would be measured every three years during the permit term. **#7:** The Village of Ruidoso would monitor snowpack on Sierra Blanca for the permit duration. At least one precipitation gage along the North Fork Eagle Creek watershed divide would be maintained, monitored and reported on by the Village of Ruidoso for the permit duration to the USDA Forest Service on a quarterly basis every year. **#8:** The Village of Ruidoso would develop and calibrate a site-specific groundwater computer model in cooperation with the Forest Service and other selected, qualified parties representing appropriate stakeholder interests along the North Fork of Eagle Creek. An implementation plan with schedule, tasks, responsible parties, reporting requirements, quality control measures, and costs would be developed.		Daily pumping quantities in cubic feet would be collected and reported monthly. An implementation plan with schedule, tasks, responsible parties, reporting requirements, quality control measures, and costs would be developed.

Table 3. Summary of environmental effects by alternative

Water Resources - Well pumping results in changes in dynamics of groundwater (groundwater drawdown and water table) and surface water (streamflows, wetlands, springs and seeps). Surface water and groundwater availability are linked and limited by accessible available quantities of water. Water resources over time can also be affected by climate change.

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Estimated duration of no surface flow conditions at the Eagle Creek Gage	One to 2 weeks a year during average precipitation periods; 8 to10 weeks a year during drier periods	Zero no-surface flow periods at the Eagle Creek gage	No more than 4 weeks a year, or 3 weeks a year over 3 years, based on implementation of adaptive management triggers, regardless of dry or wet year
Estimated occurrence of flows equal to or greater than 1.2 cubic feet per second at the Eagle Creek Gage	Forty-six percent of the time during an average precipitation year, or about 5.5 months per year; 19 percent of the time during a below-average precipitation year, or about 2.3 months per year	Fifty-seven percent of the time, or about 6.8 months per year during an average precipitation year	Would likely range from 47 percent to 57 percent of the time, regardless of dry or wet year
Impacts to springs and seeps based on drawdown	Two springs are within the area of projected drawdown (figure 7 and figure 8 in chapter 3) and could be affected; effects would likely range from moderate to severe. Other existing groundwater modeling indicates that more extensive drawdown could occur (Balleau Groundwater 2004). Under those conditions, a number of other springs or seeps in the upper North Fork drainage could be similarly adversely affected	No spring or seeps affected	Decreased drawdown and shorter water-level recovery times would also decrease the duration and extent of drawdown, reducing impacts to springs and seeps compared to alternative 1. Impacts would be local and long term, but minor to moderate since some recovery would be provided during dry periods.
Impacts to domestic wells based on drawdown	Two domestic wells are within the area of project drawdown (figure 7 and figure 8 in chapter 3) and could be affected; effects would likely range from moderate to severe. Other existing groundwater modeling indicates that more extensive drawdown could occur (Balleau Groundwater 2004). Under those conditions, a number of other domestic wells in the upper North Fork drainage could be similarly adversely affected	No domestic wells affected	Decreased drawdown and water level recovery times would also decrease the duration and extent of drawdown, reducing the impacts to domestic wells compared to alternative 1. Impacts would be local and long term, but minor to moderate since some recovery would be provided during dry periods.

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Success of the alternatives over time considering possible climate change	If climate change predictions occur, streamflow quantities may decline; spatial extent and duration of no-flow conditions and flow conditions below 1.2 cubic feet per second could increase; stream temperatures could increase; springs, seeps, and domestic wells may experience declining flows or water levels at a faster pace under potential changing climatic conditions over the long term.	If predicted changes in temperature, precipitation and runoff conditions occur, they could continue to create long-term declines in North Fork flows, even without pumping. Water temperatures may rise overall; this could be particularly noticeable during summer low flows. Springs, seeps, and nearby domestic wells may eventually experience declines or go dry. Qualitatively, these effects could occur at a slower pace than under alternative 1. This could allow greater flexibility and time for resource management to adapt to changing conditions, if they occur.	Predicted effects of climate changes may still occur over the long run, as described for alternative 1 and 2. However, adaptive management strategies could reduce the timing and severity of these effects to the extent possible, when compared to alternative 1. If they occur, increased temperatures, reduced snowpack, and accelerated snowmelt would require ongoing adjustments in adaptive strategies to maintain streamflows and groundwater availability. However, experience gained through adaptive management could allow more informed strategies to be developed for water resources management under changing climatic conditions, if they occur.
Updated Direct and Indirect Effects due to Little Bear Fire: Short Term	Over the short term (until water recovery occurs in about 2019), continued pumping would reduce streamflow and groundwater. While increased soil moisture and streamflow are possible due to reduced transpiration losses, these are likely to be offfset by increased runoff and reduced infiltration and groundwater recharge. The accumulation of sediment and debris could increase depth to saturated conditions. In some locations, greater thickness of newly deposited alluvium could reduce the presence of surface flow or pooling; continued pumping at historic levels could further reduce the occurrence of surface flow or pools.	Over the short term (until water recovery occurs in about 2019), effects of no pumping would encourage the occurrence of streamflow and increased groundwater levels. Large portions of the stream would remain intermittent during periods of average precipitation. The accumulation of sediment and debris could increase depth to saturated conditions. In some locations, greater thickness of newly deposited alluvium could reduce the presence of surface flow or pooling, even without pumping. If this occurs, it would be less frequent or extensive than under either alternative 1 or 3.	Over the short term (until water recovery occurs in about 2019), water resource impacts from implementing alternative 3 would be limited by the application of pumping restrictions. During this period, impacts of natural post-wildfire recovery would override some of the pumping impacts and some of the adaptive management effort. During the short term post-wildfire recovery period, pumping effects would be limited to the extent possible through an iterative and adaptive approach as the landscape, stream channel, and groundwater recharge processes adjust to the fire disturbance.

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Updated Direct and Indirect Effects due to Little Bear Fire: Long Term	In the long term (after post-wildfire recovery), watershed conditions are expected to return to approximate pre-wildfire conditions. If conifer stands burned at moderate to high severity convert to grass or shrubs, less evapotranspiration could improve water yield and groundwater availability. Effects from implementing alternative 1 over the long term would be the same as, or potentially slightly less than, those described above for each indicator for the pre-wildfire assessment.	In the long term (after post-wildfire recovery), watershed conditions are expected to return to approximate pre-wildfire conditions. If conifer stands burned at moderate to high severity convert to grass or shrubs, less evapotranspiration could improve water yield and groundwater availability. If this occurs in the absence of pumping under alternative 2, aquatic habitats could be enhanced and additional opportunities for improving riparian conditions would result.	Over the long term, the Village of Ruidoso would be able to pump its municipal supply from the North Fork Eagle Creek most of the time, and would be able to pump at reduced levels during some, but not all, of the restricted periods. During dry years, adaptive management would improve flow conditions and reduce the amount of no-flow days along the North Fork Eagle Creek. With respect to surface flows and alluvial groundwater levels, an approximate middle ground between alternative 1 and 2 would be attained during average precipitation years under alternative 3. Drawdown effects may still occur at springs, seeps, and domestic wells, but are anticipated to be less than those expected under alternative 1. If climate changes to warmer and drier conditions occur, ongoing adjustments in management strategies to maintain streamflows, alluvial groundwater levels, and Village of Ruidoso water supplies would be required. Experience gained through adaptive management would allow more informed water resources strategies if climatic changes occur. In the long term (after post-wildfire recovery), watershed conditions are expected to return to approximate pre-wildfire conditions. If conifer stands burned at moderate to high severity convert to grass or shrubs, less evapotranspiration could improve water yield and groundwater availability. If this occurs with adaptive management of North Fork Eagle Creek pumping under alternative 3, aquatic habitats could be enhanced and additional opportunities for improving riparian conditions could result.

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Cumulative Effects	Cumulative water resources impacts would involve ongoing reductions in flow and water quality along Eagle Creek within the cumulative impact area, due primarily to reduced groundwater recharge. These would be adverse, long-term and regional impacts that would range in severity from moderate to severe. Additional water supply developments in the region would create further impacts to surface water, groundwater, and associated resources.	Beneficial cumulative recharge effects to aquifers, springs and seeps, and possibly stream baseflows may result within parts of the Eagle Creek drainage. The magnitude and extent of these effects is unknown, since it is likely that the Village of Ruidoso would continue to exercise its water rights and make withdrawals elsewhere in the Eagle Creek system. Impacts from such activities could offset beneficial impacts from no pumping at the North Fork Eagle Creek well field.	Cumulative water resources impacts would include flow and water quality reductions in Eagle Creek within the cumulative impact area. Water supply pumping for the Village of Ruidoso is conducted at five water wells along lower Eagle Creek and the Village of Ruidoso diverts surface water from the stream a short distance below the Eagle Creek gage. As a result, groundwater recharge in downstream alluvial and bedrock aquifers would still be adversely affected, but to a lesser extent than under alternative 1. Implementing alternative 3 would have minor effects on these impacts, as pumping in the North Fork Eagle Creek would generally be permitted most of the time.
Updated Cumulative Effects due to Little Bear Fire: Short Term	Over the short term (until water recovery occurs in about 2019), continued pumping under alternative 1 would add cumulatively to downstream water resources impacts from the fire as well as other water uses outside the forest boundary, resulting in reductions of downstream baseflows and groundwater levels. Adverse effects to streamflows would be masked by accelerated surface runoff, erosion and debris flows, channel geometry changes, and reduced water quality, however. Other water users in the cumulative impact study boundary would affect surface drainage and groundwater levels. Depending on the timing and volumes of these other water withdrawals and returns, all these factors would combine to largely obscure the downstream effects of North Fork Eagle Creek pumping.	Over the short term (until water recovery occurs in about 2019), the cessation of pumping under alternative 2 would contribute beneficially to downstream baseflows and groundwater levels outside the forest boundary. Beneficial effects to streamflows could be masked by accelerated surface runoff, erosion and debris flows, channel geometry changes, and reduced water quality, however. Other water users in the cumulative impact study boundary would affect surface drainage and groundwater levels. Depending on the timing and volumes of these other water withdrawals and returns, these factors could obscure some of the beneficial effects from alternative 2 in the short term.	Over the short term (until water recovery occurs in about 2019), management of pumping under alternative 3 would contribute beneficially to downstream baseflows and groundwater levels outside the forest boundary. Beneficial effects to streamflows could be masked by accelerated surface runoff, erosion and debris flows, channel geometry changes, and reduced water quality, however. Other water users in the cumulative impact study boundary would affect surface drainage and groundwater levels. Depending on the timing and volumes of these other water withdrawals and returns, these factors could obscure some of the beneficial effects from alternative 3 in the short term.

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Updated Cumulative Effects due to Little Bear Fire: Long Term	Over the long term, cumulative effects would be the same as those described above for the pre-wildfire assessment; potential cumulative effects on streamflows and groundwater would not be restricted to water uses by the Village of Ruidoso, as described in detail in chapter 3.	Over the long term, additional streamflow and groundwater would pass downstream from North Fork Eagle Creek into the cumulative impact study area resulting in beneficial recharge effects to aquifers, springs and seeps, riparian condition, and possibly stream baseflows. Due to the number of other water users in the cumulative impact study area, the magnitude and extent of these effects is unknown. Implementing alternative 2 would preclude the use of the North Fork Eagle Creek well field for municipal water which would create additional demands and associated pumping drawdown effects on other water resources in the Eagle Creek drainage or nearby.	Over the long term, post fire cumulative impacts would be the same as those described above for the pre-wildfire assessment. Potential cumulative effects on streamflows and groundwater would not be restricted to water uses by the Village of Ruidoso, as described in detail in chapter 3. Implementing alternative 3 would occasionally create temporary demands by the Village for other water sources. It is likely that the Village would met those demands by pumping groundwater supplies elsewhere, by additional leasing of existing water rights, by developing additional storage facilities, by enacting further water use limitations beyond its current practices, or some combination of these.

Aquatic Habitat and Fish - Well pumping results in changes in the water table which may affect streamflow to varying degrees. Lowering streamflow may increase temperatures and temperature-related fish mortality. Quantity, quality, and water flow availability that mirrors natural flow patterns are important for aquatic habitat and fish. Suitable water quality and temperatures, which are partially based on water depth and channel conditions, are necessary to support fish populations. Sufficient water supplies must also be available during summer months to provide water temperatures needed for survival of aquatic species.

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Streamflow quality and quantity indicators for water resources and implications for aquatic habitat and fish	The North Fork Eagle Creek below the well field to the Eagle Creek gage was probably never a high quality fishery and has always been limited by the intermittent nature of the creek. There are now fewer fish in North Fork Eagle Creek and fewer opportunities for recreational fishing along North Fork Eagle Creek than there were before 1988. This is probably due, at least in part, to reduced streamflow as a result of North Fork Eagle Creek well pumping. This trend would continue by implementing alternative 1.	Improved surface flow, eliminated or reduced no-flow days and reduced duration of stream temperatures above 68 degrees Fahrenheit would improve aquatic habitat and fishing potential. While this segment of North Fork Eagle Creek is not considered a high quality trout fishery and this would not change with implementation of alternative 2, aquatic habitat conditions would improve over the long term and provide higher quality fish habitat over time and fish recovery would be enhanced.	Effects would be similar to alternative 2 because surface flow would improve, no-flow days would be reduced (but not eliminated) and there would be a reduction in the duration of stream temperatures above 68 degrees F; these changes would result in improved aquatic habitat and fishing potential, but these changes would be less than those for alternative 2 but greater than those for alternative 1.
Updated Effects due to the Little Bear Fire: Short Term	No fish were observed in the upper perennial reaches (upstream of the North Fork gage) during surveys conducted in 2013 after the fire. Aquatic invertebrates typically decline immediately after a fire. In the short term, reduced water quality, channel morphology changes, and deeper alluvial deposits due to the fire would continue to reduce the fish and aquatic habitat quality in the project area while the watershed is recovering. Pools and stretches of surface water may be reduced and this would affect aquatic habitat and fish presence. Continued pumping under alternative 1 during the short term is expected to continue to limit the potential for fish and aquatic habitat improvement.	In the short term, reduced water quality, channel morphology changes, and deeper alluvial deposits due to the fire would continue to reduce the fish and aquatic habitat quality in the project area while the watershed is recovering. The effects of no pumping, however, would encourage the occurrence of streamflow and increased groundwater levels (more so than under alternative 1) although large portions of the stream would remain intermittent during periods of average precipitation. Pools and stretches of surface water may be reduced and this would affect aquatic habitat and fish presence. Under alternative 2, the potential for fish and aquatic habitat improvement will continue to be limited but not as much as under alternative 1.	In the short term, reduced water quality, channel morphology changes, and deeper alluvial deposits due to the fire would continue to reduce the fish and aquatic habitat quality in the project area while the watershed is recovering. During the short term post-wildfire recovery period, pumping effects would be limited to the extent possible through an iterative and adaptive approach as the landscape, stream channel, and groundwater recharge processes adjust to the fire disturbance. Under alternative 3, the potential for fish and aquatic habitat improvement will continue to be limited but not as much as under alternative 1.

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Updated Effects due to the Little Bear Fire: Long Term	Over the long term, after post-wildfire recovery, watershed conditions are expected to return to approximate pre-wildfire conditions. Aquatic invertebrates could respond positively to increased stream productivity but the timeframe for this recovery is difficult to predict. Water yield and groundwater availability may improve as shown in the water resources analysis and debris flows could result in a more dynamic channel environment benefiting fish habitat. However, continued pumping would obscure some of these potential benefits. Therefore, adverse effects from implementing alternative 1 over the long term would be the same as, or slightly less than, the pre-wildfire assessment for alternative 1.	Over the long term, after watershed recovery, effects from no pumping would be the same as those described in the pre-wildfire assessment for alternative 2. Aquatic invertebrates could respond positively to increased stream productivity but the timeframe for this recovery is difficult to predict. Water yield and groundwater availability may improve as shown in the water resources analysis and debris flows could result in a more dynamic channel environment benefiting fish habitat. With the cessation of pumping, these potential benefits could be increased Therefore, beneficial effects from implementing alternative 2 over the long term would be the same as, or slightly more than, the pre-wildfire assessment for alternative 2.	Over the long term, during dry years, adaptive management would improve flow conditions and reduce the amount of no-flow days along the North Fork Eagle Creek. With respect to surface flows and alluvial groundwater levels, an approximate middle ground between alternative 1 and 2 would be attained during average precipitation years under alternative 3. In the long term (after post-wildfire recovery), watershed conditions are expected to return to approximate pre-wildfire conditions. If conifer stands burned at moderate to high severity convert to grass or shrubs, less evapotranspiration could improve water yield and groundwater availability. If this occurs with adaptive management of North Fork Eagle Creek pumping under alternative 3, aquatic habitats could be enhanced and additional opportunities for improving riparian conditions could result. Therefore, beneficial effects from implementing alternative 3 over the long term would be the same as the pre-wildfire assessment for alternative 3.

Riparian Vegetation - Well pumping results in changes in the water table which may affect streamflow to varying degrees. These water quantity changes could indirectly affect quantity and quality of riparian vegetation along the stream corridor.

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Predicted qualitative shifts in communities over time	Since the spatial extent and duration of no-flow conditions and flows less than 1.2 cubic feet per second would increase over time (climate change combined with continued pumping), there would be less water available in the alluvium for plant growth and sustenance. If groundwater levels lower beyond current levels, there would be an increase in xeric, upland species and a decrease or loss in riparian species dependent on shallow groundwater, over the long term.	Project design features minimize any direct effects to riparian vegetation during well and facility removal. Indirectly, improved groundwater and surface flow would increase available moisture for riparian vegetation and could result in maintenance or expansion of the riparian zone over time; slight increases in communities featuring facultative wetland species is possible, but may not be fully realized due to the possibility of continued climate change-related drying trends, over the long term.	Indirectly, improved groundwater and surface flow would increase available moisture for riparian vegetation and could result in maintenance or expansion of the riparian zone over time; slight increases in communities featuring facultative wetland species is possible, but may not be fully realized due to the possibility of continued climate change-related drying trends, over the long term. Effects would be more similar to alternative 2 than alternative 1 due to improvements in water availability.
Predicted qualitative shifts in riparian tree species	Box elder, Pacific willow and other riparian tree species would show signs of stress and reduced canopy cover over time due to reductions in groundwater and streamflow. It is likely that Pacific willow would eventually die out and would no longer occur along North Fork Eagle Creek below the well field over the long term (Pacific willow upstream of the North Fork gage would not be affected).	Project design features would minimize any direct effects to riparian trees during well and facility removal. Indirectly, increased water availability would likely not result in measurable changes in box elder but Pacific willow would likely experience increased seedling recruitment and could expand; however, this may not be a substantial change over the current condition considering the possibility of continued climate change-related drying trends, over the long term.	Indirect effects to box elder and Pacific willow would be more similar to alternative 2 than alternative 1 due to improvements in water availability.

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Updated Effects due to Little Bear Fire: Short Term	In the short term, fire effects are likely to result in a shifting of sediment and cobble. This channel instability could result in some riparian areas being buried and an increase in alluvium that would reduce surface flow. However, these adverse effects to riparian tree species and communities could be offset by the opportunity for species such as willows to colonize new areas.	In the short term, fire effects are likely to result in a shifting of sediment and cobble. This channel instability could result in some riparian areas being buried and an increase in alluvium that would reduce surface flow. However, these adverse effects to riparian tree species and communities could be offset by the opportunity for species such as willows to colonize new areas. The effects of no pumping would encourage the occurrence of streamflow and increased groundwater levels (more so than under alternative 1) although large portions of the stream would remain intermittent during periods of average precipitation. Pools and stretches of surface water may be reduced and this could affect riparian habitat. Under alternative 2, the potential for riparian habitat improvement will continue to be limited but not as much as under alternative 1.	In the short term, fire effects are likely to result in a shifting of sediment and cobble. This channel instability could result in some riparian areas being buried and an increase in alluvium that would reduce surface flow. However, these adverse effects to riparian tree species and communities could be offset by the opportunity for species such as willows to colonize new areas. During the short term post-wildfire recovery period, pumping effects would be limited to the extent possible through an iterative and adaptive approach as the landscape, stream channel, and groundwater recharge processes adjust to the fire disturbance. Under alternative 3, the potential for riparian habitat improvement will continue to be limited but not as much as under alternative 1. Alternative 3 would encourage the occurrence of streamflow and increased groundwater levels (more so than under alternative 1) although large portions of the stream would remain intermittent during periods of average precipitation. Pools and stretches of surface water may be reduced and this could affect riparian habitat.

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Updated Effects due to Little Bear Fire: Long Term	Over the long term, water yield and groundwater availability may improve as shown in the water resources analysis, benefiting riparian habitat. However, continued pumping would obscure some of these potential benefits. Therefore, adverse effects from implementing alternative 1 over the long term would be the same as, or slightly less than, the pre-wildfire assessment for alternative 1.	Over the long term, after watershed recovery, effects from no pumping would be the same as those described in the pre-wildfire assessment for alternative 2.	Over the long term, during dry years, adaptive management would improve flow conditions and reduce the amount of no-flow days along the North Fork Eagle Creek. With respect to surface flows and alluvial groundwater levels, an approximate middle ground between alternative 1 and 2 would be attained during average precipitation years under alternative 3. Over the long term, after watershed recovery, effects from implementing an adaptive management strategy would be the same as those described in the pre-wildfire assessment for alternative 3.
Socioeconomics - Effects on water available for diversion have potential to affect local social and economic conditions. Well pumping may result in changes in groundwater and surface water availability. Limiting access to groundwater pumping has potential to alter municipal water supply, affect streamside recreational use (public use of streams for streamside recreation, fishing, and wildlife viewing), and affect private land (availability of water for domestic wells).			
Measurement Indicators	**Alternative 1 – No Change (Continue Pumping at Historic Levels)**	**Alternative 2 – No Action (No Pumping)**	**Alternative 3 – Proposed Action (Adaptive Management)**
Municipal water supply (overall and during 5-month summer resort period)	Average annual contributions from North Fork Eagle Creek wells would continue to provide from 25 to 29 percent percent of the Village of Ruidoso water supply if current trends in total diversion and North Fork Eagle Creek wells diversion continue; past trends in North Fork Eagle Creek wells diversion during the 5-month summer resort period would also continue (38 to 58 percent in 2006 and 2004, respectively). Consideration of additional contributions attributable to North Fork Eagle Creek well diversions (50 percent return flow credit) North Fork Eagle Creek wells would continue to provide 36-43 percent to the municipal water supply overall, and 57-87 percent during the summer months. Annual diversions in the future could average approximately 569 acre-feet per year.	North Fork Eagle Creek wells would not contribute 25-29 percent of the municipal water supply or 38-58 percent during the summer months; this need would have to come from another water source There would be no water diverted; this water would need to come from another source.	There would be periodic restrictions on pumping, particularly during the summer. Based on the streamflow adaptive management triggers, North Fork Eagle Creek wells would provide about 23-25 percent to the municipal water supply overall, and 25-57 percent during the summer. Including the 50 percent return flow credit; North Fork Eagle Creek wells would continue to provide 34.5-37.5 percent to the municipal water supply overall, and 37.5-85.5 percent during the summer months. Restrictions based on the streamflow triggers would likely be enacted fequently during below-average precipitation years but infrequently during average or above average precipitation years. Annual diversions could average 236 acre-feet per year or more depending on how the adaptive management triggers were implemented

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Projected production	If average annual diversion from these wells continues they would contribute 11 percent of the projected adjusted diversion needs (5,097 acre-feet) for the year 2045.	Without groundwater withdrawal, North Fork Eagle Creek wells would not contribute towards future Village of Ruidoso demand and their projected contribution (11 percent) in 2045 would have to come from another source.	Average annual diversion from North Fork Eagle Creek wells would continue and they would continue to contribute towards future Village of Ruidoso demand; Based on enacting the streamflow adaptive management triggers, their projected contribution in 2045 would be 0.1 - 1.3 percent less than under alternative 1.
Streamflow quality and quantity and springs/seeps indicators for water resources and implications for streamside recreational use	With continued periods of no flow days, flows below 1.2 cubic feet per second, periods of stream temperatures above 68 degrees Fahrenheit and effects to springs/seeps (as shown in the water resources section), streamside recreational use would be negatively affected; the quality of this recreation experience would be less than that provided by either alternative 2 or 3.	With elimination of no-flow days and approximately 7 months annually with flows above 1.2 cubic feet per second, and no effects to springs/seeps (as shown in the water resources section), streamside recreational use would improve over current conditions and would be of higher quality compared to either alternative 1 or 3.	With a decrease in the number of no-flow days, an increase in the duration of flows greater than 1.2 cubic feet per second, a reduction in times when stream temperatures are above 68 degrees Fahrenheit, and a decrease in the potential effect to springs/seeps, streamside recreational use would improve over current conditions and over that provided by alternative 1, but would be of lower quality than that provided by alternative 2.
Domestic wells indicator for water resources and implications for private land water supply	The potential for adverse effects to the availability of domestic well water are greatest under this alternative compared to alternative 2 or 3; up to two domestic wells could be directly affected.	Because no domestic wells would be directly affected by groundwater drawdown under this alternative, there would be no effect to the availability of water for domestic use.	Decreased drawdown and water level recovery times would decrease the duration and extent of drawdown, which would lessen the impacts to domestic wells. The potential for adverse effects to the availability of domestic well water would be less than alternative 1 but greater than alternative 2.

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Values, attitudes and beliefs	Quality of life as it relates to municipal water supply would remain unchanged under this alternative; quality of life associated with the quality of recreation experience and the availability of domestic well water would remain unchanged; the Lincoln National Forest would continue to support quality of life at levels experienced currently.	Quality of life as it relates to municipal water supply would be adversely affected since North Fork Eagle Creek wells would no longer contribute to the water supply; quality of life associated with the quality of recreation experience and the availability of domestic well water would be improved over current conditions; the Lincoln National Forest would continue to support quality of life in the area but less than currently supported from municipal water supply and more in terms of the quality of recreation experience and the availability of domestic well water.	Quality of life as it relates to municipal water supply would be less than experienced currently due to restrictions on North Fork Eagle Creek well pumping. However, quality of life associated with the quality of recreation experience and the availability of domestic well water would be improved over current conditions; the Lincoln National Forest would continue to support quality of life in the area but less than currently supported from municipal water supply and more in terms of the quality of recreation experience and the availability of domestic well water.
Environmental justice (effects of agency programs that disproportionately impact minority and low income populations)	There would be no disproportionately high or adverse human health or environmental effect on minority or low-income populations. Quality of life related to water supply, recreation and domestic well water would remain unchanged from current conditions.	There would be no disproportionately high or adverse human health or environmental effect on minority or low-income populations. While adverse effects to total municipal water diversions are anticipated they are expected to be distributed amongst all segments of the Village of Ruidoso population since water diversion from the North Fork Eagle Creek wells cannot be attributed to supply certain areas of the Village of Ruidoso. Consequently, effects are not considered disparate since effects would occur to communities regardless of racial, ethnic or poverty status.	There would be no disproportionately high or adverse human health or environmental effect on minority or low-income populations. While adverse effects to total municipal water diversions are anticipated they would be the same as those described for alternative 2.

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Cumulative effects	Since there are no direct and indirect effects (conditions would remain unchanged), there would be no cumulative effects.	Regardless of the contributions of the North Fork Eagle Creek wells to the water supply, future water supply needs exceed existing supply and existing water rights, even with implementation of utility use reduction and conservation. Without North Fork Eagle Creek contributions, the potential for adverse cumulative effects to municipal water supply would be greater under this alternative than either alternative 1 or 3. However, adverse cumulative economic effects to the quality of recreation experience would be less under this alternative than alternative 1 or 3. Similarly, adverse cumulative economic effects to nearby domestic wells would be less under this alternative than alternative 1 or 3.	Regardless of the contributions of the North Fork Eagle Creek wells to the water supply, future water supply needs exceed existing supply and existing water rights, even with implementation of utility use reduction and conservation. With limited North Fork Eagle Creek contributions, adverse cumulative economic effects to municipal water supply would be greater under this alternative than under alternative 1but less than alternative 2. Adverse cumulative economic effects to the quality of recreation experience would be less under this alternative than under alternative 1 but more than alternative 2. In addition, the potential for adverse cumulative economic effects to nearby domestic wells would be less than under alternative 1 but more than alternative 2.

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Updated Direct, Indirect and Cumulative Effects Due to Little Bear Fire	Implementation of alternative 1 would achieve the first need statement regarding the Village of Ruidoso's ability to access and divert groundwater from its North Fork Eagle Creek wells because it would continue to provide water to the Village of Ruidoso. Once conditions allow for North Fork Eagle Creek well pumping to resume at pre-wildfire levels it is likely that the Village of Ruidoso will have made water supply adjustments in order to meet water supply demand and their reliance on North Fork Eagle Creek well pumping may be less. While the short-term effects of implementing alternative 1 to other aspects of the socioeconomic analysis are uncertain during the watershed recovery period, the long-term effects are the same as those described above for the pre-wildfire assessment.	Alternative 2 does not address the first need statement and would not provide any contribution to the municipal water supply. Without groundwater withdrawal, the North Fork wells would not provide their pre-fire share of Village of Ruidoso water supply and would not contribute toward future demands for water diversion. While the short-term effects of implementing alternative 2 to other aspects of the socioeconomic analysis are uncertain during the watershed recovery period, the long-term effects are the same as those described above for the pre-wildfire assessment.	Implementation of alternative 3 would achieve the first need statement regarding the Village of Ruidoso's ability to access and divert groundwater from its North Fork Eagle Creek wells because it would continue to provide water to the Village of Ruidoso. However, alternative 3 may not provide the pre-wildfire share of water as would alternative 1. Regardless, when additional indirect contributions attributable to the 50 percent return flow credit are considered under alternative 3, North Fork Eagle Creek wells would continue to provide 37.5 to 85.5 percent of municipal water supply during the 5-month summer resort period. Once conditions allow for North Fork Eagle Creek well pumping to resume at pre-wildfire levels it is likely that the Village of Ruidoso will have made water supply adjustments in order to meet water supply demand. Consequently reliance on North Fork Eagle Creek well pumping may be less than depicted above. While the short-term effects of implementing alternative 3 to other aspects of the socioeconomic analysis are uncertain during the watershed recovery period, the long-term effects are the same as those described above for the pre-wildfire assessment.

Water Rights - Well pumping results in changes in dynamics of groundwater and surface water. Surface water and groundwater availability are linked and are limited not only by accessible available quantities of water, but also by available water rights. Limiting access to groundwater pumping has potential to alter municipal water supply and affect beneficial use of the Village of Ruidoso's total adjudicated water rights.

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Beneficial use of the Village of Ruidoso's water rights	Without limitations on groundwater withdrawal, the Village of Ruidoso would be able to access and put to beneficial use their adjudicated water rights, which total 2539.34 acre feet per year.	Without groundwater withdrawal at the current location, the Village of Ruidoso would need to file application with the Office of the State Engineer to transfer the point of diversion of their water rights. If protests are filed the Office of the State Engineer would hold a formal hearing and decide the case. This decision could be appealed. These hearings can take months or years to complete. This is a state of New Mexico process that does not involve the USDA Forest Service.	With the potential for limited groundwater withdrawal at the current location, the Village of Ruidoso would need to file application with the Office of the State Engineer to transfer the point of diversion of a portion of their water rights (as summarized for alternative 2).
Updated Effects due to the Little Bear Fire: Short Term	The fire halted the production of both surface and groundwater diversions along Eagle Creek due to water quality and debris flow issues. This impacted water production and the Village of Ruidoso's ability to access the return flow credits along the Rio Ruidoso. The shift from the Eagle Creek watershed to the Rio Ruidoso watershed created a temporary redistribution of water rights along the Rio Ruidoso (also impacted by water quality from the Little Bear Fire). Approved on an emergency basis by the Office of the State Engineer, the Village of Ruidoso received a temporary additional point of diversion, at the confluence of the Rio Ruidoso and Carrizo Creek to the south, to provide water to the Grindstone Dam for use in the municipal supply. This redistribution is anticipated to be short-term in nature. Lack of diversion due to emergency circumstances created by the Little Bear Fire in 2012 is not expected to have a direct effect on the beneficial use of the Village of Ruidoso's adjudicated water rights.	Same as alternative 1.	Same as alternative 1.

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Updated Effects due to the Little Bear Fire: Long Term	Over the long term, historic water rights and allocation will remain as defined in the 2010 Consent Order. Therefore, the effects of implementing alternative 1 to the beneficial use of the Village of Ruidoso's water rights is the same as that described in the pre-wildfire assessment above.	Same as alternative 1.	Same as alternative 1.

Non-Significant Issue - Vegetation (other than riparian)			
Measurement Indicators	**Alternative 1 – No Change (Continue Pumping at Historic Levels)**	**Alternative 2 – No Action (No Pumping)**	**Alternative 3 – Proposed Action (Adaptive Management)**
Invasive Plants (musk thistle)	There would be no direct effects since there would be no ground disturbance. This species occurs in a wide enough range of conditions to be neither beneficially nor detrimentally affected by changes in water depth. Therefore, there would be no direct or indirect effects on the increased risk of spread for musk thistle or other non-native invasive plants.	This alternative includes removal of facilities with the end of the permit. Although the area of the disturbance would be relatively small, this ground disturbance would still contribute to the increased likelihood of non-native plant spread, minimized by the implementation of mitigation measures.	Same as alternative 1
2013 Regional Forester's Sensitive Species (Wooton's hawthorn and Sierra Blanca cliff daisy)	No effect to Regional Forester's sensitive species determination. There would be no direct effects since there would be no ground disturbance. Because Sierra Blanca cliff daisy is not dependent on groundwater or surface water there would be no indirect effects to this species. Wooton's hawthorn populations are stable to increasing in the project area and appear to have a wide enough range of conditions to not be indirectly affected by changes in groundwater or surface water.	No effect to Regional Forester's sensitive species determination. Mitigation measures would be implemented to ensure there would be no direct effects from ground disturbance associated with removal of wells and facilities. Indirect effects would be the same as those described for alternative 1.	Same as alternative 1
Upland Vegetation	There would be no direct effects since there would be no ground disturbance. Indirect effects of water drawdown would reach into the North Fork Eagle Creek basin and would result in a reduction of available moisture for new growth. However, upland vegetation is not as sensitive to water fluctuation as riparian vegetation and would be resistant to changes in moisture; adverse effects would be minimal. Growth of individual trees may be stunted, but would not result in any measurable affects across the project area as a whole.	There would be no direct effects since ground-disturbing activities would be limited to the riparian corridor and project design features would minimize the effects to vegetation in the area of disturbance. Having more groundwater available in the North Fork Eagle Creek basin would provide added moisture for new growth. However, upland vegetation is not as sensitive to water fluctuation as riparian vegetation; beneficial effects would be minimal. Growth of individual trees may increase, but would not result in any measurable affects across the project area as a whole.	There would be no direct effects since there would be no ground disturbance. Indirect effects would be the same as alternative 2.

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Updated effects to Vegetation due to the Little Bear Fire	Upland vegetation burned by the fire is likely to experience additional stress due to effects from fire damage and therefore could be adversely impacted from reduced water availability due to drawdown from well pumping. Therefore, the potential for adverse impacts from alternative 1, as described above, could be somewhat greater than predicted above, post-wildfire. Because upland vegetation is less sensitive to groundwater drawdown effects from pumping than vegetation in the riparian zone, these differences between pre-wildfire and post-wildfire effects are likely negligible to minor. The impacts to Wooton's Hawthorn and Sierra Blanca cliff daisy are the same as those described for the pre-wildfire assessment above. All musk thistle populations were burned in the project area and increases in occurrences in the project area are likely as a result of the wildfire. Native seeding was undertaken following the Little Bear Fire to reduce further noxious weed spread (USDA Forest Service 2012). Project design features would minimize spread. Therefore, the impacts to invasive plants are the same as those described for the pre-wildfire assessment above.	Same as alternative 1	Same as alternative 1

Non-Significant Issue - Wildlife			
Measurement Indicators	**Alternative 1 – No Change (Continue Pumping at Historic Levels)**	**Alternative 2 – No Action (No Pumping)**	**Alternative 3 – Proposed Action (Adaptive Management)**
Federally listed species (Mexican spotted owl)	No effect determination under section 7 of the Endangered Species Act; nearest nesting area is 0.75 miles from North Fork Eagle Creek; no suitable nesting/roosting or critical habitat within action area. There would be a mitigation measure to avoid disturbance activities to Mexican spotted owl during breeding and nesting season from March 1 to August 31.	Same as alternative 1	Same as alternative 1
2013 Regional Forester's Sensitive Species	No effect to Regional Forester's sensitive species (Northern goshawk, Sacramento mountains salamander, Ruidoso red squirrel). Nearest northern goshawk nesting area is 0.1 mile from action area; nearest known salamander location is 0.4 mile from action area; no known populations of Ruidoso red squirrels in project area There would be a mitigation measure to avoid disturbance activities to northern goshawks during the breeding season.	Same as alternative 1	Same as alternative 1
Management Indicator Species	No management indicator species for riparian habitat are known to occur in the project area; management indicator species for mixed conifer (pygmy nuthatch), aspen (hairy woodpecker), high quality browse (mule deer), mixed conifer (elk and Ruidoso red squirrel) would not be affected; Forest-wide habitat and population trends as a whole would not be affected due to the small size of the project area.	Same as alternative 1; the increase in available surface water and indirect benefit to riparian vegetation could result in improved water availability (particularly for elk and deer) and habitat quality	Same as alternative 1

Measurement Indicators	Alternative 1 – No Change (Continue Pumping at Historic Levels)	Alternative 2 – No Action (No Pumping)	Alternative 3 – Proposed Action (Adaptive Management)
Migratory Birds	There would be no impact to migratory bird species or their habitats There would be no unintentional take of adults, eggs, and/or chicks and no ground or habitat disturbance for migratory birds. The mitigation measure to avoid disturbance activities to northern goshawks and Mexican spotted owls during the breeding season would also minimize the potential for effects to migratory birds.	Same as alternative 1	Same as alternative 1
Updated Effects due to the Little Bear Fire	While impacts from the Little Bear Fire to threatened, endangered and sensitive species, management indicator species, migratory birds, and their habitats are not known with certainty, it is likely that some of these species were affected to some degree, at least in the short term. However, based on supplemental analysis, implementation of any of the alternatives post-wildfire should not contribute to any additional direct or indirect adverse impacts (see the wildlife section in chapter 3). The effects from implementing alternative 1 are the same as those for the pre-wildfire assessment.	Same as alternative 1	Same as alternative 1

Chapter 3. Affected Environment and Environmental Consequences

This chapter summarizes the physical, biological, social, and economic environments of the project area and the effects of implementing each alternative on that environment. It also presents the scientific and analytical basis for the comparison of alternatives presented in the alternatives chapter. Significant issues (water resources, aquatic habitat and fish, riparian vegetation, socioeconomics, and water rights) are discussed first, followed by nonsignificant issues.

Where there are differences in the affected environment and environmental consequences of the alternatives due to the Little Bear Fire, these are noted.

Figure 4 is a map of the project area and the cumulative impact analysis area. Figure 5 depicts the boundary and burn severities of the Little Bear Fire in relation to the North Fork project area.

Methodology

The impact analysis and conclusions contained in this chapter were based on Lincoln National Forest staff knowledge of the resources and site, reviewing of existing literature and agency studies, information provided by specialists within the USDA Forest Service, other agencies and contractors, and professional judgment. The methodology section at the beginning of each resource heading describes any additional specific data collection/analysis or other methods used for that resource.

Potential impacts in this chapter are described in terms of type (direct, indirect, cumulative and are the effects beneficial or adverse?), context (are the effects site specific, local, or even regional?), duration (are the effects short term or long term?), and intensity.

Direct effects occur at the same time and in the same locations as actions that cause them. Indirect effects are those that occur at a later time or in a different location than the actions that were their cause. Cumulative impacts result from the additive impacts of past, present, and reasonably foreseeable future actions in or near the area.

For purposes of this analysis, short-term effects are those expected within the next 1 to 10 years and long-term effects are those that are expected between 10 and 20 years or more unless specifically defined in individual resource sections below.

The analysis we present for alternative 3 (proposed action) in each resource section assumes that all adaptive management triggers are implemented as described in the description of the proposed action in chapter 2. The analysis we present for all alternatives in each resource section assumes that all mitigation measures and monitoring specific to each alternative (as described at the end of chapter 2) are implemented.

The methodology section in each resource section later in this chapter includes a summary of any changes to the methods used for analysis based on the Little Bear Fire.

The specialist reports used in preparation of this chapter are:

- Water Resources Report for the DEIS (AECOM 2012) and Supplemental Water Resources Report for the SDEIS (AECOM 2014)

- Riparian Vegetation Report and Botanical Resources Report for the DEIS (Miller 2012a and Miller 2012b) and Supplemental Vegetation Report and Supplement Botanical Resources Report for the SDEIS (Miller 2014a and 2014b)
- Fish and Wildlife Report and Biological Evaluation and Wildlife Biological Assessment for the DEIS (Bright 2012a and Bright 2012b) and Supplemental Fish and Wildlife Report and Biological Evaluation and Wildlife Biological Evaluation and Assessment for the SDEIS (Bright 2014)
- Socioeconomics Report for the DEIS (Eichman 2012) and Supplemental Socioeconomics Report for the SDEIS (Eichman and Loughery 2014)
- Water Rights Report for the DEIS (Thompson 2012) and Supplemental Water Rights Report for the SDEIS (Thompson 2014)

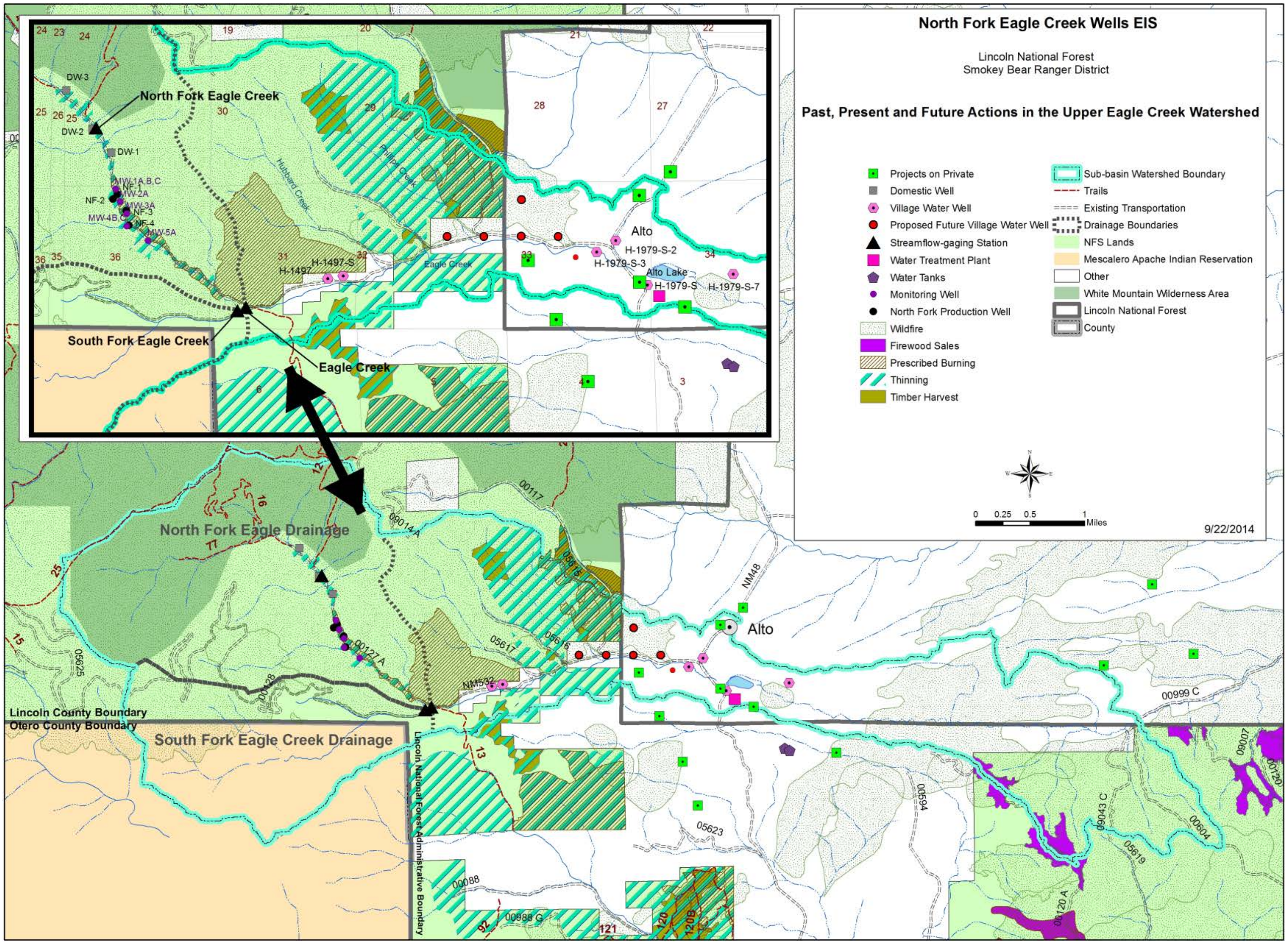

Figure 4. Upper Eagle Creek drainage for cumulative impact analysis

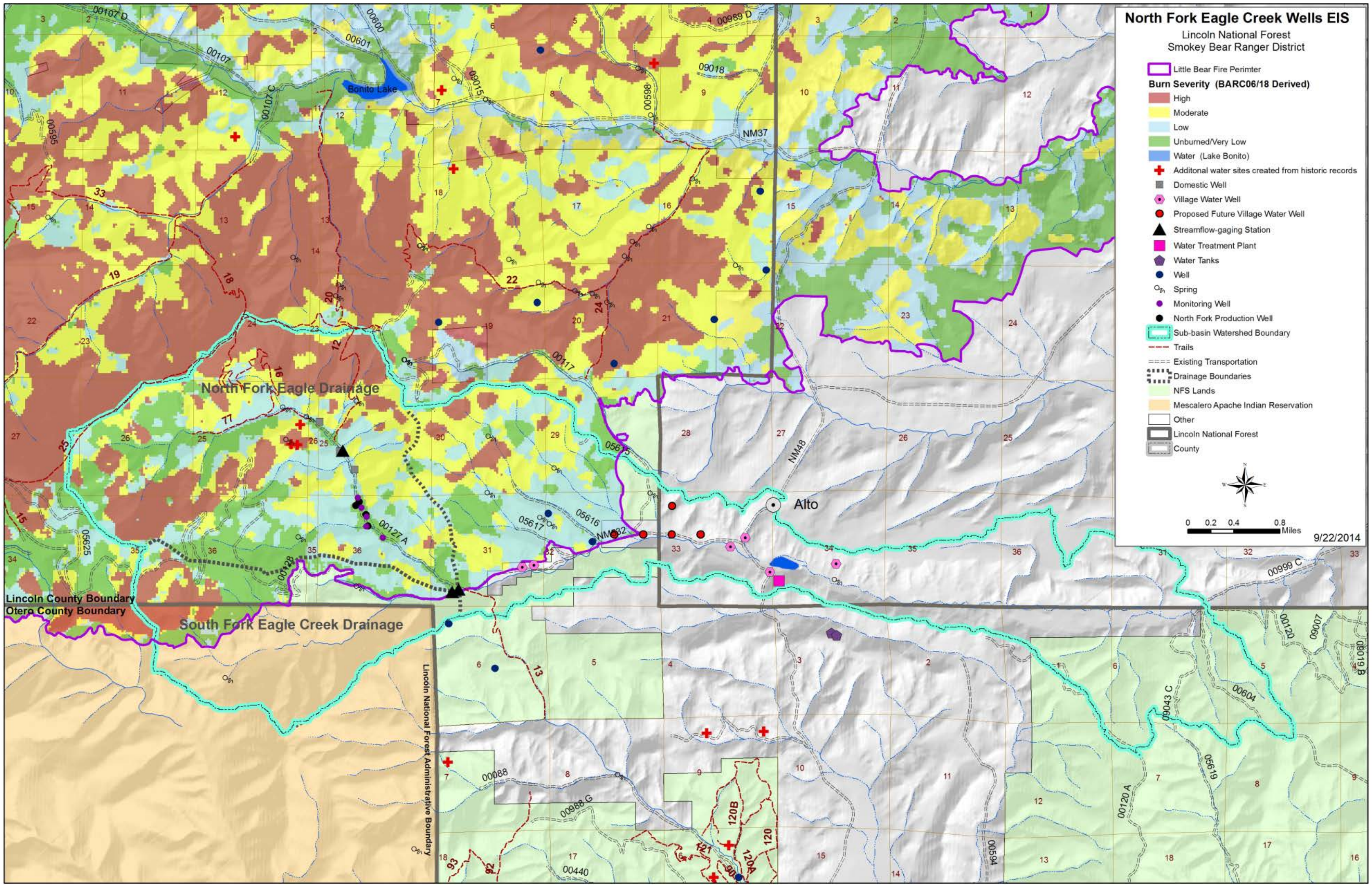

Figure 5. Little Bear Fire

Past, Present, and Reasonably Foreseeable Future Actions

Cumulative impact is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes the action (40 CFR 1508.7).

The baseline used for cumulative effects analysis is the no action alternative. The cumulative effects analysis; while it includes some consideration of past human actions; does not fully quantify all effects of past human actions by adding up all prior actions on an action-by-action basis. By looking at current conditions, we capture residual effects of past human actions and natural events, regardless of which particular action or event contributed those effects. The Council on Environmental Quality issued an interpretive memorandum on June 24, 2005, regarding analysis of past actions, which states, "agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without delving into the historical details of individual past actions." The cumulative effects analysis in this EIS is also consistent with Forest Service NEPA regulations (36 CFR 220.4(f)). For these reasons, while some past actions are listed and considered, the focus of the cumulative analysis is based on current environmental conditions, and to the extent possible, the no action (no pumping alternative).

The North Fork Eagle Creek project area lies wholly within the 3,400-acre North Fork Eagle Creek basin, which is located within the larger 10,300-acre upper Eagle Creek drainage. The upper Eagle Creek drainage is a subset of the 37,200-acre Devil's Canyon hydrological unit code 6th field (HUC 6) watershed. We assessed watershed conditions within the Devil's Canyon HUC 6 as part of a nationwide effort (USDA Forest Service 2010) and these assessment results were used in evaluation of cumulative effects.

We chose the upper Eagle Creek drainage (figure 4) for the cumulative impact analysis area because of the potential for impacts of multiple actions on the natural environment, particularly hydrologic resources, within this one drainage. As described in more detail in the "Water Resources" section later in this chapter, this smaller and more relevant drainage boundary was used instead of the larger Devil's Canyon HUC 6 boundary in order to focus analysis on that portion of the Eagle Creek drainage above Alto Lake and within a few miles downstream of the lake, with the most potential to be affected by North Fork Eagle Creek well pumping in combination with other actions in the same drainage. Alto Lake controls the flows downstream and is part of the Village of Ruidoso's and Alto's water supply. The drainage area below this is also quite different than the upper drainage in terms of climate, geology, and precipitation. However, the area of cumulative impact may differ depending on the resource affected. If a different cumulative impact area is chosen for a specific resource, we discuss this in that specific resource section later in this chapter.

We received several comments during the public scoping period and subsequent comment periods related to the size and boundary of the cumulative impact study area, as shown in appendix A and C but we continue to feel confident in the size and configuration of the cumulative impact study area as depicted in figure 4 and figure 5, for the reasons described above. The list in table 4 and the actions shown on the map in figure 4 have been updated since the 2012 DEIS.

The upper Eagle Creek drainage is comprised of approximately 66 percent National Forest System land (6,750 acres), 11 percent Bureau of Indian Affairs land (1,150 acres on the

Mescalero Apache Reservation) and 23 percent private land (2,360 acres). Populated communities within the upper Eagle Creek drainage include Alto and portions of the Village of Ruidoso. Generally, the major use of private property located within the drainage is for the rural residential lifestyle. Many residences are seasonally occupied.

A catalog of certain actions (ones that are contributing effects to affected resources analyzed) occurring within the upper Eagle Creek drainage is summarized in table 4 below. In progress or planned actions, known as of this writing, are also included and were compiled from the “Lincoln National Forest Schedule of Proposed Actions” (queried in August 2011 and again in May 2014), input from the district staff, New Mexico State Forestry Division, and applicant.

As shown in table 4, approximately 3,406 acres within the 10,300-acre upper Eagle Creek drainage (or 33 percent) have been treated or are planned for treatment in the foreseeable future with fuel reduction, road work, or facility construction. Approximately 6,700 acres (or 65 percent of the drainage) has been burned in past wildfires, including the recent 2012 Little Bear Fire.

There are currently no reasonably foreseeable future plans for vegetation treatments on National Forest System lands within the drainage but one New Mexico State Forestry project is planned in the next 1–2 years.

The “Affected Environment” sections for each resource later in this chapter discuss the current conditions in the project area. Cumulative watershed effects analysis assumes all planned projects have been completed.

The “Water Resources” and “Socioeconomics” sections of this chapter provide additional detail related to the municipal water supply and how this is currently managed and plans for future management.

Table 4. Past, in progress and planned activities within the Upper Eagle Creek drainage

Project	Type/Timing	Within Upper Eagle Creek Drainage?	Approximate Acreage/miles within Upper Eagle Creek Drainage
Forest Service in progress or planned projects			
El Capitan mineral exploration	Test core drilling/planned	No	
Hale Lake and East Hale Lake grazing allotments management	Livestock grazing/ongoing	No	
Stokes Easement and road construction/reroute of National Forest System Road 256	Acquisition of an easement to cross private land and reroute portion of National Forest System Road 256	No	
NM 532 road realignment	Rebuilding of three curves on NM 532 is planned for FY12.	Yes	2 miles
Integrated Non-native Invasive and Native Invasive Plant Project	Vegetation management	Yes	
Divide Grazing allotment management	Livestock grazing	No	
Grindstone Wetland Development	Watershed management	No	
Merchant Grazing allotment management	Livestock grazing	No	
Skinner Grazing Allotment	Livestock grazing	No	
Seven Cabins Road Realignment	Road management	No	
Ski Apache Postfire Rehabilitation	Special Use Management	Yes	80 acres
Ski Apache Recreation Enhancement	Special Use Management	Yes	40 acres
West Mountain Push Units 7-9	Fuels Management	No	

Project	Type/Timing	Within Upper Eagle Creek Drainage?	Approximate Acreage/miles within Upper Eagle Creek Drainage
Forest Service ongoing, routine management activities			
Outfitter/guide permittees	Outfitter/guides utilize the Eagle Creek area for access to trails and dispersed camping.	Yes	
North Fork wells maintenance	Routine maintenance of the municipal North Fork well field and pipeline	Yes	4 acres
National Forest System Road 127A maintenance	Routine maintenance of National Forest System Road 127A for access to dispersed camping, well field, and Summer Homes Tract.	Yes	2 miles
National Forest System Road 117 maintenance	Routine maintenance of National Forest System Road 117 for access to national forest.	Yes	7 miles
Forest Trail T-12 maintenance	Routine maintenance of T-12 in the Summer Home Tract. This trail is located directly above the Eagle Creek well field.	Yes	2 miles
Relevant Forest Service past activities			
U.S. Geological Survey gage installation	U.S. Geological Survey installed weirs in Upper Eagle Creek and at the confluence of the north and south forks. A flume was also installed along the south fork.	Yes	0.25 acre
National Forest System Road 127A road work	The first low water crossing was rebuilt after a flood event in 2008.	Yes	0.25 acre
Village of Ruidoso surface diversion	The Village of Ruidoso surface diversion for collection of water along Eagle Creek.	Yes	0.25 acre 1 surface diversion along Eagle Creek
Village of Ruidoso municipal well field installation	The Village of Ruidoso municipal well field and pipeline were installed in the early 1980s for access to groundwater rights supplemental to the surface diversion.	Yes	4 acres
Eagle Creek Summer Homes domestic well installation	A series of six domestic wells were installed at the summer home tract for drinking water in 2009.	Yes	6 domestic wells

Project	Type/Timing	Within Upper Eagle Creek Drainage?	Approximate Acreage/miles within Upper Eagle Creek Drainage
Eagle Creek Summer Homes septic tank installation	A series of septic tanks were installed at the summer home tract for waste disposal in 2009.	Yes	0.5 acre
NM 532 road reconstruction	Reconstruction of NM 532 at mile marker #3 due to flood in 2008.	Yes	0.5 mile
Burned Area Emergency Response Treatment	Trash bars installed at mouth of Carlton Canyon in response to Ski Run Fire.	Yes	0.25 acre
Eagle II thin and hand pile projects	Thinning, hand piling, and burning projects.	Yes	1,770 acres
Oak Grove Host site	Construction of a host site at Oak Grove Campground above the North Fork of Eagle Creek.	Yes	0.25 acre
Ski Run Wildfire	Wildfire in 2003 located between Carlton and Johnson Canyons. Fire bisected by NM 532. Area burned to around 1 mile of Eagle Creek Summer Home Tract.	Yes	265 acres
Cree Wildfire		Yes – a portion	912 acres
Little Bear Fire	Wildfire in 2012	Yes	5498 acres
Thinning in southeast corner of project area		Yes – a portion	2 acres
Firewood sales	Firewood treatments	Yes – a portion	89 acres
Burned Area Emergency Response (BAER) Activities for the Little Bear Fire	The placement of 150 feet of Jersey barriers along Eagle Creek; installation of 100 cubic yards Gabion baskets; installation of a 10 foot culvert extension and overflow drain; installation of concrete slope paving around each bridge; aerial seeding and mulching was accomplished in high-severity burned areas in the drainage and hillsides above the cabin areas.	Yes	100 acres

Project	Type/Timing	Within Upper Eagle Creek Drainage?	Approximate Acreage/miles within Upper Eagle Creek Drainage
Past and ongoing activities outside of National Forest System lands			
Eagle Creek RV Resort	Installation of a privately owned campground 3 miles downstream from the North Fork Eagle Creek in 2010.	Yes	33 acres
Bottlehouse Cabin rentals	Installation of cabins and rental units ¼ mile south of well field on private land in 2009.	Yes	Unknown
Various domestic wells	Approximately 20+ domestic wells at residences located below the Eagle Creek well field.	Yes	1 acre Water use – greater than 20 domestic wells
Softball field	Municipal softball fields are located on village land approximately 3 miles below the Eagle Creek well field	Yes	5 acres
Ruidoso Winter Park tubing area	A private tubing area is located on private lands 3 miles below the Eagle Creek well field. Snow blowing machines utilizing private Eagle Creek water rights are used to supplement snowfall. The tubing area was installed in 2008 approximately.	Yes	5 acres water use
State Forestry projects	Hazardous fuel reduction and wildland-urban interface biomass projects.	Yes	900 acres
State Forestry projects	Hazardous fuel reduction and wildland-urban interface treatments (Moon Mountain and Lincoln Country Wildland-urban Interface).	No	
Village of Ruidoso water line	The abandonment and relocation of a water line within Eagle Creek. Requirement by the Dam Safety Bureau after the Little Bear Fire	Yes	5 acres
Village of Ruidoso wells	Rehabilitation of North Fork well #4	Yes	0.25 acres
Village of Ruidoso surface diversion	Cleaning and maintenance of the Village of Ruidoso surface diversion	Yes	1 acre
Village of Ruidoso wells	Placement of jersey barriers around National Forest System well #4 and Green well. New Mexico Environment Department requirement for security	Yes	0.5 acres

Project	Type/Timing	Within Upper Eagle Creek Drainage?	Approximate Acreage/miles within Upper Eagle Creek Drainage
Village of Ruidoso wells	Deepening supplemental wells to 1,500 feet	Yes	4 acres
Planned activities outside of National Forest System lands			
State Forestry project	Hazardous fuel reduction project planned for 2012–2013	Yes	300 acres
Village of Ruidoso wells	Applications to pump from an additional 7 wells, supplemental to the North Fork Eagle Creek wells	Yes	7 wells
Totals: **Acreage/miles within Upper Eagle Creek Drainage**	**15 miles of road and trail maintenance** **345 acres of past or ongoing ground disturbance due to structures or facilities** **6,700 acres of area burned in previous wildfires** **1,861 acres of fuels reduction and firewood treatments (National Forest System lands)** **1,200 acres of state forestry fuels reduction treatments** **Approximately 33 municipal water and domestic wells combined**		

Significant Issues

Water Resources

The major issue addressed in this section is the effect that well pumping has on hydrologic resources in the North Fork Eagle Creek drainage, including potential cumulative effects downstream in the larger Eagle Creek drainage. This issue encompasses multiple subjects that include understanding the connection between the stream, the alluvial aquifer, and the deeper groundwater that is extracted by the wells, as well as characterizing the effects that climate change may be playing in these processes.

Well pumping results in changes in the dynamics of groundwater (groundwater drawdown and water table elevations) and surface water (streamflows, wetlands, springs, and seeps). Lowering streamflow may increase surface water temperatures, and reduce the amount of water accessible to vegetation. Surface water and groundwater availability are linked and are limited not only by accessible available quantities of water, but also by available water rights. Water resources over time can also be affected by climate change.

The Water Resources Report (AECOM 2012) provides a more detailed description of affected environment, methods, and environmental consequences for this project. The supplemental Water Resources Report (AECOM 2014) provides a more detailed description of affected environment, methods, and environmental consequences, considering the changes caused by the Little Bear Fire. These reports are incorporated by reference, discussed briefly below, and available in their entirety in the project record.

Methodology

The direct effects study area is the upper Eagle Creek drainage (figure 2) above the Eagle Creek gage. The cumulative impacts area extends through the Eagle Creek drainage to the location of the former U.S. Geological Survey stream gage named Eagle Creek near Alto, New Mexico (Eagle Creek near Alto, U.S. Geological Survey gage number 08387800) (figure 4). This area incorporates an additional approximately 7 stream miles of Eagle Creek below the direct effects study area.

The cumulative impact area occupies 15.7 square miles (including the project study area) and extends into lower elevations than the North Fork drainage. Eagle Creek near Alto gage, now discontinued, is located at approximately 6,840 feet above mean sea level. Major water features in the cumulative impact area, but outside the direct effects study area, include the Eagle Creek surface water diversion for the applicant; lower Eagle Creek; Alto Reservoir; several additional municipal water supply wells; and Alto Crest Water Treatment Plant No. 3. The Water Resources Report provides more details regarding why this area was selected (AECOM 2012).

Water supply pumping for the applicant is conducted at six water wells along lower Eagle Creek (figure 6), and the Village of Ruidoso diverts surface water from the stream a short distance below the Eagle Creek gage. Approximately 26 individual homes are located along the North Fork and upper Eagle Creek, a number of which are located downstream of the North Fork well field.

The analysis methods we use here are based on a comprehensive review of existing hydrologic and geologic reports and memoranda, as well as data available for groundwater depths, aquifer characteristics, streamflows, and water chemistry. From this review, we have ascertained and described an understanding of the baseline hydrologic and geologic conditions. We determined causes and effects on the hydrologic system for the alternatives on a qualitative or semi-quantitative basis. We used descriptive or analytical approaches for this effort, employing existing data that include known or assumed characteristics of aquifers, geologic factors, groundwater levels, streamflows, channel conditions, surface water and groundwater chemistry, wells, and well field pumping. No further groundwater modeling or data collection efforts were undertaken.

The original impact assessment as documented in the 2012 DEIS was based on carefully-selected long-term data that included a pre-pumping baseline period (before the North Fork Eagle Creek well field was activated). By using extended periods-of–record in the original assessment, the effects of short-term natural variation were minimized when comparing potential pumping impacts. Short-term natural variation effects are believed to be substantial in the mountainous watershed setting, so the original assessment approach and its impact indicators are judged to remain appropriate for longer-term post-wildfire impact comparisons. Given the complications of limited post-wildfire data availability and quality, qualitative appraisals have been used as necessary in the post-wildfire water resources impact assessment.

We describe direct, indirect, and cumulative effects in terms of duration and extent. Short-term impacts include those that would be in effect over a relatively limited duration. For purposes of this assessment, short-term refers to a period of approximately 3 months or less. We have determined this on the basis of annual seasons and the general responses of surface water and groundwater conditions to seasonal variations. In addition, at the fairly high elevations and limited fair weather durations in the North Fork, perturbations to water resource conditions may have related effects on watershed condition, riparian communities, aquatic resources, and recreational uses in a 3-month period or less. We describe long-term impacts as those having effects greater than 3 months. Typically for this project, however, long-term impacts would affect surface water, groundwater, or their uses by water dependent resources for periods of years.

We considered context and intensity when describing impacts. An action must be analyzed in several contexts—such as the immediate vicinity, affected interests, and locality. Intensity refers to the severity of the impact. Thus, we describe impacts in terms of negligible, minor, moderate, or substantial. Because of the complexity of the water resources setting and the level of quantification available from existing data and information in both the project study area and the cumulative impact area, the significance of potential impacts is qualitatively assessed. Professional judgment is involved here, with the goal of making an unbiased assessment that addresses USDA Forest Service management objectives and the project purpose and need. These findings may depart from other determinations based on differing information or viewpoints.

The spatial extent of potential impacts is described as being site specific, local, and/or regional. For the purposes of this assessment, site-specific impacts are those that would occur at the North Fork Eagle Creek well field and in the immediate vicinity approximately one-half mile upstream (to the North Fork gage) or downstream. Local impacts would extend over the upper Eagle Creek drainage, defined as the drainage area upstream of the Eagle Creek gage. The Eagle Creek gage, with its long data history and location at the mouth of the drainage, serves as a logical limit of focus for local concerns and water resources characterization. Regional impacts would occur within the cumulative impact area, as shown in figure 4.

Updates to Methodology Due to the Little Bear Fire

The Little Bear Fire modified watershed conditions in the North Fork of Eagle Creek drainage area. Major wildfire effects that influence the water balance of the area include changes in the frequencies and magnitudes of surface runoff and groundwater recharge, modified snow accumulation and melt, shifts in evapotranspiration rates, and additional sedimentation and debris accumulation in the stream channel. Most of these factors will offset each other. However, the accumulation and movement of coarse sediment through the North Fork Eagle Creek valley and stream system is likely to occur for many years. This will affect the locations and time-spans of flow exposure in the open channel.

Based on recent research, a transient or short-term wildfire recovery period may last roughly three to seven years from the summer of 2012 (when the Little Bear Fire occurred). During this transition, there is likely to be reduced infiltration, increased surface water runoff, and reduced partitioning of precipitation to groundwater recharge. After approximately four to eight years following the Little Bear Fire, long-term post-wildfire conditions are expected to more generally resemble the pre-wildfire hydrologic setting.

If long-term stand conversions from coniferous forest to grass or shrubs occur extensively in the study area, decreased evapotranspiration could encourage greater water yield. The potential for this could be greater if more extensive grassland types become established in the watershed. Preliminary results from ongoing regional studies also suggest that exceptional monsoonal moisture also may provide additional groundwater recharge in some areas where tree cover is reduced (Newton et al. 2012a, b). However, the North Fork Eagle Creek has a different geologic setting than the area in that investigation, so such recharge may not occur in the project study area. In short, once the transitional wildfire recovery period has passed, water yield from the North Fork Eagle Creek watershed is expected to be similar or at most, slightly greater than pre-wildfire conditions. On this basis, long-term post-wildfire impact characterizations are generally consistent with the pre-wildfire assessments.

Eventually, post-fire recovery is expected to return to the North Fork project area to approximate the pre-fire water resources conditions. For this reason, much of the original pre-fire impact assessments remain pertinent to long-term anticipated post-fire effects of the alternatives.

Measurement Indicators

We used the following measurement indicators to compare the potential impacts of implementing the alternatives.

Streamflow Quantity: Compare the estimated durations of no surface flow conditions anticipated to occur at the Eagle Creek gage during a year of average precipitation. No-flow conditions are defined as 0.01 cubic feet per second or less in the stream at the gage.

Streamflow Quantity: Compare the estimated occurrence of flows equal to or greater than 1.2 cubic feet per second at the Eagle Creek gage during a year of average precipitation.

Pre-wildfire Streamflow Quality indicator: Based on available surface water and air temperature data, analyze the Proposed Action, and compare it with project alternatives, for the anticipated occurrence of periods when the mid-day streamflow temperature during the growing season (May to October) would exceed 20 degrees Celsius (68 degrees Fahrenheit) at the Eagle Creek gage. After the Little Bear Fire, this impact indicator no longer applies. Soil erosion and nutrient changes, organic debris, and sediment and rubble transport will continue to modify North Fork Eagle Creek water chemistry, turbidity, and channel geometry (depth, width) over time after the wildfire. Based on this, the broad pre-wildfire trends in streamflow temperature at the Eagle Creek gage (or other locations) probably would not apply to general post-wildfire conditions, and post-wildfire data to modify this indicator are lacking.

Springs and Seeps: Identify springs and seeps that may be affected by pumping as those within the area of projected drawdown (see figure 7 and figure 8).

Domestic Wells: Identify domestic wells that may be affected by pumping as those within the area of projected drawdown (see figure 7 and figure 8).

Success of the Alternatives over Time Considering Climate Change: This indicator involves a qualitative analysis without significance determination, based on a general review of the indicators above under possible climate change effects. Potential effects on water resources from climate changes may include reduced basin yield and recharge from changes in rainfall, reduced snowpack accumulation, evapotranspiration; more frequent early season snowmelt; later onset of winter, reduced seasonal peak flows, and/or shorter flow durations.

We derived these measurement indicators on the basis of existing data, anticipated future data that may result with additional monitoring (see chapter 2), and the management objectives stated in more detail in chapter 1 and in the supplemental Water Resources Report (AECOM 2014). These indicators are oriented to flow presence in the North Fork, water availability for riparian vegetation and aquatic habitat, improving watershed condition, and maintaining domestic water uses along the North Fork.

The climate change indicator was developed in response to USDA Forest Service policy requirements (Joyce 2008). It is based on a review of recent research and published agency viewpoints for the Southwestern U.S. Currently none of the alternatives are anticipated to have a noticeable effect on climate change. Actions that typically may have an effect on climate change are generally those that create substantial greenhouse gas emissions. Due to the nature of the well field infrastructure (wells, pumps, electrical power, and pipelines), greenhouse gas emissions are expected to be negligible. Based on this, the anticipated effects of climate change are oriented to potential effects on the project alternatives, rather than potential effects from the project alternatives.

We provide more detail regarding the rationale for the selection of these measurement indicators, and why others were not used, in the Water Resources Report (AECOM 2012) and supplemental Water Resources Report (AECOM 2014). We document below the process used to review each of these indicators following the Little Bear Fire.

Updates to Measurement Indicators Due to the Little Bear Fire

We reviewed fire effects on stream gage conditions and data records, of monitoring well data records, of precipitation data and well field pumping records. Sediment and debris adversely affected data collections at streamgages, and either wildfire effects and/or access restrictions appear to have adversely affected some of the monitoring well data. Interruptions in electrical power sources for data logging equipment may also have resulted from the Little Bear Fire.

In re-examining water resources impact indicators, an effort was made to compare pre-wildfire streamflow and monitoring well conditions to similar post-wildfire conditions. This effort was limited by the short post-wildfire data record, by compromised or missing data, and by the considerable natural variation of precipitation inputs to the hydrologic system over the relatively short pre-wildfire versus post-wildfire comparison periods. As described in more detail in AECOM 2014, periods selected for attempted comparisons of wildfire effects focused on generally similar precipitation inputs for a 2- or 3-month, season when stream flows would primarily reflect groundwater conditions, and lesser evapotranspiration effects. Based on this detailed exercise and other similar reviews, no consistent comparative impact indicators were developed for pre-wildfire versus post-wildfire conditions. In addition, the post-wildfire watershed recovery period, estimated at approximately 3 to 7 years after the summer of 2012, is temporary enough to have minimal influence on the alternatives or decision-making.

For these reasons, the original water resources impact indicators, with the exception of the streamflow water quality indicator, are valid for longer-term post-wildfire conditions. The former streamflow water quality indicator is not likely to apply either to short-term or long-term post-wildfire conditions, since the North Fork Eagle Creek channel will transport and re-work sediment and debris for a considerable number of years. In the short-term, additional nutrient content in surface flows may enhance aquatic habitat conditions for some species. As stream deposits are re-worked over the long-term, additional turbidity and suspended organic carbon and silt will likely increase surface water temperatures and reduce oxygen availability as a result of the fire. Such re-working will likely occur periodically over the long term, due to intense rainfall or snowmelt events. During relatively stable interim periods, however, parts of the channel could reflect water quality similar to that before the fire. These areas would be pools and riffles that form and change over time as the channel geometry adjusts.

Incomplete or Unavailable Data

Although a substantial amount of surface water and groundwater data are available in the study area and the cumulative impact area, much of these data are sparse and/or have been retrieved at different times and locations. This prevents a thorough understanding of the hydrologic systems involved. In addition, some factors of interest (such as water quality) simply have too little data for anything other than cursory interpretations. The North Fork Eagle Creek hydrologic system is complex, and varies from season to season, from year to year, and from place to place. Characterizing this system by itself, as well as in the light of manmade perturbations, requires a consistent and extensive dataset both temporally and spatially. Information lacking in the water resources data and analysis include water quantity and quality information for surface water and groundwater; further definition of water-bearing zone characteristics; and a strong definition of the temporal and spatial relationships between pumping activities, groundwater levels in the various zones, and the extent, magnitudes, and durations of surface flows. We describe monitoring methods in chapter 2 that satisfy these information needs.

Updates to Incomplete and Unavailable Data Due to the Little Bear Fire

Several factors complicated the original pre-wildfire assessment; and comparisons between pumping conditions and time periods were configured to treat these factors as similarly as possible between the pre-pumping period and subsequent pumping periods. Uncertainties in the approaches and the assessment results were clearly spelled out in previous resource documentation. It must be emphasized that impact assessments are founded on making comparisons between an undisturbed “baseline” condition (e.g., no pumping) and the potential disturbance being considered (e.g., pumping). If possible, comparisons should account for other variables in a consistent manner from one case to another. To encourage this, available data should be treated and used similarly across comparisons unless departures can be accurately defined. For example, in the pre-pumping data for Eagle Creek (approximately 1980 and earlier), there are no separate data available for flows from the South Fork tributary. South Fork contributions are essentially a random signal in that data set. In fact, South Fork flows are reflected in all Eagle Creek flow data. Specific South Fork data are only available for four years beginning in September 2007, approximately 30 years after the onset of pumping. For purposes of comparisons, removing the South Fork contribution from the Eagle Creek confluence gage data would require a convincing and accurate approach to projecting those tributary flows back to other time periods considered in the assessment (e.g., the baseline period, and other periods before September 2007). Such an approach would need to consistently explain what happens to South Fork flows when they are greater than the Eagle Creek flows, which occurs almost as frequently as the lesser condition, and then treat (i.e., modify) all data through time with a consistent and convincing quantification of tributary watershed responses and variations in gaging conditions. Or, impact comparisons could (and did) treat South Fork contributions to the Eagle Creek gage consistently, as essentially a random signal in all the downstream flow data used in the assessment.

Alluvial underflow at the surface water gages is probably a factor influencing Eagle Creek streamflow records. After the original water resources impact assessments were completed in 2011, the USDA Forest Service and AECOM learned from the Village of Ruidoso that the Eagle Creek gage had been moved downstream from its original location in the mid-1980s. The original gaging site is not specifically known. More importantly, it is not known if alluvial underflow at the old U.S. Geological Survey gage location was greater than, less than, or equal to conditions at the new location. For this and other data-based reasons, uncertainties and approximations in the assessments were identified in the pre-wildfire water resources text. The Little Bear Fire has not changed those. Uncertainty remains as to the long-term average groundwater recharge volume in the North Fork Eagle Creek basin. This is discussed in greater detail in other sections, in the U.S. Geological Survey project study (Matherne et. al. 2011), in several consulting documents, and in the alternatives discussion section in chapter 2 of the DEIS and SDEIS. This uncertainty is largely caused by year-to-year natural variation, and by differences in measurement and estimation techniques between investigators. The Little Bear Fire has not modified that situation.

During supplemental document preparation following the occurrence of the Little Bear Fire, additional background information was collected from the U.S. Geological Survey, the Western Regional Climate Center, the Village of Ruidoso (including Shomaker and Associates and others), and Balleau Groundwater (Balleau 2014). Information provided by the Village of Ruidoso consisted of water level data collected from ongoing measurements at monitoring wells along the North Fork Eagle Creek, daily pumping records for recent years, and a summary of water supply issues related to the Little Bear Fire (Peery 2013, Atkins 2014). Information from the U.S. Geological Survey consisted of their post-wildfire debris flow probability report (Tillery and Matherne 2013) as well as additional monitoring data for streamflow and local precipitation. Western Regional Climate Center information consisted of additional precipitation, snowfall, and temperature data for recent years. This additional information is largely discussed in the previous supplemental Affected Environment text.

Reduced water quality and debris flows resulting from the Little Bear Fire adversely affected Village surface diversions and storage facilities. Significant sediment as well as suspended and dissolved organic matter prevented surface water treatment. In addition, reduced aquifer recharge adversely affected the North Fork Eagle Creek well field capacity (Atkins 2014). New pump installations were completed in North Fork wells NF-1 and NF-4 to maintain sufficient groundwater supply in light of these issues. Reduced surface water and groundwater production along Eagle Creek also created the need by the Village of Ruidoso to increase diversions of both surface water and groundwater from the Rio Ruidoso. Surface water from that source was similarly contaminated by the Little Bear Fire, or was unavailable due to drought. At the same time, water for the Village of Ruidoso in storage at Grindstone Reservoir was at historic lows (Atkins 2014). After the recent drought and the Little Bear Fire, surface water diverted from Eagle Creek has been non-existent or extremely polluted with ash and silt during flash flood events (Atkins 2014). This water is not treatable in the Village of Ruidoso’s existing facilities.

Since 1966, the Village of Ruidoso has been authorized by the New Mexico Office of the State Engineer (Office of the State Engineer) to divert part of its water supply from the Rio Ruidoso by discharging (“returning”) treated municipal wastewater to that stream. Some of that discharged water is originally diverted from the Eagle Creek drainage (both surface water and groundwater) for Village supply. The surface water diversion on Eagle Creek is downstream of the North Fork Eagle Creek; currently used water wells are both within and downstream of the North Fork Eagle Creek. After use and treatment, Eagle Creek water is released to the Rio Ruidoso for effluent credits, allowing additional diversion from the latter system. All of these diversion points and wells are metered, and daily readings are reported monthly to the Office of the State Engineer. The Rio Ruidoso has greater surface water and groundwater availability, and is a primary source of Village supply. Additional details on Village water supplies are presented in the Water Rights and Socioeconomics reports.

The Little Bear Fire reduced the Village’s ability to divert adequate supplies from the Eagle Creek drainage and maintain return flow credits on the Rio Ruidoso. Historically, water from the North Fork Eagle Creek well field has significantly contributed to the Eagle Creek/Rio Ruidoso credits (Atkins 2014). To meet municipal demand under the post-wildfire circumstances, the Village has relied on basic water rights to divert from the Rio Ruidoso system. These basic rights are being depleted at a rate that will exhaust them well before the end of their associated five-year accounting period ending on October 31, 2016 (Atkins 2014). By October 31, 2013, the Village of Ruidoso’s five-year basic rights accounting totals on the Rio Ruidoso had been substantially expended. At that time, basic water rights remaining for diversion in the Rio Ruidoso drainage had been depleted to only 865 acre-feet for the remainder of the accounting period. The Village will have diverted all of its basic rights on the Rio Ruidoso by approximately the end of August 2014 (Atkins 2014).

In addition to these supply concerns, the need to lease and temporarily move water rights has created additional costs to the Village for the leases, Office of the State Engineer permitting, and related litigation. The Village anticipates that a number of years will pass before the Little Bear Fire effects are sufficiently reduced to allow a return to full use of Eagle Creek surface water and groundwater, as well as diversion credits for return flows on the Rio Ruidoso. A substantial contributor to the Eagle Creek/Rio Ruidoso credits historically has been the North Fork Eagle Creek well field (Atkins 2014).

The Village of Ruidoso continues to rely on the Eagle Creek well field and drainage area for its water supply. Following a Memorandum of Agreement and settlement with Rio Hondo Land and Cattle Company, the Village’s right to water diversion within the drainage consists of approximately 1,624 acre-feet per year of groundwater, approximately 761 acre-feet per year of surface water, and supplemental groundwater from all Eagle Creek wells on and off National Forest System lands. In addition, the Village has an approximately 137 acre-feet per year groundwater right in the H-1497 and S wells, for a total of approximately 2,523 acre-feet per year, plus return flow credit from diversion of approximately 2,386 acre-feet per year. Some of these water rights have priority dates as early as 1882 (Atkins 2014).

Information provided by Balleau Groundwater, Inc. further described the local and regional groundwater modeling work being done by that firm. Preliminary simulations conducted by Balleau Groundwater for long-term post-wildfire conditions indicate that pumping the North Fork Eagle Creek wells for a 20-year period would create drawdown and stream depletions at the well field. The potential for more extensive regional pumping effects was also discussed in Balleau Groundwater investigations and supporting material (U.S. Environmental Protection Agency 2013).

If the Forest Service approved a special use permit allowing North Fork Eagle Creek well field pumping, an important tool resulting from the Balleau Groundwater modeling work is that, over the post-wildfire long term, North Fork Eagle Creek well field pumping rate and North Fork Eagle Creek stream depletion can be correlated. Their modeling indicated a time-lag (in years) between pumping adjustments and water levels in the well field; in addition, some simulations of well field management indicated dry conditions along the North Fork Eagle Creek much of the time (Balleau 2014).

The cumulative study area for water resources was determined by reviewing available streamgaging data along the Eagle Creek drainage, the increasing complexity of the geologic and water resources setting at greater distances from the mountain front, the availability of data within that setting, and the substantial expansion of water uses and returns, water rights, infrastructure, and related data requirements downstream of National Forest System lands. The USDA Forest Service has no jurisdiction for permits, monitoring, or mitigation outside its own boundaries. So, while water use and supply issues are regional concerns in south-central New Mexico, they are difficult to address due to USDA Forest Service jurisdictional issues.

It should be noted that there are considerable differences of opinion between credible, qualified water resource specialists about the potential effects of pumping the North Fork Eagle Creek well field. For example, see the discussions in this report under “Extent of Pumping Drawdown” and “Mountain-Front Recharge. Other investigators note that assumptions used in calculating stream depletions frequently lead to overstating actual effects, and that lack of data often leads to overly-conservative analysis (Finch 2014). Because of these discussions, an additional measure to include groundwater model development, calibration, and application through stakeholder cooperation has been added to chapter 2 of the EIS (see “Monitoring; Water Resources and Fisheries; Item 8). If implemented, that measure would enhance the potential for informed well field management if a special use permit is issued by the Forest Service.

This recommended modeling measure would likely provide valuable management tools. If implemented, modeling would require cooperative development and documentation of the inputs, the calibration criteria, and the interpretation of outputs for well field management purposes. Other recommended adaptive management practices, monitoring, and mitigation measures (see chapter 2) would be implemented during the modeling timeframe if a special use permit for continued pumping is approved through a selected alternative.

Pre-Little Bear Fire Affected Environment

Climate and Geology

The study area encompasses approximately 8.1 square miles and has a total relief of over 2,900 feet. The North Fork drainage covers an area of 5.3 square miles and confluences with Eagle Creek just upstream from the Eagle Creek gage at 7,610 feet in elevation. It is a steep-sided drainage (slopes approaching 50 percent in areas) consisting of evergreen forest, with a riparian corridor up to several hundred feet wide that flanks the stream channel in the lower reaches near the confluence with the South Fork (Matherne et al. 2011) (We describe riparian vegetation more fully in the “Riparian Vegetation” section of this chapter). North Fork Eagle Creek stream channel gradient ranges from over 1,400 feet of rise per mile of run (27 percent slope) in the headwater reaches to less than 190 feet per mile (4 percent) in the lower reaches. The average gradient along the North Fork channel upstream from the confluence as defined by the U.S. Geological Survey 7.5 minute topographic map is approximately 470 feet per mile (9 percent).

Precipitation varies with altitude, varying from an average 37 inches per year or more at the Sierra Blanca climate station (10,280 feet above mean sea level) to 14 inches per year at Fort Stanton climate station (6,220 feet above mean sea level) and lower averages at other stations at lower elevations (Matherne et al. 2011, Western Regional Climate Center 2011). Precipitation consists mainly of winter snow and summer monsoonal rains. On average, 65 percent of the annual precipitation falls as monsoonal rains from mid-June through October. Precipitation not only varies significantly by elevation and time of year, but also from year to year. The Ruidoso climatic station (6,930 feet above mean sea level) averaged 21.8 inches per year from 1942 through 2010, with a range of values from 34.81 inches (1965) to 12.27 inches (1970) (National Climatic Data Center 2010, Western Regional Climate Center 2010).

The study area lies within the Sierra Blanca Structural Basin with Permian and Cretaceous sedimentary rocks that are overlain by up to 3,000 feet of Tertiary volcanic flows and flow breccias. The lower part of the North Fork drainage is comprised of the Tertiary Sierra Blanca volcanics, which consist of andesitic lava flows and pyroclastic deposits up to 3,000 feet thick (Matherne et al. 2011, Rawling 2009, Allen and Kottlowski 1981).

The geology underlying the alluvium and volcanic rocks is not well defined. Outside the study area but within the cumulative impacts area, significant geologic changes occur along the reach between Alto Reservoir and the old gage location (see figure 4 where there is a substantial geologic fault system – the Ruidoso Fault Zone (Rawling 2009).

Based on data compilation and evaluation of the best available information (as described in detail in AECOM 2012), the Tertiary volcanics are fractured and there may be a number of major fracture sets that have not been previously recognized in field mapping. These fractures have the potential to control groundwater flow and may allow for connection between groundwater in the Tertiary volcanics and surface waterflow in the North Fork.

Groundwater

The groundwater system in the North Fork drainage consists of a fractured volcanic rock aquifer overlain in some locations by discontinuous alluvial aquifer along the North Fork. The volcanic aquifer outcrops in the area near and directly downstream of the North Fork gage. The alluvial aquifer is present where the river valley widens in the general area of the village well field, beginning near the location of monitoring well MW-1A and extending to the confluence with the South Fork with volcanic bedrock outcrops in areas below the well field forcing any alluvial water to the stream.

Both the volcanic system and the alluvial system are recharged by streamflow. The volcanic system is recharged through fracture zones in outcrops along the stream channel, including near the North Fork gage. Recharge of the alluvial system in the area of the well field exhibits some amount of dependence upon whether the volcanic aquifer’s water level is depressed. If the water level is depressed, a streamflow between 0.8 and 1.2 cubic feet per second is necessary to overcome the induced infiltration occurring at the volcanic outcrop before alluvial recharge can occur. The alluvial system easily transmits water horizontally, where it discharges back to the stream in the form of base flow, but does not readily transmit water vertically into the underlying volcanic aquifer.

The aquifer tests of the volcanic system by Atkins-Landfair (1985) and Shomaker (1989) have yielded a range of estimates for the hydraulic properties of the village well field along the North Fork. The best estimate for transmissivity seems to be in the range of 1,200 to 1,500 feet squared per day. This is the range found in the reanalysis of the Atkins-Landfair (1985) data and in the one radial flow plot found by Shomaker (1989). The storage coefficient estimates range from 0.0001 to 0.006. Probably, the best estimate is in the range of 0.001 to 0.002.

The Village of Ruidoso wells in the volcanic aquifer show both radial flow and fracture flow. Most of the wells show fracture flow early in the drawdown history and this can change over to radial flow with time. The key is the proximity of the well to a fracture and whether the well is a pumping or monitor well. As noted by Shomaker (1989), fracture flow will give way to radial flow as water is drained from the fracture. In a few cases, we noticed the unit slope on a radial flow plot and this can be interpreted as indicating a boundary condition that forces the well to draw water from the aquifer as if it were draining a closed volume. Because of the limited duration of the pumping tests, the different screened intervals within the volcanic aquifer for the village wells, the dominant effect of fracture flow, and the fact that none of the village wells are fully penetrating, we should view any interpretation of boundary effects with caution. The aquifer in the Tertiary volcanics is not confined, is not homogeneous, and does not meet the limiting assumptions used in developing type curves for the hydraulic properties of an aquifer. Thus, the results of the aquifer tests by Atkins-Landfair (1985) and Shomaker (1989) need to be used with caution and treated as a general approximation of the behavior of the aquifer in the Tertiary volcanics in response to pumping. Storage in fractured volcanic aquifers is generally lower than for porous media equivalents, with the exception of the upper weathered zone; and though the hydraulic conductivity may be high, a unit volume of such an aquifer only holds a small percentage of water.

Multiple springs and seeps have been mapped or documented in the study area and are depicted on figure 8. These range in elevation from 8,020 feet to nearly 8,400 feet. A group of springs are present near the summer home area just upstream of well DW-3 along the North Fork and another group approximately 0.25 mile up the side canyon that enters from the southwest in that area. A spring is located in Telephone Canyon, Carlton Canyon, and two in the South Fork drainage (USDA Forest Service 2007, Chaves County District Court 1979). These springs may or may not be connected to the more extensive groundwater system that provides stream base flows, depending on whether they are associated with a perched aquifer; more information is necessary to determine this.

Surface Water

North Fork Eagle Creek is classified on the U.S. Geological Survey 7.5 minute topographic map as an intermittent stream, which indicates flow during wet seasons and times when the groundwater table is higher than the stream, contributing to the surface flow. In its upper reaches upstream of the North Fork well field, perennial streamflow conditions are maintained in years of average and higher precipitations by springs fed by groundwater (Matherne et al. 2011). Both the South Fork and Eagle Creek below the confluence were originally classified as perennial streams with year-round flow (U.S. Geological Survey 1963). In general, at the well field and downstream, the North Fork Eagle Creek flowed intermittently in most years prior to pumping. The extent and duration of surface flow has since been reduced along the North Fork by pumping. We ascertained general relationships between flow in the North Fork and pumping using consistent, fairly long-term data periods. These are summarized below from the preceding text sections, but described in detail in AECOM (2012).

We derived water balance estimates and reviewed flow frequencies for three separate time periods of the same length before the Little Bear Fire. The first time period, from 1971 to 1980, was a period prior to the Village of Ruidoso’s well field installation. This period’s overall precipitation was slightly above average based on regional meteorological data. The second time period, from 1989 to 1998, was after the village had begun pumping. The overall precipitation for this second period was again slightly above average. The third period, from 2000 to 2010 (excluding water year 2005 due to a lack of gaging data) was a period of pumping during overall below average precipitation. Severe back-to-back drought years and a few wet years characterized this latter period.

We made general qualitative comparisons between these pre-wildfire periods from the water balance approximations, as follows.

When comparing the first two periods—where the major difference in watershed conditions was the onset of well field pumping—the latter period (with pumping) shows somewhat reduced overall streamflow, reduced average base flow, and an increase in total estimated average recharge plus pumping. These conclusions are consistent with independent findings by Finch et al. (2004) and Balleau Groundwater (2004).

The last period (2000–2010) indicates generally lower average basin yield than the preceding periods, due to droughty conditions in the late 1990s/early 2000s and vacillating wet/dry conditions later in the period. During this back-and-forth climatic condition, mean annual base flows generally appear to decline still further when compared to the previous two periods. Similarly, further reduction in overall mean annual streamflow has apparently occurred, beyond the amount that might be anticipated by reduced basin yield. However, this is complicated by the occurrence of drought.

Complicating factors in the water balances mainly include: estimating basinwide precipitation from point precipitation data, potential changes in forest canopy evapotranspiration over time, and relocation of the Eagle Creek stream gage in 1988 to a site that may allow more alluvial underflow. In addition, there may be a slight regional groundwater effect from snowmaking withdrawals at Ski Apache wells in the nearby Rio Ruidoso watershed. Basinwide precipitation estimates were derived consistently for all of the time periods examined. Forest canopy changes are known to have occurred since the late 1800s; the change between analysis periods beginning in 1971 is unknown. The stream gage relocation may have had a slight effect on flow measurements; more information on this would be needed if future flow monitoring is done. While it is possible that there may be interbasin groundwater transfer (based on the nature of the fractured volcanic aquifer), the fact that Ski Apache wells are outside the Eagle Creek watershed reduces the likelihood that those diversions have affected flow at the Eagle Creek gage. While these factors and others contribute some quantitative uncertainty to the comparisons, well field pumping remains the dominant hydrologic influence between comparison periods.

In general, some reduction in streamflows and increases in recharge factors result on the North Fork from pumping during average to wet years. These effects are somewhat moderated during multiple years of average or greater precipitation. During drought years or more extended dry periods, pumping effects on North Fork streamflows and groundwater conditions are more noticeable. In either case, the greatest pumping influences on surface water, over longer periods of time, appear to be on the occurrence of lower flow rates in the North Fork. These flows in particular are reduced so that the presence of water in deeper pools, or in isolated stream portions that flow over bedrock, is less likely now than before pumping began.

We did not discover any direct correlation between pumping and streamflow over shorter time steps (e.g. daily, weekly or monthly), even when considering multiple variables, as discussed in more detail in AECOM (2012). This result is likely due to data limitations and the wide variation in hydrologic factors at shorter time periods.

Streamflow and Pumping Correlation Based on Geology and Water Chemistry

We evaluated the potential effect of village well pumping on North Fork streamflow through examination of the village wells, the geology of the North Fork area, the aquifer properties of the Tertiary volcanics, and the chemistry of surface and groundwater. We discuss this approach in detail in AECOM (2012). We describe conclusions from this evaluation here.

The study of Finch et al. (2004) of monitored flow along the North Fork Eagle Creek shortly after the village wells had been shut off and were recovering, showed a definite loss of streamflow in the range of 0.3 to 0.69 cubic feet per second while the water table was depressed over 200 feet below the base of the stream. This study used five flow measurement locations along the stream reach near the village wells. Flow measurement techniques were not documented, but results suggest streamflow loss by induced infiltration. This hypothesis would be consistent with the geology of the North Fork area and also the water chemistry. Matherne et al. (2011) also showed that there are periods when the water table in the volcanics can rise even when the village wells are pumping and conversely, the water table can fall when the village wells are not pumping. This suggests that the key to streamflow loss along the North Fork is the depth of the water table below the base of the stream. The village wells can certainly affect the water table depth when they are pumping, but other factors can depress the water table, even when the wells have been shut off.

Balleau and Silver (2010) estimated the potential base flow capture by the village wells by comparing prepumping flows along the North Fork as recorded at the Eagle Creek gage with flows since the onset on pumping and for the period from approximately 1989 to 2010. Their analysis showed that the wells capture about 0.7 cubic feet per second of flow along the North Fork on an average annual basis. The maximum capture would be the pumping rate, which is approximately 0.8 cubic feet per second on an average annual basis (Balleau and Silver 2010).

Geochemistry of Surface and Groundwater

Groundwater tapped by village wells NF-4 and NF-3 and the monitor wells MW-4B and MW-4C near these village wells is distinct from groundwater tapped by village wells NF-1 and NF-2 and the monitor wells MW-1B and MW-1C. This may be due to the somewhat deeper well screens in NF-4 and NF-3 and their associated monitor wells. NF-1 (as shown in figure 8) has never been used by the applicant; it is not equipped nor tied into the main line and it does not have power.

If there is any interaction between surface water and groundwater along the North Fork, it is near village well NF-1. Groundwater near this well may be the result of infiltration of surface water and reaction of the surface water with the minerals in the surrounding rock. Groundwater near NF-4 does not interact with surface water, except possibly in MW-4B due to a fault that connects to lower Carlton Canyon (Matherne et al. 2011). Groundwater along the North Fork has an isotope signature for deuterium and oxygen-18 that is distinct from surface water; deuterium and oxygen-18 isotopes suggest that surface water does not directly recharge groundwater. The isotope signatures are distinctly different, even though groundwater is mostly less than 30 years old.

Domestic and Municipal Water Use

Downstream from the North Fork, the majority of water rights along Eagle Creek are for domestic and municipal uses, with some irrigation use and a few commercial uses. Surface diversions have historically occurred just outside the study area downstream on Eagle Creek below the confluence of the North and South Forks prior to 1985 and through to present time. Existing water rights in the project area are discussed in more detail in the “Water Rights” section later in this chapter.

Roughly 20–30 individual domestic water wells occur in the upper Eagle Creek drainage and 6 of these are located in the Eagle Creek summer home area upstream from the North Fork well field (Medlock 2011 and Forest Service files). The available well log information indicates that, for wells along the North Fork with recorded construction details, recent installations were completed in fractured basalt zones at depths ranging from about 50 to 60 feet, or through to deeper zones ranging from about 160 to 180 feet. Additional information (Midkiff 2002) indicates that some of the early private wells along Eagle Creek Canyon Road were originally less than 100 feet deep. Other early wells were about 110-feet deep (H. Puckett in Medlock 2011). Since the late 1990s, several historic wells have been deepened to between 200 to 400 feet (Midkiff 2002). Some wells may have shallower or deeper source zones. Original estimated yields varied broadly, on the order of 5 to 25 gallons per minute, and some wells may still deliver in the higher range of these yields. Substantial declines in well yields were noted around the year 2002 (Midkiff 2002).

It is assumed that most of the homes along the North Fork use septic systems. Self-supplied domestic demands for homes on septic systems are about 44 gallons per capita per day (New Mexico Office of the State Engineer 2005). Assuming 3 individuals year around for each of 26 assumed homes in the vicinity of the North Fork well field, the total demand from domestic wells would be approximately 1.25 million gallons per year (about 3.8 acre-feet per year). This is a negligible amount in comparison to well field pumping.

Village of Ruidoso Water Supply

The Village of Ruidoso water supply system provides supply from two subwatersheds, Devils Canyon (Eagle Creek) and Upper Rio Ruidoso, through surface water diversion and groundwater pumping in both. These two subwatersheds are both part of the larger Pecos River basin. The delivery system infrastructure consists of 2 raw water reservoirs, 2 surface water treatment plants, and 18 permitted wells, of which 11 are active wells, capable of together producing peak capacity of approximately 6 million gallons per day (Wilson and Company et al. 2005). Groundwater is combined with surface water at Alto Lake Reservoir and piped to the Alto Crest Water Treatment Plant (WTP 3) and treated before being pumped into the system. Potable water production from Alto Crest WTP 3 varies depending upon water demands from the system, averaging as much as 2.3 million gallons per day (7.06 acre-feet/day), or as little as 0.5 million gallons per day (1.53 acre-feet/day) for water supply (Wilson and Company et al. 2005).

The Village of Ruidoso water supply in the Eagle Creek drainage includes surface water from the Eagle Creek surface diversion (just downstream from the Eagle Creek gage), the four North Fork wells (although NF-1 is not used and is not tied into the system), four supplemental wells to the North Fork wells (located near Alto Lake), and both the brown well and green well (located near the surface diversion). Figure 6 illustrates this system. We provide more details regarding both the Eagle Creek and Rio Ruidoso water supply in AECOM (2012), the socioeconomics report (Eichman 2012), and the water rights report (Thompson 2012). Both the “Socioeconomics” and “Water Rights” sections of this chapter provide additional information regarding municipal water supply.

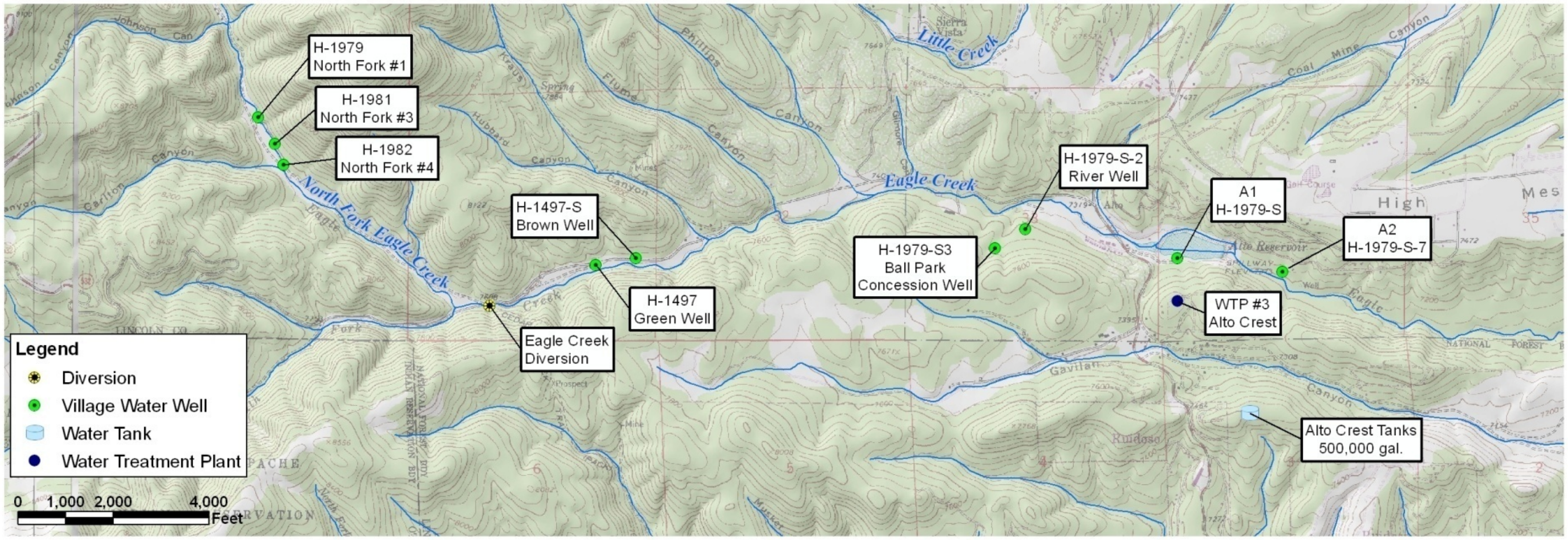

Figure 6. Village of Ruidoso water supply in the Eagle Creek drainage

Watershed Condition Classification

Regionally, watershed conditions have been recently classified by the USDA Forest Service according to a nationwide Agency program (the “Watershed Condition Framework,” USDA Forest Service 2011a) and its associated protocols (Potyondy and Geier 2011). Objectives of the program include integrating ecosystem-based approaches to managing watersheds; improving efforts to restore watersheds and aquatic habitats; and enabling priority-based resource allocations for restoration efforts. This program establishes a consistent approach to watershed assessment. Twelve indicators are scored (either good, fair, or poor and then averaged) by multidisciplinary agency teams, and used to classify watershed condition. These indicators represent underlying ecological, hydrological, and geomorphic functions and processes that can affect watershed condition. The major program emphasis is on aquatic and terrestrial processes and conditions that Forest Service management activities can influence on National Forest System lands (USDA Forest Service 2011a, Potyondy and Geier 2011).

These average scores are then further averaged between indicators to ultimately arrive at an overall score by which to assign watershed condition classes 1, 2, or 3 as follows:

- Class 1 (functioning properly) scores of 1 to 1.6;
- Class 2 (functioning at risk) scores from 1.7 to 2.2; and
- Class 3 (impaired function) scores from 2.3 to 3 (USDA Forest Service 2011a).

Based on the “Watershed Condition Framework,” the North Fork and South Fork drainage areas on National Forest System lands have been classified as impaired function (USDA Forest Service 2011b, Banks 2011). Watersheds classified at impaired function exhibit low geomorphic, hydrologic, and biotic integrity relative to their natural potential condition (Potyondy and Geier 2011). Typically such drainages have exceeded some physical, hydrological, or biological threshold, and substantial changes to the factors that caused the degraded state are needed to restore proper functioning condition (Potyondy and Geier 2011). On National Forest System lands in the study area, the lowest relative scores were received for aquatic habitat, aquatic biota, riparian/wetland vegetation, fire regime, and terrestrial invasive species.

Regional Extent of Pumping Drawdown

Information from the U.S. Geological Survey and other investigators (Finch et. al. 2004, Balleau Groundwater 2004, Midkiff 2002) show that when groundwater is pumped from the North Fork wells, a temporary decline in the water table results, creating a cone of depression around the wells. This cone of depression deepens water levels in both the alluvium and underlying volcanics. Pumping and streamflow are related, in that pumping near a stream will deplete surface flows in a porous channel setting. This effect occurs within the North Fork Eagle Creek. As a result, the intermittent (seasonal) flows or pools that historically occurred from a short distance above the well field downstream to the Eagle Creek gage have been reduced in magnitude and extent by pumping. These effects are more pronounced during dry seasons or dry years. However, the degree of these connections and the nature of groundwater flow paths are complex in the North Fork Eagle Creek study area and have not been fully characterized. For this reason, the actual extent of long-term drawdown from pumping is unknown, as are the details of pumping effects on streamflows and groundwater levels. These conditions have been estimated by the investigations described above.

Because of the fractured nature of the Tertiary volcanics and limiting factors on drawdown migration, such as the Bonito Lake stock, estimating the approximate regional extent of drawdown due to Village well pumping requires simplifying assumptions. Balleau Groundwater (2004) developed some hypothetical cases for possible drawdown migration. One of those cases simulated the aquifer system with a line barrier boundary 1,100 feet northwest of the well field and a line recharge boundary (Eagle Creek) 5,000 feet southwest. Recharge and barrier boundaries were modeled to restrict north-south migration of the cone of influence. The aquifer was simulated with transmissivity of 1,250 feet per day, and it was assumed that there was no surface water capture. The well field was simulated to pump 570 acre-feet per year for 15 years. Resulting drawdown was about 40 feet at the well field at 15 years (Balleau Groundwater 2004).

In actuality, the Tertiary volcanics in the area of the Village well field along the North Fork of Eagle Creek are fractured, very heterogeneous, and the wells pump from different horizons within the volcanics. To develop an analytical model for estimating the regional effect of pumping on water levels in the volcanics requires the following assumptions: 1) the aquifer in the volcanics is homogenous and isotropic; 2) the Village wells pump from the same level in the volcanics and thus tap the same aquifer; and 3) the aquifer properties determined from pumping tests where radial flow was evident in some wells apply to all wells – thus ignoring the role of fracture flow. In addition, Balleau Groundwater (2004) assumed the volcanic aquifer was confined, when in fact it is unconfined.

Under current data conditions, analytical models of regional drawdown effects include a number of assumptions that produce different estimates of regional drawdown caused by the Village wells. From a data perspective, the U.S. Geological Survey made observations of drawdown during two separate occasions; these results are presented in figure 7, and have been projected on an area basis for this assessment in figure 8.

Although a projected drawdown is indicated on figure 7 and figure 8, it must be recognized that with the existing monitoring data and available modeling inputs, there are substantial uncertainties in predicting groundwater drawdown in this hydrologic system under various conditions of pumping and precipitation.

Based on the information available, the projection based on observed drawdown is of interest for ascertaining effects on springs, water available for riparian vegetation, and domestic well pumping. That drawdown is anticipated to remain within the Eagle Creek drainage.

Pumping drawdown may be more extensive than indicated in figure 7 and figure 8, based on results of predictive groundwater models (Balleau Groundwater 2004). However, if a projected 10-foot drawdown contour is accepted as reasonable sensitivity when making comparisons of pumping effects, then other existing modeling work indicates that the maximum extent of the 10-foot drawdown impacts due to Village well pumping is limited to the Eagle Creek drainage.

There are differences of opinion between investigators regarding the influence on water levels between regional (i.e., background) recharge versus induced (from pumping) recharge during monitoring. In addition, the monitoring that resulted in the ascertained cone of depression during the U.S. Geological Survey investigation took place after a major recharge period. Above-average precipitation occurred in the 2 years preceding the monitoring, and storms associated with Hurricane Dolly contributed to the flood of late July 2008. Monitored water levels continued to rise until winter in spite of continued pumping (Matherne et al. 2011). Then in March 2009, the stream channel was dry from a point just below Domestic Well #3 (DW-3) downstream to immediately above the Eagle Creek gage (Matherne et al. 2011).

Based on field surveys and monitoring measurements, the U.S. Geological Survey is reasonably certain that the North Fork gage is outside the zone of influence of well field pumping. A number of other features, namely domestic wells, springs, and zones of existing or potential riparian habitat, occur outside the drawdown identified in U.S. Geological Survey monitoring. For purposes of assessing potential impacts, the observed and projected drawdown in figure 7 and figure 8 are thought to be appropriate. As indicated on figure 8, two springs, one in Carlton Canyon and another in an unnamed tributary to the South Fork, occur within the projected drawdown based on the U.S. Geological Survey observations.

Conditions before Pumping Began in 1988

Prior to the establishment of the North Fork Eagle Creek well field, the volume of water withdrawn for use in the North Fork drainage was minimal. No municipal groundwater pumping occurred on the North Fork prior to 1985, when water rights were exercised by the applicant to construct the well field.

Although actual data that characterized the prepumping conditions is limited to stream gage data at the Eagle Creek gage, there are multiple sources for personal accounts and anecdotal evidence to the conditions prior to installation of the North Fork Eagle Creek well field.

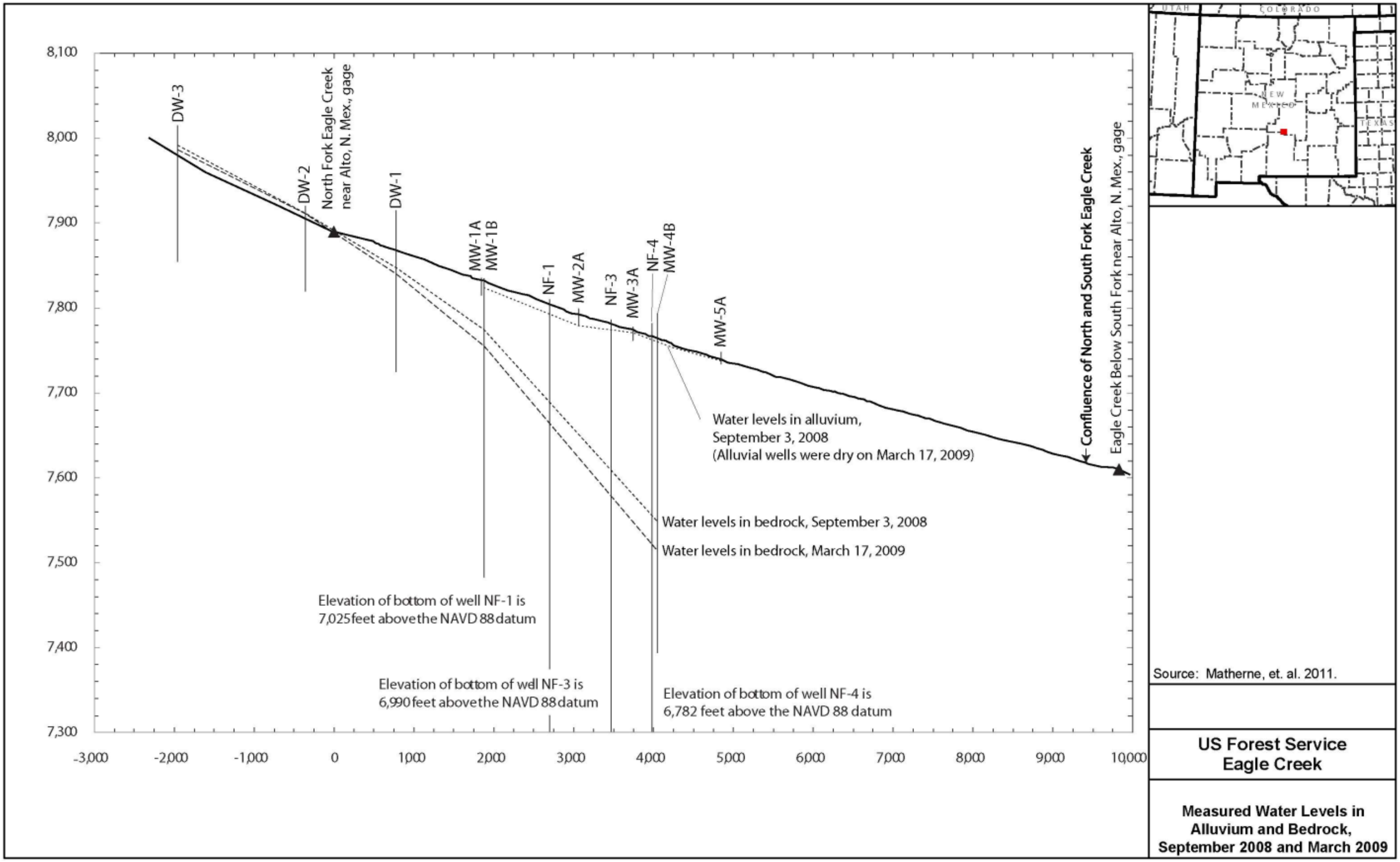

Figure 7. Measured water levels in alluvium and bedrock, September 2008 and March 2009

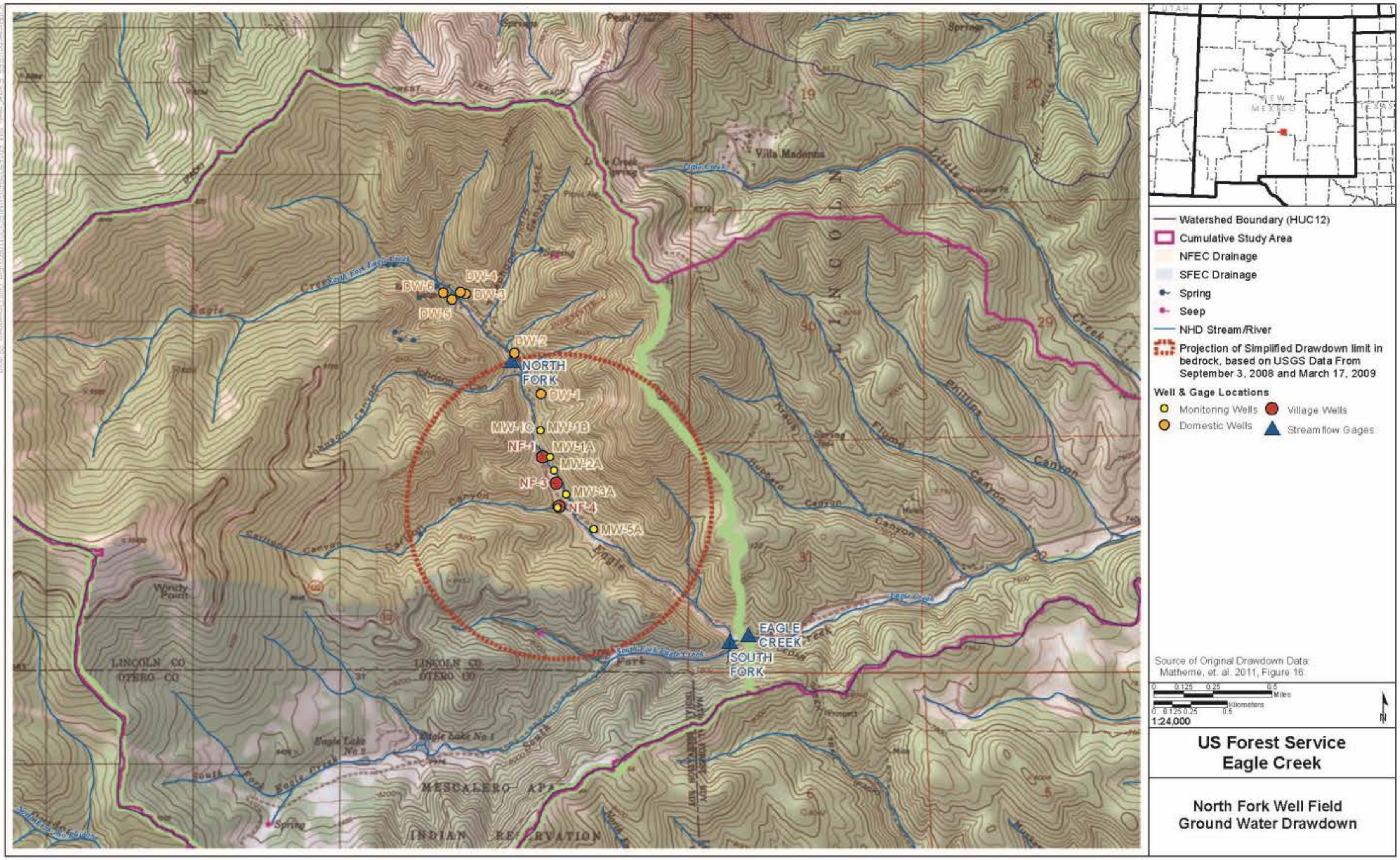

Figure 8. North Fork well field groundwater drawdown

While flows were generally perennial in upper reaches above the North Fork gage historically, anecdotal evidence of the North Fork Eagle Creek stream conditions indicates that, prior to pumping, flows further downstream were inconsistent, that the stream has been a marginal fishery, and that surface water availability for domestic purposes above the well field has often been scarce (McGlothlin 2011, Medlock 2011). Typically the stream disappears into the alluvium for some distance, resurfacing as streamflow when an impermeable obstruction is reached.

The U.S. Geological Survey conducted studies from 2007 to 2009 to determine potential effects of the North Fork well field on streamflow in the Eagle Creek basin, and to provide data for the EIS. The U.S. Geological Survey report was released on October 21, 2010, and subsequently revised in November 2010. It concluded that, in parts of its upper reaches, the North Fork Eagle Creek is a perennial stream maintained by base flow from groundwater. It becomes intermittent in the 2 miles upstream from the Eagle Creek gage (Matherne et al. 2011). Without pumping, North Fork Eagle Creek would still be intermittent below the wells. About 1,600 feet downstream of the North Fork stream gage, streamflows sink into the channel alluvium and bedrock aquifer. As a result, this reach remains dry during dry periods, although water resurfaces from the alluvium in some downstream reaches (stretches ranging from 10 to 50 feet long). More extensive flow presence occurs along the stream during wet years or seasons. At other times, streamflow, when present, tends to occur in reaches where there are bedrock outcrops in the channel.

As discussed previously in the “Surface Water” section, the Eagle Creek gage flow frequency was compared for two 10-year periods of similar precipitation, one during pre-pumping and one during post-pumping timeframes. Figure 9 depicts the flow frequency from 1971 to 1980 before pumping began, and figure 10 depicts the flow frequency from 1989 to 1998 after pumping had commenced. The frequency of a certain flow decreased from the pre-pumping to the post-pumping period. Flows of 1 cubic feet per second or greater were experienced in the pre-pumping period approximately 60 percent of the time, and flows of 0.1 cubic feet per second or greater were experienced approximately 98 percent of the time; flows exceeded 0.01 cubic feet per second 100 percent of the time. During the post-pumping period, flows of 1 cubic feet per second or greater, 0.1 cubic feet per second or greater, and 0.01 cubic feet per second or greater were experienced approximately 52 percent, 96 percent, and 98 percent of the time, respectively, at the Eagle Creek gage below the confluence of the North and South Forks. An analysis of flow conditions generally similar to these are summarized in table 5. It should be noted that other calculations of flow frequencies may vary depending on the time periods used and the flow rates compared. In addition, unknown factors discussed previously for the water balance comparisons also apply to flow frequency comparisons.

These results indicate that prior to well field pumping, mean daily flows consistently occurred at the Eagle Creek gage. The stream never went dry at that location, although it likely was dry at various locations upstream where extensive alluvial deposits absorbed flow. Flows greater than 1.2 cubic feet per second occurred approximately 57 percent of the time, or generally about 7 months of the year.

In a 10-year period having generally similar precipitation, but after the onset of pumping, the stream occasionally went dry at the Eagle Creek gage. This occurred about 2 percent of the time. The occurrence of flows in the lower range between 0.01 and 1.2 cubic feet per second increased somewhat, and the occurrence of flows above 1.2 cubic feet per second decreased somewhat from the prepumping period (table 5).

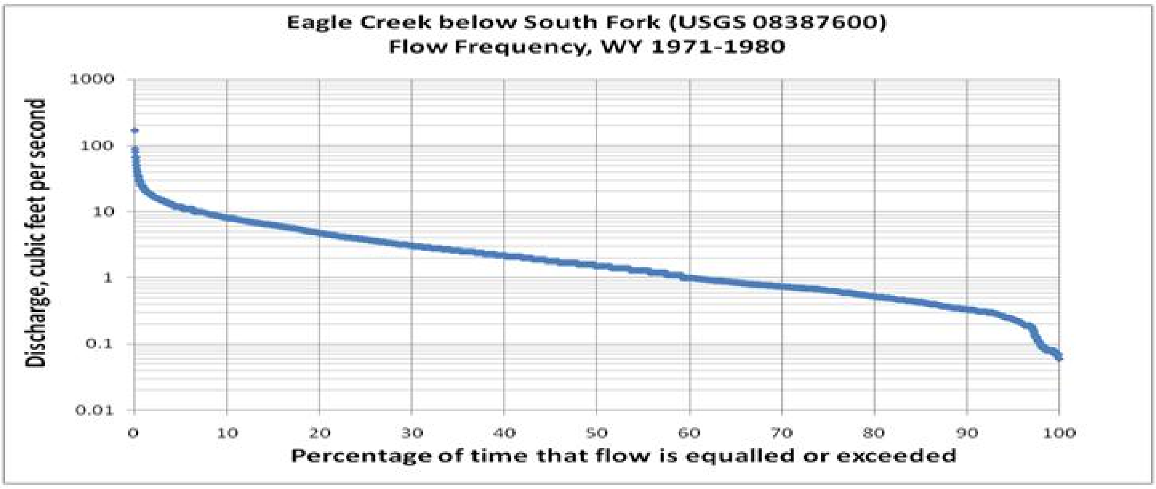

Figure 9. Flow frequency from 1971-1980 before pumping began

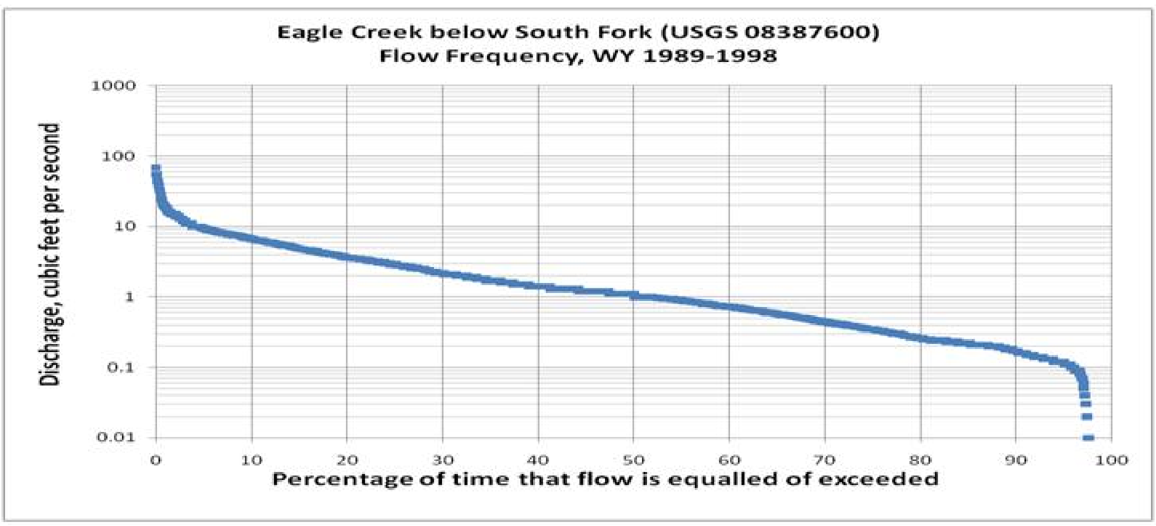

Figure 10. Flow frequency depicts the flow frequency from 1989-1998 after pumping had commenced

The later 10-year period of pumping (2000 through 2010) was characterized by precipitation swings between drought and above average amounts. Larger changes in overall flow conditions occurred at the Eagle Creek gage as pumping continued. Flows ceased at the gage approximately 22 percent of the time, and smaller flow rates occurred approximately 60 percent of the time. The general percentage of time that the larger flows (above 1.2 cubic feet per second) occurred at the gage, about 19 percent, continued to decline from previous 10-year periods.

Table 5. Streamflows measured at the Eagle Creek gage

Flow Measured at Eagle Creek Gage	Percent of Time	Months per Year
Prepumping 10-Year Period (1971 through 1980)		
Time dry (flow 0.01 cubic feet per second or less)	0	0
Flow greater than 0.01 to 1.2 cubic feet per second	43.4	5.2
Flow greater than 1.2 cubic feet per second	56.6	6.8
Early Pumping 10-Year Period (1989 through 1998)		
Time dry (flow 0.01 cubic feet per second or less)	2.5	0.3
Flow greater than 0.01 to 1.2 cubic feet per second	51.7	6.2
Flow greater than 1.2 cubic feet per second	45.8	5.5
Later Pumping 10-Year Period (2000 through 2010, without data for 2005)		
Time dry (flow 0.01 cubic feet per second or less)	21.6	2.6
Flow greater than 0.01 to 1.2 cubic feet per second	59.2	7.1
Flow greater than 1.2 cubic feet per second	19.2	2.3

From this analysis, it is clear that during average or above average precipitation periods, the effects of well field pumping are discernible but create generally minor differences from historical prepumping conditions at the Eagle Creek gage. Greater effects may or may not occur upstream. In less than average precipitation periods, however, the effects of pumping on streamflows are much more pronounced. The stream goes dry at the Eagle Creek gage for a substantial part of the time, and other flow rates are generally reduced below prepumping conditions. These effects translate into corresponding reductions of streamflow and near surface water availability up to and somewhat beyond the well field.

Information from the U.S. Geological Survey and other investigators (Finch et al. 2004, Balleau Groundwater 2004, Midkiff 2002) show that when groundwater is pumped from the North Fork Eagle Creek wells, a temporary decline in the water table results, creating a cone of depression around the wells. This cone of depression deepens water levels in both the alluvium and underlying volcanics. Pumping and streamflow are related, in that pumping near a stream will deplete surface flows in a porous channel setting. This effect occurs within the North Fork. As a result, the intermittent (seasonal) flows or pools that historically occurred from a short distance above the well field downstream to the Eagle Creek gage have been reduced in magnitude and extent by pumping. These effects are more pronounced during dry seasons or dry years. As surveyed in combination, the North Fork and South Fork watershed condition classification on National Forest System lands has been listed at impaired function, exhibiting low geomorphic, hydrologic, and biotic integrity relative to natural potential conditions. However, the degree of these connections and the nature of groundwater flow paths are complex in the North Fork Eagle Creek study area and have not been fully characterized. For this reason, the actual extent of long-term drawdown from pumping is unknown, as are the details of pumping effects on streamflows and groundwater levels. We estimate these conditions through the investigations described above.

We conducted a further review exercise to compare, in a very general fashion, flow conditions at the Eagle Creek Gage to those of the Rio Ruidoso at Ruidoso (U.S. Geological Survey Gage 08386505). While there are differences between the drainages these gages represent (e.g. size, elevation ranges, aspects, geology, channel length, alluvial deposits, vegetation), both drainages are fairly high elevation, forested drainages next to each other on the east side of Sacramento Mountains/Sierra Blanca region. For the purposes of general comparison, flow frequencies were developed for both drainages over a common period of record represented by mean daily discharge data at the gages.

Results indicate that, in a general sense, unit-area discharges during a pumping period on Eagle Creek are substantially smaller than on the Rio Ruidoso, particularly in the lower flow ranges. For example, the Eagle Creek flow having a 50 percent chance of being equaled or exceeded in a recent year is approximately 0.065 inches per day per 100 acres. On the Rio Ruidoso, the flow at the same frequency is approximately 0.5 inches per day per 100 acres, almost an order of magnitude greater than on Eagle Creek. Flows essentially cease on Eagle Creek whereas they continue on the Rio Ruidoso. Although there are differences in these drainages and sources of error in the gaging data, the results indicate substantial differences in recent flows even after adjusting for differences in basin area. It is likely that some of these differences result from pumping in the North Fork Eagle Creek well field.

Climate Change

There appears to be a general consensus currently among climate specialists that, regionally, the Southwestern United States is experiencing a drying trend. Modeling indicates that this is expected to continue well into the latter part of the 21st century (USDA Forest Service 2010). A slight warming trend observed over the past 100 years is anticipated to continue, with the greatest warming expected during winter. Snowpack monitoring suggests that increasing temperatures have generated snowmelt progressively earlier in the year, causing streamflows to deliver water to storage and water users in larger volumes earlier in spring (USDA Forest Service 2010). In western North America regionally, there is later onset of winter, spring snowpack has declined, and snowmelt timing has come earlier in the year (Knowles et al. 2006; Mote et al. 2005; Cayan et al. 2001; Stewart et al. 2005). Shorter winters, and less snowpack, may also affect the timing of peak river flows. In addition, as snowpacks shrink, seasonal stream temperatures could increase (USDA Forest Service 2008).

Changes in overall precipitation are more difficult to predict than temperature changes, because precipitation is more variable in time and space. Added complexities such as topography and monsoonal timing complicate precipitation predictions in the Southwest (USDA Forest Service 2010). Southwestern precipitation may be reduced overall, and skewed toward fewer larger events. Increased frequency of drought could occur by mid-century (Enquist et al. 2009). However, predictions vary as to effects on runoff caused by broad regional precipitation and temperature changes. These potential effects deserve more investigation, particularly for small, high elevation headwater basins where most runoff is generated (Christensen and Lettenmaier 2007).

Post-Little Bear Fire Affected Environment

Fire Extent and Severity

As summarized in chapter 1 and in figure 5, the Little Bear Fire burned approximately 35,300 acres within the Smokey Bear Ranger District on the Lincoln National Forest in June of 2012 (USDA Forest Service 2012b). Wildfire characteristics within the Eagle Creek watershed are summarized in table 6.

Table 6. Little Bear Fire conditions in the North Fork and South Fork, Eagle Creek Watersheds

Burn Severity	North Fork Eagle Creek, Acres (Percent of Total)	South Fork Eagle Creek[a] Acres (Percent of Total)
High	877 (25.9)	176 (9.8)
Moderate	877 (25.9)	63 (3.5)
Low	905 (26.8)	128 (7.1)
Unburned/Very Low	723 (21.4)	276 (15.3)
Area Outside Wildfire Perimeter	0 (0.0)	1,157 (64.3)
Totals	3282	1,700

a - The South Fork listing includes the area between the South Fork and the streamgage at the confluence (U.S. Geological Survey Eagle Creek below the South Fork, #0387600).

Source: USDA Forest Service GIS information 2013.

The purpose of this section is to describe how hydrologic conditions have changed (or are expected to change) in the North Fork Eagle Creek project area and surrounding watersheds as a result of the wildfire. This Water Resources section is based on the detailed analysis provided in the supplemental Water Resources Report (AECOM 2014). This AECOM (2014) report, available in the project record, includes multiple tables, maps and figures to illustrate and support the information provided therein. Not all of these tables, figures and maps are included here in this section but are instead either referenced or the information summarized.

During and after the wildfire, Burned Area Emergency Response (BAER) efforts were undertaken by the Forest Service to characterize resource conditions within the wildfire perimeter. The BAER reports (USDA Forest Service 2012a, b) and additional information from existing research form the basis for much of this supplemental description of affected water resources within the study areas.

Extensive, damaging wildfire is widely acknowledged to be a major watershed disturbance, and to potentially create substantial changes in watershed dynamics and water balance factors. These modifications especially occur where large fires take place in coniferous mountain watersheds such as the Eagle Creek headwaters. Although the Little Bear Fire intensity varied over the study area watershed, BAER investigators identified water-repellent soils across intensity categories, and fires typically convert forest types on the Smokey Bear District. Hydrologic responses also vary according to complex relationships of slope and aspect, geology, and regional climate characteristics. In addition to information retrieved from the BAER reports, changes in hydrologic conditions are anticipated on the basis of research into large fires in the Southwest.

The following information focuses on the primary water balance factors affected by the Little Bear Fire, as determined from available data collections and ascertained from existing research. Other conditions that will likely affect water monitoring, mitigation and management also are considered.

Precipitation and Snow Accumulation/Ablation

Precipitation continues to be monitored at several established Federal and state sites within the region (Natural Resource Conservation Service 2013; Western Regional Climate Center 2013). In addition, the U.S. Geological Survey installed a number of rain gages in or near the Eagle Creek watershed after the Little Bear Fire. The purpose of the U.S. Geological Survey network is to provide information related to the potential for high runoff and flooding, erosion, and debris flow conditions in response to precipitation events (oral communication with Dr. A.M. Matherne, U.S. Geological Survey, November 12, 2013); data collection began on July 16, 2013 (U.S. Geological Survey 2013). Major rainfall events recorded at the Buck Mountain near Alto gage, at elevation 10,751 feet near the western divide of the study area watershed, occurred in roughly the second week of September. This also is reflected in other U.S. Geological Survey rain gages recently installed in the vicinity. Larger events recorded at Buck Mountain also included events in July, August, September and October 2013, as described in more detail in AECOM 2014. There is substantial variation in precipitation data including that discussed above and other data analyzed (variation from place-to-place, month-to-month, and year-to-year) and in many locations, data are missing.

Beyond these additional data, current and expected future conditions reflect the influence of the Little Bear Fire. Large severe fires affect water balance factors such as snow accumulation and ablation, infiltration, surface runoff and groundwater partitioning, and evapotranspiration. Potential changes in snow accumulation and ablation (collective processes of snow removal) are perhaps the most directly related precipitation effects from moderate to severe wildfires; these are discussed here, and effects on evapotranspiration and other factors are discussed subsequently.

A number of investigations have examined the effects of coniferous stand reductions (thinning, clearcutting, fire, beetle kill) on canopy interception, snowpack accumulation, and snow losses in the mountain west (Biederman and Brooks 2013; Harpold et al. 2013; Hibbert 1967; Pugh and Small 2011; Newton et al. 2012; Stednick 1996; Troendle 1983; Troendle and Meiman 1986). Early investigations into thinning or clearcutting effects indicated that, although snowpack in treated areas generally accumulated to greater depths, this was highly variable based on aspect and slope. In general, the peak water equivalent of the snowpack increased less than 12 percent in most studies based on small treatment plots. Larger treatments (up to 83 percent of stand reduction) in lodgepole pine resulted in a 20 percent increase in peak water equivalent within the snowpack (Wilm and Dunford as cited in Troendle 1983). However, in watershed-scale studies after clearcutting, increased snowpack ablation losses in the cleared areas (through additional solar radiation, sublimation, and winter melt) resulted in no significant gains in total seasonal water equivalent (Troendle 1983).

Similarly, it is expected that in the study area there will be little or no additional water input from snow accumulation and melt after the wildfire. Recent studies in New Mexico indicate that after the Las Conchas Fire (southwest of Los Alamos), a single snow event generated much greater accumulation in the burned area compared to unburned coniferous forest (Harpold et al. 2013). For single snow events, generally 25 to 45 percent of the snow was intercepted by the coniferous canopy in the unburned area, compared to no interception in the burned area. However, over the longer term, seasonal ablation in the burned areas reduced snowpack there. Ablation during the winter reduced the snowpack in the burned areas by 50 percent prior to the onset of melt (Harpold et al. 2012). Ultimately, there was approximately 10 percent greater water available for melt in the unburned areas. These investigators also concluded that topography played an important role in post-burn snow conditions. Another study at Valles Caldera indicated that vegetation structure played a major role in snowpack distribution, and noted both greater snow accumulation as well as ablation in open areas (Molotch et al. 2009). The duration of snowpack was greater under the forest canopy. That study suggested that snow accumulation (and water availability) under the forest canopy was less sensitive to weather variations between years than in the open areas.

These findings generally agree with investigations by Troendle and others. In summary, for cleared coniferous western forests, investigations indicate that snow losses from increased solar radiation and other factors will offset the potential snowpack gains and also accelerate melting of the remaining snow. There may be somewhat less water input from snow in the burned areas, and seasonal weather variations will have greater effect on water inputs from snow.

Vegetation Changes and Evapotranspiration

The North Fork Eagle Creek project area contains a variety of vegetation communities, including mixed conifer, ponderosa pine, pinyon-juniper, and grassland vegetation types (Kuhar 2013). All of these are interspersed with patches of oak brush (*Quercus* spp.). Forest Service monitoring during 2006 and 2007 in the adjacent Bonito watershed has lately been used to characterize pre-wildfire conditions in the North Fork Eagle Creek project area, which has similar elevations and vegetation types. On the sampled sites, grasses and forbs contributed to less than 50 percent of the total plot vegetation cover, and tree species were the dominant cover. The greatest proportions of grasses and forbs occurred in areas that had undergone large wildfires in the first half of the twentieth century (Kuhar 2013).

Research indicates that stem densities in southwestern forest stands have increased (Covington and Moore 1994; Johnson 1994; Kilgore 1981). Historically, dry upland sites had more open, park-like stands, while stands in protected, moist areas tended to have dense, closed canopies (Kuhar 2013 and summarized in the Vegetation section later in this chapter). Current densities range between 1,700 to 2,900 trees per acre in dry upland mixed conifer stands, about 3,900 trees per acre in ponderosa pine stands, and about 6,800 trees per acre in pinyon juniper stands (based on the Bonito watershed sampling). Over 90 percent of these trees are less than 5 inches in diameter (Kuhar 2013). The U.S. Geological Survey noted that pre-wildfire tree-canopy cover ranged from 0 to 100 percent in all of the elevation bands in the study area vicinity; the average pre-wildfire canopy cover in the North Fork Eagle Creek Basin was about 69 percent; in the South Fork Eagle Creek Basin, it was about 65 percent; and in the Eagle Creek-below-confluence contributing area, pre-wildfire canopy cover was about 83 percent (Matherne et al. 2011).

The timing of these changes in watershed vegetation is important to water balance characterization in the North Fork Eagle Creek hydrologic study area. Anecdotal information from Forest Service personnel indicate that the vast majority of this growth occurred in the last part of the 1800s and the first part of the twentieth century (written communication with Ms. Kim Kuhar, Lincoln National Forest, January 21, 2014). This would have been prior to streamgaging in the 1970s and the beginning of the Village well field utilization in the late 1980s. On this basis, since the 1970s, the most substantial changes in evapotranspiration and canopy interception within the study area watersheds are due to the Little Bear Fire.

The USDA Forest Service study in the area indicates that historically, topography did not limit fires to discrete vegetation types. This is documented from the 3,600-acre wildfire in 1935 that burned through ponderosa pine, mixed conifer, and some pinyon-juniper stands (Kuhar 2013). (This also is consistent with the Little Bear Fire, which burned through high-elevation mixed conifer to lower-elevation pinyon-juniper woodlands.) In addition, the study indicated that all larger fires were stand-replacing. Large-scale fires such as these on the Lincoln National Forest have typically converted coniferous forests to grass-shrubland associations. Based on both photographic evidence and monitoring data, these conditions can persist for multiple decades (Kuhar 2103). For example, a 3,000-acre wildfire in the nearby Bonito watershed in the 1930s converted the landscape to predominantly oak shrublands. Evidence of the wildfire could still be seen in 2002. Based on this local information, the wildfire-caused reduction in forest canopy and the shift to grass or grass-shrubland vegetation could modify evapotranspiration factors in the water balance of the North Fork Eagle Creek project area. Additional information about potential post-wildfire vegetation succession and fire return-interval is presented in the Fuels Specialist Report for the North Fork Eagle Creek EIS (Kuhar 2013).

A number of investigators have studied the effects of forest canopy reductions on watershed yield (Hibbert 1967; MacDonald and Stednick 2003; Troendle and Meiman 1986). Most of these authors addressed watershed yield as equivalent to streamflow, and provided little or no analysis of groundwater conditions. Nonetheless, fairly consistent findings indicate that reducing forest canopies increases water yield, increasing forest canopies reduces water yield, and the responses to treatments are highly variable (Hibbert 1967; Stednick 1996). Latitude and solar radiation, precipitation patterns, and treatment types and extents are some of the major influences on changes in water yield produced by manipulating vegetation.

General indications are that annual evapotranspiration rates in ponderosa pine stands range from about 10 to 20 inches, with more specific data indicating 17 inches annually in western interior ponderosa pine stands (Lull, section 6 in Chow 1964). Thompson (1974) indicated 19.4 inches per year in ponderosa pine on the Apache-Sitgreaves National Forests in Arizona, so it appears that 17 to 20 inches is a reasonable range for ponderosa pine evapotranspiration in the region. Evapotranspiration rates in western mixed conifer stands were estimated at 22 inches annually, and approximately 14.5 inches annually for pinyon-juniper woodland types (Lull, section 6 in Chow 1964). Over several years, Johnston et al. (1969) investigated evapotranspiration on Gambel oak types underlain by herbaceous vegetation near Ephraim, Utah. They found rates ranging from about 13 to 16 inches per year in those communities, with the higher values at higher elevations of about 7,900 feet. Soils were thin and underlain by fractured rock; measurements in oak communities were based on depths drilled to 6 feet. At 9,200 feet, the grass-herbaceous type had reasonably consistent evapotranspiration rates of approximately 11 inches per year (Johnston et al. 1969), substantially less than documented for the forest types.

In general, these findings indicate that there may be some net water gain in the long term in those parts of the North Fork Eagle Creek watershed that undergo stand conversion from forest types to grass-shrublands. Fires typically convert forest types to oak shrublands on the Sacramento and Smokey Bear Ranger Districts. This is evident on multiple fires since the 1970s, such as the Burgett, Patos, Cree, Scott Able, Walker, Penasco fires, as well as fires documented in the Bonito River Corridor from the 1930s-50s (Kuhar 2012). If high and moderate severity burns convert vegetation types, this could occur on 52 percent of the North Fork watershed (table 6). The occurrence and maintenance of post-wildfire grassland types likely would further reduce annual evapotranspiration losses from the water budget.

In the southern Sacramento Mountains, preliminary results from ongoing hydrogeology studies related to the potential effects of tree thinning indicate that preferential flow paths in soils have a role in groundwater recharge (Newton et al. 2012a). This study examined the stable isotopic composition of soil water, and identified snowmelt water in soil storage that is slowly evaporated. In general, groundwater recharge and availability in the area heavily depends on snowmelt (Newton et al. 2012b). Research appears to indicate that in the spring, trees generally utilize this water in the soil. However, water in heavy monsoonal rains has a different isotropic signature, and infiltrates quicker and deeper through preferential flow paths. This water from exceptional monsoon events likely reaches underlying bedrock, and may recharge groundwater (Newton et al. 2012a). After the beginning of monsoons, at least 50 percent of the water taken up by trees comes from this deeper infiltrating water. After the monsoon season, trees return to using the shallower soil moisture (Newton et al. 2012a). Thus, although a decrease in trees may increase soil evaporative losses, and regrowth of grass-shrubland vegetation may or may not substantially reduce water uptake, there may be water budget benefits from tree removal if more groundwater recharge is available through preferential flow paths. Newton et al. (2012b) noted that water effects from reducing tree stands are site-specific and variable, and depend on a number of factors such as geology, climate, vegetation types, and hydrogeologic setting.

Surface Runoff and Streamflow Gaging Data

A frequent wildfire effect is the formation of water-repellent soils from the heating of organic resins, excessive drying, and changes in soil structure and pore space (Debano 1990; Luce 2005). Early characterization of this phenomenon was done in the 1940s by the USDA Forest Service in fire-prone chaparral watersheds in California. This effect also is known as “soil hydrophobicity”. Under such conditions, soils actually repel water (snowmelt, rainfall, overland flow) rather than infiltrating it. Coarse, sandy or gravelly soils tend to be more susceptible to water repellency than finer (silty or clayey) soils (Luce 2005). Surface runoff can be dramatically altered if fire-induced water repellency is extensive. Hydrologic responses such as reduced infiltration, irregular surface and subsurface wetting, preferential runoff pathways, and accelerated overland flow can result from soil hydrophobicity (Doerr and Moody 2004). In general, the hydrophobicity is broken up or is sufficiently washed away within 1 to 2 years after the wildfire (Robichaud 2000), but this is likely to vary considerably with site-specific factors. The BAER report and associated maps for the Little Bear Fire indicate that water repellent soils were inventoried in the North Fork Eagle Creek watershed (USDA Forest Service 2012a). Based on inspection of the fire severity/soil inventory maps, it appears that the severity of soil water repellency generally corresponds to fire severity for the Little Bear Fire overall. This is not entirely consistent, however. Within the North Fork Eagle Creek study area itself, the water repellency investigation plots and results are indicated in table 7. Investigators in Colorado found that strongly hydrophobic soils formed most commonly under moderate and severe fire intensities in ponderosa and lodgepole pine communities, they also occurred (but not as strongly) under low-intensity burns (Huffman, et. al. 2001). Statistically significant differences between fire intensities and soil hydrophobicity were not identified due to the large variability within and between sites.

Variation in soil hydrophobicity at different spatial scales appears to be linked to the amount of hydrophobic organic matter in the soil, and the variability of macropores (e.g., root channels)

(Doerr and Moody 2004). Water repellency can occur at the surface, or at greater depths (usually less than 20 inches) in the soil (Doerr and Moody 2004; Ericksen and White 2008). Ponderosa pine, mixed conifer and spruce/fir ecosystems have larger and thicker duff layers when compared to pinyon pine/juniper and grassland ecosystems. These heavier layers provide longer burn time, thereby enhancing the potential for hydrophobic soils (Clark 2001; USDA Forest Service 2012a). Soil and remaining ash layers above the water repellent layer can be more prone to erosion. Importantly, because of this and accelerated runoff conditions, erosion and sedimentation frequently increase under post-wildfire runoff conditions. This in turn reduces surface water quality. Runoff event modeling was conducted by the USDA Forest Service BAER team shortly after the Little Bear Fire (USDA Forest Service 2012b). The BAER hydrologists analyzed 25-year, 50-year, and 100-year recurrence interval storms with durations of 6 hours. Runoff simulations used storm duration inputs of 6 hours, to reflect typical late summer high intensity monsoonal events that are considered the principal threat from these fires. The extent of the monsoonal convective design-storm generally does not exceed 5 square miles (3,200 acres) (USDA Forest Service 2012b). Continued rainfall or consecutive days with light precipitation will fill the remaining soil pore space (that is left above hydrophobic layers), to the point where a subsequent event could generate substantial peak flow rates and runoff volume. BAER modeling predicts that the storm event peak flows in the Eagle Creek area are expected to increase as indicated in table 8.

Table 7. Water repellency classes in the North Fork Eagle Creek Basin

Site Id	Hydrophobicity (field points)	Burn Severity
CarltonCny_1	Low	Low
CarltonCny_2C	High	Moderate
BuckMtn_1	High	Unburned/Very Low
3_EagleCreek	Low	Low
Up_EagleCrk_1	Low	Moderate

Source: USDA Forest Service 2012a.

Table 8. Changes in storm event peak flows after the Little Bear Fire, Eagle Creek modeling locations

Watershed	Area, Square Miles	Pre-Burn/ Post-Burn 100-year, 6-hour peak, cubic feet per second	Change	Pre-Burn/ Post-Burn 25-year, 6-hour peak, cubic feet per second	Change
Upper North Fork	2.5	3,483/6,511	1.9x	2,007/4,468	2.2x
Lower North Fork	2.9	3,947/5,719	1.5x	2,378/3,774	1.6x
South Fork	2.8	3,388/4,911	1.5	1,966/3,202	1.6x
Confluence, North and South Forks	8.1	10,147/16,982	1.7x	5,949/11,088	1.9
Eagle Creek into Alto Lake	11.8	13,258/21,274	1.6x	7,523/13,751	1.8

Source: USDA Forest Service 2012b

From table 8, it is important to note that in general, the modeled peak flow rates expected after the Little Bear Fire are approximately 1.5- to 2-times the pre-burn estimates. Increases for more frequently expected storms such as the 10-year or 2-year, 6-hour storms, would likely be similar. These more frequent storms are more likely to occur in the period during which recovery of the watershed surface occurs. Other measurements in the Southwest indicate that post-wildfire peak flows from storms can be one or more orders of magnitude greater than pre-wildfire peak flows (Woodhouse 2004, Gottfried et al. 2003, Veenhuis 2002). In addition, the frequency of larger runoff events likely increases in response to wildfire, although precipitation inputs are not modified (Veenhuis 2002). Further, research has found that the change in the unit-area peak discharge is greater for the more frequent, lower-intensity rainfall events than for the less frequent, higher-intensity rainfall events (Moody and Martin 2001). Southwestern investigators also found that measurements of post-wildfire changes in storm peak discharges (which had 1.45-fold to 870-fold increases) were much larger than measurements of post-wildfire changes in annual runoff (which had a 0.5-fold decrease to a 4.5-fold increase) (Moody and Martin 2001). These changes could occur in both severely-burned and moderately-burned watersheds (Neary et al. 2005).

A two- to 3-year period of vulnerability to debris flow occurrence on sideslopes within the study area watershed is estimated by the U.S. Geological Survey (Tillery and Matherne 2013). Soil hydrophobicity generally lasts 1 or 2 years, but may vary widely depending on fire and soil conditions. (Extreme durations of up to 6 years were recorded in DeBano 1981). Recovery of hillslope hydrologic conditions in the Little Bear Fire area may take 5 to 7 years (USDA Forest Service 2012b). On the basis of these estimates, hillslope hydrologic recovery may take as little as 2 to 5 years, or up to 6 or 7 years post-wildfire. For purposes of further discussion, an approximate period of 3 to 7 years is described as the post-wildfire hydrologic “short-term”. With this approximation, short-term effects on hillslope hydrology are anticipated to occur between the years 2012 to 2015, or possibly until 2019.

Large, damaging fires do not modify the occurrence of precipitation, but do modify hillslope hydrologic processes. Since the frequency of larger runoff events is likely to increase (Veenhuis 2002), incidental streamflows may increase over limited periods of several days or a couple of weeks. These flows will result from “flashy” runoff events - when flows increase and decrease, they will do so sharply. In general, however, given that there will be less infiltration and larger amounts of surface runoff during the 3 to 7 year period of transient post-wildfire hillslope recovery, less water from snowmelt and rain will be available to recharge the underlying aquifer zones, sustain low-flow period baseflows in the stream, and supply the well field. If the amount of precipitation input remains similar to pre-wildfire conditions, but more surface water runs off faster, the amount of water available to be partitioned to groundwater recharge will be less over the hydrologic short term. If groundwater recharge conditions lag hillslope conditions by a year, then overall hydrologic recovery to a resemblance of pre-wildfire conditions may take roughly 4 to 8 years or so post-wildfire, generally estimated as sometime between 2016 to 2020.

Current conditions at existing streamgages (illustrated in AECOM 2014 and also shown in some post-wildfire photos in appendix D) depicts between 4 to 6 feet of sediment infill. Repeated episodes of such infilling at the streamgages are anticipated for at least between 3 to 7 years after the wildfire, as the watershed slopes re-stabilize. In addition, sediment and debris (e.g., gravel, cobble, and wood) will be stored and routed through the North Fork valley over a considerable period of time. During that time, which may be several decades (oral communication with Mr. N.C. Myers, U.S. Geological Survey, November 12, 2013), the stream alluvium will be re-worked and the channel may migrate within its floodplain. These dynamics will repeatedly pile sediments in the approaches to the gages.

Without suitable flow approach conditions, streamgages are woefully inaccurate. Essentially streamgages measure the level of free-flowing open-channel flow in relation to a known datum, and then that level is converted to a discharge value through rating equation(s) specific to the measurement device. When sediment or debris collects in the gage approach or throat, what is actually measured is the water level within a porous medium with reduced cross-sectional area and additional energy losses. Although the water may be stagnant or nearly so, its level is still being measured and converted to an erroneous flow rate. Inaccuracies are particularly likely at high flows during scour and fill, and afterwards as new ratings need to be established.

Because of the unstable channel and gaging conditions at the North Fork and Eagle Creek (confluence) surface flow gages, alternative means of monitoring along the stream will be needed in order to implement effective adaptive management or simply to collect reliable data for a future use. In order to obtain more reliable data and provide for stabilization and potential recovery of the riparian system, the expanded use of monitoring wells is advised. Otherwise, frequent surface gage inspection and maintenance would be required to provide monitoring data, and this would be time-consuming and expensive. In addition, surface flow data collected between maintenance activities would be suspect in such an active channel environment. Further, the problem of underflow bypassing the gages through porous alluvium would continue to challenge data assessments, unless monitoring wells were established as the basis for an adaptive management program or reliable data collection effort.

As shown in figure 38 in the water resources specialist report, located in the project record, indicates much of the tributary flow from the North Fork and South Fork, respectively, that contributes to the Eagle Creek gage below the confluence. Figure 39 in the water resources specialist report, located in the project record, indicates the flows, however inaccurate, being measured on the mainstem of Eagle Creek below the South Fork (U.S. Geological Survey 08387600). Based on available U.S. Geological Survey data collected in early December 2013, flow measurements had ceased at the downstream gage (Eagle Creek below South Fork) in June 2013, and had been zero for a considerable period beforehand (9 months - since October 2, 2012). New U.S. Geological Survey data downloaded in mid-January 2014 indicates late-summer monsoonal moisture effects on streamflow. These new records may reflect recent site maintenance activities and the time required for data review and approval. Using available data, general comparisons were made between the amounts of runoff generated by pre-wildfire versus post-wildfire summer storms. The events and seasonal conditions were selected on the basis of reasonably discrete periods of rainfall (recorded at Cloudcroft and Ruidoso) and streamflows recorded at the North Fork (U.S. Geological Survey 083875500) and Eagle Creek below South Fork (U.S. Geological Survey 08387600).

Comparisons did not include the South Fork since wildfire damage was much more limited in that watershed. Each period was selected on the basis of little or no rainfall or streamflow for several days before and after the timeframes inspected. Differences in pumping are described in the discussions below. For a fairly short 9 day rain period in July 2011 (July 17 to 26, 2011), the total rainfalls at Cloudcroft and Ruidoso were approximately 1.0 and 0.8 inches, respectively. Total pre-wildfire streamflows over the period were approximately 0.6 acre-feet at the North Fork gage, and about 1.1 acre-feet at the Eagle Creek confluence gage. At the time, the Village of Ruidoso was pumping approximately 1.1 acre-feet per day from supply well NF-4. Over an 8-day post-wildfire event (July 1 to 8, 2012), the total rainfalls at Cloudcroft and Ruidoso were approximately 1.3 and 0.9 inches, respectively. Total post-wildfire streamflows over the period were approximately 9.6 acre-feet at the North Fork gage, and about 8.1 acre-feet at the Eagle Creek confluence gage. However, there was no pumping in July 2012 according to Village records, except 1.2 acre-feet pumped on July 26 from well NF-4.

So, for somewhat more precipitation over similar durations, the amount of water estimated at the gages increased by roughly an order of magnitude from pre-wildfire to post-wildfire conditions. In neither case was there an unusual, 1-day downpour. The greatest daily precipitation during the pre-wildfire timeframe was 0.44 inches (recorded at Cloudcroft). The greatest daily precipitation during the post-wildfire timeframe was 0.88 inches (also at Cloudcroft). However, there had been nearly constant well field pumping throughout July 2011, in comparison to essentially no pumping in July 2012.

Over a more lengthy pre-wildfire period (July 11 to September 11, 2011), the total rainfalls at Cloudcroft and Ruidoso were approximately 9.8 and 8.5 inches, respectively. (Several days of data were missing at Ruidoso.) Total pre-wildfire streamflows over the period were approximately 43.1 acre-feet at the North Fork gage, and about 3.5 acre-feet at the Eagle Creek confluence gage. Pumping records indicate that approximately 1.1 acre-feet per day were withdrawn in July, 1.06 acre-feet per day in August, and about 1.3 acre-feet per day in September.

Over a similar post-wildfire period (July 3 to September 12, 2012), the total rainfalls at Cloudcroft and Ruidoso were approximately 7.7 and 4.9 inches, respectively. (Again, several days of data were missing at Ruidoso.) Total post-wildfire streamflows over the period were approximately 93 acre-feet at the North Fork gage, and about 73 acre-feet at the Eagle Creek confluence gage. There was essentially no pumping in July or most of August, but about 1 acre-foot per day was withdrawn in the last 10 days of August and through September.

So, for even somewhat less post-wildfire precipitation over similar durations, the amount of water estimated at the gages increased by over a factor of two in the North Fork, and by a factor of roughly 20 at the confluence gage from pre-wildfire to post-wildfire conditions. The greatest daily precipitation during the pre-wildfire timeframe was 4.02 inches (recorded at Cloudcroft). The greatest daily precipitation during the post-wildfire timeframe was 1.85 inches (also at Cloudcroft). Flow conditions for these two periods are reflected in Figures 38 and 39 in the water resources specialist report. However, there were pumping differences between these periods, notably between the weeks in July and early August. There was continuous pumping in July and August 2011, but no pumping in July and the first 3 weeks of August, 2012.

While these events or timeframes generally indicate the effects of the Little Bear Fire on surface runoff, there are several uncertainties involved in reviewing them. Available pumping well information indicates that there were differences in pumping activities between these comparison periods. Also, precipitation fields vary in mountainous terrain, so there is no assurance that these short-term data for Cloudcroft and Ruidoso represent rainfall over the study area. They probably do serve as indications, however. (U.S. Geological Survey raingages in and near the North Fork Eagle Creek watershed were not activated until July 2013). In addition, the water balance is clearly not preserved between the North Fork gage (U.S. Geological Survey 08387550) and the Eagle Creek confluence gage (U.S. Geological Survey 08387600). For the short-term post-wildfire event (July 1 through 8, 2012), there is a loss of about 1.5 acre-feet (15 percent) from the North Fork to the Eagle Creek confluence gage even without pumping.

In the July to September 2011 period, there is a tremendous pre-wildfire difference (about 12x) between the North Fork flow and the much smaller flow downstream at the Eagle Creek mainstem. Pumping occurred throughout this period. In the post-wildfire July to September 2012 data, there are still approximately 20 acre feet lost (27 percent) between the gages. According to Village records, pumping occurred during approximately the last half of this period, and totaled approximately 20 acre-feet. Based on the shorter period of early July 2012, flow differences could also result from malfunctions at the surface water gages, seepage losses to groundwater, or both. Again, the expanded use of monitoring wells in a data collection program would resolve these issues in any future monitoring.

Erosion and Debris Flows

Investigations indicate that a major post-wildfire effect is the lack of effective ground cover, litter, and vegetation to intercept rainfall and attenuate overland flow. In general, erosion and runoff increase with a reduction in cover. This is true in the burned area (USDA Forest Service 2012a). In areas investigated within the Little Bear Fire perimeter, a thin ash layer was common on areas of moderate and severe burns where high winds and vertically rotating columns of air (whirlwinds) within the steep canyons may have blown ash away. Experience has shown that, regardless of the degree of water repellency, areas in the southwest that have short duration, high intensity storms produce extreme runoff events. Ash and soil is lost if most of the vegetative cover has been removed.

The Forest Service BAER team estimated post-wildfire erosion losses and volumes using a standard approaches, the Water Erosion Prediction Project (WEPP) model and the Erosion Risk Management Tool (ERMiT). Within the Little Bear Fire perimeter in general, the average pre-wildfire erosion rate was less than 1 ton/acre. Near the project area, the average post-wildfire erosion rate for Ski Apache in high and moderate severity was estimated to be 114 tons/acre, and sediment delivery was estimated to be about 7,500 cubic yards per square mile (USDA Forest Service 2012a). In addition, past work indicates that post-wildfire erosion rates and sediment yields are underestimated from the WEPP model (USDA Forest Service 2012a). These projected losses can be considerably reduced by post-wildfire treatments, however, and treatments were applied in the North Fork Eagle Creek project area.

Sheet, rill and gully erosion of these magnitudes will form preferential overland flow paths that exacerbate flash flooding and greater rates of surface runoff. In addition to the suspended sediment and channel bedload from accelerated erosion, more severe debris flows are likely to occur within the project area and nearby.

After the Little Bear Fire, the U.S. Geological Survey conducted debris flow probability modeling for lands within the wildfire perimeter (Tillery and Matherne 2013). Using a set of empirical hazard-assessment models, developed from data from recently-burned drainage basins throughout the intermountain West, general estimates of the probability and volume of debris-flows were made for selected drainage basins within the burn area. Several of the smaller sub-basins within the direct/indirect hydrologic study area watersheds were included in those selected for the U.S. Geological Survey analysis. The analysis indicates that debris flows are highly probable over much of the North Fork Eagle Creek study area, and also nearby over parts of the cumulative study area. Debris flow volume estimates were derived independently of the debris flow probabilities. Based on the empirical modeling, volume estimates indicate that the North Fork of Eagle Creek downstream of Telephone Canyon (i.e., downstream of a point about 0.2 miles upstream of the North Fork streamgage) is anticipated to receive over 100,000 cubic meters (at least 3.5 million cubic yards) of debris from the watershed sideslopes in response to a 2-year recurrence interval 30-minute rainfall accumulation of about 1 inch (Tillery and Matherne 2013).

Relative hazard-rankings of post-wildfire debris flows were produced by summing the estimated probability and volume rankings to illustrate those areas with the highest potential occurrence of debris flows with the largest volumes (Tillery and Matherne 2013). The central part of the North Fork of Eagle Creek, from about 0.2 miles upstream of the North Fork streamgage to about 1/8 mile downstream of Carlton Canyon, is ranked as one of the drainages having the highest combined probability and volume relative-hazard ranking for debris flows (Tillery and Matherne 2013). Below Carlton Canyon, the downstream segment of the North Fork to its confluence with the South Fork has the second highest combined relative-hazard ranking. In addition, most tributaries of the North Fork upstream of the summer home locale, including Telephone Canyon and others, also have the second highest combined relative-hazard ranking of debris flow probability and volume.

The significance of these conditions is that scour and fill, headcuts, and other channel modifications will occur over a considerable number of years in the North Fork and South Fork of Eagle Creek. The channel environment, and particularly the locations of surface flows, will be more dynamic than before the wildfire. Regular measurement of open channel flow over time, such as might be done in a monitoring program, will be much more expensive and less reliable. These factors will likely require revised approaches to water management for environmental purposes along the North Fork Eagle Creek.

Groundwater Recharge and Water Levels

Groundwater recharge in the Sacramento Mountains is heavily dependent on snowmelt (Newton et al. 2012b). Based on the discussions above, there are not likely to be additional inputs to the overall water balance, and particularly to aquifer recharge, from wildfire effects on snowpack due to increased ablation losses. Over the short-term transient post-wildfire recovery (i.e., generally 3 to 7 years), soil hydrophobicity and the removal of vegetation and litter are likely to increase surface water runoff and reduce infiltration and deeper percolation. In the longer term post-wildfire condition (i.e., 4 to 8 years or more), stand conversion from coniferous forest types to grass-shrublands in some parts of the study areas may decrease evapotranspiration losses and encourage the movement of water to greater depths within soil, unconsolidated deposits, and fractured rock. Preliminary results from ongoing studies indicate that exceptional monsoonal moisture also may provide additional groundwater recharge in areas where tree cover is reduced (Newton et al. 2012a). The potential for this could be greater if more extensive grassland types became established in the watershed.

Water levels in monitoring wells along the North Fork of Eagle Creek have continued to be recorded by the Village of Ruidoso (written communication from Ms. C. Thompson, USDA Forest Service, November 26, 2013). Recent water level graphs from the monitoring wells are indicated in Figures 43 through 47 in the water resources specialist report, located in the project record. The deep wells (MW-1B, MW-1C, and MW-3A) show a more-or-less consistent springtime water level rise from late January through mid-April of 2013, with a steady rise from early March through mid-April. Substantial water level rises in these wells can be noted during the onset of monsoonal moisture in July 2013, corresponding to precipitation increases indicated in U.S. Geological Survey rain gages around the watershed, and at Cloudcroft and Ruidoso. The rapid water level rises in September 2013 likely correspond to the relatively large total precipitation (over 8 inches) during roughly the second week of that month, as also recorded by U.S. Geological Survey precipitation monitoring.

The shallower monitoring wells (MW-1A, MW-5A) appear to react more quickly to precipitation or snowmelt pulses. Monthly total precipitation values at the regional stations were generally less than average for the winter of 2012 and 2013, and daily air temperatures indicate melt was likely occurring sporadically throughout the winter and early spring. At MW-5A, the hydrograph in August 2012 is responding to a mid-month precipitation series that totaled about 3.9 inches at Cloudcroft and 3.0 inches at Ruidoso. Monitoring well MW-1A did not respond to that event. For the March 2013 water level rises at MW-1A and -5A, about 1.2 inches of precipitation fell in early March at Cloudcroft, but data at Ruidoso are missing, and the U.S. Geological Survey rain gages were not operating then. Given the mixed freeze-thaw temperatures at Cloudcroft, the March 2013 rises might have been a rain-on-snow or frozen ground event. The rapid water level rises in early September 2013 correspond to the greater total rainfall falling at that time, as discussed in chapter 2.

There is a substantial amount of missing data, but the record does extend through the 2012 rainfall series, with an essentially flat trend likely indicating that the pump was off. Pumping occurred sometime around May 2013, at roughly the same time as water level declines in the deep monitoring wells MW-1B, MW-1C, and MW-3A (Figures 44, 45, and 46, respectively in the water resources specialist report, located in the project record). These conditions may relate to pumping drawdown in bedrock, as water placed in storage (on the seasonal rising limb) is removed. Alternatively, the water levels in deeper wells may simply reflect seasonal precipitation changes, noting the rises following rainfall after July 2013. (Pumping conditions after May 2013 are unknown.) The recession lines at shallow monitoring well MW-5A are parallel between the August 2012 event (likely non pumping in NF-1) and the May 2013 period (likely pumping in NF-1). There also is a general surface flow decline indicated at the North Fork streamgage during the May 2013 period.

Water Quality

Large wildfires generally reduce surface water quality as a result of substantially increased sediment concentrations, ash and other organic materials, and nutrient changes. Often, concentrations of nitrogen, phosphorus, and other ions increase in streams after burning (Tiedemann et al. 1979 as cited in Clark 2001). Increases in bicarbonates, nitrates, ammonium, and organic nitrogen are common (Chandler et al. 1983 as cited in Clark 2001). These may contribute to eutrophication or algal blooms in downstream waterbodies.

Runoff water chemistry is typically modified in the first few storms after a large wildfire, and frequently returns to pre-burn characteristics after 1 or 2 years (Clark 2001). However, increased turbidity, sediment, and organic carbon loads may persist for much longer, depending on the stream network and transport through the watershed. Higher post-wildfire sediment concentrations, organic debris, and nutrient concentrations from hillslopes may reduce dissolved oxygen availability in streamflows. In combination, these changes would alter water quality for a period of years after the wildfire. Based on the BAER fire intensity mapping, the project area along the North Fork underwent low intensity to under-burn fire conditions. This indicates that the remaining overstory along the stream may be mostly green and have limited scorch, or may have been subjected to even less fire damage (USDA Forest Service 2012a, b). In addition, the low fire severity or under-burn areas along the North Fork may contain adequate remaining ground cover to help reduce accelerated sheet erosion from source areas within the stream corridor.

Climate Change

In the final draft of the pre-wildfire Water Resources Technical Report (dated November 9, 2011), the introductory text to the precipitation analysis done for preceding years of record is no longer necessary in the context of the current U.S. Geological Survey report version (Matherne et al. 2011). In their final report revision (also released in November 2011), the U.S. Geological Survey no longer described a shift in seasonal moisture as a factor in runoff patterns or baseflow conditions in the Eagle Creek watershed. Since a comparison of seasonal conditions had already been done for the project, indicating that precipitation shifts were unlikely, previous climate explanations for flow conditions are no longer presented in this technical report following the latest U.S. Geological Survey revision. Other discussion of the potential nature of long-term climate change is anticipated to apply to post-wildfire conditions.

Summary

Water resources effects from the Little Bear Fire are anticipated to generally follow the preceding discussions, which are based largely on collected research and USDA Forest Service post-wildfire investigations. Some research was conducted under different conditions than those in the study areas; however, on-site, local, or regional findings have been incorporated where available. These more-applicable investigations create a different perspective from some of the findings from other parts of the West. In general, ongoing and anticipated wildfire effects in the Eagle Creek study area watersheds and the North Fork project area can be summarized as indicated in table 9 below. It should be noted that the duration of some effects depends on the timing, extent, and nature of vegetation changes within the burned areas, as previously discussed. In addition, some processes interact to increase or decrease the overall effects.

Table 9. Summary of anticipated wildfire effects on water resources

Hydrologic Process	Type of Change	Specific Effect	Anticipated Duration of Effects[a]
1. Canopy Interception	Reduced	Reduced moisture storage in the canopy	Short-term, and possibly long-term
		Greater runoff in smaller storms	Short-term, and possibly long-term
		Temporarily increased surface water yields	Short -term
2. Litter Storage of Water	Reduced	Less water stored in litter	Short-term, and possibly long-term
		Overland flow increased	Short-term, and possibly long-term

Hydrologic Process	Type of Change	Specific Effect	Anticipated Duration of Effects[a]
3. Transpiration	Temporary elimination or possible long term reduction	Soil moisture increased	Possibly long-term
		Streamflow increased	Possibly long-term
		Recharge possibly increased from large monsoonal events	Possibly long-term
4. Infiltration	Temporarily reduced	Temporary increases in overland flow and erosion	Short-term
		Temporary increases in storm flows	Short-term
5. Surface Streamflow	Changed	Temporary increases in “flashy” responses to rainfall or rapid snowmelt	Short-term
		Seasonally maintained or decreased during snowmelt	Short-term and possibly long-term
		Water quality reduced	Short-term
6. Baseflow	Changed	Short-term decreases (less infiltration and recharge)	Short-term
		Long-term return to pre-burn conditions, or potential long-term increases due to reduced evapotranspiration and monsoonal recharge through preferential pathways	Long-term
7.Stormflow and Sediment/ Debris Yields	Increased	Event volumes and peak flow rates substantially greater for period of years	Short-term
		Volume “bulked” by sediment and debris	Short-term
		Time to peak shorter (“flashier”)	Short-term
		Greater flash flood frequency	Short-term
		Erosive power increased	Short-term
		Channel modification and transport of sediment/debris, over decades	Both short-term and long-term
8. Snow accumulation	Changed (Generally these factors offset each other)	Increased snow accumulation	Both short-term and long-term
		Increased or accelerated evaporation, sublimation, and melt	Both short-term and long-term

a - Short-term durations are estimated to range from three to seven years post-wildfire. Long-term durations are estimated to extend beyond that time-frame. Some long-term effects (particularly related to canopy, litter, and transpiration changes) are more or less likely depending on the nature and extent of any stand conversions that may occur.

Source: Modified from Neary et al. 2005.

Environmental Consequences

Alternative 1 - No Change
(Continue Pumping at Historic Levels)
Direct/Indirect Effects

Streamflow Quantity

Based on inferences from historical conditions, under alternative 1 (no change), the general duration of no surface flow days at the Eagle Creek gage would be approximately 1 to 2 weeks a year during average precipitation periods and approximately 8 to 10 weeks a year during drier periods. By themselves, impacts from no-flow conditions would be short term and local. According to the flow frequency analysis of pumping during approximately average precipitation, flows of 1.2 cubic feet per second or greater would occur approximately 46 percent of the time. This would be a reduction of at least 10 percent from prepumping conditions, when flows of 1.2 cubic feet per second or greater occurred about 57 percent of the time (table 5). During drier years, flows of 1.2 cubic feet per second or greater would occur approximately 19 percent of the time, a substantial reduction from average prepumping conditions.

The actual occurrence of no-flow or reduced-flow periods would heavily depend on pumping rates, timing, and precipitation. If it is assumed that historic conditions can be used to infer future conditions, then according to table 5, the combined periods of flows less than 1.2 cubic feet per second (below which alluvial groundwater is assumed to become limiting to riparian and aquatic communities) would average approximately 6.5 months of the year during years of generally average precipitation. This would be an average increase of approximately 1.3 months over the duration of these lower flows (5.2 months) during the prepumping period. During drier years, the period of flow below 1.2 cubic feet per second would be extended on average to approximately 9.7 months of the year. This would be an increase of approximately 4.5 months over the duration of these lower flows during the prepumping period (5.2 months), a long-term impact in relation to prepumping conditions. Over a 20-year period of permit authorization, years of these severely reduced flows would be likely.

Discontinuous intermittent streamflows at reduced levels would continue near and downstream of the well field, creating site specific and local adverse impacts on flow rates and extent. The availability of alluvial groundwater would continue to be locally limited. These adverse direct impacts would be short term to long term and moderate to severe, depending on background precipitation. Over a 30-year period of permit authorization, years of severe impacts from reduced flows would be likely, and opportunities for achieving management objectives would be limited.

Springs and Seeps

A number of springs or seeps are outside of the assumed pumping drawdown as depicted in figure 7 and figure 8. Based on this information, it is unlikely that these springs have or would experience impacts from the Village well field operations. A spring in Carlton Canyon and another in an unnamed tributary to the South Fork are likely to undergo flow reduction impacts from pumping based on U.S. Geological Survey observations and projections derived from them. Given the general uncertainties associated with drawdown impacts, effects at those sites would likely range from moderate to severe. Other existing groundwater modeling indicates that more extensive drawdown could occur (Balleau Groundwater 2004). Under those conditions, a number of other springs or seeps in the upper North Fork drainage could be similarly adversely affected.

Nearby Domestic Wells

The estimated drawdown encompasses or is immediately adjacent to two upstream domestic wells (DW-1 and DW-2). Water level measurements indicate that the nearest (DW-1) was within the actual cone of depression of the Village well field on September 3, 2008, and again on March 17, 2009 (Matherne, et. al. 2011). Under alternative 1, water levels would decline according to assumed drawdown approximations, creating long-term, site-specific adverse impacts on domestic water supplies. These impacts would be moderate to severe, depending on the existing depths and yields of individual wells, which vary between locations. Other existing groundwater modeling indicates that more extensive drawdown could occur (Balleau Groundwater 2004). Under those conditions, a number of other domestic wells in the upper North Fork drainage could be similarly adversely affected.

Anticipated Effects of Climate Change

Under alternative 1 (no change), streamflow quantities may decline from climate change effects. Quantifying these effects is not possible due to uncertainties in climate predictions. Qualitatively, the spatial extent and duration of no-flow conditions may increase along the North Fork. The presence of flows equal to or greater than 1.2 cubic feet per second may decline with drier climatic conditions, which could reduce water availability in the alluvium for plant growth and sustenance. Opportunities for maintaining or improving watershed condition on National Forest System lands in the upper Eagle Creek drainage would be limited. Improving resource conditions and achieving the management objectives described above would become qualitatively more difficult under drier conditions. This would be exacerbated by ongoing well field pumping.

Streamflow temperatures could increase beyond those expected under current conditions, due to decreasing snowpack accumulations, more rapid seasonal melt, and generally warmer and dryer conditions overall. Qualitatively, pumping under the no action alternative could intensify these adverse conditions. Reduced recharge to zones supplying water to springs, seeps, and nearby domestic wells could be further exacerbated by these same climatic effects. Springs, seeps, and nearby domestic wells could experience declining flows or water levels at an accelerated pace under anticipated climate changes. If they occur, these adverse effects would be long term, local to regional, severe impacts.

Updates to Direct and Indirect Effects from Alternative 1 Due to the Little Bear Fire

Over the short-term (i.e., until watershed “recovery” in three to seven years, or until about 2019), pumping effects under Alternative 1 are likely to reduce streamflows and groundwater levels along the North Fork Eagle Creek. Based on table 9, reduced transpiration losses from vegetation have the potential to increase soil moisture and streamflow, but these will likely be offset by increased surface runoff from flashy events, and reduced infiltration and groundwater recharge. In some locations, the accumulation of sediment and debris in the stream channel could physically increase the depth to saturated conditions below the new surface of the channel bed. Flows in intermittent parts of the North Fork Eagle Creek are understood to be related to shallower alluvial deposits over near-surface bedrock. In some locations, greater thickness of newly-deposited alluvium could reduce the presence of surface flow or pooling. Pumping at historic levels under this alternative could further reduce the occurrence of surface flow or pools under short-term post-wildfire conditions.

Over the long term (after post-wildfire recovery), watershed conditions are expected to return to approximate pre-wildfire conditions. If conifer stands convert to grasses or shrubs, somewhat less evapotranspiration may slightly improve watershed yield. This could also improve groundwater availability within the North Fork Eagle Creek.

If these long-term post-wildfire effects occur, potential impacts from this alternative would be similar or slightly less than those described above for the pre-wildfire assessment. If long-term additional recharge and water yield increases do not result from watershed recovery, then long-term impacts from this alternative would be expected to resemble those described in the pre-wildfire water resources assessment and DEIS (USDA Forest Service 2012).

Over the long-term, the general durations of flow conditions would be similar to those described in the DEIS and technical report developed before the Little Bear Fire. Based on inferences from historical conditions (see table 10 and "Eagle Creek Flow Patterns before the Little Bear Fire"), over the long term post-wildfire setting the general duration of no-surface-flow days in the lower reaches of the North Fork Eagle Creek would be approximately 1 to 2 weeks a year during average precipitation periods. This could increase to approximately 8 to 10 weeks a year during drier periods. Streamflows of 1.2 cubic feet per second or more at the Eagle Creek gage location would be anticipated to occur about 10 percent less than under no-pumping conditions during average precipitation periods, and about 40 percent less than the no-pumping condition during drier years. Springs and seeps at low elevations within the Eagle Creek watershed would likely undergo flow volume and duration reductions from pumping drawdown. Similarly, water levels in domestic wells would likely decline. If climate changes occur, and drier conditions result, pumping under this alternative would further reduce streamflows and exacerbate adverse climatic effects on springs, seeps and domestic wells. Opportunities for improving riparian conditions along the North Fork Eagle Creek would be reduced in comparison to alternatives 2 or 3.

Cumulative Effects

Potential cumulative water resources impacts from alternative 1 (no action) would include additional adverse flow and water quality reductions in Eagle Creek, and continued groundwater drawdown in alluvial and bedrock aquifers throughout the cumulative impact area resulting from other village wells along Eagle Creek (figure 6). These combined adverse effects would largely result from the ongoing water supply withdrawals in the drainage. By far, near-term withdrawals would be dominated by the North Fork wells, based on pumping capacities and historical withdrawals, described in more detail in the "Socioeconomics" and "Water Rights" section of this chapter. Alternative 1 would continue these withdrawals. In turn, these could create adverse impacts to riparian vegetation, aquatic habitat, and other beneficial uses along the Eagle Creek corridor through reduced groundwater recharge. These impacts would be long term and regional.

Future estimated water supply requirements by the village are estimated to be approximately 5,097 acre-feet per year, even with conservation. Existing water supplies and water rights as developed do not meet those needs. Current diversions along Eagle Creek and the Rio Ruidoso, as described in the "Affected Environment, Domestic and Municipal Water Use," are about 3,850 acre-feet per year. This leaves approximately 2,125 acre-feet per year yet to be obtained and developed to meet eventual demand. Given that the Eagle Creek water rights total approximately 2,539 acre-feet per year, a substantial amount of additional water supply infrastructure will be required in the Ruidoso region. Qualitatively, this will generate additional long term, regional impacts in the area. Some of these may occur along Eagle Creek in the cumulative impacts area.

Forest fuel reductions, prescribed burns, recreational developments, and wildfires (as listed in table 4) act to increase runoff and sedimentation in the cumulative impact area. Planned activities would be conducted using best management practices to avoid or minimize these impacts. Historically, wildfires have ranged from roughly 40 to 600 acres in size near the North Fork Eagle Creek. These are relatively small disturbances in terms of increasing runoff or sediment yields, and impacts to surface water and groundwater availability would be local and minor. Occasional water quality impacts from turbidity and sediment concentrations may result from forestry operations or wildfires in the cumulative impact area.

Updates to Cumulative Effects from Alternative 1 due to the Little Bear Fire

Over the short term (three to seven years after the Little Bear Fire in mid-summer 2012), continued pumping under alternative 1 cumulatively would add to downstream water resources impacts from the wildfire as well as other water uses outside the forest boundary. An adverse effect of North Fork Eagle Creek pumping would be reductions of downstream baseflows and groundwater levels. Over the post-wildfire short term (until hillslope recovery), the adverse effects to streamflows would be masked by accelerated surface runoff, erosion and debris flows, channel geometry changes, and reduced water quality resulting from the Little Bear Fire. In addition, other water users would affect surface drainage and groundwater levels. Depending on the timing and volumes of other water withdrawals and returns in the cumulative study area, all these factors would combine to largely obscure the downstream effects of North Fork Eagle Creek pumping in the short term.

Long-term (four to eight years post-wildfire) cumulative effects anticipated under alternative 1 would be similar to those previously described above for the pre-wildfire cumulative assessment. These would generally include streamflow reductions in Eagle Creek, and continued groundwater drawdown in alluvial and bedrock aquifers throughout the cumulative study area. As discussed in the Water Rights section, applications by the Village of Ruidoso for additional points of diversion along Eagle Creek are pending at the New Mexico Office of the State Engineer. If wells are pumped at these points, it could extend drawdown effects in combination with pumping of the existing wells.

It should be noted, however, that potential cumulative effects on streamflows and groundwater resources would not be restricted to water uses by the Village of Ruidoso. A substantial number of individual domestic wells and other points of diversion exist within the Eagle Creek basin, within and downstream of the North Fork Eagle Creek drainage. Approximately 20 domestic wells (or more) occur within the Eagle Creek drainage below the North Fork Eagle Creek well field. Real estate developments and resorts particularly have points of diversion along the lower Eagle Creek drainage near Alto, as recorded by the New Mexico Office of the State Engineer (2014). All of these uses would contribute to moderate to major long-term cumulative water resources impacts, depending on the amount and timing of water withdrawals and the nature of measures implemented to control surface drainage and runoff water quality. Although the Village of Ruidoso implements water conservation measures and enacts water restrictions during periods of drought or other emergencies (such as the Little Bear Fire), the Village of Ruidoso is not the only water user in the region and has limited, if any, control over other water users. In addition to these considerations, the Little Bear Fire was widespread across several drainage basins, including Little Creek and the Rio Bonito. Widespread cumulative wildfire impacts on surface runoff, groundwater recharge, and water quality were described previously. The effects of forest fuel reductions, prescribed burns, and other activities would be the same as qualitatively described previously for the alternative 1 pre-wildfire cumulative assessment.

Conclusion

Spatially discontinuous, intermittent streamflows would persist at reduced levels near and downstream of the well field, creating site specific and local impacts on flow rates and extent. The availability of alluvial groundwater would continue to be reduced locally. These adverse direct impacts would be short term to long term and moderate to severe, depending largely on background precipitation. Drawdown impacts on springs or seeps would be site specific and moderate to severe. Adverse long-term, site-specific impacts to domestic water supplies would occur. These impacts would be moderate to severe, depending on the actual extent of drawdown, and the existing depths and yields of individual wells. All of these effects could be made more adverse in significance and duration by possible climate changes toward more extended drier conditions.

Cumulative water resources impacts would involve ongoing reductions in flow and water quality along Eagle Creek within the cumulative impact study area, primarily due to reduced groundwater recharge. These could be adverse, long term, regional impacts that would likely range in severity from moderate to severe. Additional water supply developments in the region could create further impacts to surface water, groundwater, and associated resources.

Alternative 2 - No Action (No Pumping)
Direct/Indirect Effects

Streamflow Quantity

Based on historical data for prepumping conditions, the lower portions of North Fork Eagle Creek would remain an intermittent stream during periods of average precipitation. No-flow days would still occur at various locations along stream reaches where large alluvial deposits are located, generally starting in June or later. These flow conditions would occur because smaller streamflows would be absorbed by the alluvium. Without pumping, however, the magnitudes and extents of intermittent flows would increase above current conditions during pumping or those anticipated under alternative 1 (no change). Isolated perennial pools may occur in some locations above the Eagle Creek gage. These would be beneficial long term, local impacts to current conditions with pumping, but would represent minimal or negligible changes from prepumping conditions. Opportunities for improving watershed condition and achieving other management objectives would improve.

If historical prepumping conditions are assumed, the occurrence of no-flow days would be eliminated downstream at the Eagle Creek gage during average or wetter years. According to the flow frequency analysis during the prepumping period of slightly above average precipitation (figure 7 and figure 8), flows of 1.2 cubic feet per second or greater would occur approximately 57 percent of the time (table 11). This would represent an absolute increase of about 10 percent beyond the occurrence of these flows anticipated under the no action alternative during average years. This would be a beneficial, long term local impact in comparison to current conditions with well field pumping.

Springs and Seeps

Under this alternative, there would be no groundwater drawdown due to village well field pumping, and springs and seeps would not be impacted by pumping the wells.

Nearby Domestic Wells

Similar to the reasoning for springs and seeps, because there would be no groundwater drawdown under this alternative, there would be no impact to nearby domestic wells from the village well field.

Anticipated Effects of Climate Change

Under alternative 2 (no action – no pumping), the potential climate change effects could still occur. Predicted changes in temperature, precipitation, and runoff conditions could continue to create long-term declines in North Fork flows, even without pumping. Water temperatures may rise overall; this would be particularly noticeable during summer low flows. Springs, seeps, and nearby domestic wells could eventually experience declines or go dry. Qualitatively, these effects would occur at a slower pace than under alternative 1 (no change). This would allow greater flexibility and time for resource management to adapt to changing conditions, if they occur.

Under alternative 2, there would be no groundwater drawdown due to pumping, and springs, seeps, and domestic wells would not be affected by Village of Ruidoso pumping. If climate change occurred and resulted in drier conditions, long-term reductions in North Fork flows would occur. Qualitatively, these effects would occur at a slower rate under alternative 2 than under alternative 1. This may allow more opportunity for resource management responses to climatic conditions.

Updates to Direct and Indirect Effects from Alternative 2 Due to the Little Bear Fire

Over the short-term (i.e., until watershed "recovery"), effects under alternative 2 would encourage the occurrence of streamflows and increased groundwater levels along the North Fork Eagle Creek. Large portions of the stream would remain intermittent during periods of average precipitation. In some locations, the accumulation of sediment and debris in the stream channel could physically increase the depth to saturated conditions below the new surface of the channel bed. Flows in intermittent parts of the North Fork Eagle Creek are understood to be related to shallower alluvial deposits over near-surface bedrock. In some locations, greater thickness of newly-deposited alluvium could reduce the presence of surface flow or pooling, even without pumping. If this occurs, under alternative 2 it would likely be less frequent or extensive than under alternatives 1 or 3.

Over the long-term, post-wildfire hillslope and vegetation conditions are expected to return to approximate pre-wildfire conditions. If conifer stands convert to grasses or shrubs, somewhat less evapotranspiration may slightly improve watershed yield. If these conditions occur in the absence of pumping under alternative 2, aquatic habitats could be enhanced and additional opportunities for improving riparian conditions would result.

Cumulative Effects

If alternative 2 (no pumping) were implemented, additional groundwater would pass downstream from the well field area into the cumulative impact area. On this basis, combining the effects of alternative 2 (no pumping) with other past, present, and foreseeable future action would result in downstream migration of groundwater within the stream alluvium and/or bedrock. As a result, beneficial recharge effects to aquifers, springs and seeps, riparian condition, and possibly stream base flows may result. The magnitude and extent of these effects is unknown, since the village operates five additional water supply wells in the drainage.

Implementing alternative 2 would effectively preclude the use of the existing well field for municipal water supply by the village. As such, it would conflict with part of the purpose of the action: authorizing the village under a special use permit to access and divert groundwater from its North Fork Eagle Creek wells. This would create additional demands by the Village of Ruidoso on other water sources downstream within the Eagle Creek drainage or in other drainages. These demands would most likely be met by groundwater supplies elsewhere, with associated aquifer withdrawals. Associated impacts would probably involve drawdown related reductions in stream base flows, nearby well water levels, and flow reductions at springs and seeps. The occurrence of these impacts would depend on the water sources used to meet the demand, whether or not new water wells were brought into service, and where and how pumping occurred. These additional water supply factors and related impacts would be the same as those qualitatively described for alternative 1 (no action).

Forest fuel reductions, prescribed burns, recreational developments, and wildfires would all act to increase runoff and sedimentation in the cumulative impact area. Controls on forest activities and the impacts of wildfires would be the same as qualitatively described under alternative 1.

Updates to Cumulative Effects from Alternative 2 Due to the Little Bear Fire

Over the short term (3 to 7 years after the Little Bear Fire in mid-summer 2012), the cessation of North Fork Eagle Creek pumping under alternative 2 would contribute to downstream baseflows and groundwater levels outside the forest boundary. Over the post-wildfire short term (until hillslope recovery), these beneficial effects would be masked by accelerated surface runoff, erosion and debris flows, channel geometry changes, and reduced water quality resulting from the Little Bear Fire. In addition, other downstream water users would affect surface drainage and groundwater levels. Depending on the timing and volumes of other water withdrawals and returns in the cumulative study area, these factors could obscure some of the beneficial effects of alternative 2 in the short term.

After longer-term watershed recovery in the basins affected by the Little Bear Fire, additional streamflow and groundwater would pass downstream from the North Fork Eagle Creek well field area into the cumulative study area under alternative 2. As a result, beneficial recharge effects to aquifers, springs and seeps, riparian condition, and possibly stream baseflows may result. The magnitude and extent of these effects is unknown, due to the number of other water users in the area. Over the long-term, cumulative water resources impacts would be similar to those previously described for alternative 2 in pre-wildfire assessments. The effects of forest fuel reductions, prescribed burns, and other activities would be the same as qualitatively described for alternative 1.

Implementing alternative 2 would effectively preclude use of the North Fork Eagle Creek well field for municipal water supply by the Village of Ruidoso. This would most likely create additional demands and associated pumping drawdown effects on other water resources in the Eagle Creek drainage or nearby. As discussed in the Water Rights section, applications by the Village of Ruidoso for additional points of diversion along Eagle Creek are pending at the New

Mexico Office of the State Engineer. It should be noted, however, that potential cumulative effects on streamflows and groundwater resources would not be restricted to water uses by the Village of Ruidoso, as mentioned above under alternative 1.

Conclusion

Under alternative 2 (no pumping), the upper portions of the North Fork would be maintained as perennial reaches. Intermittent flows would occur from slightly above the well field downstream to the Eagle Creek gage, wherever alluvial deposits entirely absorb streamflows. On the basis of historical prepumping data, the occurrence of no-flow days at the Eagle Creek gage would be substantially reduced or eliminated. Similarly, flows greater than 1.2 cubic feet per second could be expected to occur between 55 to 60 percent of the time under average precipitation. This would increase opportunities for watershed improvement, and allow increased water availability for other uses.

Beneficial cumulative recharge effects to aquifers, springs and seeps, and possibly stream base flows may result under alternative 2 (no pumping) within parts of the Eagle Creek drainage. The magnitude and extent of these effects is unknown, since it is likely that the village would continue to exercise its water rights and make withdrawals elsewhere in the Eagle Creek system. Impacts from such activities could offset beneficial impacts from no pumping at the North Fork Eagle Creek well field.

Alternative 3 - Proposed Action

Direct/Indirect Effects

Streamflow Quantity

Under the proposed action, we would enact pumping restrictions when the no-flow day management trigger reached the prescribed thresholds. These restrictions would decrease the amount of water the village could withdraw by limiting the pumping rate to 50 percent of the streamflow reported at the North Fork gage.

Using the potential adaptive management triggers (monitoring indicators) described for the proposed action (alternative 3) in chapter 2 of the EIS, we conducted a review of the hypothetical implementation of the flow volume triggers, using historical flow conditions as data inputs. Table 10 displays the results of this exercise.

Based on an analysis of no-flow durations per year, we approximated the amount of time that pumping would be limited each year, assuming that pumping could resume without limitation once flow resumed at the Eagle Creek gage, but that the pumping limit would be imposed immediately if no flow occurred again in the water year. For this exercise, we assumed the management trigger reset every October 1 if there was flow on that date. If there was no flow on October 1, the pumping limit that was triggered the previous year was assumed to remain in effect until flow resumed. No-flow days that occurred during pumping limits of this type counted toward the new water year’s trigger limit. Table 10 indicates the approximate total duration in each historical year when pumping would have been limited. Note that the estimated limitations would not necessarily have been continuous over the entire durations indicated.

Under the adaptive management strategy for the proposed action, it can be seen from table 10 that management triggers are most generally enacted during dry years. During average years, the triggers would be enacted much less frequently. The effects of this approach would be to generally maintain perennial streamflow conditions in the upper reaches of the North Fork, and to mitigate the potential adverse pumping impacts on intermittent flows from the well field downstream to the Eagle Creek gage. As a result, only minor, local, short-term impacts to streamflow magnitude and extent would occur. The Village of Ruidoso would be able to pump its municipal supply most of the time, and would be able to pump at reduced levels during some, but not all, of the restricted periods. It is estimated that the change in the occurrence of the 1.2 cubic feet per second streamflows would be between 0 and 10 percent of the prepumping condition during average years. During dry years, adaptive management would improve flow conditions and reduce the amount of no-flow days at the Eagle Creek gage. An approximate middle ground between the prepumping and pumping conditions would be attained during average years. Pumping restrictions would mitigate adverse effects to surface waterflows and alluvial water availability during dry years.

Table 10. Historical perspective: durations of no surface flow and hypothetical pumping limitations using potential adaptive management triggers for flow volume

Water Year	Approximate No-flow Period (Weeks)	Potential Adaptive Management Trigger Enacted[a]	Approximate Weeks of Limited Pumping
Prepumping, approximately average precipitation conditions			
1971	0	None	0
1972	0	None	0
1973	0	None	0
1974	0	None	0
1975	0	None	0
1976	0	None	0
1977	0	None	0
1978	0	None	0
1979	0	None	0
1980	0	None	0
Period Average	0	NA	0
Postpumping, approximately average precipitation conditions			
1989	<1	None	0
1990	3	None	0
1991	0	None	0
1992	0	None	0
1993	0	None	0
1994	0	None	0
1995	0	None	0

Water Year	Approximate No-flow Period (Weeks)	Potential Adaptive Management Trigger Enacted[a]	Approximate Weeks of Limited Pumping
1996	8 to 9	30 d/y[a]	4 to 5
1997	0	None	0
1998	0	None	0
Period Average	1 to 2	n/a	<1
Postpumping, drought or fluctuating precipitation conditions			
2000	6 to 7	30 d/y	2 to 3
2001	10 to 12	30 d/y	6 to 7
2002	16 to 18	Both[c]	14 to 16
2003	18 to 20	Both	15 to 17
2004	20 to 22	Both	22 to 24[d]
2005	1 to 2	None	0
2006	18 to 20	30 d/y	14 to 16
2007	0	None	0
2008	3 to 4	None	0
2009	9 to 10	30 d/y	5 to 6
2010	4 to 5	20 d/y for 3 y[b]	4 to 5[d]
Period Average	10 to 12	n/a	8 to 10

a - “30 d/y”: This proposed adaptive management trigger would be enacted to restrict pumping where there are 30 or more no-flow days within 1 water year.

b - “20 d/y for 3 y”: This proposed adaptive management trigger would be enacted to restrict when there are 20 or more no-flow days over 3 consecutive water years.

c - “Both”: This indicates that both triggers were reached during the water year.

d - The no-flow period extended from the previous water year into the new, which did not allow the trigger to reset on Oct. 1.

By limiting pumping, the aquifer drawdown would decrease, and the proportion of volcanic aquifer recharge that would remain for water level recovery would increase. This would shorten aquifer water level recovery times, and decrease the duration of no-flow periods at the stream gage.

As described in detail in the alternative 3 (proposed action) description in chapter 2, other management triggers, in addition to the trigger for no-flow days, would be used to manage pumping operations.

Springs and Seeps

The decreased drawdown and shorter water level recovery times would also decrease the duration and extent of drawdown, lessening impacts to springs and seeps. Some drawdown impacts would still occur over the approximated area of drawdown depicted in figure 7 and figure 8. These are anticipated to be local and long term, but minor to moderate since some recovery would be provided during dry periods. Adaptive management would address impacts to springs and seeps if they become more extensive or severe.

Nearby Domestic Wells

The decreased drawdown and water level recovery times would also decrease the duration and extent of impacts to domestic wells. Potential impacts would be the same as those described for springs and seeps; local and long term, but minor to moderate. Adaptive management would address greater impacts to domestic wells if they occurred.

Anticipated Effects of Climate Change

Under the proposed action, the expected effects of climate change could still occur over the long run, as described for the other alternatives. However, adaptive management strategies would reduce the timing and severity of these effects to the extent possible. Increased temperatures, reduced snowpack, and accelerated snowmelt could require ongoing adjustments in adaptive strategies to maintain streamflows and groundwater availability. However, experience gained through adaptive management would allow more informed strategies to be developed for water resources management under changing climatic conditions, if they occur.

Updates to Direct and Indirect Effects from Alternative 3 Due to the Little Bear Fire

Under alternative 3, potential water resources impacts in the North Fork Eagle Creek over the short term (3 to 7 years) after the Little Bear Fire may be limited by the application of pumping restrictions. During this period, however, the impacts of natural post-wildfire watershed and channel adjustments will override some of the pumping impacts and some of the adaptive management effort. Even with stabilization efforts, watershed sideslopes will continue to erode for a period of years under the severe rainfall events common to the region. This will decline over time on sideslopes during the short-term recovery period, but a much longer period will involve active sediment and debris accumulation and transport through the valley, the North Fork Eagle Creek channel system, and downstream.

During the short-term, channel re-configuring processes will modify the locations and durations of open channel flow or pools. This will be most noticeable after severe rainfall events. Similarly, riparian conditions at a given point along the North Fork Eagle Creek will be modified through natural post-wildfire adjustments to the channel bed and banks. For this reason, periodic and spatially-distributed monitoring measures are described and recommended in chapter 2. Adaptive management practices have been re-oriented toward monitoring well placement and recording, in an effort to minimize the reliance on shifting channel and streamgage conditions. During the short term post-wildfire recovery period, pumping effects would be limited to the extent possible through an iterative and adaptive approach as the landscape, stream channel, and groundwater recharge processes adjust to the wildfire disturbance.

Over both the short- and long-terms, management triggers would be most generally enacted during dry years. During average or wet years, management triggers would be enacted much less frequently. For this reason, measures for monitoring precipitation conditions, groundwater conditions, and employing computer simulations of surface- and groundwater interactions have been described and recommended in chapter 2.

Over the long-term, the Village of Ruidoso would be able to pump its municipal supply from the North Fork Eagle Creek most of the time, and would be able to pump at reduced levels during some, but not all, of the restricted periods. During dry years, adaptive management would improve flow conditions and reduce the amount of no-flow days along the North Fork Eagle Creek. With respect to surface flows and alluvial groundwater levels, an approximate middle ground between alternative 1 (continued pumping at historic levels) and alternative 2 (no pumping) would be attained during average precipitation years under alternative 3. Drawdown effects may still occur at springs, seeps, and domestic wells, but are anticipated to be less than those expected under alternative 1. If climate changes to warmer and drier conditions occur, ongoing adjustments in management strategies to maintain streamflows, alluvial groundwater levels, and Village of Ruidoso water supplies would be required. Experience gained through adaptive management would allow more informed water resources strategies if climatic changes occur.

Over the long term, watershed conditions are expected to return to approximate pre-wildfire conditions. If conifer stands convert to grasses or shrubs, somewhat less evapotranspiration may slightly improve watershed yield. There may be additional groundwater recharge. If these conditions occur along with adaptive management of North Fork Eagle Creek pumping, other resource effects could occur. For example, habitats could be enhanced and additional opportunities for improving riparian conditions would result.

Cumulative Effects

Combining the effects of the proposed action with other past, present, and foreseeable future actions would result in potential cumulative water resources impacts that would include flow and water quality reductions in Eagle Creek within the cumulative impact area. Water supply pumping for the applicant is conducted at six water wells along lower Eagle Creek (figure 6), and the Village of Ruidoso diverts surface water from the stream a short distance below the Eagle Creek gage. As a result, groundwater recharge in downstream alluvial and bedrock aquifers would still be adversely affected, but to a lesser extent than under current conditions or alternative 1 (no action). The proposed action would have minor effects on these impacts, as pumping in the North Fork Eagle Creek would generally be permitted most of the time.

Implementing the proposed action would occasionally create temporary demands for other water sources on the part of the Village of Ruidoso. It is possible that the Village of Ruidoso would meet those demands by pumping groundwater supplies elsewhere or by constructing additional storage facilities, by enacting water use limitations, or some combination of these approaches. In addition, future water supply infrastructure and withdrawals would create additional water resources impacts as qualitatively described previously for alternative 1 (no action).

Forest fuel reductions, prescribed burns, recreational developments, and wildfires would all act to increase runoff and sedimentation in the cumulative impact area. Controls on forest activities and the impacts of wildfires would be the same as qualitatively described under alternative 1 (no action). The extent and effects of these potential activities are unknown.

Updates to Cumulative Impacts from Alternative 3 Due to the Little Bear Fire

Over the short term (3 to 7 years after the Little Bear Fire in mid-summer 2012), the management of North Fork Eagle Creek pumping under alternative 3 would contribute to downstream baseflows and groundwater levels outside the forest boundary. Over the post-wildfire short term (until hillslope recovery), these beneficial effects would be masked by accelerated surface runoff, erosion and debris flows, channel geometry changes, and reduced water quality resulting from the Little Bear Fire. In addition, other downstream water users would affect surface drainage and groundwater levels. Depending on the timing and volumes of other water withdrawals and returns in the cumulative study area, these factors could obscure some of the beneficial effects of alternative 3 in the short term. The effects of management under alternative 3 would likely range between the adverse (but obscured) effects of alternative 1 and the beneficial (but obscured) effects of alternative 2.

Over the long term, post-wildfire cumulative water resources impacts would be similar to those previously described for alternative 3 in pre-wildfire assessments (AECOM 2011, USDA Forest Service 2012). Implementing alternative 3 would occasionally create temporary demands by the Village of Ruidoso for other water sources. It is likely that the Village of Ruidoso would meet those demands by pumping groundwater supplies elsewhere, by additional leasing of existing water rights, by developing additional storage facilities, by enacting further water use limitations beyond its current practices, or some combination of these. As discussed in the Water Rights section, applications by the Village of Ruidoso for additional points of diversion along Eagle Creek are pending at the New Mexico Office of the State Engineer. If wells are pumped at these points, it could extend drawdown effects in combination with pumping of the existing wells.

It should be noted, however, that potential cumulative effects on streamflows and groundwater resources would not be restricted to water uses by the Village of Ruidoso, as mentioned above under alternative 1. The effects of forest fuel reductions, prescribed burns, and other activities would be the same as qualitatively described for alternative 1.

Conclusion

Under the proposed action, the purpose and need for the action would be addressed in a manner that satisfies the municipal water supply demands of the village to the extent possible while providing for resource values on National Forest System lands. Surface water and groundwater availability in the North Fork would improve, and the intermittent flow durations in the stream would be generally similar to prepumping conditions. Adaptive management restrictions on pumping would mitigate impacts during dry periods. There would still be some drawdown impacts on springs, seeps, and domestic wells, but the extent and severity of these impacts would be reduced from current conditions. Climate changes in the Southwest may occur, but their effects would be accommodated to the extent possible under the adaptive management approach. Cumulative impacts to surface water and groundwater availability would occur. Adaptive management under an approved permit authorization would help address cumulative impacts and water supply issues as they were identified.

Summary

As described in table 2, the alternatives differ in how they respond to the purpose and need for action related to protecting forest resources. Alternative 1 (no action) would not meet this need since allowing applicant operations to continue at current levels would continue to result in substantially more time when flows measured at the Eagle Creek gage are below 1.2 cubic feet per second. Alternative 2 (no pumping) would allow for natural conditions to return and groundwater pumping would cease. This would result in a return to natural conditions. Alternative 3 (proposed action) would also meet this need since the change in the occurrence of 1.2 cubic feet per second streamflows would be between 0 to 10 percent of the prepumping condition during average years. During dry years, adaptive management would improve flow conditions and reduce the amount of no-flow days at the Eagle Creek gage; an approximate middle ground between the prepumping and pumping conditions would be attained during average years. Implementing a closely monitored adaptive management strategy with thresholds would minimize impacts of groundwater drawdown and provide increased groundwater and surface waterflow under alternative 3 (proposed action). This increase would provide adequate flows for protecting water dependent ecosystems. Table 2 also provides a comparative summary of the effects of each alternative on each water resource measurement indicator.

Aquatic and Fish Habitat

The fishery and aquatic habitat issues related to North Fork Eagle Creek well pumping include changes in the water table which may affect streamflow to varying degrees. Lowering streamflow may increase temperatures which can adversely affect fish. Quantity, quality, and waterflow availability that mirrors natural flow patterns are important for aquatic habitat and fish. Suitable water quality and temperatures, which are partially based on water depth and channel conditions, are necessary to support fish populations. Sufficient water supplies must also be available during summer months to provide water temperatures needed for survival of aquatic species.

We include a more detailed description of affected environment, methods, and environmental consequences for this project in the fish and wildlife report and biological evaluation (Bright 2012a). The supplemental fish and wildlife report and biological evaluation (Bright 2014) provides a more detailed description of affected environment, methods, and environmental consequences, considering the changes caused by the Little Bear Fire. These reports are incorporated by reference, discussed briefly below, and available in their entirety in the project record.

Methodology

The direct effects study area is the upper Eagle Creek drainage (figure 2) above the Eagle Creek gage. The cumulative impacts area extends through the Eagle Creek drainage to the location of the former U.S. Geological Survey stream gage named Eagle Creek near Alto, New Mexico (Eagle Creek near Alto, U.S. Geological Survey gage number 08387800) (figure 6). This area incorporates approximately 7 additional stream miles of Eagle Creek below the study area.

Baseline information used to assess impacts to aquatic habitat and fish was provided by Forest Service specialists using professional judgment. New Mexico Department of Game and Fish fisheries biologists were consulted for information regarding past and current fish management along the North Fork and levels of angler use. Forest Service records from the pre-well pumping period were searched for information related to aquatic habitat and fish management prior to well pumping. Other agency records, literature, and anecdotal information and photographs were also used where appropriate to assist in determining whether any changes have occurred to aquatic habitat and fish populations in the project since pumping began as well as to assist in determining effects of the alternatives on these important resources.

Well pumping may affect the quantity and quality of aquatic habitat, including temperature, (salmonids require summer water temperatures at or below 68 degrees Fahrenheit), and waterflow availability and seasonality (seasonal and year-long flows compared to expected flows without pumping). Alternatives were compared using the water resource streamflow quantity and quality indicators (see “Water Resources Methodology” in the previous section of this chapter).

The “Methodology” section at the beginning of this chapter describes the general approach used for cumulative effects analysis. Activities and projects summarized in table 4 and figure 4 were considered in the aquatic habitat and fish cumulative analysis.

Post-wildfire conditions were assessed to compare with the pre-wildfire conditions described in the DEIS. All post-wildfire reports including the BAER reports, field visit reports by resource specialists, wildfire impact assessments, and post-wildfire assessment maps were reviewed and cited in describing changes to fish and wildlife conditions. Literature relevant to wildfire effects on fish and wildlife habitats and resources were reviewed and cited where applicable to the Little Bear Fire situation.

Affected Environment

There are no federally listed, proposed, or candidate fish species, nor any Regional Forester sensitive species occurring in the North Fork Eagle Creek. Brook trout and rainbow trout are the only fish species currently documented in the portion of the North Fork between the North Fork gage and Eagle Creek gage. Persistent brook trout populations occur primarily in the perennial stretches and in the headwaters of the drainage in the White Mountain Wilderness (upstream from the North Fork gage), but during streamflow periods they have been found in some ponded sections of the North Fork in the Eagle Creek summer home area (upstream from the North Fork gage) and further downstream.

The New Mexico Department of Game and Fish records indicate that fish stocking has occurred along the North Fork as far back as 1896 with rainbow trout (a nonnative species). There have been releases of nonnative brown trout, catfish, and brook trout and native Rio Grande cutthroat trout periodically through the 1960s as reported by Little (1960a, b) and Hansen (pers. comm. 2011).

Fish survey records from the 1960s through 2007 document the presence of brook trout in the North Fork (Little 1960a, Little 1960b, Little 1961, Hansen and Denny, personal communication 2011). As summarized in McGlothlin (2011) and in table 11, in the 1960s, brook trout were collected in a 100-foot section 1 mile below Eagle Creek Lodge (which is now in the present day Eagle Creek summer home area). Fish averaged about 4-5 inches in length and there were no other species besides brook trout collected. Water temperatures varied between surveys and ranged from 55 to 70 degrees Fahrenheit. These reports note: (1) very little fishing during the summer months because of low water conditions; (2) low densities of emergent and submerged aquatic vegetation (including algae and cattails); (3) ponderosa pine and spruce-fir as the dominate vegetation type; and (4) perennial reaches for the first 3.5 miles and then intermittent reaches downstream, except during periods of high runoff.

Medlock (2011) also provides insights into pre-well pumping stream conditions and fishing opportunities along the North Fork consistent with the summaries above.

Ross (1970) documents very good aquatic insect populations (the food source for trout) and an opinion that the North Fork has the capability of producing a quality cold water fishery, but notes that overall stream conditions were measurably better above the Eagle Creek summer home area than below. Patterson (1971) notes that the North Fork fishery is nearly nonexistent and that any improvement would be beneficial. Only brook trout were caught in the North Fork in 2007.

Table 11. Summary of past and present aquatic habitat and fish information for the North Fork Eagle Creek

Date	Source	Information
1920s - 1930s	Richard Hansen, New Mexico Department of Game and Fish (Hansen, pers. comm. 2011)	North Fork Eagle Creek stocked with brook trout and Rio Grande cutthroat trout in the 1920s and 1930s.
1959 - 1960	New Mexico Department of Game and Fish Basic Survey of Eagle Creek Report (Little 1960a)	Surveyed manmade pond areaa which is believed to be within the present day well field (T10S, R12E, Section 36), although there are differing opinions among agency biologists on this; rainbow trout and stunted brook trout observed in stream; noted that creek was shallow and narrow with the exception of two ponds; permanent water exists for 3.5 miles and then becomes intermittent except during periods of high runoff; boulders and rubble with some areas of sand and silt documented; water temperature varied from 55 °F to 66 degrees Fahrenheit. Recommends fish only be planted during years of adequate precipitation (except at manmade fish ponds); noted that stream is unsuitable for trout plantings except during high runoff from winter snows and noted little fishing during summer months.
1960	New Mexico Department of Game and Fish Basic Survey of Eagle Creek Report (Little 1960b and Little 1961)	Fish restricted to pools during low water; noted stream 6 feet wide and 3 feet deep; 37 fish sampled.
1963	Forest Service Upper Eagle Creek Watershed Analysis (USDA Forest Service 1963)	Notes that “the Eagle Creek water sinks and seeps away and is not delivered to the Rio Ruidoso or Rio Hondo system except during short periods of peak flow” and “records of the Eagle Creek drainage show some flood damage nearly every year with major floods occurring every 3 to 4 year intervals”.
1970	Forest Service Report (Ross 1970)	Survey to determine if North Fork Eagle Creek has potential as a cold water fishery. Sampled three areas (above summer homes, below summer homes and near “old gravel borrow pit”); above summer home reach ranked highest for potential, but noted all three areas with potential; report author recommended stream improvements to enhance fish habitat; also noted “high amount of alluvium” in stream and recommended removing this alluvium (to provide gravel) in order to improve stream habitat.
1971	New Mexico Department of Game and Fish letter (1971)	Memo to Forest Service in response to Ross report stating the report gave good ideas; noted North Fork Eagle Creek has potential for “limited access fishing” and “present day fishing is nearly nonexistent.”

a - It is also well documented and understood that manmade ponds used to occur in the Eagle Creek summer home area and were stocked with fish.

As shown in table 12, the number of fish caught and the angler use days on Eagle Creek have dropped dramatically since 1990. As discussed with Hansen (personal communication 2011) the New Mexico Department of Game and Fish records indicate that Eagle Creek (all of Eagle Creek and not just the North Fork) angler pressure in the mid-2000s dropped to about half the angler pressure of the late 1980s based on their mail surveys (about 400 angler days annually in the later surveys compared to about 700 angler days annually in the 1980s). The average number of angler use days from 1975-1989 was 717 and the average number of fish caught in this same period was 3,220; this has since dropped in 1990-2008 to 320 and 890 respectively. For comparison, angler use on the Rio Ruidoso showed just the opposite trend; it received about 34,000 angler days of use annually in the 2000s but only about 15,000 angler days annually in the 1980s. Hansen speculates that one factor that may be affecting the drop in angler pressure is the loss of the ponds in the Eagle Creek summer home area due to flooding.

The New Mexico Department of Game and Fish does not currently highlight the North Fork as a fishery with the public. They consider the North Fork a “self-sustaining brook trout fishery” (meaning they don’t stock it or otherwise encourage the fishery in this area, but it does have a population of brook trout that persists). The New Mexico Department of Game and Fish likely stopped investing in stocking it in the 1970s and 1980s due to fluctuating water levels and the quality of the habitat (Hansen, personal communication 2011). Over the last few years, the New Mexico Department of Game and Fish has moved fish from various isolated pools near road crossings upstream (presumably upstream of the North Fork gage) to where there was more consistent flow (Denny personal communication 2011).

Table 12. Eagle Creek fishing pressure and fish caught (New Mexico Department of Game and Fish 2011)

Year	Angler Days	Fish Caught
1975-76	1,722	4,220
1978-79	867	2,746
1981-82	69	0
1982-83	337	3,232
1983-84	1,266	6,054
1984-85	117	780
1985-86	238	210
1986-87	453	3,816
1988-89	1,381	7,922
Average 1975-1989 before North Fork well pumping began	**717**	**3,220**
1990-91	192	1,536
1997-98	489	1,252
1998-99	355	2,444
1999-00	143	491
2000-01	99	0
2001-02	141	141
2007-08	821	367
Average 1990-2008 after North Fork well pumping began	**320**	**890**

As described in detail in the “Water Resources” section previously in this chapter (and documented in detail in AECOM (2012)), the North Fork streamflow has been affected by well pumping and is less now than it was prior to the onset of pumping in 1988; dry periods have increased and there are substantially more months per year when flow is less than 1.2 cubic feet per second.

An area below the confluence of the North and South Forks of Eagle Creek is listed by the New Mexico Environment Department as impaired because of reduced flows from well pumping (New Mexico Environment Department 2011a and 2011b). The department concludes that without improved management of the North Fork Eagle Creek well field, these conditions would be expected to persist or worsen.

Conditions before Pumping Began in 1988

Based on the compilation and evaluation of the best available data (summarized above), there is sufficient information to substantiate reduced flows, less fish presence, and decreased fishing recreation in the North Fork since the wells were authorized and began pumping in 1988. It appears that higher quality aquatic habitat and fishing opportunities existed in the North Fork before the North Fork Eagle Creek wells began pumping when compared to current conditions and fish populations (primarily brook trout) are substantially less now than they were before 1988. While many factors likely contribute to this shift (e.g. flood events, seasonal variations in precipitation and recreational use, loss of manmade fishing ponds due to flooding, variability in data collection and reporting, and reductions in direct New Mexico Department of Game and Fish fish stocking), it is likely that pumping is a one of the primary causes reducing the North Fork streamflow. However, as shown in table 11 and summarized above, the North Fork never provided a high quality trout fishery; conditions appear to always have been variable from year to year. Variations in seasonal flows in many reaches of the North Fork can affect stream temperature (important for fish survival) and algae and aquatic insect habitat (trout prey base), and have likely done so since before 1988.

There is no concrete evidence to conclude whether North Fork Eagle Creek well pumping is affecting groundwater and surface water upstream from the well field and above the North Fork gage. Matherne et al. (2011) concluded the cone of depression created by well pumping did not extend further upstream than the North Fork gage, but, as described in the “Water Resources” section of this chapter, worst-case drawdown effects are possible above the gage (figure 7 and figure 8) extending into the Eagle Creek summer home area. For purposes of this analysis, it is assumed that, while effects to aquatic habitat and fish are possible above the North Fork gage, the majority of the most important North Fork aquatic habitat and brook trout habitat (occurring in the historically and currently perennial upper reaches and upstream of the summer home area) are not being measurably affected by North Fork Eagle Creek well pumping.

Therefore, while the North Fork, particularly below the North Fork gage, has always been a marginal trout fishery, the quality of trout habitat and recreational fishing experience it currently provides is lower today than it was in the late 1980s, and North Fork Eagle Creek well pumping has contributed to this decline.

Conditions after the Little Bear Fire

Cordova (2013) reported that three visits were made to the North Fork Eagle Creek drainage during the field season in 2013 that document post-wildfire conditions. Each visit to this drainage had a different emphasis (debris flow information, botany survey, college field trip). All three of these visits encompassed a review of the upper reaches of the drainage (Wilderness Area). During each of these visits (April, early July, late July) a cursory observation of pools where fish were seen historically was assessed. No fish were observed during these outings. He concluded that "I feel very confident in saying that the fish population in the North Fork Eagle Creek was extirpated by the floods that occurred after the Little Bear Fire". Cordova (2013a) reported that the riparian system is in excellent shape in the upper watershed! Once we get stability on the upper slopes we will have the opportunity to consider introducing fish back into the system, possibly Rio Grande cutthroat. The South Fork of the Bonito may be a better candidate due to 7.5 miles of riparian habitat. There is only a very small stretch of year round flow in the North Fork Eagle Creek (approx. 1.5 miles) (Cordova 2013a).

Dunham et al. (*in* University of Idaho 2007) showed that physical stream habitats can remained altered (e.g., stream temperatures) for many years following wildfire, but that native aquatic vertebrates can remain resilient. In a management context, this suggests that wildfire may be less of a threat to native species than human influences that alter the capacity of stream-living vertebrates to persist in the face of natural disturbance.

AECOM (2014) presents information directly relevant to the post-wildfire situation indicating that there is a potential to have perennial or near perennial stream flows reestablished from combined summer rain falls and increased surface runoff. However, the spikes in water flow will most likely be seasonal and of short duration instead of year-round which may not provide a perennial water flow. However, there should be a greater volume of water in the North Fork Eagle Creek as a result of the wildfire. The significance of erosion and debris flows will be to make the channel environment more dynamic than they were before the Little Bear Fire with the potential to rejuvenate fish habitat and overall conditions (AECOM 2014). This report indicates that post-wildfire water quality is likely to be affected for 1-2 years and turbidity impacts could last considerably longer than 2 years both in the wildfire area and downstream.

Environmental Consequences

Alternative 1 - No Change

Direct/Indirect Effects

The current level of effects to aquatic habitat and fish would continue. As shown above, there is sufficient information to substantiate reduced flows, less fish presence, and decreased fishing recreation in the North Fork since the North Fork Eagle Creek wells were authorized and began pumping in 1988. This trend would continue with implementation of alternative 1 (no action).

As described in the "Water Resources" section of this chapter, spatially discontinuous, intermittent streamflows would continue at reduced levels near and downstream of the well field under alternative 1 (no action), creating site specific and local impacts on flow rates and extent. The duration of excessively warm low-flow water temperatures would continue to be about 1 or 2 weeks longer per year than under prepumping conditions; an adverse effect on aquatic uses and fish. All of these effects could be exacerbated over the long term by possible climate changes toward more extended drier conditions, with resultant adverse effects to the quality of habitat for aquatic species and fish.

As stated previously, the majority of the most important North Fork aquatic habitat and brook trout habitat (occurring in the historically and currently perennial upper reaches further upstream from the North Fork Eagle Creek wells and the North Fork gage) are not being measurably affected by North Fork Eagle Creek well pumping and this would not change with implementation of alternative.

Cumulative Effects

As described in the water resources of this chapter, cumulative water resources impacts include ongoing reductions in flow and water quality along Eagle Creek within the cumulative impact area, due primarily to reduced groundwater recharge. Additional water supply developments in the region would create further impacts to surface water, groundwater, and associated resources.

Combining the direct and indirect effects to aquatic habitat and fish with other past, present, and foreseeable future actions with the larger drainage (as summarized in table 4 and figure 4) and for water resources above, implementation of alternative 1 (no change) would result in minor to moderate adverse cumulative effects to aquatic habitat and fish similar to those described for water resources.

The burn severity of the Little Bear Fire burn was high or moderate throughout 53 percent of the wildfire boundary. Bury et al. (no date) reports that some research on large, stand-replacing wildfires on lotic biota suggests that wildfire ultimately benefits aquatic invertebrates and fishes, even those species that are negatively affected by the disturbance in the short-term, immediately after the wildfire. For example, Lyon suggested that some aquatic invertebrates may decline immediately after a wildfire, then increase to levels above pre-wildfire conditions as a response to increased stream productivity. Large fires can have long-term effects on streams by: (1) reducing invertebrate diversity for a decade or longer; (2) changes in peak discharge, stream channel morphology, large woody debris inputs, and sediment loadings; and (3) elevated temperature and altered water chemistry. Also, the effects of wildfire on stream biota may be more pronounced in headwater streams than in mid-order or larger streams. McCormick, et.al.(2010) provide references that indicate that where native fish populations are naturally depauperate or have declined and become increasingly isolated because of anthropogenic activities, the effects on fish populations are more pervasive and long lasting.

Conclusion

Implementation of alternative 1 (no change) would result in a “may impact” determination to aquatic habitat and fish species (primarily nonnative brook trout and rainbow trout) and their habitat.

In some locations, the accumulation of sediment and debris in the stream channel due to the Little Bear Fire could physically increase the depth to saturated conditions below the new surface of the channel bed. Flows in intermittent parts of the North Fork Eagle Creek are understood to be related to shallower alluvial deposits over near-surface bedrock. In some locations, greater thickness of newly-deposited alluvium could reduce the presence of surface flow or pooling. Pumping at historic levels under this alternative could further reduce the occurrence of surface flow or pools under short-term post-wildfire conditions (AECOM 2014).

Reduced water flow in the North Fork Eagle Creek compared to no pumping would impact the ecology of many aquatic organisms including aquatic flora and fish. There are no listed, management indicator, or sensitive fish species in the North Fork of Eagle Creek. There will be no disturbance to aquatic and fish species from activities at the well sites including road maintenance, well house activities, maintenance of underground power line and pipeline, well operation, vehicle ingress and egress, and mechanical maintenance of the wells because there will be no soil movement into the stream because of conservation measures. Cumulative effects contributed to this determination.

Update to overall effects from Alternative 1 due to the Little Bear Fire:

No fish were observed in the upper perennial reaches (upstream of the North Fork gage) during surveys conducted in 2013 after the wildfire. Aquatic invertebrates typically decline immediately after a wildfire. In the short-term, reduced water quality, channel morphology changes, and deeper alluvial deposits due to the wildfire would continue to reduce the fish and aquatic habitat quality in the project area while the watershed is recovering. Pools and stretches of surface water may be reduced and this would affect aquatic habitat and fish presence. Continued pumping under alternative 1 during the short-term is expected to continue to limit the potential for fish and aquatic habitat improvement.

Over the long term, after post-wildfire recovery, watershed conditions are expected to return to approximate pre-wildfire conditions. Aquatic invertebrates could respond positively to increased stream productivity but the timeframe for this recovery is difficult to predict. Water yield and groundwater availability may improve as shown in the water resources analysis and debris flows could result in a more dynamic channel environment benefiting fish habitat. However, continued pumping would obscure some of these potential benefits. Therefore, adverse effects from implementing alternative 1 over the long term would be the same as, or slightly less than, the pre-wildfire assessment for alternative 1.

Alternative 2 - No Action (No Pumping)

Direct/Indirect Effects

Over the short term (i.e., until watershed recovery after the Little Bear Fire), effects under this alternative would encourage the occurrence of stream flows and increased groundwater levels along the North Fork Eagle Creek. Large portions of the stream would remain intermittent during periods of average precipitation. In some locations, the accumulation of sediment and debris in the stream channel could physically increase the depth to saturated conditions below the new surface of the channel bed. Flows in intermittent parts of the North Fork Eagle Creek are understood to be related to shallower alluvial deposits over near-surface bedrock. In some locations, greater thickness of newly-deposited alluvium could reduce the presence of surface flow or pooling, even without pumping. If this occurs, it would be less frequent or extensive than under alternative 1(AECOM 2014).

As shown in the “Water Resources” section of this chapter, increased surface flows would result from implementation of alternative 2 (no pumping). Intermittent flows would occur from slightly above the well field downstream to the Eagle Creek gage, wherever alluvial deposits entirely absorb streamflows, as occurred before pumping began. On the basis of historical prepumping data, the occurrence of no-flow days at the Eagle Creek gage would be substantially reduced or eliminated. Similarly, flows greater than 1.2 cubic feet per second would occur approximately 57 percent of the time under average precipitation conditions. This would increase opportunities for watershed improvement and allow increased water availability for other uses.

Streamflow temperatures would still exceed 68 degrees Fahrenheit during part of the summer season, but this would occur for a total of about 4 weeks or so under average conditions and is thought to be within the normal range for this stream system historically. Climate change impacts could still occur, which have the potential to reduce flows and increase water temperatures over time, but there would be more flexibility and time available to select and implement climate change strategies for water resources management.

These improvements in streamflow quantity and quality would improve aquatic and fish habitat in the North Fork and provide for improved recreational fishing opportunities over the long term.

The most important North Fork Eagle Creek aquatic habitat and brook trout habitat (occurring in the historically and currently perennial upper reaches further upstream from the North Fork Eagle Creek wells and the North Fork gage) are not being measurably affected by North Fork Eagle Creek well pumping. However, by stopping all pumping, any potential for effects above the North Fork gage would be eliminated.

Cumulative Effects

Beneficial cumulative recharge effects to aquifers, springs and seeps, and possibly stream base flows may result under alternative 2 (no pumping) within parts of the Eagle Creek drainage. The magnitude and extent of these effects is unknown, since it is likely that the village would continue to exercise its water rights and make withdrawals elsewhere in the Eagle Creek system. Impacts from such activities could offset beneficial impacts from no pumping at the North Fork Eagle Creek well field.

Combining the direct and indirect effects to aquatic habitat and fish with other past, present, and foreseeable future actions within the larger drainage (as summarized in table 4 and figure 4) and for water resources above, implementation of alternative 2 (no pumping) has the potential to improve aquatic and fish habitat and recreational fishing in the larger Eagle Creek, but since the magnitude and extent of other water withdrawals in the larger drainage in the future is unknown, beneficial effects could be offset in the cumulative impact area.

The following discussion is relevant to the post-wildfire situation. Bury et al. (no date) reported that some research on large, stand-replacing wildfires on lotic biota suggests that wildfire ultimately benefits aquatic invertebrates and fishes, even those species that are negatively affected by the disturbance immediately after the wildfire. For example, Lyon suggested that some aquatic invertebrates may decline immediately after a wildfire, then increase to levels above pre-wildfire conditions as a response to increased stream productivity. Large fires can have long-term effects on streams by: (1) reduced invertebrate diversity for a decade or longer; (2) changes in peak discharge, stream channel morphology, large woody debris inputs, and sediment loadings; and (3) elevated temperature and altered water chemistry. Also, the effects of wildfire on stream biota may be more pronounced in headwater streams than in mid-order or larger streams. McCormick, et al. (2010) provide references that indicate that where native fish populations are naturally depauperate or have declined and become increasingly isolated because of anthropogenic activities, the effects on fish populations are more pervasive and long lasting.

Conclusion

Implementing alternative 2 (no pumping) would result in a “beneficial impact” determination for aquatic and fish habitat.

Update to overall effects from Alternative 2 due to the Little Bear Fire:

In the short term, reduced water quality, channel morphology changes, and deeper alluvial deposits due to the wildfire would continue to reduce the fish and aquatic habitat quality in the project area while the watershed is recovering. The effects of no pumping, however, would encourage the occurrence of streamflow and increased groundwater levels (more so than under alternative 1) although large portions of the stream would remain intermittent during periods of average precipitation. Pools and stretches of surface water may be reduced and this would affect aquatic habitat and fish presence. Under alternative 2, the potential for fish and aquatic habitat improvement will continue to be limited but not as much as under alternative 1.

Over the long term, after watershed recovery, effects from no pumping would be the same as those described in the pre-wildfire assessment for alternative 2. Aquatic invertebrates could respond positively to increased stream productivity but the timeframe for this recovery is difficult to predict. Water yield and groundwater availability may improve as shown in the water resources analysis and debris flows could result in a more dynamic channel environment benefiting fish habitat. With the cessation of pumping, these potential benefits could be increased Therefore, beneficial effects from implementing alternative 2 over the long term would be the same as, or slightly more than, the pre-wildfire assessment for alternative 2.

Alternative 3 - Proposed Action

Direct/Indirect Effects

As stated in the “Water Resources” section of this chapter, implementing alternative 3 (proposed action), would result in improved surface water and groundwater availability in the North Fork Eagle Creek over current conditions, and intermittent flow durations in the stream would be generally similar to prepumping conditions; summer stream temperatures would also be roughly similar to those experienced historically. Because surface flow would improve, no-flow days would be reduced (but not eliminated) and there would be a reduction in the duration of stream temperatures above 68 degrees Fahrenheit; aquatic habitat and fishing potential would improve over current conditions; these changes would be less than those for alternative 2 (no pumping) but greater than those for alternative 1 (no action).

However, continued removal of water from the basin would affect fish habitat in the stream by continuing to reduce waterflows from historic prepumping conditions which would continue to create dry periods and the potential for extended durations of elevated water temperature. The adaptive management strategy as part of alternative 3 (proposed action) would minimize impacts during dry periods and provide opportunities to reduce the potential for adverse effects to aquatic habitat and fish. Over the long term, possible climate change effects could occur, but their effects would be accommodated to the extent possible under the adaptive management approach.

The most important North Fork aquatic and brook trout habitat (occurring in the historically and currently perennial upper reaches further upstream from the North Fork Eagle Creek wells and the North Fork gage) are not being measurably affected by North Fork Eagle Creek well pumping. With restrictions on pumping, any potential for effects above the North Fork gage would be minimized.

Under alternative 3, potential water resources impacts in the North Fork Eagle Creek over the short-term (three to seven years) after the Little Bear Fire may be limited by the application of pumping restrictions. During this period, however, the impacts of natural post-wildfire watershed and channel adjustments will override some of the pumping impacts and some of the adaptive management effort. Even with stabilization efforts, watershed side slopes will continue to erode for a period of years under the severe rainfall events common to the region. This will decline over time on side slopes during the short-term recovery period, but a much longer period will involve active sediment and debris accumulation and transport through the valley, the North Fork Eagle Creek channel system, and downstream action.

During the short term, channel re-configuring processes will modify the locations and durations of open channel flow or pools. This will be most noticeable after severe rainfall events. Similarly, riparian conditions at a given point along the North Fork Eagle Creek will be modified through natural post-wildfire adjustments to the channel bed and banks. Adaptive management practices have been re-oriented toward monitoring well placement and recording, in an effort to minimize the reliance on shifting channel and stream gage conditions. During the short term post-wildfire recovery period, pumping effects would be limited to the extent possible through an iterative and adaptive approach as the landscape, stream channel, and groundwater recharge processes adjust to the wildfire disturbance.

Effects would be similar to alternative 2 because surface flow would improve, no-flow days would be reduced (but not eliminated) and there would be a reduction in the duration of stream temperatures above 68 degrees Fahrenheit; these changes would result in improved aquatic habitat and fishing potential, but these changes would be less than those for alternative 2 but greater than those for alternative 1 (Table 3, chapter 2, Supplemental Information Report).

Cumulative Effects

There would be cumulative impacts to surface water and groundwater availability as described in the “Water Resources” section. Adaptive management under an approved permit authorization would help address cumulative impacts and water supply issues as they were identified. Ongoing water supply developments and activities on National Forest System lands, as described under alternative 1 (no action), would add to regional, long-term impacts to water resources and, thus, would have potential to adversely impact aquatic resources due to reductions in groundwater and surface water availability in the cumulative assessment area.

Combining the direct and indirect effects to aquatic habitat and fish with other past, present, and foreseeable future actions within the larger drainage (as summarized in table 4 and figure 4) and for water resources above, implementation of alternative 3 (proposed action) has the potential to result in cumulative effects to aquatic and fish habitat and recreational fishing in the larger Eagle Creek drainage due to reductions in surface water and groundwater availability. However, implementation of adaptive management would help to minimize cumulative impacts.

In June of 2012, the Little Bear Fire burned approximately 35,300 acres of National Forest System Lands on the Smokey Bear Ranger District of the Lincoln National Forest, with a total burn area 44,330 acres as of June 28, 2012. The burn severity was high or moderate throughout 53 percent of the wildfire. Bury et al.(no date) report that some research on large, stand-replacing wildfires on lotic biota suggests that wildfire ultimately benefits aquatic invertebrates and fishes, even those species that are negatively affected by the disturbance immediately after the wildfire. For example, Lyon suggested that some aquatic invertebrates may decline immediately after a wildfire, then increase to levels above pre-wildfire conditions as a response to increased stream productivity. Large fires can have long-term effects on streams by: (1) reducing invertebrate diversity for a decade or longer; (2) changes in peak discharge, stream channel morphology, large woody debris inputs, and sediment loadings; and (3) elevated temperature and altered water chemistry. Also, the effects of wildfire on stream biota may be more pronounced in headwater streams than in mid-order or larger streams. McCormick, et al.(2010) provide references that indicate that where native fish populations are naturally depauperate or have declined and become increasingly isolated because of anthropogenic activities, the effects on fish populations are more pervasive and long lasting.

Conclusion

Implementation of alternative 3 (proposed action), may impact aquatic habitat and fish habitat (primarily nonnative brook trout and rainbow trout habitat) including habitat for many aquatic organisms and aquatic plants when compared to a no pumping situation; continued pumping would prohibit full recovery to pre-pumping conditions, but closely monitored pumping, as described for alternative 3 (proposed action), would be an improvement over existing conditions.

There would be no disturbance to aquatic or fish species' habitat from activities at the well sites including road maintenance, well house activities, maintenance of underground power line and pipeline, well operation, vehicle ingress and egress, and mechanical maintenance of the wells because there would be no soil movement into the stream and because of implementing conservation measures.

Update to overall effects from Alternative 3 due to the Little Bear Fire:

In the short term, reduced water quality, channel morphology changes, and deeper alluvial deposits due to the wildfire would continue to reduce the fish and aquatic habitat quality in the project area while the watershed is recovering. During the short term post-wildfire recovery period, pumping effects would be limited to the extent possible through an iterative and adaptive approach as the landscape, stream channel, and groundwater recharge processes adjust to the wildfire disturbance. Under alternative 3, the potential for fish and aquatic habitat improvement would continue to be limited but not as much as under alternative 1.

Over the long term, during dry years, adaptive management would improve flow conditions and reduce the amount of no-flow days along the North Fork Eagle Creek. With respect to surface flows and alluvial groundwater levels, an approximate middle ground between alternative 1 and 2 would be attained during average precipitation years under alternative 3.

In the long term (after post-wildfire recovery), watershed conditions are expected to return to approximate pre-wildfire conditions. If conifer stands burned at moderate to high severity convert to grass or shrubs, less evapotranspiration could improve water yield and groundwater availability. If this occurs with adaptive management of North Fork Eagle Creek pumping under alternative 3, aquatic habitats could be enhanced and additional opportunities for improving riparian conditions could result. Therefore, beneficial effects from implementing alternative 3 over the long-term would be the same as the pre-wildfire assessment for alternative 3.

Summary

Implementation of alternative 2 (no action) and alternative 3 (proposed action), would both achieve the second need statement for this project which is "protecting natural resources on the national forest by maintaining adequate surface and groundwater flows to sustain or improve the riparian and aquatic ecosystems that may be affected by groundwater drawdown from the pumping of these wells"; alternative 2 (no action) would likely improve aquatic and fish habitat while alternative 3 (proposed action) would likely sustain aquatic and fish habitat. Because both alternatives would either sustain or improve aquatic habitat quality, both alternatives meet this need. However, alternative 2 (no action), would move the project area toward desired conditions quicker than alternative 3 (proposed action). Alternative 1 (no change) does not meet this need statement since long-term adverse impacts to streamflows and aquatic habitat and fish are predicted, particularly when combined with long-term shifts in climatic conditions.

Riparian Vegetation

Relevant forest plan direction related to riparian vegetation in this project is included in chapter 1. We used this direction to guide the analysis of the effects of the alternatives to riparian resources.

We include a more detailed description of affected environment, methods, and environmental consequences for this project in the riparian report (Miller 2012a). The supplemental riparian report (Miller 2014) provides a more detailed description of affected environment, methods, and environmental consequences, considering the changes caused by the Little Bear Fire. These reports are incorporated by reference, discussed briefly below, and available in their entirety in the project record.

Methodology

In order to determine existing conditions, we conducted riparian vegetation surveys in 2010 and 2011 in order to characterize the vegetation along the North Fork Eagle Creek (North Fork) and provide a baseline for future monitoring to determine changes over time. The field protocol we used was created by the Stream Systems Technology Center (Merritt and Dwire 2008). We collected tree composition, stem density, basal area, frequency, dominance, and importance at each plot and elevation above the channel and we calculated distance from the active channel from survey data and through use of 2009 National Agriculture Imagery Program aerial imagery using ArcGIS 9.3. Merritt and Dwire (2008) and Miller (2012a) provide detailed field methods, preliminary results, and photographs. Analysis and interpretation of this baseline riparian vegetation data is provided in Merritt and Bevan (2011) and Miller (2012a) and summarized in this section.

In order to determine the conditions of riparian vegetation before North Fork Eagle Creek well pumping began in 1988 and whether North Fork riparian vegetation has changed as a result, qualitative differences in vegetation along the North Fork Eagle Creek and South Fork Rio Bonito were made through use of photographs taken in July 2011 (Merritt and Bevan 2011), as described in more detail in the next section. We explored other methods to assist in describing pre-well pumping riparian conditions and these are summarized in the next section and provided in detail in Merritt and Bevan (2011) and Miller (2012a).

Well pumping results in changes in the water table which may affect streamflow to varying degrees. These water quantity changes could indirectly affect the quantity and quality of riparian vegetation along the stream corridor. Alternatives are compared using the following indicators:

Canopy Cover: Predicted qualitative shifts in canopy cover for trees over time, based on implementing each alternative.

Species Composition: Predicted qualitative shifts in communities over time, based on implementing each alternative.

The analysis of the alternatives presented in this section is qualitative and predicts the effect of proposed actions on riparian vegetation and riparian tree species within the North Fork Eagle Creek. We characterize short-term effects as 1 to 10 years and long-term effects as 10 to 20 years. We selected the North Fork Eagle Creek drainage area (figure 2) as the spatial effects boundary it contains the area of predicted direct/indirect effects from projected drawdown (figure 7 and figure 8). Accordingly, the cumulative effects boundary matches the largest area of indirect effects.

Analysis emphasis was put on the North Fork below the North Fork gage since this area is within the cone of depression as identified by Matherne et al. (2011) and within the area of drawdown as depicted in figure 7 and figure 8 meaning that this area is the most likely to show changes to riparian vegetation due to changes in hydrology. Cumulative effects were determined using Lincoln National Forest shapefiles of past project areas and considered past, present, and foreseeable future actions as described in table 4 and figure 4. Baseline information used to assess impacts to riparian vegetation was provided by USDA Forest Service specialists using professional judgment.

While the area has been examined during the Burned Area Emergency Response effort and some quantitative work has been done (Kuhar 2012 and 2013), the original transects that established the baseline riparian vegetation were not sampled again.

Incomplete and Unavailable Information

There is minimal information and data regarding the condition and extent of riparian vegetation along the North Fork prior to well pumping. We have no baseline vegetation monitoring or any photo sampling prior to the initiation of North Fork Eagle Creek well pumping in 1988. Because of this, we attempted to establish a reference reach (another physically and hydrologically similar stream that might emulate prepumping conditions along the North Fork). We initially considered several areas (South Fork Eagle Creek, North Fork Eagle Creek upstream from the wells and above the North Fork stream gage, Eagle Creek below the Eagle Creek gage, Turkey Canyon, Bear Creek, upper watershed of South Fork Rio Bonito, Bonito Creek, Cedar Creek and South Fork of Rio Bonito). With the exception of South Fork Rio Bonito, none of these other reaches met the criteria for a suitable reference reach based on various rigorous GIS analyses of physical conditions, opinions from local district staff familiar with these areas, and/or field visits. South Fork Rio Bonito seemed the most similar to the North Fork Eagle Creek based on physical attributes and we field checked it in 2011. This field check concluded that, while the reach had similar characteristics, it was different enough than the North Fork Eagle Creek in several factors that it raised doubt about whether it would provide a suitable comparison. For purposes of this analysis, we did not pursue a quantitative comparison for these reasons. However, detailed photos were taken along South Fork Rio Bonito during 2011 and were used to provide some qualitative generalized comparisons to riparian vegetation potential along the North Fork Eagle Creek. Merritt and Bevan (2011) provide more details regarding this comparison and the results.

We obtained prepumping aerial images of the North Fork Eagle Creek and they showed significant flooding in 1986 and 2007/2008 between photographic periods (prepumping images from 1987; postpumping images from 1994 and 2009) and this likely obscured any changes in channel form that might have been attributable to upstream groundwater pumping and depletion of surface flow and groundwater levels. Changes attributable to altered groundwater levels and streamflow can include channel narrowing or channel widening depending upon the type of alteration and the setting; we could not ascertain this from the aerial photo analysis.

Affected Environment

Current Conditions

Riparian vegetation along the North Fork is comprised largely of upland, xeric species. This is indicative of riparian areas adjacent to streams with intermittent flow and water tables sufficiently deep to exclude many phreatophytes[3] and plants with high water requirements.

There are seven primary community types represented but the most frequently occurring plant community type is the creeping bentgrass/orchard-grass/fringed brome community, followed by the marsh muhly/wheatgrass community.

Seven species in all the sampled quadrats[4] were facultative wetland plant species[5] (occurring in wetlands 67 to 99 percent of the time), as shown in table 13, and these facultative wetland species make up only 13 percent of all species sampled. With the exception of marsh muhly, none of these species were community dominants and none occurred in more than three quadrats. All of the facultative wetland species were native to New Mexico with the exception of common sheep sorrel and curly dock. There were no obligate wetland species[6] (occuring in wetlands 99 percent of the time) in any sampled quadrat. Rooting depths for these species are also noted in table 13.

Table 13. Species classified as facultative wetland plants (Reed 1988) occurring in the North Fork Eagle Creek sampled quadrats

Common Name Species	Species	Number of Quadrats	Minimum Rooting Depth (inches)[a]
boxelder	*Acer negundo*	2	40
Parry's thistle	*Cirsium parryi*	1	Not applicable
largeleaf avens	*Geum macrophyllum*	1	12
marsh muhly	*Muhlenbergia racemosa*	13	8
cutleaf coneflower	*Rudbeckia laciniata*	3	12
common sheep sorrel	*Rumex acetosela*	3	Not applicable
curly dock	*Rumex crispus*	3	Not applicable

a - From USDA Natural Resources Conservation Service, 2012: http://plants.usda.gov

We recorded four tree species in sampled plots and we used their relative density, dominance, and frequency to develop an importance value (as described in more detail in Merritt and Bevan (2011) and Miller (2012a)). These species, ranked from most important to least important, are as follows: white fir, ponderosa pine, boxelder, and Mexican white pine.

Boxelder is the only species on this list that is considered a riparian species due to its dependence on shallow groundwater. Boxelder ranked below or nearly equal to the upland species occurring on the valley bottom, indicating that it is no more abundant in the North Fork riparian areas than

[3] A plant with a deep root system that draws its water supply from near the water table.
[4] A quadrat is a square (of either metal, wood, or plastic) used in ecology and geography to isolate a sample, usually about $1m^2$ or $0.25m^2$. The quadrat is suitable for sampling plants, slow moving animals (such as millipedes and insects), and some aquatic organisms.
[5] Facultative wetland species usually occur in wetlands (estimated probability 67–99 percent), but are occasionally found in nonwetlands.
[6] Obligate wetland species occur almost always (estimated probability 99 percent) under natural conditions in wetlands.

drought tolerant upland species. Both Pacific willow and Wooton's hawthorn (a Forest Service sensitive species) occur along the sampled North Fork reach, but none were sampled in the inventory. Pacific willow is a riparian species dependent upon shallow water tables (with a minimum rooting depth of 10 inches) and Wooton's hawthorn is a riparian species indicative of relatively shallow groundwater; because this species is a Forest Service sensitive species, it is discussed further in the "Vegetation" section later in this chapter, under "Threatened, Endangered and Sensitive Species."

The presence of willow, Wooton's hawthorn and seven facultative wetland species indicates that the North Fork Eagle Creek maintains some moister microhabitats with sufficiently shallow groundwater and or soil moisture to support such species.

Conditions before Pumping Began in 1988

Data relating to the pre-well pumping riparian vegetation in the project area is sparse. Fish survey reports from the 1960s (Little 1960a, b; Little 1961) include notes regarding vegetation in the project area (shoreline vegetation was ponderosa pine with various grasses and forbs) and include photos at sampling stations that closely resemble current vegetation, with ponderosa pine and grass along streambanks. Range reports (Edwards 1963, Edwards 1964) include notes that the area was comprised of several vegetation types including mixed conifer, ponderosa pine, mountain bunchgrass and bluegrass bottom and that the area had "deteriorated" to a Kentucky bluegrass, forb type with an increase in erosion. Medlock (2011) provides a compelling case for the lower half of the North Fork being intermittent prior to pumping. Included in his report is an historical photo of the area showing vegetation similar to current vegetation in the area above the well field in 1947. Of particular note in this photo is the lack of obligate wetland species one would associate with a riparian community along a perennial stream (e.g. willow and cottonwood in the overstory).

Though we do not know the prepumping condition of North Fork riparian vegetation, we do know there has been reduced water availability along the North Fork since the North Fork Eagle Creek wells began pumping, as described in more detail in the "Water Resources" section of this chapter. Reduced water availability can affect riparian vegetation. Reduced water availability for plants can also be influenced by flood deposited alluvium in the valley bottom of the North Fork which raises the flood plain and channel, and causes the stream to flow below the alluvium. Either of these factors could explain the existing conditions and composition of the riparian vegetation along the North Fork. Figure 11 illustrates a typical reach of the North Fork during the 2011 survey. We did note significant changes in the aerial extent of coarse alluvium and channel widening in aerial images taken after major flooding in 1986 and in 2007/2008. For comparison, figure 12 illustrates a typical reach along South Fork Rio Bonito during the 2011 field visit. While we determined that, based on the current level of information, South Fork Rio Bonito may not provide a suitable reference reach from which to establish a baseline survey and quantitatively compare to survey results from the North Fork Eagle Creek, it provided a useful tool for visual comparison and inferences about riparian potential along the North Fork if there were more sustained elevated water tables.

Figure 11. North Fork Eagle Creek showing channel and adjacent vegetation (photographs taken by Terry Miller in July 2011)

The upper and lower left frames of figure 11 show a dry streambed, with vegetation on either side of a barren channel. A solitary *Salix lucida*, shown in the left lower frame, looks to be in poor condition either from drought stress or browsing. The lower right frame shows a quadrat (R2T1P1) that is dominated by *Sprorobolus cryptandrus* and follows into the community of the same name. The plot also contains *Artemisia ludoviciana* and *Muhlenbergia racemosa*.

The riparian vegetation in figure 12 appears roughly similar in composition with the North Fork Eagle Creek, but with higher abundance than seen in figure 11. This may be indicative of more sustained elevated water tables along the South Fork Rio Bonito compared to the North Fork.

Figure 12. South Fork Rio Bonito showing various degrees of intermittent to perennial flows (photographs taken by Terry Miller in July 2011)

Conditions Following the Little Bear Fire

The Little Bear Fire burned throughout the analysis area. Burn intensities in the riparian area (200 feet on each side of Eagle Creek) were low in general. Approximately 82 acres (47 percent of total riparian) were underburned, 93 acres (53 percent of total riparian) burned at low intensity and 1 acre (less than 1 percent of total riparian) burned at moderate intensity.

A field visit on November 19, 2013 revealed that most of the riparian vegetation in the sampling area looked minimally unaffected by the wildfire and related indirect effects such as flooding. Some sites showed signs overland flow of sediment where vegetation was buried at the time of the field visit. Most transects were missing at least one of the rebar pieces marking the beginning or end of the transect. Bank erosion had scoured away at least five meters of bank at Reach 3 Transect 1. Additionally, neither piece of rebar was located at this transect. Larger and more durable transect markers will have to be placed using GPS and photos from the monitoring report. The area most affected (in the reaches where riparian monitoring took place) by the flooding following the wildfire is at the confluence of the north and south forks of Eagle Creek. Deep cobble dominates the area from Reach 4, Transect 2 to Reach 4, Transect 1, which totals approximately 400 feet (700 feet from the gage at the road).

Environmental Consequences

Alternative 1 - No Change

Direct and Indirect Effects

There are no direct effects to riparian vegetation from continuing current pumping operations under alternative 1 (no action). However, indirect effects are likely. Indirect effects would occur when water table drawdown limits available moisture to riparian vegetation and creates sustained water tables below the minimum rooting depths for facultative wetland species (table 13). This can cause poor growth, reduced seed production, and in severe enough cases, the death of individual plants, loss of species, and vegetation change.

As described in the “Water Resources” section earlier in this chapter, the general duration of no surface flow days at the Eagle Creek gage is approximately 1 to 2 weeks during average precipitation periods and approximately 8 to 10 weeks during drought periods. Streamflow quantities are anticipated to decline over the long term from climate change effects, with the spatial extent and duration of no-flow conditions increasing along the North Fork. The presence of flows equal to or greater than 1.2 cubic feet per second would decline, which would reduce water availability in the alluvium for plant growth and sustenance. Opportunities for maintaining or improving watershed condition on National Forest System lands in the upper Eagle Creek drainage would become severely limited.

If groundwater levels were lowered below present levels for a sustained period of time and surface flow was to become less frequent, it is very likely that vegetation change would occur. This shift would likely include a decrease or loss in those species dependent upon shallow groundwater (table 13), and an increase in xeric, upland plant species. Factors that distinguish riparian areas from uplands include the presence of shallow groundwater and periodic flood-related disturbance (Merritt et al. 2010).

Though groundwater pumping would likely have no effect on periodic high flows and related fluvial processes, reductions in groundwater levels could cause riparian areas to become compositionally similar to adjacent uplands. Shifts in vegetation along riparian areas correspond to the degree of hydrologic change. Minor changes (e.g., small reductions in groundwater levels) could result in a shift in species to lower elevations closer to the water table and nearer the active channel. Such shifts are common along streams in response to the availability of water (Merritt et al. 2010). However, once groundwater levels (and subsequent vadose zones[7] and seasonal soil moisture) fall below the threshold of the water requirements of a species, those species will not persist in the system. The vadose zone extends from the top of the ground surface to the water table.

If groundwater were depleted and surface flow were reduced from its current state along the North Fork, one might initially expect boxelder, Pacific willow, and other phreatophytic shrubs and trees to temporarily show signs of drought stress and reduced canopy cover. Shifts and losses of the primary community types along the North Fork would likely occur as well. Chronic reduction in groundwater levels during the growing season would likely result in the loss of phreatophytes, and conversion to upland forest and meadow, and the potential for communities

[7] Vadose water is located in the pore spaces of a rock or soil, in the zone of soil or rock between the ground surface and the water table.

not currently represented along the North Fork to become established. In such a scenario, communities in and along the channel may be well represented by ruderal species[8], generalists, and those natives adapted to periodically disturbed, dry conditions.

Species Composition:

Although most of the North Fork riparian vegetation is well adapted to dry periods, maintaining diversity in the riparian area relies on retaining the facultative wetland species and the communities in which they live. While elements of these species and communities would probably remain in microsites, it is likely that vegetation would shift toward the channel and to lower elevations nearer the water table under alternative 1 (no action).

Riparian Tree Species Canopy Cover:

Boxelder would likely remain in the North Fork Eagle Creek riparian area at its currently low levels in even the most extreme drawdown scenarios due to the widespread nature of the species and the continued recruitment of new generations. However, only nine individual Pacific willow plants were identified and there appears to be no recruitment of younger age classes even though the adult plants looked healthy.

Updates to Direct/Indirect Effects of Alternative 1 Due to the Little Bear Fire

The Little Bear Fire will likely result in a shifting of sediment and cobble around as seen in the area between Reach 4, Transect 2 to Reach 4, Transect 1(AECOM 2014). The instability of the channel could result in some riparian areas being buried and an increase in alluvium that would reduce surface flow in the short term. However, these effects could be offset by the opportunity for species such as willows to colonize new areas. Water availability to riparian vegetation is not likely to be greatly changed as a result of the Little Bear Fire in the long term. One possibility is that there might be a slight increase in water availability if large portions of the upland vegetation convert to shrub species (AECOM 2014). While possible, this conversion is not a forgone conclusion. However, nearby burned areas have converted from upland vegetation to shrub species (Kuhar 2013).

Cumulative Effects

Implementing past, present, and future activities within the North Fork drainage area (figure 2 and table 4) with implementing alternative 1 (no action) would result in no more than minor cumulative impacts to riparian vegetation because these activities do not typically take place in the riparian corridors or would have effects that are so small in magnitude as to be irrelevant.

Streamside riparian vegetation outside of the North Fork drainage area was not included in the cumulative effects boundary (based on the definition and rationale for spatial boundaries we present in the “Methodology” section) but we did qualitatively consider it using the results of the water resources evaluation in this larger area. As stated in the “Water Resources” section, cumulative water resources impacts would involve ongoing reductions in flow and water quality along Eagle Creek within the larger upper Eagle Creek cumulative impact area, due primarily to reduced groundwater recharge. These would be adverse, long term and regional impacts that would range in severity from moderate to severe. Additional water supply developments in the region would create further impacts to surface water and groundwater; these impacts would also

[8] A ruderal species is a plant species that is first to colonize disturbed lands.

likely result in adverse impacts to associated resources, like streamside riparian vegetation. The level of site-specific effect to riparian vegetation further downstream and outside the North Fork Eagle Creek project area cannot, however, be predicted with certainty.

Updates to Cumulative Impacts from Alternative 1 Due to the Little Bear Fire

The Little Bear Fire was widespread across several drainage basins, including Little Creek and the Rio Bonito. Widespread cumulative wildfire impacts on surface runoff, groundwater recharge, and water quality were described in the water resources report (AECOM 2014). Riparian vegetation downstream and outside the North Fork Eagle Creek drainage area could experience greater cumulative impacts since the footprint of effects from the Little Bear Fire is so large.

Conclusion

Implementing alternative 1 (no change) could result in the loss of Pacific willow, which is an important component of the North Fork riparian vegetation diversity. However, based on the best available information, this stretch of the North Fork was intermittent before the wells began pumping and exhibited periodic stretches of no flow regardless of pumping. Pacific willow, then, has probably never been a major component of the vegetation in this area, but is well represented in the perennial portion of the North Fork upstream from the wells. This upstream area would not be affected by implementation of alternative 1 (no change), as described in more detail in the “Aquatic Habitat and Fish” section earlier in this chapter.

Implementing alternative 1 (no change), then, would either marginally maintain current riparian vegetation condition in the project area in the short term or result in some declines due to continued reductions in water availability. Over the long term, however, climate change induced shifts toward drier conditions, as described in the “Water Resources” section of this chapter, would result in additional stress to riparian vegetation and would experience adverse effects. Therefore, alternative 1 (no change) may be in compliance with the forest plan over the short term, but would not achieve the purpose and need for action or project objectives and would not move the project area toward desired conditions over the long term.

Update to overall effects from Alternative 1 due to the Little Bear Fire:

In the short-term, wildfire effects are likely to result in a shifting of sediment and cobble. This channel instability could result in some riparian areas being buried and an increase in alluvium that would reduce surface flow. However, these adverse effects to riparian tree species and communities could be offset by the opportunity for species such as willows to colonize new areas.

Over the long term, water yield and groundwater availability may improve as shown in the water resources analysis, benefiting riparian habitat. However, continued pumping would obscure some of these potential benefits. Therefore, adverse effects from implementing alternative 1 over the long term would be the same as, or slightly less than, the pre-wildfire assessment for alternative 1.

Alternative 2 - No Pumping

Direct and Indirect Effects

Implementing alternative 2 (no pumping) would result in direct adverse effects to a small portion of the riparian vegetation because of ground disturbance related to removing pumps. This could result in plants being uprooted, crushed, and killed. Due to the size of area of disturbance and implementation of project design features, this effect would be minor and short term.

Indirect beneficial effects from alternative 2 (no pumping) would result from an increase in available moisture for riparian vegetation. While surface flow would remain consistent with an intermittent stream, increases in surface flow and groundwater and subsequent moisture available for plant growth would provide an opportunity for riparian vegetation expansion.

Species Composition:

Facultative wetland species would be beneficially affected by implementing alternative 2 (no pumping). Increases in communities featuring facultative wetland species would likely occur due to increased water availability, but the magnitude of change would likely be relatively minor. Over the long term, these positive changes could be affected by climate change and may be less widespread with shifts toward drier conditions, as described in the “Water Resources” section of this chapter.

Riparian Tree Species Canopy Cover:

Boxelder would remain relatively constant or would increase somewhat under implementation of alternative 2 (no pumping), and Pacific willow would likely increase due to improved moisture for seedling establishment. Over the long term, these positive changes could be affected by climate change and may be less widespread with shifts toward drier conditions, as described in the “Water Resources” section of this chapter.

There are no anticipated changes in effects to riparian vegetation as a result of the Little Bear Fire in alternative 2.

Cumulative Effects

Implementing past, present, and future activities within the North Fork drainage area (figure 2 and table 4), in addition to implementing alternative 2 (no pumping), would result in no more than minor cumulative impacts to riparian vegetation because these activities do not typically take place in the riparian corridors or would have effects that are so small in magnitude as to be irrelevant.

Streamside riparian vegetation outside of the North Fork Eagle Creek drainage area was not included in the cumulative effects boundary (based on the definition and rationale for spatial boundaries we present in the “Methodology” section) but we did qualitatively consider it using the results of the water resources evaluation in this larger area. As stated in the “Water Resources” section, beneficial cumulative recharge effects to aquifers, springs and seeps, and possibly stream base flows may result within parts of the Eagle Creek drainage. The magnitude and extent of these effects is unknown, since it is likely that the Village of Ruidoso would continue to exercise its water rights and make withdrawals elsewhere in the Eagle Creek system. Impacts from such activities could offset beneficial impacts from no pumping at the North Fork Eagle Creek well field. These impacts could result in beneficial impacts to associated resources, like streamside riparian vegetation. The level of site-specific effect to riparian vegetation further downstream and outside the North Fork Eagle Creek project area cannot, however, be predicted with certainty.

Conclusion

Implementing alternative 2 (no pumping) would at least maintain and possibly improve riparian vegetation condition in the project area. Therefore, it would be in compliance with riparian direction in the forest plan and would achieve the purpose and need for action and project objectives. Implementation of alternative 2 (no pumping) would move the project area toward desired conditions more so than either alternative 1 (no change) or alternative 3 (proposed action).

Update to overall effects from Alternative 2 due to the Little Bear Fire:

In the short term, wildfire effects are likely to result in a shifting of sediment and cobble. This channel instability could result in some riparian areas being buried and an increase in alluvium that would reduce surface flow. However, these adverse effects to riparian tree species and communities could be offset by the opportunity for species such as willows to colonize new areas. The effects of no pumping would encourage the occurrence of streamflow and increased groundwater levels (more so than under alternative 1) although large portions of the stream would remain intermittent during periods of average precipitation. Pools and stretches of surface water may be reduced and this could affect riparian habitat. Under alternative 2, the potential for riparian habitat improvement will continue to be limited but not as much as under alternative 1.

Over the long term, after watershed recovery, effects from no pumping would be the same as those described in the pre-wildfire assessment for alternative 2.

Alternative 3 - Proposed Action
Direct and Indirect Effects

There are no direct effects as a result of implementing alternative 3 (proposed action), since no ground-disturbing activities would occur. Indirect effects would be more similar to those from the no pumping alternative 2, than to the no action alternative 1. Beneficial effects would result from an increase in available moisture for riparian vegetation. While surface flow would remain consistent with an intermittent stream, and no-flow days would not be eliminated, increases in surface flow and groundwater and subsequent moisture available for plant growth would provide an opportunity for limited riparian vegetation expansion.

Species Composition:

Facultative wetland species would be beneficially affected by this alternative compared to implementing alternative 1 (no action) but less so than for alternative 2 (no pumping). Increases in communities featuring facultative wetland species would likely occur due to increased water availability, but the magnitude of change would be relatively minor and less than that expected for alternative 2 (no pumping). Over the long term, positive changes could be affected by climate change and may be less widespread with shifts toward drier conditions, as described in the “Water Resources” section of this chapter.

Riparian Tree Species Canopy Cover:

Boxelder and Pacific willow would remain relatively constant under implementation of the proposed action, alternative 3, although some willow recruitment would be possible if climatic conditions are favorable. Over the long term, any changes could be affected by climate change and may be less widespread over the long term with shifts toward drier conditions, as described in the “Water Resources” section of this chapter.

Updates to Direct/Indirect Effects from Alternative 3 Due to the Little Bear Fire

Change in effects are expected to be the same as those described in alternative 1, except that any positive benefit from increased availability of water to riparian vegetation would be greater in magnitude in alternative 3.

Cumulative Effects

Implementing past, present, and future activities within the North Fork drainage area (figure 2 and table 4) in addition to implementing the proposed action (alternative 3), would not result in more than minor cumulative impacts to riparian vegetation because these activities do not typically take place in the riparian corridors or would have effects that are so small in magnitude as to be irrelevant.

Streamside riparian vegetation outside of the North Fork Eagle Creek basin was not included in the cumulative effects boundary (based on the definition and rationale for spatial boundaries we present in the "Methodology" section) but we did qualitatively consider it using the results of the water resources evaluation in this larger area. As stated in the "Water Resources" section, cumulative water resources impacts would include flow and water quality reductions in Eagle Creek within the cumulative impact area. Water supply pumping for the applicant is conducted at six water wells along lower Eagle Creek, and the village diverts surface water from the stream a short distance below the Eagle Creek gage. As a result, groundwater recharge in downstream alluvial and bedrock aquifers would still be adversely affected, but to a lesser extent than under alternative 1 (no action). Implementing alternative 3 (proposed action) would have minor effects on these impacts, as pumping in the North Fork Eagle Creek would generally be permitted most of the time. These impacts could result in impacts to associated resources, like streamside riparian vegetation. The level of site-specific effect to riparian vegetation further downstream and outside the North Fork Eagle Creek project area cannot, however, be predicted with certainty.

Conclusion

Implementing alternative 3 (proposed action), would maintain and likely improve riparian vegetation condition in the project area, although not to the level expected under alternative 2 (no pumping). Therefore, it would be in compliance with riparian direction in the forest plan and would achieve the purpose and need for action and project objectives. Implementing alternative 3 (proposed action) would move the project area toward desired conditions but likely at a slower pace than alternative 2 (no pumping).

Update to overall effects from Alternative 3 due to the Little Bear Fire:

In the short-term, wildfire effects are likely to result in a shifting of sediment and cobble. This channel instability could result in some riparian areas being buried and an increase in alluvium that would reduce surface flow. However, these adverse effects to riparian tree species and communities could be offset by the opportunity for species such as willows to colonize new areas.

During the short term post-wildfire recovery period, pumping effects would be limited to the extent possible through an iterative and adaptive approach as the landscape, stream channel, and groundwater recharge processes adjust to the wildfire disturbance. Under alternative 3, the potential for riparian habitat improvement will continue to be limited but not as much as under alternative 1.

Alternative 3 would encourage the occurrence of streamflow and increased groundwater levels (more so than under alternative 1) although large portions of the stream would remain intermittent during periods of average precipitation. Pools and stretches of surface water may be reduced and this could affect riparian habitat.

Over the long term, during dry years, adaptive management would improve flow conditions and reduce the amount of no-flow days along the North Fork Eagle Creek. With respect to surface flows and alluvial groundwater levels, an approximate middle ground between alternative 1 and 2 would be attained during average precipitation years under alternative 3. Over the long term, after watershed recovery, effects from implementing an adaptive management strategy would be the same as those described in the pre-wildfire assessment for alternative 3.

Summary

Implementing the no pumping alternative 2 or the proposed action alternative 3, would achieve the second need statement for this project which is "protecting natural resources on the national forest by maintaining adequate surface and groundwater flows to sustain or improve the riparian and aquatic ecosystems that may be affected by groundwater drawdown from the pumping of these wells." Because both alternatives would either sustain or improve riparian vegetation in the North Fork Eagle Creek drainage area, both alternatives meet this need. However, alternative 2 (no pumping) would move the project area toward desired conditions more quickly than alternative 3 (proposed action). Alternative 1 (no change) does not meet this need statement since long-term adverse impacts to streamflows and riparian habitat are predicted, particularly when combined with long-term shifts in climatic conditions.

Implementation of alternative 1 (no change) would either marginally maintain current riparian vegetation condition in the project area in the short term or result in some declines due to continued reductions in water availability. Over the long term, however, climate change induced shifts toward drier conditions, as described in the "Water Resources" section of this chapter, would result in additional stress to riparian vegetation and would experience adverse effects. Therefore, alternative 1 (no action) may be in compliance with the forest plan over the short term, but would not achieve the purpose and need for action or project objectives and would not move the project area toward desired conditions over the long term.

Socioeconomics

The level of North Fork Eagle Creek well pumping has the potential to affect local social and economic conditions. Defining features of every area influence and shape the nature of local economic and social activity. Among these are unique area natural amenities and features provided by the Lincoln National Forest. Changes to these features in turn can affect local social and economic conditions. For example, the quality of recreation experience may be affected by changes in the quantity and quality of surface flow in Eagle Creek. In addition, limitations on groundwater withdrawals under this EIS could affect the supply of water available for diversion for the Village of Ruidoso.

We include a more detailed description of affected environment, methods, and environmental consequences for this project in the socioeconomics report (Eichman 2012). The supplemental socioeconomics report (Eichman and Loughery 2014) provides a more detailed description of affected environment, methods, and environmental consequences, considering the changes caused by the Little Bear Fire. These reports are incorporated by reference, discussed briefly below, and available in their entirety in the project record.

Methodology

Groundwater withdrawal limitations may affect the supply of water available for diversion by the applicant. Well pumping may result in changes to groundwater and surface water availability which has the potential to affect streamside recreation use (public use of streams for streamside recreation, fishing, and wildlife viewing) and private land (availability of water for domestic wells). In addition, impacts to quality of life and environmental justice effects were of concern. Consequently, the following social and economic indicators are used to compare the effects of each alternative.

Where updates are necessary due to the Little Bear Fire, these are noted in the following text for this section.

Municipal Water Supply:

Estimates of potential forgone water diversion from groundwater withdrawal limitations are used to measure the potential for change to historic North Fork Eagle Creek well diversion. Effects of groundwater withdrawal limitations are examined on historic North Fork Eagle Creek well diversion (average annual), diversion for Alto Creek and Grindstone Reservoirs (average annual) and projected demands from the 40-year water plan. In addition, effects of groundwater withdrawal limitations are examined on historic North Fork Eagle Creek well diversion during the 5-month summer resort period (high demand on water use) from May to September. These estimates also consider effects to village diversion from additional indirect diversion attributable to North Fork Eagle Creek wells from the 50 percent return flow credit[9].

Municipal water supply indicators examine the effect of groundwater withdrawal limitations using an estimate of potential forgone water diversion over estimates of pumping restriction durations. The Village of Ruidoso anticipates that it will be a period of years before attenuation of wildfire effects will allow a resumption of the full use of Eagle Creek surface water, groundwater and the diversion credits for the return flow credit (Atkins 2014). This analysis assumes this attenuation will occur as stated in the water resources section: “After approximately four to eight years following the Little Bear Fire, long-term post-wildfire conditions are expected to more generally resemble the pre-wildfire hydrologic setting” (page 88 of “Water Resource” section). Thus the pre-wildfire data characterizing historic municipal water supply sources are an accurate depiction of a post-wildfire baseline useful for analysis of groundwater withdrawal limitations. Historic data on surface flow indicate that, had similar restrictions been implemented historically, pumping would have been limited over a broad range of time (from 0 weeks in most years, to 2 to 3 weeks in water year 2000, and approximately 20 weeks in water year 2004) (AECOM 2012). Restrictions would decrease the amount of water the village could withdraw by limiting the pumping rate to 50 percent of the streamflow reported at the North Fork gage. Using historic data of surface flow during years where restrictions would have occurred provides a frame of reference for forgone water diversion (50 percent of streamflow) during these periods. During water years 2000, 2003, and 2004 half of the average daily surface flow was 0.219 cubic feet per second, based on data in the Water Resources Report, appendix A (AECOM 2012). Over periods ranging between 2 to 22 weeks, restrictions would have amounted to approximately 3.3 to 33.5

[9] The village receives a 50 percent return flow credit for all water produced from the North Fork well field. The return flow credit is the result of at least 50 percent of the water diverted from the North Fork well field being returned to the Rio Ruidoso via the village’s wastewater treatment plant. The return flow credit allows the village to divert 50 percent of the total quantity of water produced from the North Fork well field from other wells outside of the Eagle Creek watershed or surface water from the Rio Ruidoso.

cubic feet per second of forgone water diversion in some water years between 2000 and 2010. Converting to acre feet per day indicates that restrictions, when they might have occurred historically, would have ranged from approximately 6.5 acre-feet over 2 to 3 weeks up to approximately 66.5 acre-feet over 20 to 22 weeks in a water year.

Loss of North Fork Eagle Creek well diversion has occurred as a result of the Little Bear Fire in June of 2012. The Village of Ruidoso anticipates that it will be a period of years before attenuation of wildfire effects will allow a resumption of the full use of Eagle Creek surface water, groundwater and the diversion credits for the return flow credit (Atkins 2014). This analysis assumes this attenuation will occur. Thus the pre-wildfire data characterizing historic municipal water supply sources are an accurate depiction of a post-wildfire baseline useful for analysis of groundwater withdrawal limitations.

Over the long term, post-wildfire vegetative transitions in the watershed may slightly improve groundwater availability within the North Fork Eagle Creek (North Fork Eagle Creek drainage on and off Federal land) (see water resources section). If this occurs, contributions to municipal water supply could be slightly greater throughout the year and during the 5-month summer resort period. Consequently, reliance on North Fork Eagle Creek well pumping may be less than depicted above. Effects on measures of dependency presented above can be considered an upper bound of potential effects. Thus, this should be considered a maximum reduction to municipal water supply contributions.

Streamside Recreational Use:

Streamside recreational use indicators are used to measure the potential for change to the quality of recreation experience from streamflow quantity and riparian vegetation associated with springs and seeps (as described in the "Water Resources" section earlier in this chapter).

As stated in the water resource section, the former streamflow water quality indicator is not likely to apply either to short-term or long-term post-wildfire conditions, since the North Fork Eagle Creek channel will transport and re-work sediment and debris. In the short term, additional nutrient content in surface flows may enhance aquatic habitat conditions for some species. As stream deposits are reworked over the long term, additional turbidity and suspended organic carbon and silt will likely increase surface water temperatures and reduce oxygen availability, intermittently, as a result of the wildfire. Thus conclusions about effects to the quality of recreation experience, from changes to water quality, are difficult to make. If oxygen availability is reduced significantly, then impacts to recreation could be negative. However, if additional nutrients enhance the habitat for fish, recreation experiences could improve. Regardless, the streamflow quantity and springs and seeps indicators are sufficient for analysis of effects to the recreation experience.

Availability of Domestic Well Water and Water for Irrigation:

Availability of domestic well water indicators are used to measure the potential for change to private land water supply using an estimate of water drawdown similar to the springs and seeps indicator used above (as described in the "Water Resources" section earlier in this chapter). The availability of surface water for irrigation uses employs the streamflow quantity indicator (estimated durations of no surface flow and estimated occurrence of flows equal to or greater than 1.2 cubic feet per second during a year of average precipitation; Water Resources Report; AECOM 2012).

Values, Beliefs, and Attitudes:

The values, beliefs, and attitudes of area communities are presented to address social considerations: where economic or other effects on area communities cannot be quantified, a qualitative discussion of nonmarket and social values has been added. Direction provided in 40 CFR 1502.23 and Forest Service Handbook 1909.15 (July 6, 2004) and 22.35 (January 14, 2005) provides for qualitative analysis to evaluate the effects of nonmarket values. Therefore, the alternatives' nonmarket aspects are discussed qualitatively where appropriate and are described in other resource sections of the EIS.

Accordingly, the values, beliefs, and attitudes of area communities are presented to address social considerations.

Environmental Justice:

Executive Order 12898, issued in 1994, orders Federal agencies to identify and address environmental justice effects, which are any adverse human health and environmental effects of agency programs that disproportionately impact minority and low income populations.

In order to accurately portray local social and economic conditions above and potential effects under the alternatives, the geographic scope of analysis must be defined. The social and economic relationships and effects extend beyond the immediate vicinity of the project area. The role of actions under the EIS within the larger county must be addressed while not masking potential change within communities in the area. Thus area information is presented at two geographic scales based on available data: county and census county subdivision. Characteristics of Lincoln County are presented alongside characteristics of Ruidoso census county subdivision given economic linkages between the county and the census county subdivision containing the Village of Ruidoso and the project area. Environmental justice is examined at both the county and census county subdivision level.

When we look at the social effects of land management actions, the most critical impacts may be to small, rural communities (Rudzitis and Johnson 2000, pg 5). Consequently, geographically defined communities are an important and relevant level for social assessment. However, not all social scientists agree that the geographically based community is always the appropriate level of analysis. The Northwest Forest Plan's Federal Ecosystem Management Advisory Team (FEMAT 1993, pg VII-35) makes the point that this view "only refers to physical or political boundaries and not to the relationships among people who reside within such boundaries." Consequently, social relationships are examined regardless of geography in the section on values, beliefs, and attitudes.

This analysis examines effects of groundwater withdrawal limitations on projected demands from the 40-year water plan. Projections that consider water utility use reductions indicate 5,097 acre-feet per year will be required in 2045; however, existing water supplies and water rights as developed do not meet these needs. Consequently a number of other water supply alternatives need to be discussed as part of the plan for future Ruidoso water supply and water rights needs (Wilson and Company 2005, pp. 1–53).

Baseline information used to assess impacts to social and economic resources was provided by USDA Forest Service specialists, literature, and professional judgment.

The primary differences between the content of the DEIS and the SDEIS is in reference to the Little Bear Fire. In this updated Socioeconomics report for the SDEIS, additional literature review was conducted, new information from the Village of Ruidoso was sought (Atkins 2014), and the analysis was modified to reflect changes to the water resources report. The Atkins (2014) data outlined that the Village of Ruidoso anticipates that it will be a period of years before attenuation of wildfire effects will allow a resumption of the full use of Eagle Creek surface water, groundwater and the diversion credits for the return flow credit (Atkins 2014). In addition to the six existing and operating wells that are supplemental to the North Fork Eagle Creek wells in the Eagle Creek basin, there are an additional 7 supplemental wells in the cumulative impact analysis area off of National Forest System lands that the Village has applied for and that could also divert the Eagle Creek water right in the future (Office of the State Engineer, personal communication, 2014). The water resources report provides updated underlying assumptions for the socioeconomics analysis (e.g. post-wildfire estimated to have eight year full attenuation period).

Incomplete Information

Post-wildfire socioeconomic information is not available, so this analysis relied on assumptions based on conclusions in water resources report (AECOM 2014) which are summarized at the beginning of this chapter. This analysis assumes the attenuation of wildfire effects will occur as stated in the water resources section: "After approximately four to eight years following the Little Bear Fire, long-term post-wildfire conditions are expected to more generally resemble the pre-wildfire hydrologic setting" (page 88 of "Water Resource" section). Thus the pre-wildfire data characterizing historic municipal water supply sources are an accurate depiction of a post-wildfire baseline useful for analysis of groundwater withdrawal limitations.

Affected Environment

History

The Mescalero Apaches were some of the first to inhabit the area. They hunted and fished in the Sacramento Mountain area surrounding the Village of Ruidoso and were only occasionally visited by Spanish explorers who ventured into the Rio Bravo Valley. Trappers followed the Spanish and were then followed by traders, merchants, and their families (Village of Ruidoso 2010). The Ruidoso area was first settled in the 1850s, with mining and ranching among the primary draws. The settlement, originally called "Dowlins Mill," thrived on logging, hunting, and the mill (Wilson and Company 2005).

By the end of the 19th century, the Village of Ruidoso was a small settlement, known for its associations with Billy the Kid and other historic figures of the West. In the beginning of the 20th century the Village of Ruidoso became increasingly known as a vacation destination for its natural amenities; its elevation and resulting cooler temperatures provided refuge from the heat in New Mexico and west Texas. After World War II, the Village of Ruidoso's reputation as a resort destination grew with construction of Ruidoso Downs. Tourism began to flourish in 1962, when the Sierra Blanca Ski area (now Ski Apache) was opened (Village of Ruidoso 2010). The town grew dramatically in the 1970s with an influx of retirement homes, second homes, resort related cabins, town homes, and motels (Wilson and Company 2005).

The expansion seen in the 1970s provided the first challenge for the Village of Ruidoso's water utility. Individual utility systems were constructed for the developments and subdivisions. These systems were often stand-alone, in difficult terrain, with waterline sizes that were insufficient for community needs such as fire protection. In the mid-1970s water system improvements were undertaken, under the first water master plan, to address system inadequacies across the entire Village of Ruidoso. Under the plan, a number of improvements were recommended including storage at Alto Crest and a new treatment plant at Eagle Creek (Wilson and Company 2005).

Population Change

Population in Lincoln County increased by 12,897 people (61 percent) between 1969 and 2010 (figure 13). Growth in the county over this period was outpaced by the State (100 percent) and exceeded growth in the Nation (52 percent). Population within Ruidoso census county subdivision increased by 7,298 people (100 percent) between 1990 and 2010 which, in terms of growth, outpaced the Nation (24 percent), the State (35 percent) and Lincoln County (67 percent) over these 2 decades of available data (U.S. Department of Commerce 2011). Population projections suggest Lincoln County and the State of New Mexico will increase in the next 15 years. Projections suggest that between 2010 and 2025, Lincoln County will increase by 20 percent (4,021 persons) while the State will increase by 36 percent (648,578 persons) (State of New Mexico 2008).

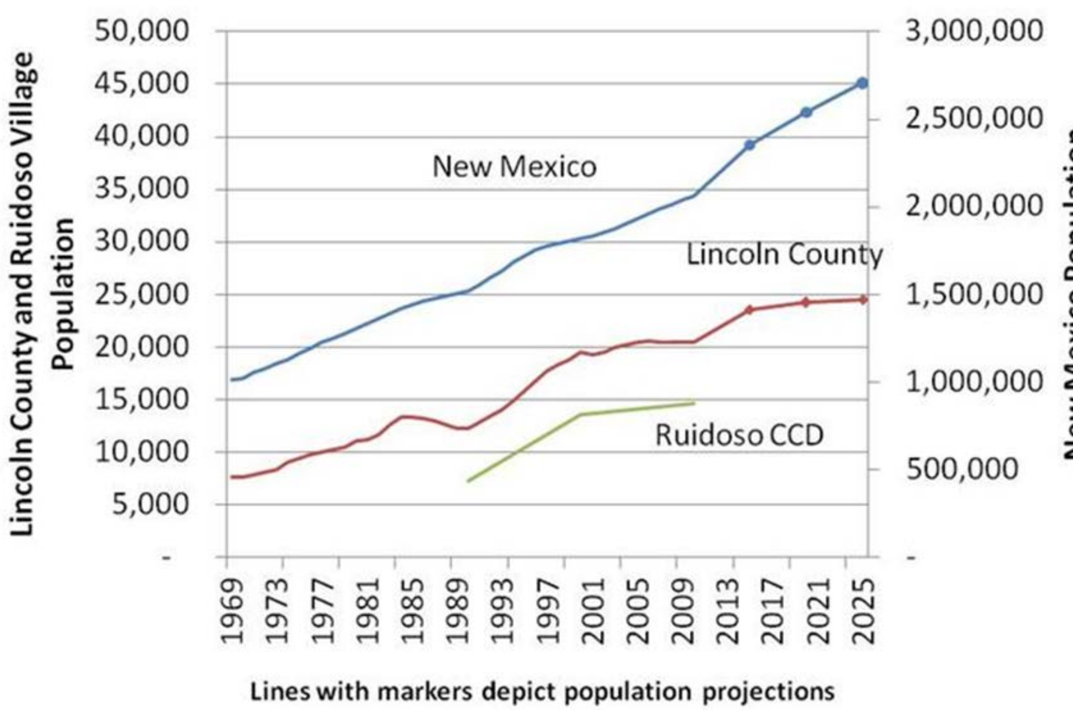

Figure 13. Population change for the Village of Ruidoso, Lincoln County and the State of New Mexico (U.S. Department of Commerce 2011, State of New Mexico 2008)

The 10-year historical trend of full-time resident population growth is not considered dependable by the Village of Ruidoso (Village of Ruidoso 2010). Using data from the "Village of Ruidoso Comprehensive Plan," village officials have accepted the use of population growth scenarios that range from 2 to 3.5 percent growth per year (Village of Ruidoso 2010). This range coincides with the rate of growth calculated for the 40-year water use plan of 2.63 percent per year; which was based upon existing water usage data, from the years 1997 through 2004 (Wilson and Company 2005).

Conditions before Pumping Began

By the time pumping of North Fork Eagle Creek wells had started in 1988, the Village of Ruidoso had established itself as a resort destination community and had also made water system upgrades to accommodate the expansion of the community (Wilson and Company 2005). In the mid-1980s, employment and population declined along with construction and related sectors. However, growth resumed in the early 1990s (figure 13) and water diversion from North Fork Eagle Creek wells became part of the Village of Ruidoso water supply.

The importance of the North Fork Eagle Creek to community well-being and quality of life was apparent long before pumping began. Summer homes in the area benefited from the stream, its vegetation, and dependent wildlife. Dispersed recreational use of the area was common and included hiking, wildlife viewing, and some fishing.

Per Capita Water Use

Standard measures of per capita water use for the applicant do not reflect true individual residential water use, as the actual number of persons using water is far higher than the per capita figure, due to the presence of part-year residents and tourists. The 40-year water plan notes that full-time resident population figures for the village, from the 2000 U.S. Census, account for only 30 to 45 percent of occupancy and, thus, do not reflect the number of persons present in the Village of Ruidoso using water (Wilson and Company 2005). Since water use information is unavailable for this unaccounted population, the data on per capita water usage for the Village of Ruidoso presented below only provides a frame of reference for comparison with other cities.

Village of Ruidoso per capita water use is obtained from the 40-year water plan, which is the most current information available, and metered water use data. This data yields an estimate of 136 gallons per capita per day (Wilson and Company 2005). While this figure is not directly representative of Village of Ruidoso water use, as has been stated, it provides a comparison with other New Mexico cities in the area. Compared to the Village of Ruidoso, the cities of Albuquerque and Las Cruces had higher gallons per capita per day (185 an d189 per capita per day, respectively) while Rio Rancho and Santa Fe's use were similar (140 gallons per capita per day). The combination of climate, altitude, and surrounding forest moderates outdoor water use in the Village of Ruidoso in comparison to surrounding towns and villages. Thus, the water usage per person is likely lower in the Village of Ruidoso compared to other communities (Wilson and Company 2005).

Trends in Water Use

As a year-round mountain destination resort and a hub for regional recreation, the Village of Ruidoso has several unique and distinguishing characteristics that influence both water use growth (instead of population growth) and total water usage. The first characteristic influencing water usage is that full-time residents make up less than half of the water usage of the village (Wilson and Company 2005). Historical water data shows that water use is heavily impacted by the size of the part-time, resort related population. The 1998 Water Master Plan indicated the metered water total for the 5-month summer resort period (May through September) served an average of 14,000 persons while the census estimated population in 1998 at 6,500 persons. The

Village of Ruidoso's 40-year water plan estimates that less than half of the total water is comsumed by this permanent population (Wilson and Company 2005).

Metered water, is that water represented from reading the water meters of billed customers, and for the Village of Ruidoso, includes ONLY totals of residential and commercial metered water. Existing metered water records for summer months (from May and September) and by year (from 1991 through 2004) are utilized for examining water consumption. The peak related summer months are used to identify resort related variations and demonstrate the degree of water use during the summer season related to total metered water use per the convention used by Wilson and Company (2005).

Total metered water use per year in figure 14 below shows an increase early in the period examined; from 1,100 acre feet in 1991 to 1,360 in 1998. The decrease in 1996 likely occurred as a result of adopting a policy focusing on water conservation planning efforts, system-wide utility use reductions, and leak reduction efforts. From 1999 to 2004 a decrease in total metered water use to 1,200 acre feet occurred as a result of per person water conservation, system-wide reductions in water losses, and village enforced restrictions on water use (Wilson and Company 2005). The adoption of restrictive water rate ordinances in 1998 and revisions in 2000 and 2002 likely had the negative effects on consumption depicted in figure 14 below. In addition, the decreases seen from 1999 through 2004 are due, in part, to village efforts to reduce leakage and conserve water, but also, due to the ongoing drought during which outdoor watering enforced restrictions were instituted from 2001 through 2003. In addition, local forest fires in 2000, 2001, and 2002 kept many part-time residents and visitors away, further reducing use (Wilson and Company 2005).

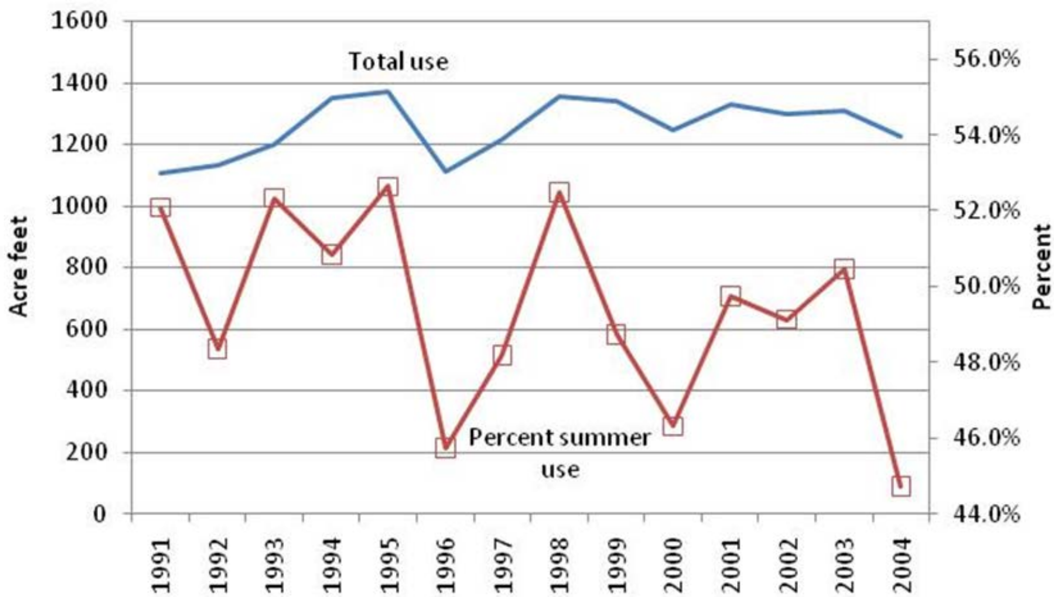

Figure 14. Total metered water use and the percent of use occurring in summer months (Wilson and Company 2005)

Recreation use and the resort related population vary depending on factors such as national and regional economies, weather issues (drought and snowfall), and fires (noted above). Summer use (the sum of consumption in summer months) as a percent of total metered water use increased slightly over the same period as above (from 52 percent in 1991 to 53 percent in 1998) and correspondingly decreased to 45 percent in 2004. While summer recreation use may be increasing, policies to reduce consumption and drought have likely resulted in the observed reduction in the share of consumption over the summer months.

The Importance of the North Fork Eagle Creek Wells Relative to Water Supply for the Village of Ruidoso

The water supply for the Village of Ruidoso is derived from surface and ground water sources in the Rio Ruidoso and Eagle Creek drainages which are within the Hondo Basin, in the upper reaches of the Pecos River watershed. In water supply terminology, total water production is sometimes used interchangeably with the term total water diversion, to mean the total water produced or withdrawn from surface or groundwater for a water supply system. The two terms do not mean the same thing, and the recorded amounts are not always equal, thus, use of these terms interchangeably is not accurate.

Water production is always measured at the end of a treatment system, prior to release to the public as potable water. Water diversions may be measured at any number of locations: lake or stream intake structures, interim raw water meters, or at the raw intake meter at the beginning of a treatment plant. Measurement differences between the two terms include process uses through the plants, including backwash water and other uses between the measurements. Also, depending upon location of the raw water meter, losses due to reservoir water evaporation, or reservoir leakage (which is significant for Grindstone Reservoir), or delivery line leakage (for diverted water transmission lines such as the Eagle Creek line), may also account for differences between the water as measured for diversion and the water as measured for production (Wilson and Company 2005).

Since the share of production from the North Fork Eagle Creek wells cannot be determined, their importance is measured relative to total water diversion. As discussed above, water diversion estimates depend upon the location of measurement and are subject to variation based on leakage and other losses. Therefore, diversion as reported and adjusted diversion estimates are presented below in order to establish a range of values for use in estimating the contribution from the North Fork Eagle Creek wells to total water diversion for the applicant.

Adjusted diversion estimates are available from Wilson and Company 2005. They report values adjusted for volume adjustments in Grindstone and Alto Reservoirs due to net filling or withdrawal from raw water reservoirs. In addition their adjusted estimates consider unaccounted leakage through Grindstone Dam. Figure 15 shows that over the period of available data from 1998 to 2004, adjusted diversion ranged from a high of 2,656 acre-feet in 1999 to a low of 1,901 in 2003 and averaged 2,248 acre-feet.

Estimates of diversion as reported are also available from Wilson and Company 2005. Figure 15 shows that over the period of available data from 1998 to 2004, diversion as reported from Wilson and Company ranged from a high of 2,842 acre-feet in 2001 to a low of 1,793 in 2003 and averaged 2,261 acre-feet.

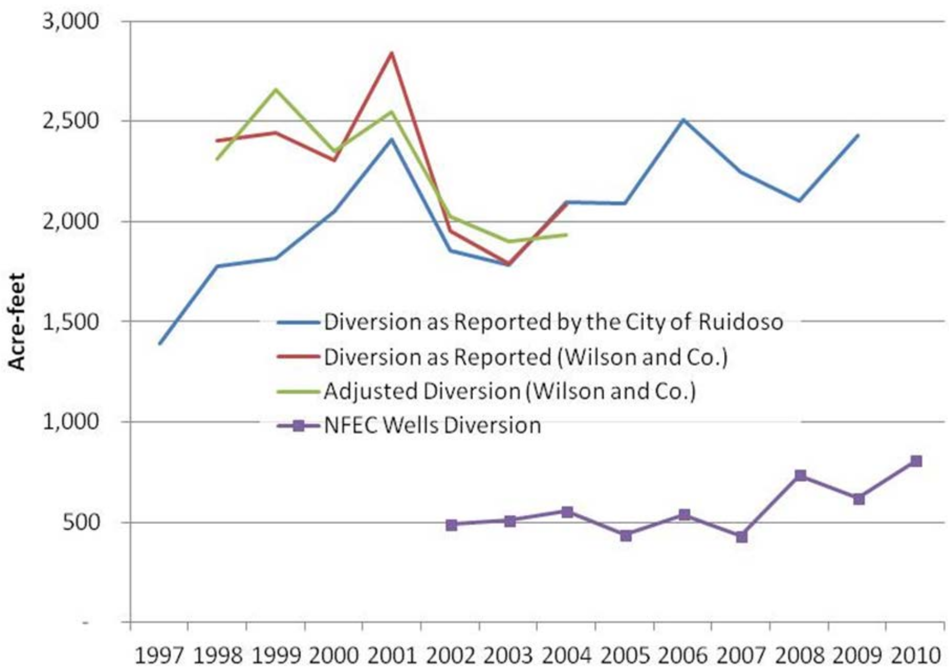

Figure 15. Diversion estimates

A second source of diversion as reported was made available by the Village of Ruidoso for the period from 1997 to 2009. Figure 15 shows that over this period, diverted water ranged from a high of 2,506 acre-feet in 2006 to a low of 1,394 in 1997 and averaged 2,043 acre-feet.

Diversion data specific to the North Fork Eagle Creek wells are available for the period from 2002 to 2010, based on data obtained in preparation of the Water Resources Report (AECOM 2012). Over this period diversion from these wells has averaged 569 acre-feet per year, has not fallen below 433 acre-feet per year, and has not exceeded 807 acre-feet per year. The 3 years of North Fork Eagle Creek well diversion data that overlap total diversion estimates for the Village of Ruidoso (from 2002 to 2004; figure 15) give insight on the importance of North Fork Eagle Creek wells diversion to the applicant water supply. North Fork Eagle Creek well diversion as a share of total diversion for the Village of Ruidoso varies depending on the source of total diversion data used. North Fork Eagle Creek wells diversion as a share of adjusted diversion ranges from 24 percent in 2002 to 29 percent in 2004. North Fork Eagle Creek wells diversion as a share of diversion as reported (Wilson and Co. 2005) ranges from 25 percent in 2002 to 27 percent in 2004. Lastly, North Fork Eagle Creek wells diversion from diversion as reported by the Village of Ruidoso ranges from 26 percent in 2002 to 27 percent in 2004. Considering these three sources of total diversion for the Village of Ruidoso, North Fork Eagle Creek wells diversion has contributed from 24 to 29 percent of Village of Ruidoso water supply over the period of available data (2002 to 2004). In addition, indirect diversion attributable to North Fork Eagle Creek wells from the 50 percent return flow credit[10] adds to the Village of Ruidoso water supply contribution.

[10] The village receives a 50 percent return flow credit for all water produced from the North Fork well field. The return flow credit is the result of at least 50 percent of the water diverted from the North Fork well field being returned to the Rio Ruidoso via the village's wastewater treatment plant. The return flow credit allows the village to divert 50 percent of the total quantity of water produced from the North Fork well field from other wells outside of the Eagle Creek watershed or surface water from the Rio Ruidoso.

Accounting for these additional indirect contributions, North Fork Eagle Creek wells has provided 36 to 43 percent of Village of Ruidoso water supply.

Wilson and Company characterize the 5-month summer resort period as May through September in order to examine water consumption during this period. This period typically has a pattern of higher streamflows from spring snowmelt, followed by low flows in June and July, and then higher streamflows again in August and September from monsoonal rains. The recent monthly diversion data for North Fork Eagle Creek wells (from the Village of Ruidoso) indicates that from 38 to 58 percent (in 2006 and 2004, respectively) of total annual diversion from the well field has been pumped during this 5-month summer resort period. Accounting for the additional indirect contributions from the return flow credit indicates that from 57 to 87 percent of total annual diversion can be attributable to the North Fork Eagle Creek wells during the 5-month summer resort period. For the overlapping years with total municipal diversion data (2002 through 2004), the well field pumping during the 5-month summer resort period represents 11 percent (2002) to 16.6 percent (2004) of the total municipal adjusted diversion for the year.

Future Village of Ruidoso demand for adjusted diversion is projected in the 40-year water plan and considers water utility use reductions. These projections indicate 5,097 acre-feet per year will be required in 2045 and exceed existing supplies and rights, thus, additional water supply sources will be necessary (Wilson and Company 2005).

Loss of North Fork Eagle Creek well diversion has occurred as a result of the Little Bear Fire in June of 2012. The Village of Ruidoso anticipates that it will be a period of years before attenuation of wildfire effects will allow a resumption of the full use of Eagle Creek surface water, groundwater and the diversion credits for the return flow credit (Atkins 2014). This analysis assumes this attenuation will occur as stated in the “Water Resources” section: “After approximately four to eight years following the Little Bear Fire, long-term post-wildfire conditions are expected to more generally resemble the pre-wildfire hydrologic setting” (page 88 of “Water Resources” section). Thus the pre-wildfire data characterizing historic municipal water supply sources are an accurate depiction of a post-wildfire baseline useful for analysis of groundwater withdrawal limitations.

Values, Beliefs, and Attitudes

The “Village of Ruidoso’s 2010 Comprehensive Plan” lauds the area’s natural amenities such as beautiful mountains and green pines. It notes that its most important attributes are “Ruidoso’s diversity, friendliness, and quality of life for future generations” (Village of Ruidoso 2010).). In addition, in 2012 the Village council reached an agreement on a slogan that represents the vision for Ruidoso: “Ruidoso… Living in Nature’s Playground.” Thus, quality of life can certainly be considered linked to area natural amenities managed in part by the Lincoln National Forest.

A range of values were evident from public scoping comments received as part of the public involvement process for this EIS. The value of present and future water supply for the applicant was expressed. In addition, the importance of the quality of streamside recreation experience was also expressed. Specific recreational opportunities include activities such as fishing, wading, dispersed camping, and wildlife viewing, as discussed briefly in the “Recreation and Scenery” section in chapter 1. The quality of life of private landowners in the area with domestic wells potentially affected by surface water changes also deserves consideration. This range of values indicates where shared values exist and where values may conflict among community members.

This information is a fundamental part of the USDA Forest Service's social impact analysis process; it enables Agency staff to address these values (USDA Forest Service 2009).

Environmental Justice

Executive Order 12898 requires Federal agencies to "identify and address the disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low income populations." According to the Council on Environmental Quality's (CEQ) Environmental Justice Guidelines for NEPA (1997) "minority populations should be identified where either: (a) the minority population of the affected area exceeds 50 percent or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis . . . a minority population also exists if there is more than one minority group present and the minority percentage, as calculated by aggregating all minority persons, meets one of the above stated thresholds." Thus, the ethnic and racial composition of New Mexico, Lincoln County, and Ruidoso census county subdivision are of interest. The shares of 2000 population by race and ethnicity are displayed in table 14 below.[11] In the year 2010, the share of population described as white was greater than the state in Lincoln County and Ruidoso census county subdivision. In Ruidoso census county subdivision, the shares of American Indian and Alaska Natives, Asians, and Pacific Islanders were slightly greater than Lincoln County in 2010 (U.S. Department of Commerce 2010). Since the difference in shares between the different geographies is small, these differences may not be considered "meaningful" as defined by the Council on Environmental Quality. However, populations of minority groups that live outside these geographies or live within this area at different spatial scales may use the Lincoln National Forest within the project area. Thus, while the data may not reflect the presence of environmental justice populations as defined by the Council on Environmental Quality they still may exist in the area or use national forest lands in the project area. Consequently, the potential for disparate or adverse effects to minority groups are examined under socioeconomic effects of the alternatives.

Table 14. Population by race and ethnicity (2010)

	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Two or More Races	Hispanic (of any race)
United States	72.4%	12.6%	0.9%	4.8%	0.2%	6.2%	2.9%	16.3%
New Mexico	68.4%	2.1%	9.4%	1.4%	0.1%	15.0%	3.7%	46.3%
Lincoln County	85.1%	0.5%	2.4%	0.4%	0.0%	9.2%	2.5%	29.8%
Ruidoso CCD[a]	85.0%	0.5%	2.9%	0.5%	0.1%	8.9%	2.3%	29.6%

Source: U.S. Department of Commerce 2010

a – CCD = Census County Division

[11] Race and ethnicity shares do not add to 100 percent because Hispanics can be of any race.

In addition to race, concentrations of people living under the poverty level are of interest when considering the environmental justice implications of the proposed action. Council on Environmental Quality guidance on identifying low income populations states "agencies may consider as a community either a group of individuals living in geographic proximity to one another, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect." In 2012, the percent of people living in poverty in the Village of Ruidoso (13.6 percent) was less than shares in Lincoln County and the State (14.7 and 19.5 percent, respectively) (U.S. Department of Commerce 2013). Thus, the census data indicate that low income populations, as defined by the Council on Environmental Quality may not exist. However, low income populations that live outside these geographies or live within this area at different spatial scales may use the Lincoln National Forest within the project area. Thus, while the data may not reflect the presence of environmental low income populations as defined by the Council on Environmental Quality, they still may exist in the area or use National Forest System lands in the project area. Consequently, the potential for disparate or adverse effects to low income groups are examined under socioeconomic effects of the alternatives.

Environmental Consequences

Alternative 1 - No Change

Direct/Indirect Effects

Municipal Water Supply

Without limitations on groundwater withdrawal, municipal water supply, as it relates to North Fork Eagle Creek wells diversion, would not be affected under the no change alternative. Over the short term (i.e., until watershed "recovery") contributions would remain uncertain during the transitional wildfire recovery period. Over the long term (i.e., after the wildfire recovery period) watershed conditions are expected to return to approximate pre-wildfire conditions ("Water Resources" section beginning on page 88); thus, average annual contributions from North Fork Eagle Creek wells could continue to provide from 24 to 29 percent of the Village of Ruidoso water supply (see discussion above) if current trends in total diversion and North Fork Eagle Creek wells diversion continue. In addition, past trends in North Fork Eagle Creek wells diversion during this 5-month summer resort period could continue (38 to 58 percent of well field pumping in 2006 and 2004, respectively). Consideration of additional indirect contributions attributable to North Fork Eagle Creek well diversions from the 50 percent return flow credit indicate that North Fork Eagle Creek wells would continue to provide 36 to 43 percent to the municipal water supply overall, and 57 to 87 percent during the 5-month summer resort period. Based on recent available data, well field pumping during this 5-month period would represent between approximately 11 to 16.6 percent of total municipal pumping for the year. In addition, over the long-term, post-wildfire vegetative transitions in the watershed may slightly improve groundwater availability within the North Fork Eagle Creek (North Fork Eagle Creek drainage on and off Federal land) (see "Water Resources" section beginning on page 88). If this occurs, contributions to municipal water supply could be slightly greater throughout the year and during the 5-month summer resort period.

Future demand for diversion outlined in the 40-year water plan (5,097 acre-feet per year) exceed existing supplies and rights, thus, additional water supply sources are necessary (Wilson and Company 2005) regardless of actions under this EIS (for more detail see the discussion of cumulative effects under the action alternatives and mitigation measures identified under the proposed action alternative below). As noted above, current levels of North Fork Eagle Creek wells diversion could continue under this alternative and if recent average annual diversion from these wells continues, they would contribute 11 percent of the projected diversion demand for the year 2045.

Using available data from 2002-2010, annual diversion from the North Fork wells averaged 569 acre-feet per year. Using the most recent data available for 2008-2010, annual diversion averaged 721 acre-feet per year and ranged from 622 acre-feet per year in 2009 to 807 acre-feet per year in 2010 (table 15) (Water Resources Report, appendix A; AECOM 2012).

Streamside Recreation Use

Under the no change alternative, it is anticipated that over the short term (i.e., until watershed "recovery") the quality of recreation experience would remain uncertain during the transitional wildfire recovery period with uncertainty in water quantity and quality. Over the long term (i.e., after the wildfire recovery period) watershed conditions are expected to return to approximate pre-wildfire conditions ("Water Resources" section beginning on page 88); thus, streamflow quantity would be the same as experienced by recreationists in the recent past. At the Eagle Creek Gage the general duration of no surface flow days would continue to be approximately 1 to 2 weeks during average precipitation periods and approximately 8 to10 weeks during drought periods. Flows of 1.2 cubic feet per second or greater would occur between approximately 10 to 40 percent of the time (see "Water Resources" section v). Continuation of these conditions could support a lower quality streamside recreation experience compared to alternative 2 (no pumping) and the proposed action alternative since flows under these alternatives are greater than the no change alternative.

Over the long-term, springs, seeps and dependent riparian vegetation important to the quality of recreation experience would be the same as pre-wildfire conditions if current management continues under this alternative. Two springs are within the area of projected drawdown, as depicted in figure 7 and figure 8, and could be affected. Other existing groundwater modeling indicates that more extensive drawdown could occur and therefore, a number of springs and seeps in the upper North Fork drainage could be similarly affected (see water resources section earlier in this chapter). As noted in the riparian report, the instability of the channel could result in some riparian areas being buried. However, these effects could be offset by the opportunity for species such as willows to colonize new areas. In addition, the riparian report notes that water availability to riparian vegetation is not likely to be greatly changed as a result of the Little Bear Fire. This suggests that impacts to springs and seeps and the quality of recreation dependent on associated riparian vegetation could occur. Consequently alternative 2 (no pumping) and alternative 3 (proposed action) provide less of a possibility of major effects to the quality of recreation experience from impacts to springs, seeps and associated riparian vegetation.

Availability of Domestic Well Water and Water for Irrigation

Two domestic wells are within the area of projected drawdown, as depicted in figure 7 and figure 8, and could be affected (see water resources section earlier in this chapter). Since there would be no groundwater drawdown under alternative 2 (no action) and less groundwater drawdown under alternative 3 (proposed action) than the no change alternative, the potential for adverse effects to the availability of domestic well water are greatest under this alternative.

Under the no change alternative, it is anticipated that over the short term (i.e., until watershed "recovery") the availability of water for irrigation would remain uncertain during the transitional wildfire recovery period. Over the long term (i.e., after the wildfire recovery period) watershed conditions are expected to return to approximate pre-wildfire conditions (water resources section page 8); thus, streamflow quantity would be the same as experienced by agriculture users in the past. At the Eagle Creek Gage the general duration of no surface flow days would continue to be approximately 1 to 2 weeks during average precipitation periods and approximately 8 to10 weeks during drought periods. Flows of 1.2 cubic feet per second or greater would occur between approximately 10 to 40 percent of the time (see "Water Resources" section beginning on page 88).

Values, Beliefs, Attitudes

The "Village of Ruidoso's 2010 Comprehensive Plan" notes that the Village's most important attributes are "Ruidoso's diversity, friendliness, and quality of life for future generations" (Village of Ruidoso 2010). In addition, the slogan for the Village of Ruidoso's vision is: "Ruidoso… Living in Nature's Playground." Thus, quality of life can certainly be considered linked to area natural amenities managed in part by the Lincoln National Forest.

As discussed above, municipal water supply, as it relates to North Fork Eagle Creek wells diversion, would be unaffected under the no change alternative over the long term. Thus, quality of life as it relates to municipal water supply would remain unchanged under this alternative. In addition, quality of life associated with the quality of recreation experience and the availability of domestic well water would remain unchanged under this alternative. Thus, under this alternative, the Lincoln National Forest would continue to support quality of life at levels experienced currently.

Environmental Justice

The no change alternative is not expected to have a disproportionately high and adverse human health or environmental effect on minority or low income populations. As noted above, quality of life as it relates to municipal water supply, recreation opportunities, and the availability of domestic well water would remain unchanged under this alternative. Consequently, there would be no environmental justice effects.

Cumulative Effects

The Village of Ruidoso's 40-year plan has shown that future needs for water supply and water rights exceed existing supplies and rights. Future water usage projections show that the Village of Ruidoso will require 5,097.2 acre-feet per year diversion, even with existing and future utility use reductions and conservation. Existing water supplies and water rights as developed do not meet these needs (Wilson and Company 2005, pp. 1–53). With water supply uncertainty following the Little Bear Fire the Village of Ruidoso has taken steps to lease additional water rights and has increased diversion of surface and groundwater on the Rio Ruidoso (Atkins 2014). In addition to the six existing and operating wells that are supplemental to the North Fork Eagle Creek wells in the Eagle Creek basin, there are an additional 7 supplemental wells in the cumulative impact analysis area off of National Forest System lands that the Village has applied for and that could also divert the Eagle Creek water right in the future (Office of the State Engineer, personal communication, 2014). According to the Office of the State Engineer, "the Village has a pending application that will sever 700.00 acre feet from National Forest System well H-1979 and transfer said right to the surface diversions on Eagle Creek and at Alto Reservoir" (Office of the State

Engineer email, March 31, 2014). Once conditions allow for North Fork Eagle Creek well pumping to resume at pre-wildfire levels it is likely that the Village of Ruidoso will have made water supply adjustments in order to meet water supply demand. Consequently reliance on North Fork Eagle Creek well pumping may be less than depicted above. Effects on measures of dependency presented above can be considered an upper bound of potential effects. There are additional domestic wells and points of diversion for real estate developments and resorts, along the Eagle Creek drainage below the North Fork Eagle Creek well field, off of National Forest System land. Consequently the potential cumulative effects on streamflows and groundwater resources are not restricted to water uses by the Village of Ruidoso. More information on this uncertainty can be found in the water resources section under the "Cumulative Effects" section and the section "Additional Impact Information".

If the Village of Ruidoso resumes pre-wildfire levels of groundwater withdrawal, the potential for adverse cumulative effects to municipal water supply would be less under this alternative than the other alternatives. These effects would accrue in addition to effects from other actions identified in table 4 of the EIS. However, the potential for adverse cumulative economic effects to the quality of recreation experience provided by streamflow quantity, springs, and seeps would be more under this alternative than the other alternatives. Similarly, the potential for adverse cumulative economic effects to nearby domestic wells would be higher under this alternative than under the other alternatives.

Conclusion

Over the long-term (i.e after the wildfire recovery period), average annual water diversion from North Fork Eagle Creek wells could continue to provide historic contributions to the Village of Ruidoso water supply under this alternative. However, a lower quality streamside recreation experience is anticipated compared to alternative 2 (no pumping) and alternative 3 (proposed action) since additional surface flow, and improved spring and seep conditions are anticipated under alternative 2 (no pumping) and alternative 3 (proposed action). In addition, the potential for adverse effects to the availability of domestic well water are greatest under this alternative since there would be no groundwater drawdown under alternative 2 (no pumping) and less groundwater drawdown under alternative 3 (proposed action).

Alternative 2 - No Action (No Pumping)

Direct/Indirect Effects

Municipal Water Supply

Without groundwater withdrawal, the North Fork Eagle Creek wells would not provide their pre-wildfire share of Village of Ruidoso water supply (from approximately 24 to 29 percent of direct water supply and 36 to 43 percent of total water supply that considers indirect contributions from the 50 percent return flow credit; see discussion above). In addition, larger contributions from North Fork Eagle Creek wells during the 5-month summer resort period would also discontinue (38 to 58 percent in 2006 and 2004, respectively of direct water supply and 57 to 87 percent of water supply that considers indirect contributions from the 50 percent return flow credit). Additionally, without groundwater withdrawal, North Fork Eagle Creek wells could not contribute toward future Village of Ruidoso demand for diversion (5,097 acre-feet in 2045; Wilson and Company 2005).

As shown in table 15, alternative 2 would not provide any water to the applicant for municipal water supply.

Streamside Recreation Use

Under alternative 2 (no pumping), it is anticipated that over the short term (i.e., until watershed "recovery") the quality of recreation experience would remain uncertain during the transitional wildfire recovery period with uncertainty in water quantity and quality. Over the long term (i.e., after the wildfire recovery period) watershed conditions are expected to return to approximate pre-wildfire conditions (see water resources section); thus, streamflow quantity would be greater than experienced by recreationists in the recent past. At the Eagle Creek gage the occurrence of no-flow days would be limited and during average or wetter years, there may be continuous flow. Flows of 1.2 cubic feet per second or greater would occur approximately 60 percent of the time (AECOM (2012) located in the project record). These conditions could support a higher quality streamside recreation experience compared to the no change alternative and the proposed action alternative since flows under these alternatives would be less than under alternative 2 (no pumping).

Over the long-term, springs, seeps, and dependent riparian vegetation important to the quality of recreation experience would at least be maintained, and could be improved, over pre-fire conditions under this alternative, as described in more detail in the water resources and riparian vegetation sections earlier in this chapter. In addition, in the absence of pumping, post-wildfire vegetative transition could result in enhanced aquatic habitats and additional opportunities for improving riparian conditions ("Water Resources" section beginning on page 88). Thus, alternative 2 (no pumping) provides the least possibility of detrimental effects to the quality of recreation experience from impacts to springs, seeps, and associated riparian vegetation since no withdrawals would occur.

Availability of Domestic Well Water and Water for Irrigation

Two domestic wells are within the area of projected drawdown, as depicted in figure 7 and figure 8, and could be affected (see water resources section earlier in this chapter). Since there would be no groundwater drawdown under alternative 2 (no pumping), there would be no adverse effects from pumping on the availability of domestic well water.

Under alternative 2 (no pumping), it is anticipated that over the short term (i.e., until watershed "recovery") the availability of water for irrigation would remain uncertain during the transitional wildfire recovery period. Over the long term (i.e., after the wildfire recovery period) watershed conditions are expected to return to approximate pre-wildfire conditions ("Water Resources" section beginning on page 88); thus, streamflow quantity would be greater than experienced by agriculture users in the past. At the Eagle Creek Gage the occurrence of no flow days would be limited and during average or wetter years, there may be continuous flow. Flows of 1.2 cubic feet per second or greater would occur approximately 60 percent of the time (Water Resources Report; AECOM 2012). These conditions could support a higher quantity of water for irrigation uses compared to the no-change alternative and the proposed action alternative since flows under these alternatives would be less than under alternative 2 (no pumping).

Values, Beliefs, Attitudes

As discussed above, North Fork Eagle Creek wells diversion would no longer contribute to municipal water supply under alternative 2 (no pumping). Thus, quality of life as it relates to municipal water supply would be less than experienced before the wildfire under the no change alternative and less than under alternative 3 (proposed action). However, quality of life associated with the quality of recreation experience and the availability of domestic well water would be greater than the other alternatives. Thus, under alternative 2 (no pumping), the Lincoln National Forest would continue to support quality of life to the area community but less than supported before the wildfire from municipal water supply and more in terms of the quality of recreation experience and the availability of domestic well water.

Environmental Justice

Alternative 2 (no pumping) is not expected to have a disproportionately high and adverse human health or environmental effect on minority or low income populations. While adverse effects to total municipal water diversions are anticipated, they are expected to be distributed amongst all segments of the Village of Ruidoso population since water diversion from the North Fork Eagle Creek wells cannot be attributed to supply certain areas of the Village of Ruidoso. Consequently, effects to these communities cannot be considered disparate since effects would occur to communities regardless of racial, ethnic, or poverty status. However, low-income populations are more vulnerable to total municipal water diversions due to possible increases in the financial cost of water.

Cumulative Effects

Regardless of pumping restrictions under this EIS, the Village of Ruidoso 40-year plan has shown that future Ruidoso needs for water supply and water rights exceed existing supplies and rights. Future water usage projections show that the Village of Ruidoso will require 5,097.2 acre-feet per year diversion, even with existing and future utility use reductions and conservation. Existing water supplies and water rights as developed do not meet these needs (Wilson and Company 2005 pp. 1–53). With water supply uncertainty following the Little Bear Fire the Village of Ruidoso has taken steps to lease additional water rights and has increased diversion of surface and groundwater on the Rio Ruidoso (Atkins 2014). In addition to the six existing and operating wells that are supplemental to the North Fork Eagle Creek wells in the Eagle Creek basin, there are an additional 7 supplemental wells in the cumulative impact analysis area off of National Forest System lands that the Village has applied for and that could also divert the Eagle Creek water right in the future (Office of the State Engineer, personal communication, 2014). According to the Office of the State Engineer, “the Village has a pending application that will sever 700.00 acre feet from NF well H-1979 and transfer said right to the surface diversions on Eagle Creek and at Alto Reservoir (Office of the State Engineer email, March 31, 2014). Once conditions allow for North Fork Eagle Creek well pumping to resume at pre-wildfire levels it is likely that the Village will have made water supply adjustments in order to meet water supply demand. Consequently reliance on North Fork Eagle Creek well pumping may be less than depicted above. Effects on measures of dependency presented above can be considered an upper bound of potential effects. There are additional domestic wells and points of diversion, for real estate developments and resorts, along the Eagle Creek drainage below the North Fork Eagle Creek well field, off of National Forest System land. Consequently the potential cumulative effects on streamflows and groundwater resources are not restricted to water uses by the Village of Ruidoso. More information on this uncertainty can be found in the water resources section under the cumulative effects section (page 8) and the section “Additional Impact Information” (“Water Resources” section page 88).

Without groundwater withdrawal, the potential for adverse cumulative effects to municipal water supply would be greater under this alternative than the other alternatives. These effects would accrue in addition to effects from other actions (as identified in table 5). However, the potential for adverse cumulative economic effects to the quality of recreation experience provided by streamflow quantity, springs, and seeps would be less under this alternative than the other alternatives. Similarly, the potential for adverse cumulative economic effects to nearby domestic wells would be less under this alternative than under the other alternatives.

Conclusion

Without groundwater withdrawal, the North Fork Eagle Creek wells would not continue to provide their pre-wildfire share of Village of Ruidoso water supply (from approximately 24 to 29 percent of direct water supply and 36 to 43 percent of total water supply that considers indirect contributions from the 50 percent return flow credit; see discussion above). In addition, larger contributions from North Fork Eagle Creek wells during the 5-month summer resort period would also discontinue (38 to 58 percent in 2006 and 2004, respectively, of direct water supply and 57 to 87 percent of water supply that considers indirect contributions from the 50 percent return flow credit). Additionally, without groundwater withdrawal, North Fork Eagle Creek wells could not contribute toward future Village of Ruidoso demand for diversion (5,097 acre-feet in 2045; Wilson and Company 2005). However, the potential for adverse effects to the quality of recreation experience provided by streamflow quantity, springs, and seeps would be less under this alternative than the other alternatives. Similarly, the potential for adverse effects to nearby domestic wells would be less than under the other alternatives.

Alternative 3 - Proposed Action
Direct/Indirect Effects

Municipal Water Supply

Over the short term (i.e., until watershed "recovery") management triggers would be most generally enacted during dry years under this alternative. During average or wet years, management triggers would be enacted much less frequently. The exact effect on contributions to municipal water supply is uncertain since the Village of Ruidoso anticipates that it will be a period of years before attenuation of wildfire effects will allow a resumption of the full use of Eagle Creek surface water, groundwater and the diversion credits for the return flow credit (Atkins 2014).

Over the long term (i.e., after the wildfire recovery period) watershed conditions are expected to return to approximate pre-wildfire conditions ("Water Resources" section beginning on page 88). With restrictions on groundwater withdrawal under this alternative, the North Fork Eagle Creek wells would not provide their pre-wildfire share of Village of Ruidoso water supply (from approximately 24 to 29 percent of direct water supply and 36 to 43 percent of total water supply that considers indirect contributions from the 50 percent return flow credit; see discussion above). Restrictions under this alternative would decrease the amount of water the village could withdraw by limiting the pumping rate to 50 percent of the streamflow reported at the North Fork gage. Using pre-wildfire data of surface flow during years where restrictions would have occurred provides a frame of reference for forgone water diversion (see methods discussion above). As an example using recent historical data, over the range of restrictions, the forgone water diversion due to withdrawal restrictions could reduce the contribution of North Fork Eagle Creek wells to approximately 23 to 25 percent of the recent total Village of Ruidoso diversions under alternative

3 (proposed action). Consideration of additional indirect contributions attributable to North Fork Eagle Creek well diversions from the 50 percent return flow credit indicate that North Fork Eagle Creek wells would continue to provide 34.5 to 37.5 percent to the municipal water supply.

Over the long term, if restrictions occurred during the 5-month summer resort period, the share of summer contributions from total annual diversion from North Fork Eagle Creek wells (38 to 58 percent of annual well field pumping in 2006 and 2004, respectively, of direct water supply and 57 to 87 percent of water supply that considers indirect contributions from the 50 percent return flow credit) would also be less. Over the range of hypothetical pre-wildfire restrictions, the forgone water diversion due to withdrawal restrictions could reduce the share of summer resort contribution to between 25 and 57 percent of total annual well field withdrawal under alternative 3 (proposed action). Consideration of additional indirect contributions attributable to North Fork Eagle Creek well diversions from the 50 percent return flow credit indicate that North Fork Eagle Creek wells would continue to provide 37.5 to 85.5 percent during the 5-month summer resort period.

Restrictions on groundwater withdrawal from North Fork Eagle Creek wells would minimally reduce contributions toward future Village of Ruidoso demand for diversion (5,097 acre-feet in 2045; Wilson and Company 2005). Based on recent data, for example, the forgone water diversion due to withdrawal restrictions would negligibly reduce contributions to projected annual demand by 0.1 to 1.3 percent.

In order to determine generalized impacts to average annual diversion from implementing alternative 3 (proposed action) compared to alternative 1 (no change), pre-wildfire data available (from September 2007 to November 2011) were used. Based on this analysis, as shown in table 15, annual diversion from the North Fork wells in the future would likely be less under alternative 3 (proposed action) than that provided under alternative 1 (no change). If the adaptive management approach proposed under alternative 3 (proposed action) were applied to the years 2008–2011, annual diversion under alternative 3 (proposed action) would have ranged from 300 acre-feet per year (or more) to less than 50 acre-feet per year; this would have varied by year due to whether it was a wet or dry year and how the adaptive management triggers were implemented. Annual diversion from the North Fork wells in the future would be the least under alternative 2 (no pumping).

Based on implementing the no-flow day restriction at the pre-wildfire Eagle Creek gage under alternative 3 (proposed action), pumping reductions would likely range from 6.5 acre-feet per year to 66.5 acre-feet per year, if similar conditions occurred in the long term as the pre-wildfire years used in the analysis (see “Water Resources” section of this chapter for more information); or would provide approximately 88–98 percent of the applicant’s current average annual diversion (using a 569 acre-feet per year average for current levels). This is considered a reasonable range of estimated reductions from implementing the flow condition triggers, which are the primary proposed management tool under the proposed action.

However, there may be further reductions based on cumulative pumping volumes and water table triggers, as described in the “Adaptive Management” section of the alternative 3 (proposed action) description in chapter 2. Under adaptive management, these reductions would likely vary over time according to USDA Forest Service review, different pumping strategies, monitoring results, and hydrologic conditions. Under some circumstances, additional triggers could be applied to maintain the flow system, whereas under other conditions only the flow triggers (the primary management tool) would be applied.

Table 15. Summary of available water (acre-feet per year) per alternative, based on available past data (for alternative 1, this is actual pumping data)

Year	Alternative 1 (no change)	Alternative 2 (no action)	Alternative 3 (proposed action)[a]
2008	735	0	300
2009	622	0	300
2010	807	0	300
2011	not currently available	0	47
Average	721 (2008-2010) 569 (2002-2010)	0	236
Contribution to existing average annual Village of Ruidoso diversion	100%	0%	88–98 percent if only no-flow day triggers used, as described on page 125 8–53 percent if no-flow day and pumping volume triggers used, as shown above 42 percent average

a – It is important to note that the adaptive management triggers in the proposed action are written to provide flexibility in implementing restrictions on pumping; this analysis used the 900 acre-feet per year over 3 years or 300 acre-feet per year trigger as its starting point. If only the no-flow days trigger was used, these volumes would likely have been substantially higher and would only have reduced pumping volume from 6.5 to 66.5 acre-feet per year compared to alternative 1; projecting these results into the future should be viewed as a maximum reduction; available water to the applicant may be higher.

Assuming the 300 acre-feet per year adaptive management trigger was implemented combined with the flow condition triggers (or 900 acre-feet per year over 3 years) during 2008–2011, average annual diversions would have been reduced over actual diversions (table 15); under this scenario, alternative 3 (proposed action) would have contributed an average of 236 acre-feet per year, or between 8 and 53 percent (42 percent average) to the applicant's average annual diversion.

As shown, if available pre-wildfire data are indicative of future years, implementing alternative 3 (proposed action) could measurably limit the water available for applicant pumping through implementation of adaptive management triggers, and these limits would likely be greatest during dry years (such as 2011). However, all of the adaptive management triggers proposed are designed to be used in concert with each other and to be flexible so that a balance between providing water and protecting resources is met. In addition, over the long term, post-wildfire vegetative transitions in the watershed may slightly improve groundwater availability within the North Fork Eagle Creek (North Fork Eagle Creek drainage on and off National Forest System land) (see "Water Resources" section beginning on page 88). If this occurs, contributions to municipal water supply could be slightly greater throughout the year and during the 5-month summer resort period. This should be considered a maximum reduction scenario, based on limited data available from pre-wildfire years, and should therefore be used with caution. It is possible that available water could be higher than shown here.

Streamside Recreation Use

Under alternative 3 (proposed action), it is anticipated that over the short term (i.e., until watershed “recovery”) the quality of recreation experience would remain uncertain during the transitional wildfire recovery period with uncertainty in water quantity and quality. Over the long term (i.e., after the wildfire recovery period) watershed conditions are expected to return to approximate pre-wildfire conditions (“Water Resources”section beginning on page 88); thus, streamflow quantity would be greater than pre-wildfire levels. In addition, streamflow quantity under this alternative would be less than under no pumping alternative. By limiting pumping the aquifer water level recovery times would decrease leading to a decrease in the duration of no surface flow periods (Water Resources Report; AECOM 2012). Consequently, these conditions could support a higher quality streamside recreation experience compared to the no change alternative but lower quality than alternative 2 (no pumping).

Over the long-term springs, seeps and dependent riparian vegetation important to the quality of recreation experience could be improved over pre-fire conditions under this alternative. Two springs are within the area of projected drawdown, as depicted in figure 7 and figure 8 and could be affected. However, the decreased drawdown and shorter water-level recovery times predicted under this alternative would also decrease the potential for impacts to springs and seeps, compared to alternative 1 (see water resources section earlier in this chapter). In addition, post-wildfire vegetative transition along with pumping restrictions could result in enhanced aquatic habitats and additional opportunities for improving riparian (water resources section). Thus, alternative 3 (proposed action) provides the less detrimental effects to the quality of recreation experience from impacts to springs, seeps and associated riparian vegetation than the no-change alternative but more detrimental effects than alternative 2 (no pumping). According to the riparian report, change in effects are expected to be the same as those described in alternative 1, except that any positive benefit from increased availability of water to riparian vegetation and therefore recreation would be greater in magnitude in alternative 3.

Availability of Domestic Well Water and Water for Irrigation

Two domestic wells are within the area of projected drawdown as depicted on figures 7a and 7b, and could be affected. However, the decreased drawdown and shorter water-level recovery times predicted under this alternative would also decrease the potential for impacts to these wells, compared to alternative 1 (see water resources section earlier in this chapter). The potential for adverse effects are still greater though, than under alternative 2 (no pumping).

Under alternative 3 (proposed action), it is anticipated that over the short term (i.e., until watershed “recovery”) the availability of water for irrigation would remain uncertain during the transitional wildfire recovery period. Over the long term (i.e., after the wildfire recovery period) watershed conditions are expected to return to approximate pre-wildfire conditions (see “Water Resources” section); thus, streamflow quantity would be greater than pre-wildfire levels. In addition, streamflow quantity under this alternative would be less than under the no pumping alternative. By limiting pumping the aquifer water level recovery times would decrease leading to a decrease in the duration of no surface flow periods (Water Resources Report; AECOM 2012). Consequently, these conditions could support a higher quantity of water for irrigation uses compared to the no-change alternative but lower quantity than alternative 2 (no pumping).

Values, Beliefs, Attitudes

As discussed above under alternative 3 (proposed action), it is anticipated that North Fork Eagle Creek wells diversion would contribute less to municipal water supply than currently. Thus quality of life as it relates to municipal water supply would be less before the wildfire. However, quality of life associated with the quality of recreation experience and the availability of domestic well water would increase under this alternative relative to the current situation. Thus, under this alternative, the Lincoln National Forest would continue to support quality of life to the area community; less than supported before the wildfire from municipal water supply and more in terms of the quality of recreation experience and the availability of domestic well water.

Environmental Justice

Alternative 3 (proposed action) is not expected to have a disproportionately high and adverse human health or environmental effect on minority or low income populations. While adverse effects to total municipal water diversions are anticipated, they are expected to be distributed amongst all segments of the Village of Ruidoso population since water diversion from the North Fork Eagle Creek wells cannot be attributed to supply certain areas of the Village of Ruidoso. Consequently, effects to these communities cannot be considered disparate since effects would occur to communities regardless of racial, ethnic, or poverty status. However, low-income communities could be more adversely affected if rates for water increase.

Cumulative Effects

Regardless of pumping restrictions under this EIS, the Village of Ruidoso 40-year plan has shown that future Ruidoso needs for water supply and water rights exceed existing supplies and rights. Future water usage projections show that Ruidoso will require 5,097.2 acre-feet per year diversion, even with existing and future utility use reductions and conservation. Existing water supplies and water rights as developed do not meet these needs (Wilson and Company 2005 pp. 1–53). With water supply uncertainty following the Little Bear Fire the Village of Ruidoso has taken steps to lease additional water rights and has increased diversion of surface and groundwater on the Rio Ruidoso (Atkins 2014). In addition to the six existing and operating wells that are supplemental to the North Fork Eagle Creek wells in the Eagle Creek basin, there are an additional 7 supplemental wells in the cumulative impact analysis area off of National Forest System lands that the Village has applied for and that could also divert the Eagle Creek water right in the future (Office of the State Engineer, personal communication, 2014). According to the Office of the State Engineer, “the Village has a pending application that will sever 700.00 acre feet from NF well H-1979 and transfer said right to the surface diversions on Eagle Creek and at Alto Reservoir” (Office of the State Engineer email, March 31, 2014). Once conditions allow for North Fork Eagle Creek well pumping to resume at pre-wildfire levels it is likely that the Village of Ruidoso will have made water supply adjustments in order to meet water supply demand. Consequently effects on measures of dependency presented above can be considered an upper bound of potential effects. There are additional domestic wells and points of diversion, for real estate developments and resorts, along the Eagle Creek drainage below the North Fork Eagle Creek well field, off of National Forest System land. Consequently the potential cumulative effects on streamflows and groundwater resources are not restricted to water uses by the Village of Ruidoso. More information on this uncertainty can be found under the “Cumulative Effects” and “Additional Impact Information” headings in the “Additional Impact Information” section.

With restrictions on groundwater withdrawal under this alternative, the potential for adverse cumulative economic effects to municipal water supply would be greater under this alternative than under the no change alternative but less than alternative 2 (no pumping). These effects would accrue in addition to effects from other actions identified in table 5 of the EIS. The potential for adverse cumulative economic effects to the quality of recreation experience provided by streamflow quantity, springs, and seeps would be less under this alternative than under the no change alternative but more than alternative 2 (no pumping). In addition, the potential for adverse cumulative economic effects to nearby domestic wells would be less under this alternative than under the no change alternative but more than alternative 2 (no pumping).

Conclusion

With restrictions on groundwater withdrawal under alternative 3 (proposed action), the North Fork Eagle Creek wells would not provide their pre-wildfire share of Village of Ruidoso water supply (from 24 to 29 percent of direct water supply and 36 to 43 percent of total water supply that considers indirect contributions from the 50 percent return flow credit; see discussion above). As an example using pre-wildfire data, over the range of restrictions, the forgone water diversion due to withdrawal restrictions could reduce the contribution of North Fork Eagle Creek wells to approximately 23 to 25 percent of the recent total Village of Ruidoso diversions under alternative 3. Consideration of additional indirect contributions attributable to North Fork Eagle Creek well diversions from the 50 percent return flow credit indicate that North Fork Eagle Creek wells would continue to provide 34.5 to 37.5 percent to the municipal water supply. The potential for effects to forgone water diversion is greater during the 5-month summer resort period (38 to 58 percent of annual well field pumping in 2006 and 2004, respectively of direct water supply and 57 to 87 percent of water supply that considers indirect contributions from the 50 percent return flow credit). Over the range of hypothetical pre-wildfire restrictions, the forgone water diversion due to withdrawal restrictions could reduce the share of summer resort contribution to between 25 and 57 percent of total annual well field withdrawal. Consideration of additional indirect contributions attributable to North Fork Eagle Creek well diversions from the 50 percent return flow credit indicate that North Fork Eagle Creek wells would continue to provide 37.5 to 85.5 percent during the 5-month summer resort period. Municipal water supply would be greater under this alternative than the no pumping alternative and streamflow quantity under this alternative would be less than under the no pumping alternative.

Over the long term, post-wildfire vegetative transitions in the watershed may slightly improve groundwater availability within the North Fork Eagle Creek (North Fork Eagle Creek drainage on and off National Forest System land) (see “Water Resources” section). If this occurs, contributions to municipal water supply could be slightly greater throughout the year and during the 5-month summer resort period. In addition to the six existing and operating wells that are supplemental to the North Fork Eagle Creek wells in the Eagle Creek basin, there are an additional 7 supplemental wells in the cumulative impact analysis area off of National Forest System lands that the Village has applied for and that could also divert the Eagle Creek water right in the future (Office of the State Engineer, personal communication, 2014). According to the Office of the State Engineer, “the Village has a pending application that will sever 700.00 acre feet from NF well H-1979 and transfer said right to the surface diversions on Eagle Creek and at Alto Reservoir (Office of the State Engineer email, March 31, 2014). Once conditions allow for North Fork Eagle Creek well pumping to resume at pre-wildfire levels it is likely that the Village will have made water supply adjustments in order to meet water supply demand. Consequently reliance on North Fork Eagle Creek well pumping may be less than depicted above. Effects on measures of dependency presented above can be considered an upper bound of potential effects. Thus, this should be considered the maximum reduction to municipal water supply contributions.

The potential for adverse effects to the quality of recreation experience provided by streamflow quantity, springs, and seeps would be less under this alternative than under the no change alternative but more than alternative 2 (no pumping). In addition, the potential for adverse effects to nearby domestic wells would be less under this alternative than under the no change alternative but more than alternative 2 (no pumping).

Summary

Implementing alternative 1 (no change) or alternative 3 (proposed action) would both achieve the first need statement for this project which is “authorizing, under a special use permit, the applicant’s ability to access and divert groundwater from its North Fork Eagle Creek wells on National Forest System land, as a substantial component of the municipal water supply system that Ruidoso residents and visitors rely upon.” Because both alternatives would continue to provide water to the Village of Ruidoso and would, therefore, continue to contribute to the municipal water supply, they meet the intent of this need statement. However, alternative 3 (proposed action) may not provide the pre-wildfire share of water as would alternative 1 (no action) (from approximately 24 to 29 percent of direct water supply and 36 to 43 percent of total water supply that considers indirect contributions from the 50 percent return flow credit; see discussion above). Regardless the discussion above notes that when additional indirect contributions attributable to the 50 percent return flow credit are considered under alternative 3, North Fork Eagle Creek wells would continue to provide 37.5 to 85.5 percent of municipal water supply during the 5-month summer resort period. Alternative 2 (no pumping) does not address this need statement and would not provide any contribution to the municipal water supply. Over the long term, post-wildfire vegetative transitions in the watershed may slightly improve groundwater availability within the North Fork Eagle Creek (North Fork Eagle Creek drainage on and off National Forest System land) (see “Water Resources”section). If this occurs, contributions to municipal water supply could be slightly greater throughout the year and during the 5-month summer resort period. In addition to the six existing and operating wells that are supplemental to the North Fork Eagle Creek wells in the Eagle Creek basin, there are an additional 7 supplemental wells in the cumulative impact analysis area off of National Forest System lands that the Village has applied for and that could also divert the Eagle Creek water right in the future (Office of the State Engineer, personal communication, 2014). Once conditions allow for North Fork Eagle Creek well pumping to resume at pre-wildfire levels it is likely that the Village of Ruidoso will have made water supply adjustments in order to meet water supply demand. Consequently reliance on North Fork Eagle Creek well pumping may be less than depicted above. Effects on measures of dependency presented above can be considered an upper bound of potential effects. Thus, this should be considered a maximum reduction to municipal water supply contributions.

While the short-term effects of implementing alternatives 1, 2 and 3 to other aspects of the socioeconomic analysis (streamside recreational use; domestic wells and water for irrigation; values, attitudes and beliefs; and environmental justice) are uncertain during the watershed recovery period following the Little Bear Fire, the long-term effects are the same as those described above for each alternative for the pre-wildfire assessment.

The socioeconomic principles and goals listed above illustrate the need for the Lincoln National Forest to adopt a management alternative that adequately responds to changing human conditions and demands while also supporting multiple uses and sustained yield. Alternative 3 (proposed action) moves towards the above forest plan goals to the greatest extent, compared to the other alternatives. The no change and no pumping alternatives (1 and 2) do not address the intent of the forest plan as well as the proposed action. Alternative 2 (no pumping) meets the second goal to "Secure and provide an adequate supply of water for the protection and management of the Forest" but does not go as far towards meeting the forest plan as the proposed action in regards to other goals to "Use land ownership adjustment to accomplish resource management objectives and respond to public needs" and "Provide opportunities to satisfy local demand for Forest resources" (USDA Forest Service 1986).

Water Rights

The purpose of this section is to discuss the applicant's water rights in the context of the proposed alternatives. The issues related to reissuance of a special use permit to the applicant to continue pumping from wells located on National Forest System lands includes the beneficial use of the Village of Ruidoso's adjudicated water rights. This section provides a brief overview of the Village of Ruidoso's existing water rights and discusses water rights in the context of each alternative.

Methodology

Well pumping results in changes in the dynamics of groundwater and surface water. Surface water and groundwater availability are linked and are limited not only by accessible available quantities of water, but also by available water rights. Limiting access to groundwater pumping has the potential to alter municipal water supply and affect beneficial use of the Village of Ruidoso's total adjudicated water rights.

The North Fork Eagle Creek wells along Eagle Creek draw water in the amounts associated with the right that is attributable to each well. Changes to the amount of groundwater withdrawal by the North Fork Eagle Creek wells could potentially impact the Village of Ruidoso's timely beneficial use of the water rights tied to each well. The alternatives will be compared using the following measurement indicator:

- Beneficial use of the Village of Ruidoso's adjudicated water rights

Affected Environment

The "Water Rights Report" (Thompson 2012 and 2014) is available in the project record and includes an overview of water rights in New Mexico and a detailed history of the Village of Ruidoso's water rights. This report is incorporated by reference, discussed briefly below, and available in its entirety in the project record. The glossary also provides some of the more commonly-used terms related to water rights.

Except for Federal Reserved Rights, the Federal Government defers to state law in the allocation of water on public lands. The Federal government recognizes those water rights on public lands that were perfected according to state law [California Oregon Power Co. v. Beaver Portland Cement Co. (S.Ct.1935)].

New Mexico follows the prior appropriation doctrine. Central to New Mexico's definition of prior appropriation is that all appropriated waters must be put to beneficial use, and that priority shall give the better right. Beneficial use is the basis, the measure, and the limit of the right. The state's water law is found in New Mexico Statutes Chapter 72. The Office of State Engineer, appointed by the Governor and confirmed by the State Senate has broad authority over New Mexico's distribution of the State's water. The State Engineer is responsible for supervising the state's water resources through the appropriation and distribution of all of the state's surface and groundwater. The State Engineer is also secretary for the Interstate Stream Commission, which is responsible for investigating, protecting, conserving, and developing New Mexico's water supply.

Water rights in New Mexico can be held by any entity except by the State Engineer. A water right can be severed from the land through an application to the Office of the State Engineer. Water rights can also be transferred from one entity to another, but a change application must be filed and approved by the Office of the State Engineer. Water rights are also considered real property and may be bought or sold and can be conveyed as part of a piece of real property or it can be severed from the land and sold separately. New Mexico's surface water code was created in 1907 and when it became a state in 1912, the new constitution adopted the prior appropriation doctrine. Any appropriation of surface water initiated on or after March 19, 1907 requires a valid permit issued by the State Engineer. Since March 29, 1907, New Mexico has considered most surface water in the state to be fully appropriated, so most recent water rights are attributable to groundwater.

The New Mexico groundwater code was enacted in 1931. The groundwater code specifies the administrative procedures for processing any application of new groundwater, to change the place of use or purpose of use of an existing groundwater right, to change the location of a well, to add a supplemental well, or to drill a replacement well. However, groundwater use and development can only be administered by the Office of the State Engineer in basins that have been declared to have reasonably ascertainable boundaries. The Office of the State Engineer can close declared basins in order to limit future use and prevent impairment of existing uses.

Table 16. 2009 Consent order between the applicant and Office of the State Engineer for the four North Fork Eagle Creek wells

Well Number	2009 Final Adjudication	Applicant's Municipal Right[a] to Additional af/yr Subject to Proof of Beneficial Use on 12/31/2024[b]	Total af/yr Combined Final Adjudication and Municipal Right Still Subject to Proof of Beneficial Use[c]
H-1979 (North Fork Well 1)	700.83	350.42	1,051.25
H-1980 (North Fork Well 2)	46.77	23.39	70.16
H-1981 (North Fork Well 3)	550.71	275.36	826.07
H-1982 (North Fork Well 4)	394.57	197.29	591.86
TOTAL	1,692.88	846.46	2,539.34

a – NMSA 72-1-9 allows municipalities a water use planning period not to exceed 40 years, in which water rights can be developed based on the water development plan.

b – The applicant can pump this amount now or wait to pump as long as they show beneficial use before December 31, 2024.

c – This is the maximum amount the applicant can ever pump from each well.

Surface and groundwater can be hydrologically connected. Conjunctive water use recognizes this typical connection and tries to utilize it to more efficiently manage the water supply. Conjunctive management of both surface water and groundwater has been established by judicial affirmation in a case known as City of Albuquerque v. Reynolds (1962). The New Mexico Supreme Court recognized the statutory authority of the State Engineer to conjunctively administer hydrologically connected surface and groundwater.

In 2010, a consent order was negotiated with the Village of Ruidoso and the Office of the State Engineer to more accurately define the Village of Ruidoso's water rights in Eagle Creek. This subfile order adjudicates the groundwater rights wells (H-1979 through H-1982) in the total combined amount of 1,692.88 acre-feet per year at each respective point of diversion and also recognizes the Village of Ruidoso's right to place an additional 846.46 acre-feet per year into use subject to filing of proof of beneficial use by December 31, 2024. This consent order is the Village of Ruidoso's adjudicated water rights as of 2014. This water rights summary is shown below in table 16 and in figure 6 earlier in this chapter.

The 2010 Consent Order also discusses the Village of Ruidoso's surface rights along Eagle Creek (located off National Forest System lands and adjudicated in subfile R.33) and the separate relationship with the North Fork wells. The surface diversion can be combined with supplemental water pumped from the North Fork wells to satisfy the Village of Ruidoso's surface water rights along Eagle Creek. This surface water right and supplemental groundwater pumped from the North Fork wells is in addition to and separate from the Village of Ruidoso's groundwater rights discussed in the previous section. Therefore, an additional 761.12 acre-feet per year could be pumped from the National Forest System wells as supplemental to the Village of Ruidoso's surface water rights. This combined surface diversion and groundwater from the North Fork wells is illustrated in the following table.

Table 17. 2010 Consent Order Surface and Groundwater Rights Combined. (The surface diversion and supplemental groundwater can be combined at any rate by any withdrawal method (surface or ground)

Diversion	Amount[a]	Location
Surface Diversion	combined	Off National Forest System lands
Surface Diversion	combined	Off National Forest System lands
H 1497	combined	Off National Forest System lands
H 1497-S	combined	Off National Forest System lands
H-1979	combined	North Fork Eagle Creek -National Forest System lands
H-1980	combined	North Fork Eagle Creek -National Forest System lands
H-1981	combined	North Fork Eagle Creek -National Forest System lands
H-1982	combined	North Fork Eagle Creek -National Forest System lands
H-1979-S	combined	Off National Forest System lands
H-1979-S2	combined	Off National Forest System lands
H-1979-S3	combined	Off National Forest System lands
H-1979-S7	combined	Off National Forest System lands
Total	761.12	

a - Withdrawal is based on priority, but the amounts can be diverted from any combination of surface or groundwater. There is not an attributable amount to each individual withdrawal method (surface or groundwater).

The priority dates for the surface diversion listed in table 17 are shown below:

Priority and Amount
1882 for 91.435 af/yr
1883 for 257.01 af/yr
1884 for 21.72 af/yr
1885 for 94.115 af/yr
1887 for 10.86 af/yr
1894 for 39.82 af/yr
1895 for 50.675 af/yr
1896 for 47.055 af/yr
1902 for 36.2 af/yr
July 9, 1913 for 112.23 af/yr

In addition to the 2010 consent order, the Village of Ruidoso has several pending applications with the Office of the State Engineer (State of New Mexico, Office of the State Engineer, personal communication, September 2014) that could affect groundwater and surface water withdrawal along Eagle Creek. These applications are enumerated below:

- The Village filed an application to make wells H-1497 and H-1497-S supplemental to H-1979, H-1980, H-1981 and H-1982. In that application, the Village requested that pumping from H-1497 and H-1497-S be limited to 300 acre-feet per year for each well.
- The Village then filed an application to add wells H-1979-S-10, H-1979-S-11, H- 1979-S-12, H-1979-S-13 and H-1979-S-14 as additional supplemental wells to H-1979, H-1980, H-1981 and H-1982. In this application, the Village requested that pumping from H-1979-S-10, H-1979-S-11, H-1979-S-12, H-1979-S-13 and H-1979-S-14 be limited to 400 acre-feet per year for each well.
- Next, the Village filed an application to add wells H-1979-S-5 and H-1979-S-6 as supplemental wells to H-1979, H-1980, H-1981 and H-1982. In this application, the Village requested that the combined pumping from H-1979-S-5 and H-1979-S-6 be limited to 400 acre-feet per year.
- The current application seeks to stop the pumping of the 700.83 acre-feet per year of water right H-1979 from wells H-1979, H-1979-S, H-1979-S-2, H-1979-S-3 and H-1979-S-7 and to divert that water from two surface water points of diversion on Eagle Creek, shown on figure 4, and wells H-1497 and H-1497-S. The surface water points of diversion referred to in the application (and in the Consent Order) as 0173 and 0783 have been renumbered as 783-POD2 and 783. The original well H-1497 has been replaced by well H-1497 POD4.

If all these pending applications are approved by the Office of the State Engineer, it would enable the applicant to access their water rights (for both surface and groundwater) from approximately 16 wells and two surface diversions along Eagle Creek (see also figure 4 and figure 5). This allows the applicant to diversify extraction methods based on water availability.

The Village of Ruidoso has also entered into a memorandum of agreement with the Rio Hondo Land and Cattle Company. Both parties agreed to the following:

- The Village of Ruidoso only has 1,624.51 acre-feet per year in the North Fork Eagle Creek wells (a loss of 68.37 acre-feet per year from the 2009 consent order).
- The Village of Ruidoso will not attempt to change the diversion for any of its rights outside the Eagle Creek basin. The Eagle Creek basin is defined as the basin lying west of the north/south quarter line of Section 36 Township 10S, Range 13E, NMPM.
- The Village of Ruidoso will cancel all excess rights pertaining to the proof of beneficial use.

To our knowledge as of August 2014, this agreement between the two parties has not been acknowledged by the Office of the State Engineer. If an updated consent order from the Office of the State Engineer including this agreement is issued, the USDA Forest Service will recognize the updated consent order as the most current description of the applicant's water rights. Until that time, the USDA Forest Service will use the 2009 final adjudication as the Village of Ruidoso's water rights in the North Fork Eagle Creek. The alternatives presented in this document for analysis would not be affected by implementation of this memorandum of agreement.

Water Distribution

To summarize, the Village of Ruidoso has groundwater rights in North Fork Eagle Creek on National Forest System lands. In addition to the four North Fork Eagle Creek wells, the Village of Ruidoso also has water rights for other water diversions in other parts of the Eagle Creek basin (and off of National Forest System land) that include a surface diversion, four supplemental wells to the North Fork Eagle Creek wells, and both the brown and green wells (totaling six additional wells and one surface diversion) in the Eagle Creek drainage off of National Forest System lands; and 2,561.57 acre-feet in water rights (figure 6 and table 18). Table 18 lists the water rights associated with each of these diversions in the larger Eagle Creek drainage.

Eagle Creek Surface Supply:

This water right is the Village of Ruidoso's share (one half) of the now-dissolved Eagle Creek Inter-Community Water Supply Association, which was originally established in 1954. These water rights have priority dates ranging from 1882 to July 9, 1913. Wilson and Company (2005) report that the average annual streamflow available for diversion is approximately 1,600 acre-feet per annum or 2.21 cubic feet per second (992 gallons per minute) at the Eagle Creek diversion point. Streamflow data shows occasions during drought periods when very little or no flow is available for diversion on Eagle Creek (Wilson and Company 2005).

Brown and Green Wells:

The H-1497 series wells near the Eagle Creek point of diversion are commonly known as the Brown and Green (or Woodpecker) wells. These wells have priority dates of 1869 and 1923 and are adjudicated for 59.61 acre-feet per year. Additionally, water rights were transferred to these wells in the amount of 77.76 acre-feet per year with a priority date of 1867. The total volume of finalized water rights associated directly with these two wells is 137.37 acre-feet per year, of which half may be consumptively used while the other half must be return flow. These wells also may be used to supplement the diversion of surface flows from Eagle Creek (Wilson and Company 2005).

Table 18. Eagle Creek drainage summary of water rights (see also figure 6)

State Engineer File Number and Name	Annual Historic Maximum (acre-feet per year)
0173, 187: Eagle Creek Surface Diversion	761.12
H-1979 North Fork 1 (NF-1) H-1980 North Fork 2 (NF-2) H-1981 North Fork 3 (NF-3) H-1982 North Fork 4 (NF-4) H-1979-S "Alto Lake well" H-1979-S-2 "River well" H-1979-S-3 "Ball Field Concession well" H-1979-S-7 "Below Alto Lake well" 1979 Series Total Water Right	1,692.88
Municipal Right for H-1979 series wells subject to PBU in 2024	**846.46**
H-1497 "Green well" H-1497-S "Brown well" H-1497 Series Total Water Right	107.57
Total Eagle Creek Water Rights	**3,408.03**
Total North Fork Wells Water Rights	**2,539.34**

Groundwater is combined with surface water at Alto Lake Reservoir and piped to the Alto Crest Water Treatment Plant (WTP 3) and treated before being pumped into the system. Potable water production from Alto Crest WTP 3 varies depending upon water demands from the system, averaging as much as 2.3 million gallons per day (7.06 acre-feet per day), or as little as 0.5 million gallons per day (1.53 acre-feet per day) for water supply (Wilson and Company 2005).

Once treated, the water removed from the Eagle Creek drainage is then pumped into two large tanks that sit at the top of the drainage boundary that divides the Eagle Creek drainage and the Rio Ruidoso drainage. The water from the North Fork wells leaves the Eagle Creek drainage and enters the Village of Ruidoso's distribution system that supplies its customers in the Rio Ruidoso drainage. After the water is used by the customers, it is collected via the sewer system and sent to the wastewater treatment plant. Once treated, the effluent is then discharged into the Rio Ruidoso. Because some of the discharged effluent is actually water from the Eagle Creek drainage, the Village of Ruidoso receives an effluent credit. Based on this, the Village of Ruidoso is able to divert surface water from the Rio Ruidoso in an amount equal to what portion of the discharged effluent leaving the wastewater treatment plant is attributable to what is pumped out of the Eagle Creek drainage.

Rio Ruidoso Water Supply

We describe above the applicant's water rights associated with one part of the applicant water supply system, the Devils Canyon (Eagle Creek) portion. The other part of the Village of Ruidoso water supply comes from the Upper Rio Ruidoso watershed, through surface water diversion and groundwater pumping. These two subwatersheds are both part of the larger Pecos River basin and administered by the Office of the State Engineer. Upper Rio Ruidoso water is diverted as both pumped groundwater and through a river intake. Groundwater is treated at the wellhead and fed directly into the distribution system. Surface water is collected at Grindstone Reservoir and treated at the Grindstone Water Treatment Plant before being fed into the distribution system. Grindstone Reservoir storage capacity is 1,520 acre-feet (488 million gallons). Combining Eagle Creek and Upper Rio Ruidoso together consists of 2 raw water reservoirs, 2 surface water treatment plants, and 18 permitted wells, of which 11 are active wells, capable of together producing peak capacity of approximately 6 million gallons per day (Wilson and Company 2005).

The 2012 Little Bear Fire halted the production of both surface and groundwater diversions along Eagle Creek due to water quality and debris flow issues. This not only impacted water production, but also affected the Village of Ruidoso's ability to access the return flow credits along the Rio Ruidoso. The shift from the Eagle Creek watershed to the Rio Ruidoso watershed has created a temporary redistribution of water rights along the Rio Ruidoso (also impacted by water quality from the Little Bear Fire). Approved on an emergency basis by the Office of the State Engineer, the Village of Ruidoso received a temporary additional point of diversion, at the confluence of the Rio Ruidoso and Carrizo Creek to the south, to provide water to the Grindstone Dam for use in the municipal supply. This redistribution is anticipated to be short-term in nature and historic water rights and allocation will remain as defined in the 2010 Consent Order.

The Village of Ruidoso also has several pending applications with the Office of the State Engineer (State of New Mexico, Office of the State Engineer, personal communication, September 2014) that could affect groundwater and surface water withdrawal along Eagle Creek, as described earlier. If all of these pending applications are approved by the Office of the State Engineer, it would enable the Village to access their water rights (for both surface and groundwater) from approximately 16 wells and two surface diversions along Eagle Creek. This would allow the Village to diversify extraction methods based on water availability.

Environmental Consequences

Alternative 1 – No Change

There are no effects under alternative 1 (no action, no change) since the Village of Ruidoso would be able to put to beneficial use their adjudicated water right at the current point of diversion, which total 2,539.34 acre-feet per year and provide, on average, a direct contribution to the Village of Ruidoso water supply ranging from 24 to 29 percent. When indirect annual contributions are added to direct contributions (based on factoring in diversions from return flow credits, described in more detail in chapter 1 and in chapter 3), this increases to 36 to 43 percent. During the summer months, data show that 57 to 87 percent of total direct and indirect annual diversions can be attributable to the North Fork wells.

Lack of diversion due to emergency circumstances created by the Little Bear Fire in 2012 is not expected to have a direct effect on the beneficial use of the Village of Ruidoso's adjudicated water rights.

Alternative 2 – No Action (No Pumping)

Without groundwater withdrawal at the current location, the Village of Ruidoso would have the option to file application with the Office of the State Engineer to transfer the point of diversion of their water rights. This is a State of New Mexico process that does not involve the USDA Forest

Service. The process to transfer water rights can be time consuming. The Village of Ruidoso would need to file an application to transfer water rights with the Office of the State Engineer. After the application is filed, a notice of intent to change the right's use or place of use is published in the newspaper of record where the rights are located. Anyone who objects to the proposed transfer files a formal protest with the Office of the State Engineer. Protests must be based on a claim that the transfer will impair existing rights, be contrary to the conservation of water, or be detrimental to public welfare. If no protest is filed, the Office of the State Engineer could approve the transfer if it finds the transfer compatible with State law. If however, there is a protest, the Office of the State Engineer holds a formal hearing on issues set out in the protest and decides the case. If either party is dissatisfied with the Office of the State Engineer's decision, an appeal can be made to district court. These hearings can take months or years to complete.

Alternative 3 – Proposed Action

With the potential for limits to be placed on the amount of groundwater withdrawn from the North Fork well field, dependent on implementation of the adaptive management strategy under alternative 3 (proposed action), the Village of Ruidoso would have the option to file an application with the Office of the State Engineer to transfer the point of diversion of a portion of their water rights. This is a State of New Mexico process that does not involve the USDA Forest Service, but as described above for alternative 2 (no pumping), can be time consuming and lengthy; the Office of the State Engineer has authority to approve or disapprove an application for transfer of water rights.

Update to overall effects due to the Little Bear Fire:

The wildfire halted the production of both surface and groundwater diversions along Eagle Creek due to water quality and debris flow issues. This impacted water production and the Village of Ruidoso's ability to access the return flow credits along the Rio Ruidoso. The shift from the Eagle Creek watershed to the Rio Ruidoso watershed created a temporary redistribution of water rights along the Rio Ruidoso (also impacted by water quality from the Little Bear Fire). Approved on an emergency basis by the Office of the State Engineer, the Village of Ruidoso received a temporary additional point of diversion, at the confluence of the Rio Ruidoso and Carrizo Creek to the south, to provide water to the Grindstone Dam for use in the municipal supply. This redistribution is anticipated to be short-term in nature. Lack of diversion due to emergency circumstances created by the Little Bear Fire in 2012 is not expected to have a direct effect on the beneficial use of the Village of Ruidoso's adjudicated water rights.

Over the long term, historic water rights and allocation will remain as defined in the 2009 Consent Order. Therefore, the effects of implementing alternatives 1, 2 and 3 to the beneficial use of the Village of Ruidoso's water rights is the same as that described in the pre-wildfire assessment above.

Vegetation (Except Riparian Vegetation)

Vegetation (except riparian vegetation) is not a significant issue and we will only briefly discuss it here.

This analysis focuses on three different aspects of vegetation: upland vegetation; threatened, endangered, and sensitive plant species; and nonnative invasive plants. In the next section, we discuss the relationship between forest density and water yield.

A more detailed description of affected environment, methods, and environmental consequences for this project can be found in the vegetation report (Miller 2012b). The supplemental vegetation report (Miller 2014 and Kuhar 2014) provides a more detailed description of affected environment, methods, and environmental consequences, considering the changes caused by the Little Bear Fire. These reports are incorporated by reference, discussed briefly below, and available in their entirety in the project record.

Methodology

Baseline information used to assess impacts to vegetation was provided by specialists with the Forest Service, literature, and professional judgment. Upland vegetation was analyzed in Arcmap 10.1 using the terrestrial ecosystem unit inventory dataset clipped to the North Fork Eagle Creek drainage boundary (figure 2). North Fork Eagle Creek was buffered by 200 feet to designate the riparian area. This riparian area was then excluded from analysis for upland vegetation. Cumulative effects were determined using Lincoln National Forest shapefiles of past, present and future project areas (table 4).

Threatened, endangered, and sensitive plants were analyzed in Arcmap 10.1 using the rare plant forest inventory dataset clipped to the North Fork Eagle Creek drainage area. North Fork Eagle Creek was buffered by 200 feet to designate the riparian area. Cumulative effects were determined using Lincoln National Forest shapefiles of past, present and future project areas (table 4). Existing populations of rare plants were examined in the field in 2010 and 2011. Much of the project area was surveyed for threatened, endangered, and sensitive plants as part of the Eagle Creek project in 1996 and 2002.

Nonnative invasive plants were analyzed in Arcmap 10.1 using the corporate nonnative invasive plant forest inventory dataset clipped to the North Fork Eagle Creek drainage area. Cumulative effects were determined using Lincoln National Forest shapefiles of past, present and future project areas (table 4).

Temporal effects boundaries are 1 to 10 years for short-term effects and 10 to 20 years for long-term effects. The North Fork Eagle Creek drainage boundary (figure 2) was chosen as the spatial boundary because it contains the area of predicted direct/indirect impacts from projected drawdown, as described in more detail in the water resources section of this chapter and shown in figure 7 and figure 8.Accordingly, the cumulative effects boundary matches the largest area of direct and indirect effects.

Well pumping results in changes in the dynamics of groundwater (groundwater drawdown and water table) and surface water (streamflows, wetlands, springs, and seeps). Surface water and groundwater availability are linked and limited by accessible available quantities of water. These changes have the potential to indirectly affect water available for recruitment, growth, and maintenance of upland vegetation, depending on the extent of possible water table drawdown and rooting depth. The alternatives are compared using the following indicators:

Upland Vegetation: extent and duration of possible water table reduction and proximity to upland vegetation communities.

Threatened, Endangered, and Sensitive Plants: proximity and timing of proposed actions and possible water level changes to habitat for threatened, endangered, and sensitive species.

Nonnative Invasive Plants: possibility for increasing the spread of nonnative invasive plants.

Affected Environment

Upland Vegetation

Vegetation in the North Fork Eagle Creek project area, described prior to the Little Bear Fire in 2012, consists of mixed conifer, ponderosa pine, high grass, and mid-grass vegetation types. Mixed conifer is the most prevalent and makes up approximately 88 percent of the project area. Forest density is discussed separately in the "Conifer Density, Fire Regime, and Water Yield" section.

Upland vegetation in the project area burned in the Little Bear Fire with a mix of burn severities. Most grass, ponderosa pine and mixed conifer communities burned at low intensity or less. However, each of these vegetation types did experience some moderate and severity burn severity, as shown in more detail in Miller 2014. The areas in the drainage that burned with severe intensity were generally located in the wilderness area. These areas could potentially undergo a type change from forest to shrub types as seen after fires on the forest (Kuhar 2013). Stand data collected in 2012 to assess wildfire effects showed that areas in the perimeter of the Little Bear Fire that had previous fuels treatments were burned at low severity or less (Kuhar 2013).

Threatened, Endangered, and Sensitive Plants

We reviewed the Lincoln National Forest sensitive species list (USDA Forest Service 2007) to determine what threatened, endangered, and sensitive plant species are either known to occur or have potential to occur in the project area based on habitat preferences. We consulted the United States Fish and Wildlife Service Web site (on November 10, 2011 and again on February 4, 2014) to determine endangered and threatened species for Lincoln County (https://ecos.fws.gov/ipac/wizard). There is one endangered species, Kuenzler's hedgehog cactus (*Echinocereus fendleri var. kuenzleri*), that is listed for the county, but does not occur nor have the potential to occur in the project area, based on habitat preferences. For these reasons, this species would not be affected by proposed actions and was not considered further.

We also considered 23 other plant species on the Lincoln National Forest sensitive species list for this project, as described in more detail in Miller (2012b), but only two of these have the potential to be affected by proposed actions. The focus of this analysis, then, is on Wooton's hawthorn (*Crategus wootoniana*) and Sierra Blanca cliff daisy (*Ionactis elegans*) because they are known to occur in the project area. The other 21 species considered either do not occur in the project area, do not have habitat in the project area, or have potential habitat in the project area but that would not be affected by proposed actions.

There are four known populations of Wooton's hawthorn in the project area. This species often occurs near the banks of Eagle Creek; its preferred habitat is canyon bottoms and openings in lower montane coniferous forest. All populations occur greater than 750 feet upstream of the wells (the nearest is 750 feet from the wells and the farthest is about 0.5 mile from the wells). Populations were delineated and censused by Dr. Richard Worthington and T. Nicolet in 2001. The earliest record of this species in the project area dates from an herbarium record collected in 1899. Other specimens were collected in 1984 and 1997 (Dr. Tim Lowrey, pers. comm. 03/08/2011).

All four occurrences were burned in the Little Bear Fire (table 4). Twenty eight percent of the occurrences were underburned and 72 percent were burned at low intensity; there were no populations burned at moderate or severe intensity. Field surveys by TEAMS and Lincoln National Forest personnel determined that populations have increased since the initial survey work in 2001, with the exception of one population that was affected by the Little Bear Fire due to erosion following a flooding event.

There are six known populations of Sierra Blanca cliff daisy in the project area. All populations occur more than 1.25 miles upstream of the wells and in cliffs (the nearest is 1.25 miles and the farthest is 2.5 miles from the wells and in the cliffs). Their preferred habitat is igneous rock faces in montane coniferous forest at 7,600–9,500 feet in elevation.

All six occurrences were burned in the Little Bear Fire (table 4). Eight percent were underburned, 59 percent were burned at low intensity and 33 percent at moderate intensity.

Nonnative Invasive Species

Through Executive Order 13112 (which was signed in 1999) the National Invasive Species Council was established to ensure that Federal programs and activities to prevent and control invasive species are coordinated, effective, and efficient. Invasive species are those that are not native to the ecosystem under consideration and that cause or are likely to cause economic or environmental harm or harm to human, animal, or plant health. For policy purposes, invasive species are those whose negative impacts outweigh their beneficial effects (Invasive Species Advisory Committee 2006).

The term “noxious weed” refers to a legally defined category of nonnative invasive species. Legally, a noxious weed is any plant designated by a Federal, state, or county government as injurious to public health, agriculture, recreation, wildlife, or property (Sheley, Petroff, and Borman 1999). The current New Mexico Noxious Weed List (Gonzales 2009) includes 37 species that have the potential to negatively impact the State’s environment or economy. The list also includes eight species designated as watch list species that have the potential to become problematic in the State. The Lincoln National Forest list of nonnative invasive species known to occur on the forest (Stewart 2011) was also reviewed. The only nonnative invasive plant species from these lists that has been observed in the North Fork Eagle Creek effects analysis area is musk thistle (*Carduus nutans*). It was detected in riparian monitoring plots five times and was observed occasionally throughout the area, outside of established plots. We have identified approximately 62 acres of musk thistle in the project area, located primarily along North Fork Eagle Creek and along Ski Run Road to the west.

Musk thistle is a biennial member of the sunflower family that grows to 6 feet tall. In one growing season a single plant can produce over a 100,000 seeds. Therefore, it can increase from a single plant to a rather large infestation within 2 to 3 years. The seeds can remain viable in the soil for roughly 15 years, which necessitates intensive monitoring of sites and repeat treatments. Musk thistle does best in disturbed areas, such as along roadsides, grazed pastures, and old fields, but it can also invade deferred pastures and native grasslands. It can occur in almost all habitats except dense forest, high mountains, deserts, and frequently cultivated farmland. Musk thistle is one of the most widespread and problematic invasive species on the Lincoln National Forest.

All the musk thistle populations were burned in the project area. BAER guidance assumes that a 25-30 percent increase in area occupied by weeds would be an acceptable rate (White Paper

Noxious Weeds, BAER Guidance and Direction. March 17, 2001). It is likely that musk thistle occurrences have increased as a result of the Little Bear Fire. Seeding was undertaken following the Little Bear Fire to reduce further noxious weed spread (USDA Forest Service 2012).

Environmental Consequences

All Alternatives

Direct/Indirect Effects

Upland Vegetation

Neither alternative 1 (no change) or alternative 3 (proposed action) propose any new substantial ground disturbance and, therefore, would not result in any direct effects to upland vegetation. Any minor amounts of ground disturbance associated with routine maintenance and monitoring needs under alternative 1 (no change) would be negligible and minimized by project design features. Under the worst case drawdown scenario (figure 7 and figure 8) for alternative 1 (no change), indirect effects of water drawdown would reach into the North Fork Eagle Creek drainage area and could reduce available moisture for new growth. Upland vegetation is not as sensitive to water fluctuation as riparian vegetation and would be resistant to changes. Upland species have colonized dry soils with only natural precipitation as a water source. These species would be marginally affected by groundwater withdrawal and any associated groundwater decline. Growth of individual trees may be stunted, but vegetation is expected to survive these impacts; while individual plants could be affected, this would not result in measurable affects to upland vegetation across the project area as a result of implementing alternative 1 (no change). Because alternative 3 (proposed action) proposes an adaptive management strategy that would reduce the level of drawdown and would result in increases in water availability, the potential indirect effects would be similar to alternative 1 (no change) and could be of less magnitude.

Because alternative 2 (no pumping) would eliminate pumping entirely, there would be no drawdown and the possibility for adverse effects to upland vegetation would be eliminated. Alternative 2 (no pumping) would result in ground disturbance through removal of wells and well facilities; this has the potential to directly affect vegetation, but this potential effect would be minimized by project design features and would be negligible.

Update to overall effects due to the Little Bear Fire:

Upland vegetation burned by the wildfire is likely to experience additional stress due to effects from wildfire damage and therefore could be adversely impacted from reduced water availability due to drawdown from well pumping. Therefore, the potential for adverse impacts from alternative 1 and 3, as described above, could be somewhat greater than predicted above, post-wildfire. Because upland vegetation is less sensitive to groundwater drawdown effects from pumping than vegetation in the riparian zone, these differences between pre-wildfire and post-wildfire effects are likely negligible to minor.

Threatened, Endangered, and Sensitive Plants

Sierra Blanca cliff daisy is a shallow-rooted small plant that prefers rocky substrates in canyons. It does not occur within the vicinity of the well field and would, therefore, not be affected by any ground-disturbing actions under any of the alternatives (routine maintenance and monitoring activities for alternatives 1 and 3 or well facility removal under alternative 2). This species is not dependent on groundwater and would not be directly or indirectly affected by well pumping.

Therefore, implementation of alternative 1 (no action) would not result in either direct or indirect effects to this species.

Wooton's hawthorn is found along the North Fork near the creek and within the riparian area but also ranges further upslope to the top of flat benches; it has been observed in dry, steep gravelly slopes on the edge of ponderosa pine forest. In other locales, populations are found in dry roadcuts away from water. Wooton's hawthorn observations along the North Fork over the last 7 years indicate stable or increasing populations (Cordova, personal communication 2011). Surveys by Richard Worthington in 2001 found that one of the occurrences in North Fork Eagle Creek had 20 plants, matching an herbarium record from 1984 (prepumping period). Monitoring undertaken in 2010 and 2011 found population sizes that matched those of Worthington. Post-wildfire monitoring found that all except one population exceeded the population sizes noted by Worthington. Post-wildfire monitoring found that one population had been affected by a flooding event where a large amount of the streambank was scoured away. Populations contained all age classes: seedlings, saplings, and mature shrubs. There is every indication that Wooton's hawthorn occupies a wide enough ecological amplitude to be unaffected by pumping.

For these reasons, there would be "no effect" to either Wooton's hawthorn or Sierra Blanca cliff daisy with implementation of alternative 1, 2, or 3.

Update to overall effects due to the Little Bear Fire:

The impacts to Wooton's Hawthorn and Sierra Blanca cliff daisy are the same as those described for the pre-wildfire assessment above.

Nonnative Invasive Species

Nonnative plant invasions can cause undesirable, irreversible changes. They have a variety of mechanisms that give them a competitive advantage over native species. Invasive plants often produce abundant seed, have extensive root systems, establish and spread in a wide range of habitats, grow rapidly, initiate growth earlier or later in the season than native plants, exploit water and nutrients better, and have no native enemies. According to Sieg et al. (2003), invasive species can displace native plants, out-cross with native flora, alter nutrient cycling and other ecosystems functions, and even change the flammability of an ecosystem. Many invasive plant species thrive in North America because they were introduced from other continents and have no natural controls here such as insect predators, plant pathogens, competing plants, and herbivores.

Neither alternative 1 (no change) nor alternative 3 (proposed action) propose any new substantial ground disturbance and, therefore, would not result in any direct effects to upland vegetation; while some minor effects are possible from ground disturbance associated with the installation and operation of new alluvial wells (estimated to be less than 0.25 acres of disturbance) and the maintenance of existing facilities and routine maintenance and monitoring activities under these alternatives, project design features would minimize the potential for more than negligible effects. Therefore, possible effects are limited primarily to the indirect effects from water drawdown. Because musk thistle has a wide ecological amplitude and occurs in many types of habitats, it would neither be beneficially nor detrimentally affected by changes in water depth under any of the alternatives. For these reasons, there would be no indirect effects from implementing any of the alternatives and there would be minimal direct effects from implementing alternative 1 (no action) or 3.

Alternative 2 (no pumping) would result in ground disturbance through removal of wells and well facilities, which has the potential to directly affect musk thistle. Although the area of the disturbance would be relatively small, the disturbance would still contribute to the increased likelihood of nonnative plant spread. This potential would be minimized through implementation of project design features and would be minor and short term.

Update to overall effects due to the Little Bear Fire:

All musk thistle populations were burned in the project area and increases in occurrences in the project area are likely as a result of the wildfire. Native seeding was undertaken following the Little Bear Fire to reduce further noxious weed spread (USDA Forest Service 2012). Project design features are part of the action alternatives to minimize spread. Therefore, the impacts to invasive plants are the same as those described for the pre-wildfire assessment above.

Cumulative Effects

Because the direct and indirect effects from implementing any of the alternatives on upland vegetation, threatened, endangered, and sensitive plant species, or nonnative invasive plants are quite minimal, the possibility for cumulative effects is, therefore, also minimal. Combining the effects from alternative 1 (no change), 2 (no action), or 3 (proposed action) with other past, present and foreseeable future actions (as shown in table 4 and figure 4) within the North Fork Eagle Creek drainage area would not result in any measurable effects to these vegetation resources; Sierra Blanca cliff daisy and Wooton’s hawthorn populations would continue to persist; project design features would be implemented to reduce the spread of nonnative invasive plants on other projects in the North Fork Eagle Creek drainage area; and upland vegetation effects would be negligible. The relationship between conifer density and water yield is discussed in the next section.

Conclusion

The direct, indirect, and cumulative effects from implementing any of the alternatives on upland vegetation, threatened, endangered, and sensitive plant species, or nonnative invasive plants would be minimal because they are not measurably affected by changes in water levels, and possible effects from ground-disturbing activities would be minimized through project design features.

Implementing any of the alternatives would be consistent with forest plan direction for upland vegetation, threatened, endangered, and sensitive plant species, and noxious weeds. The alternatives are compliant with the Endangered Species Act, Forest Service Manual 2670 (Threatened, Endangered, and Sensitive Species), Executive Order 13112 (Invasive Species) and Forest Service Manual 2900 (Invasive Species).

Conifer Density, Fire Regime, and Water Yield

As documented in detail in the Fuels Report for this project (Kuhar 2013), surveys conducted by the Ecological Restoration Institute in 2007 in the adjacent Bonito Creek drainage on the Lincoln National Forest indicate that tree stem densities were considerably less in pre-settlement conditions of the late 1800s than they are now. For mixed conifer, ponderosa pine, and pinyon-juniper woodlands, landscapes affected by frequent fire intervals, stem densities ranged from 10 to 30 trees per acre. Landscapes tended to be more heterogeneous, supporting multiple seral states where dry upland sites had open, park-like stands, while stands in protected, moist areas tended to have dense, closed canopies.

Based on data collected in the North Fork project area in 1998, tree density averaged over 2,700 trees per acre and 94 percent of this density was comprised of trees five inches or less in diameter. Following thinning treatments in this area between 2003 and 2009, tree density was reduced to 479 trees per acre in 2012 and 87 percent of this density was comprised of trees five inches or less in diameter. When data were collected following the Little Bear Fire in 2012, tree density was further reduced to 350 trees per acre and 76 percent of this was comprised of trees less than five inches in diameter.

Photographic evidence combined with local wildfire scar data indicates that the project area has experienced a short return interval of mixed severity wildfire that has included both stand-replacement and surface fire activity. Current evidence shows stand replacement occurred at 100-3,000-acre patches that affected all vegetation types within the project area. The last large wildfire (prior to the Little Bear Fire) was about 650 acres in size and occurred in 1989. Wildfire scar data suggest a fire return interval of 26 years with a range of 12-55 years between fires. Fires potentially affected all vegetation types in a single occurrence. This is evident in a 3,600 acres wildfire that occurred in 1935 which burned through ponderosa pine, mixed conifer and some pinyon-juniper stands.

Typically stand replacement fires have resulted in type conversions to shrub and grassland. This is evidenced on both the Smokey Bear and Sacramento Ranger District where fire scars can be found today and with grass-forb-shrub the dominant cover. These vegetative associations can persist for multiple decades as displayed in both photographic evidence and monitoring data.

Post-Little Bear Fire Monitoring Results

Multiple plots were established within the Little Bear Fire perimeter immediately after the passage of the wildfire and were then monitored post-monsoon season in both 2012 and 2013 to assess species composition and trends. Areas which did not burn or burned at low severity remained a combination of mixed conifer, ponderosa pine, oak species, and pinyon-juniper. It is predicted that grass and forbs will dominate the vegetative cover and species composition in areas burned in the first few years post-wildfire. As time progresses and at ten years out and later, shrubs are likely to replace grass and forbs as the dominant cover type.

Regionally

Current forest and rangeland conditions in the Southwest indicate that these systems are not functioning properly, due in part to unnaturally high tree densities (USDA Forest Service, Southwestern Region – Regional Strategic Action Plan 2003 and Dahms and Geils 1997). By the early 1900s, fire exclusion began altering forest structure and fire regime (Covington et al. 1994). Forests with high stem density and fuel loading combined with extreme fire weather conditions have led to severe and large wildfires (Graham et al. 2004). This situation has been the impetus for the creation of, among other things, the National Fire Plan, the Healthy Forest Restoration Act (HFRA 2003), and the Southwestern Region's National Forests' Central Priority Strategy (USDA Forest Service 2004). This "Central Priority" is intended to help restore ecological functionality of wildfire to fire-adapted ecosystems in the Southwestern Region, which includes the Lincoln National Forest.

It is estimated that 145 million cubic feet of biomass is added yearly to New Mexico's forests through growth (USDA Forest Service 2004) and this added forest density puts these forests at heightened risk of high severity wildfire and insect outbreaks. It is the central priority of the Forest Service in the Southwestern Region to thin these forests (USDA Forest Service 2004).

Changes in forest density, due to vegetation management activities such as thinning or fuels treatments, can influence water yield. The Water Resources section of this chapter summarizes the anticipated effects of the Little Bear Fire on hydrologic factors in the North Fork study area. In general, however, it is well accepted that forest density can influence water yield, in addition to fire severity. If forest cover is reduced, increases in water yield or runoff can result. Forests also affect the water budget by transpiration loss, the transfer of water from the soil to the atmosphere through the tree roots, trunk, and leaves (Allen 2001, MacDonald 1987, Urie 1966).

Dahms and Gils (1997) state that "probably the largest effect on forest health in Southwestern ponderosa pine is due to the increase in the density of the trees . . ." The authors go on to state that this increased density results in lower water yields, which has a negative impact on riparian areas. Stednick (1996) and Grant et al. (2008) found that reducing forest cover by 20–25 percent could result in changes in annual water yield but reductions less than this may not result in water yield changes. Grant et al. (2008) documents that although any disturbance that reduces the density of live vegetation cover will locally increase runoff from forested watersheds; flow increases are generally not measurable until about 25 percent of the basal area of a forested watershed has been harvested.

The Gila National Forest (based in Silver City, New Mexico) prepared a briefing paper recently related to the potential for increasing water yield (USDA Forest Service 2009). This paper cites Neary et al. (2008) for a summary of past research efforts to increase water yield from watersheds in the Southwest as well as factors that determine whether increases would be viable in these watersheds. The key conclusion from Neary et al. (2008) that is discussed in this paper is that Southwestern forested watersheds offer minimal potential for increases in water yield due to:

1. low and variable precipitation and high rates of evapotranspiration and sublimation found in the Southwest;
2. while high elevation mixed conifer forests and more mesic forests have the best potential for sustainable increases in water yield compared to other forested sites, this forest type is limited in the Southwest; is often difficult to access; and requires meticulous management to maintain its natural multiaged stand structure; and
3. any water yield increases would be difficult to measure and to store.

Garrett evaluated forest restoration opportunities on the Lincoln National Forest in 2001 (Garrett 2001). This report documents an increase in forest density from an average of 20–70 trees per acre before European settlement to an average of 200–250 trees currently. This evaluation notes that more water was likely available for springs, seeps, and streams in pre-European settlement conditions than is provided currently due to the more open nature of forested stands. This report also projects the effects of returning ponderosa pine and mixed conifer stands on the Smokey Bear Ranger District to presettlement conditions over 50 years and projects substantial increases in water yield and other benefits.

Has increased forest density since pre-European settlement affected water yield in the North Fork Eagle Creek drainage area?

Based on the available data summarized above, mixed conifer and ponderosa pine forests on the Smokey Bear Ranger District and within the upper Eagle Creek drainage have increased in density since the early 1900s, similar to most forests across the Southwest. It is also likely that this increased forest density has contributed to a reduction in water yield in this drainage over the last century, particularly when combined with periods of drought. There are no data available to discern the level of influence forest density has played in available surface flow and groundwater in the North Fork Eagle Creek drainage area (figure 1), particularly in the time period since the wells began operating in 1988. It is assumed that the majority of this change occurred in the 80–90 years between the turn of century and the late 1980s when the North Fork wells began pumping; how much of a influence forest density has had on water yield since 1988 (when the wells began operating) is unknown. Additional site-specific research would be necessary to determine this level of effect and how this could influence water yield over time.

See the discussion of expected changes in water resources due to the Little Bear Fire earlier in this chapter for a specific evaluation of the North Fork Eagle Creek study area.

Would the implementation of past, present, and foreseeable future actions, combined with implementing alternative 1 (no change), alternative 2 (no action/no pumping) or 3 (proposed action), result in measurable changes in conifer density and resultant changes in water yield?

Efforts have been undertaken to reduce forest density and decrease the risk of high severity fire. As described in more detail in the vegetation report (Miller 2014b) and the fuels report (Kuhar 2013), within the 3,400-acre North Fork Eagle Creek drainage area (figure 1) prior to the Little Bear Fire, past efforts (Eagle thinning and prescribed burning projects in 2003, 2004, and 2007 as shown in table 4) focused on thinning smaller diameter trees and reducing understory ladder fuels. The Ski Run wildfire in 2003 affected approximately 7 percent of the North Fork Eagle Creek basin and removed overstory trees and created openings. These past actions combined, prior to the Little Bear Fire, totaled approximately 10 percent of the North Fork Eagle Creek drainage. Since the Little Bear Fire, forest density in the Eagle Creek basin has decreased. The “Water Resources” section earlier in this chapter summarizes the impacts of the Little Bear Fire on hydrologic conditions in the watershed, over the short- and long-term. This is also detailed in the supplemental Water Resources Report in the project record (AECOM 2014).

As shown in table 4, past, current and future activities, combined with reduced forest density due to wildfires, contribute to increases in water yield (Bosch and Hewlett 1982, Grant et al. 2008); how substantial of an effect this might be is unknown, particularly when combining this possible benefit with the current level of water diversion from municipal water supply wells and domestic wells (approximately 30 wells) in this larger upper Eagle Creek drainage, as described in more detail in AECOM (2014).

Wildlife (Except Aquatic Habitat and Fish)

Wildlife (except aquatic habitat and fish) is not a significant issue and we will only briefly discuss it here.

This analysis focuses on three different aspects of wildlife: management indicator species, threatened, endangered, and sensitive wildlife species, and neotropical migratory birds.

A more detailed description of affected environment, methods, and environmental consequences for this project can be found in the fish and wildlife report and biological evaluation and the wildlife biological evaluation (Bright 2012a and 2012b, located in the project record). The supplemental wildlife report and biological evaluation (Bright 2014) provides a more detailed description of affected environment, methods, and environmental consequences, considering the changes caused by the Little Bear Fire. These reports are incorporated by reference, discussed briefly below, and available in their entirety in the project record.

Methodology

The use of a management indicator and special interest species approach is consistent with forest direction (forest plan, p. 31 and 105) and from the forest plan environmental impact statement (pgs. 108, 109, 161-163, and 309-312) and serves as the basis for this management indicator species assessment. Selected management indicator species reflect general habitat conditions needed by other species with similar habitats. Management indicator species were included in this analysis if they were known to occur in the project area.

Executive Order 13186 places emphasis on conservation of migratory birds. Migratory birds were assessed by determining important bird areas or important overwintering areas occur in the project area. The list of migratory bird species protected by the Migratory Bird Treaty Act appears in Title 50, section 10.13 of the Code of Federal Regulations (50 CFR 10.13). The memorandum of understanding between the Fish and Wildlife Service and Forest Service (USDI Fish and Wildlife Service and USDA Forest Service 2008) provides direction to the Forest Service on the preservation and reduction of take associated with migratory birds.

The effects of the proposal on selected bird species were determined primarily through coarse filter analyses, using the species' primary habitat. These are focus vegetative community types for which properly functioning conditions and desired future conditions have been identified across the forest.

Well pumping results in changes in the dynamics of groundwater (groundwater drawdown and water table) and surface water (streamflows, wetlands, springs, and seeps). Surface water and groundwater availability are linked and limited by accessible available quantities of water. These changes can directly affect water availability for wildlife species and indirectly affect the quality of wildlife habitat. In order to compare alternatives, the following measurable indicators have been developed:

- Changes in habitat quality and population trends for management indicator species in ponderosa pine, mixed conifer, woodlands, and aspen;
- Changes in habitat quality and population trends for threatened, endangered, and sensitive species; and
- Changes in vegetation community types that are primary habitats for neotropical migratory birds, regionally important species listed by Partners in Flight, important bird areas or important overwintering areas, and migratory birds.

Baseline information used to assess impacts to wildlife was provided by specialists with the USDA Forest Service, literature, and professional judgment.

The “Methodology” section at the beginning of this chapter describes the general approach used for cumulative effects analysis. Activities and projects summarized in table 4 and figure 4 were considered in the wildlife species cumulative analysis.

Affected Environment

Management Indicator Species

Five management indicator species are known to occur within the project area or have habitat in the project area, as listed below. Habitat and populations trends for these species were assessed on the forest in 2006 (Salas 2006), and these conclusions are also listed. No management indicator species that represent riparian habitats occur within the project area. However, under the 10th Circuit Court (UEC v. Bosworth, 2004), the USDA Forest Service is required to analyze all management indicator species for which habitat is present within the project area Unless the forest has actual survey information to show that the species in question is absent from the area.

Pygmy nuthatch – ponderosa pine; an indicator of snags and large trees; also uses mixed conifer. Trends in habitat quality are downward forestwide, but population trends are stable.

Hairy woodpecker – aspen; an indicator of aspen snags. Trends in habitat quality are downward forestwide, but population trends are stable.

Mule deer – piñon-juniper woodlands; an indicator of browse and dense canopy (scrubby cover, browse species, and closed landscapes). Trends in both habitat quality and populations are stable.

Elk – mixed conifer; an indicator of high quality mixed conifer and mountain meadows. Trends in habitat quality are upward and population trends are stable.

Ruidoso red squirrel – mixed conifer; an indicator of high quality mixed conifer with interlocking crowns and trees of cone-bearing age. Trends in both habitat quality and populations are stable.

While impacts from the Little Bear Fire to non-riparian management indicator species or habitat are not known with certainty, it is likely that populations of these species were affected to some degree, at least in the short-term. Ponderosa pine, mixed conifer, pinyon-juniper (and interspersed aspen) did experience wildfire, ranging from very low to high severity. Because the majority of the North Fork project area affected by the Little Bear Fire burned at moderate or low intensity, it is assumed that the habitat conditions for which these species are indicators, were not adversely impacted over the long-term. Over the short-term, it is possible that habitat quality could increase in the project area for these species due to an increase in snags (hairy woodpecker), an increase in shrubs and browse (mule deer), and an increase in grasses and forbs (elk).

Disturbance to upland vegetation would likely not be measurable, as described in more detail in the riparian vegetation section of this chapter. None of the management indicator species that represent riparian habitat occur within the project area. There would be no habitat type conversion as a result of this project. Miller (2014) concluded that facultative wetland species are likely to be beneficially affected by alternative 3 compared to the current condition (alternative 1). Slight increases in vegetation shifts favoring communities featuring facultative wetland species may occur, but gains would likely be moderated by the continued drying trends of climate change over the long-term time frame of this analysis. Therefore, there adverse impacts to management indicator species that inhabit or rely upon riparian habitats would range from negligible to minor, with the opportunity for slight improvement in riparian habitat conditions over the long-term under alternatives 2 and 3.

Threatened, Endangered, and Sensitive Species

We consulted the United States Fish and Wildlife Service Web site to determine endangered and threatened animal species for Lincoln County (http://www.fws.gov/southwest/es/NewMexico/SBC_view.cfm?spcnty=Lincoln). This list (queried March 2012 and again in July 2014) fulfills the requirements of the US Fish and Wildlife Service to provide a current species list pursuant to section 7 of the Endangered Species Act. Seven animal species (New Mexico meadow jumping mouse, black-footed ferret, Mexican spotted owl, northern aplomado falcon, whooping crane, mountain plover, and Rio Grande cutthroat trout) are listed for Lincoln County, New Mexico. We also reviewed the Forest Service Southwestern Region Regional Forester's threatened, endangered and sensitive species (USDA Forest Service 2013) and the Lincoln National Forest Sensitive Species List (USDA Forest Service 2012 (which were derived in part from the Lincoln County list of federally listed species) in order to determine which threatened, endangered, or sensitive wildlife species are either known to occur or have potential to occur in the project area vicinity based on habitat preferences. According to this information, the Mexican spotted owl is the only federally listed threatened or endangered species that is included in this analysis. No other federally listed species, or their suitable habitat or designated critical habitat, occur in the project area or that could potentially be affected by continuation of North Fork well operations. Out of the 38 species on the Lincoln National Forest Sensitive Species List (USDA Forest Service 2012) that were considered, only the following 4 species are included in this analysis, as described in more detail in Bright (2012a):

- Mexican spotted owl
- Northern goshawk
- Ruidoso red squirrel
- Sacramento Mountains salamander

Mexican spotted owls inhabit mixed coniferous and pine/oak forests, canyons, desert caves, and riparian areas throughout the Southwest and within the Lincoln National Forest (Ganey et al. 2011). The three main prey food species are wood rats, deer mice, and voles (Ward et al. 1995, Stokes 1997). Canopy cover and herbaceous ground cover are important prey habitat conditions.

There are three protected activity centers in the vicinity of the project area (Carlton, Krause and Eagle protected activity centers), with the Carlton Canyon protected activity center being the nearest of the three; its boundary is adjacent to the action area surrounding the wells, but its nesting area ("no touch zone") is approximately 0.75 mile outside the action area and is separated by steep topography. This protected activity center has produced young every year except 1995, 2000, and 2011 (Cordova, pers. comm. 2011). The Eagle protected activity center is located in the upper headwater reaches of North Fork Eagle Creek and the Krause protected activity center is almost entirely outside the 3,400-acre North Fork Eagle Creek drainage to the east of the North Fork Eagle Creek action area.

Based on monitoring results from 2011, there was no documented reproduction in any of these protected activity centers during the 2011 breeding season. All three protected activity areas were burned in the Little Bear Fire with varying levels of severity. The Carlton protected activity center burned at mostly low and very severity, the Krause protected activity center at mostly moderate and low protected activity center and the Eagle Creek protected activity center at mostly high and moderate severity. While the long-term effects from the wildfire on these owls are unknown, it is clear that the wildfire adversely impacted suitable nesting habitat within each protected activity center (USDA Forest Service 2012d).

Northern goshawks prefer large tracts of mature, closed canopy, deciduous, coniferous and mixed forests with an open understory. There are two established post-fledging areas within the vicinity of the project area. The Krause post-fledging area is approximately 0.20 mile from the 5-acre action area surrounding the wells. The Telephone post-fledging area (established in 2010), has a known nest that is about 0.10 mile from the well sites. No goshawks were found in either post-fledging area during 2011 surveys (Cordova, pers. comm. 2011). There would be a breeding season mitigation measure included in any new permit issued for any new construction or mechanized activity. This measure would prohibit construction or mechanized activity within 0.25 mile of the post-fledging areas from March 1 through September 30.

Northern goshawk habitat within these two post-fledging areas burned at moderate to high severity in the Little Bear Fire (USDA Forest Service 2012d).

The project area contains very marginal habitat for Sacramento Mountain salamanders. In 2001 an extensive survey was conducted as part of another project (Cordova, pers. comm. 2012). Surveys were conducted in areas above 8,000 feet in elevation. In all cases, salamanders were found above 8,600 feet and documented in the upper reaches of Eagle Creek within the wilderness area and the upper reaches of Carlton and Johnson Canyons. Salamanders were documented in Telephone Canyon in 2002 during a separate effort. The closest known salamander occurrence is approximately 0.4 mile from the 5-acre project area along Johnson Canyon.

While no data are currently available on direct effects to the closest salamander occurrence in Johnson Canyon, it is possible that this site and other areas of potential habitat in the upper reaches of Eagle Creek were adversely impacted by the Little Bear Fire. Salamanders could experience direct mortality and habitat loss due to post-wildfire threats (USDA Forest Service 2012). Salamanders can be negatively impacted by opening up of shady mature forest and by destruction or removal of downed logs in a post-wildfire situation (USDA Forest Service 2012d).

The Ruidoso red squirrel is a mixed conifer associated species. Based on the small size of the 5-acre project area, suitable habitat is limited; there are no known populations within the vicinity of the well field (Cordova, pers. comm. 2011).

Migratory Birds (Species Protected by the Migratory Bird Treaty Act)

The evaluation of effects to migratory birds uses the Forest Service Southwestern Region's protocol that focuses on migratory birds included on the New Mexico Partners in Flight's Highest Priority Species list, along with considering effects to important bird areas and important overwintering areas for migratory birds (New Mexico Partners in Flight 2007). The proposed project design and evaluation complies with the 2001 Executive Order 13186 regarding responsibilities of Federal agencies to protect migratory birds.

Based on a course filter analysis using species' primary habitats; regionally important species listed by Partners in Flight; important bird areas; and important overwintering areas, four migratory birds were considered further for this analysis, as follows:

- Virginia's warbler
- Grace's warbler
- Flammulated owl
- Red-faced Warbler

There are no designated important bird areas or important overwintering areas (large wetlands) on the Smokey Bear Ranger District where they would be expected to be impacted by activities proposed for this project.

Nesting habitat for these species are likely to have been adversely effected by the Little Bear Fire, at least in the short-term, due to the loss of heavy brush understory and some over story in mixed conifer and ponderosa pine vegetation types.

Environmental Consequences

All Alternatives
Direct/Indirect Effects

Management Indicator Species

There would be no direct or indirect effects to mule deer, elk, hairy woodpecker, pygmy nuthatch, or Ruidoso red squirrels or their habitat from implementation of any of the alternatives. The potential for disturbance during routine maintenance and repair of the wells and associated facilities would be minimal for alternative 1 (no change) and alternative 3 (proposed action); disturbance related to shutting the wells down under alternative 2 (no pumping) would also be minimal. Disturbance to upland vegetation would likely not be measurable (Miller 2014b). None of the management indicator species that represent riparian habitat occur within the project area. There would be no habitat type conversion as a result of this project.

The trends for management indicator species as reported in the most recent forestwide management indicator species assessment update (Salas 2006) would not be changed from the actions described in the alternatives for this project because there would be no habitat type conversions. There would be no new ground-disturbing activities or habitat type conversions and the baseline conditions would be maintained. Management indicator species habitats within the project and action areas would be less than 1 percent of the total acres on the forest. Even with the change in management indicator species habitat due to the Little Bear Fire, the implementation of the alternatives is not expected to appreciably alter this changed condition to the positive or negative.

The population and habitat trends listed previously for each management indicator species are forestwide and the project area is too small in size to create a measurable change in any of these trends. In addition, the potential effects are not measurable. Population trends for elk, mule deer, hairy woodpecker, pygmy nuthatch, and red squirrels are stable on the forest in spite of drought conditions. Habitat trends are down for pygmy nuthatch and hairy woodpecker, but proposed actions would not contribute to any habitat type conversions for these species in the project area. There are no data that suggest that populations are being affected by well site activities or water use in the North Fork Eagle Creek project area.

Threatened, Endangered, and Sensitive Species

There would be no direct or indirect effects to the Mexican spotted owl or its designated critical habitat associated with any of the alternatives. There is no suitable nesting or roosting habitat and no designated critical habitat within the project area. The nearest owl protected activity center (Carlton) is adjacent to the 5-acre action area where the wells are located, but the nesting area ("no touch zone") is 0.75 mile away from this action area across steep topography and dense forest cover. There is no line of sight between the nearest known nest and action area. Owl surveys (USDA Forest Service 2003 – Biological Analysis Supplement) and more recent annual protected activity center monitoring (current as of 2011) have not detected owl presence within the 5-acre project area. The current annual operating plan for well maintenance and operations, as well as alternative 1 (no change) and alternative 3 (proposed action) include a mitigation/conservation measure to avoid construction or mechanized equipment use during the breeding season (March 1–August 31) within 0.25 mile of the protected activity center boundary (to mitigate the potential for disturbance due to noise). Alternative 2 (no pumping) also includes a conservation/mitigation measure to avoid construction or mechanized equipment activities associated with shutting the wells down during the breeding season. Therefore, any disturbance would be virtually the same for all alternatives. There is no evidence of effects to Mexican spotted owl occurrence or reproduction from disturbance related to past well operations including maintenance of National Forest System Road 127 going into the well sites, which is 0.75 mile from the protected activity center boundary.

There would be no direct or indirect effects to the three sensitive species (northern goshawk, Sacramento Mountains salamander, or Ruidoso red squirrel) or their habitat associated with implementing any of the alternatives. Any facility maintenance and repairs, including road maintenance, would be routine and minimal, including work on approximately ¾ mile of the spur leading into the well site from the main road (National Forest System Road 127). While goshawks are known to occur in the project vicinity (the nearest nest site is 0.10 mile from the project area), upland vegetation would not be measurably affected by proposed actions (Miller 2012b). No surveys have detected Sacramento Mountains salamanders within the project area. No populations of Ruidoso red squirrels have been documented in the project area, and no upland vegetation would be measurably impacted by the project (Miller 2014b).

Update to overall effects due to the Little Bear Fire:

Based on monitoring results from 2011, there was no documented reproduction in any Mexican spotted owl protected activity centers during the 2011 breeding season. All three protected activity centers were burned in the Little Bear Fire with varying levels of severity. While the long-term effects from the wildfire on these owls are unknown, it is clear that the wildfire adversely impacted suitable nesting habitat within each protected activity center (USDA Forest Service 2012d). Northern goshawk habitat within two known post-fledging areas burned at moderate to high severity (USDA Forest Service 2012a). No data are available on possible wildfire impacts to salamander habitat. Salamanders can be negatively impacted by opening up of shady mature forest and by destruction or removal of downed logs in a post-wildfire situation (USDA Forest Service 2012d). Even with these changes in threatened, endangered and sensitive species habitat, implementation of any of the alternatives post-wildfire would not contribute to any additional direct or indirect adverse impacts. The effects from implementing alternatives 1, 2 and 3 are the same as those described above for the pre-wildfire assessment.

Migratory Birds

There would be no direct or indirect effects to any migratory bird species or their habitat associated with any of the alternatives. The potential for noise or direct disturbance from ground disturbance during routine maintenance and repair of the wells and associated facilities would be minimal for alternative 1 (no change) and alternative 3 (proposed action); disturbance related to shutting the wells down under alternative 2 (no pumping) would also be minimal. Disturbance to upland vegetation would likely not be measurable (Miller 2014b). There would be no habitat type conversion as a result of this project. There would be no unintentional take of adults, eggs, and/or chicks and no ground or habitat disturbance from any of the alternatives for migratory birds. There would be no conversion of habitat during this project.

Update to overall Effects due to the Little Bear Fire:

Migratory bird nesting habitat for these species are likely to have been adversely effected by the Little Bear Fire, at least in the short term, due to the loss of heavy brush understory and some over story in mixed conifer and ponderosa pine vegetation types. Even with these changes in migratory bird species habitat, implementation of any of the alternatives post-wildfire would not contribute to any additional direct or indirect adverse impacts. The effects from implementing alternatives 1, 2 and 3 are the same as those described above for the pre-wildfire assessment.

Cumulative Effects

The cumulative effects area for wildlife is the project area. Because the direct and indirect effects from implementing any of the alternatives on management indicator species, threatened, endangered, and sensitive wildlife species, and migratory birds are quite minimal, the possibility for cumulative effects is, therefore, also minimal. Combining the effects from alternative 1 (no change), 2 (no action), or 3 (proposed action) with other past, present, and foreseeable future actions (as shown in table 4 and figure 4) within the project area would not result in any measurable effects to these wildlife resources. While these projects and past changes such as the Little Bear Fire, forest management practices, disease, insects, and climate change have affected trends for these wildlife species and their habitats across the forest and in the Southwest, the minor effects from this project on a relatively small area would not cumulatively add to these larger trends.

Conclusion/Determination of Effect

Mexican Spotted Owl

There would be no direct or indirect (disturbance) to Mexican spotted owls, owl habitat, or prey species as a result of implementing any of the alternatives. All alternatives would have “no effect” on the Mexican spotted owl or its suitable or designated critical habitat.

Regional Forester Sensitive Wildlife Species

The current annual operating plan for well maintenance and operations, as well as alternative 1 (no change) and alternative 3 (proposed action) include a mitigation/conservation measure to avoid construction or mechanized equipment use within 0.25 mile of any northern goshawk post-fledging area during the breeding season (March 1–August 31). Alternative 2 (no pumping) also includes a conservation/mitigation measure to avoid construction or mechanized equipment activities associated with shutting the wells down during the breeding season. Therefore, any disturbance would be virtually the same for all alternatives. There is no evidence of effects to goshawk occurrence or reproduction from disturbance related to past well operations including maintenance of National Forest System Road 127 going into the well sites.

Past well pumping and related activities have also not resulted in any known or documented impacts to Ruidoso red squirrels or Sacramento Mountains salamander individuals or their habitat; implementation of any of the alternatives would not measurably effect upland vegetation (Miller 2014b) or alter the intermittent nature of North Fork Eagle Creek.

While differences in available surface water and minor changes in riparian vegetation are possible under implementation of the alternatives (AECOM 2014 and Miller 2014a), these changes would not result in changes in habitat for northern goshawks, Ruidoso red squirrels or Sacramento Mountains salamanders. Therefore, well pumping alternatives would have “no impact” on any sensitive species or their habitat.

Management Indicator Species

Forest management practices, disease, insects, and global climate change have affected trends for all management indicator species and their habitats. Climate changes have affected specific plant communities as well as the migratory habits of some species to the point that they are using areas different from those where they have been surveyed in the past. The proposed alternatives would not create any habitat type conversions. There have been no population declines of any of the management indicator species attributable to North Fork well site activities or water withdrawals. Permit reissuance and subsequent well pumping alternatives would have “no impact” on any management indicator species or their habitat.

Migratory Birds

The current annual operating plan for well maintenance and operations, as well as alternative 1 (no action, no change) and alternative 3 (proposed action) include a mitigation/conservation measure to avoid construction or mechanized equipment use within 0.25 mile of any northern goshawk post-fledging area during the breeding season (March 1–August 31) or within 0.25 mile of any Mexican spotted owl protected activity center. There are no planned activities within this buffer zone. Alternative 2 (no pumping) also includes a conservation/mitigation measure to avoid construction or mechanized equipment activities associated with shutting the wells down during these breeding seasons. The above mitigation measures would protect any migratory bird species during the nesting season and would prevent any unintentional take of birds, nests, eggs, or chicks. There would be no habitat disturbance and, thus, no habitat conversion.

While maintenance activities would occur under alternatives 1 and 3, these activities (driving existing roads to the well sites and checking well conditions, water conditions in the wells) are not ground disturbing actions and would not result in effects to migratory bird species. Past well operations have not shown any evidence of impacts to migratory bird species, nesting, or reproduction, even during drought periods. There have been no known or suspected population declines of any of the above species attributable to well site activities or water withdrawals. There would be no unintentional take on migratory bird populations. Well pumping alternatives would have “no impact” on any migratory bird species or their habitat, or any designated important bird areas.

Short-term Uses and Long-term Productivity

The National Environmental Policy Act requires consideration of "the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity" (40 CFR 1502.16). As declared by Congress, this includes using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans (NEPA Section 101).

If the short-term use of the water resources in the North Fork is defined as the well field permit authorization period of up to 20 years, with stipulations for review and verification of the permit terms and conditions at least every 5 to 10 years, then long-term productivity would extend at least that far into the future. Under alternative 1 (no change), surface water and groundwater available for forest management (including watershed condition, riparian and aquatic habitat, and recreation) would be limited to the existing conditions or further reduced. Under alternative 2 (no pumping), there would be no short-term uses of the water supply, and long-term productivity on forest lands would have substantial near-term opportunities for improving condition. Under alternative 3 (proposed action), a moderated condition would be attained that would allow maintenance of some of the applicant's existing water supply, while providing opportunities for improving existing water resources conditions.

Unavoidable Adverse Effects

The proposed action includes implementation of adaptive management, project design features, and best management practices (chapter 2) intended to avoid, minimize the extent of, or reduce the potential for adverse effects on the environment. Each section of chapter 3 describes the spatial and temporal context for unavoidable adverse effects predicted from alternatives 1, 2 and 3.

Irreversible and Irretrievable Commitments of Resources

Irreversible commitments of resources are those that cannot be regained, such as the extinction of a species or the removal of mined ore. Irretrievable commitments are those that are lost for a period of time such as the temporary loss of timber productivity in forested areas that are kept clear for use as a power line rights-of-way or road.

There are no irreversible commitments of forest resources under the proposed action (alternative 3) or either alternative 1 (no action) or 2 (no pumping). Under any of these management actions, the presence and uses of surface water or groundwater resources eventually could be returned to a prior state through subsequent management actions, subsequent precipitation and runoff, and groundwater recharge. An irretrievable commitment of water resources would occur under alternative 2 (no pumping) from the standpoint of the loss of municipal water supply on the part of the village. That loss could conceivably be reversed by other decisionmaking on the part of the forest at some remote point in time. However, alternative 2 (no pumping) does not represent a total "loss" of water resources for beneficial use. It is common in water resources management to have conflicting demands from different beneficial uses. In the case of alternative 2 (no pumping), the irretrievable loss of municipal use would allow greater use by other resource objectives. Similarly, under alternative 1 (no action), ongoing substantial withdrawals by the village for municipal supply would represent irretrievable losses for other uses. For both alternatives, water resources and their uses could be eventually retrieved under changing management conditions.

Other Required Disclosures

NEPA at 40 CFR 1502.25(a) directs "to the fullest extent possible, agencies shall prepare draft environmental impact statements concurrently with and integrated with other environmental review laws and executive orders."

Alternatives 2 and 3 comply with the following Federal laws and regulations:

- Endangered Species Act
- Clean Water Act
- Clean Air Act
- Migratory Bird Treaty Act
- National Historic Preservation Act
- National Forest Management Act

There are no conflicts between alternatives 1, 2 and 3 and the objectives of Federal, regional, State, and local policies and plans.

Chapter 4. Consultation and Coordination

Preparers and Contributors

The Forest Service consulted the following individuals, Federal, State, and local agencies, tribes and non-Forest Service persons during development of this EIS. We specifically list the project role and qualifications for those members of the IDT that prepared sections of this document. Others that were consulted throughout the project for input, advice, and review are listed separately.

Core ID Team Members

AECOM

Robert C. Berry, PhD – Hydrogeologist/Geochemist - Water Resources Analysis (Groundwater and hydrogeology): PhD, Geology/Geochemistry, Princeton University; Prof. Degree, Hydrogeology, Colorado School of Mines; BS, Geology, University of Hawaii; 36 years of experience.

Dr. Berry is a groundwater hydrologist and geochemist responsible for hydrogeological evaluation of groundwater basins, aquifer testing and evaluation, aqueous geochemistry and geochemical modeling, and groundwater flow and transport modeling. He is also experienced in modeling entire groundwater basins, investigating mining hydrology issues, and water supply evaluations. Dr. Berry is an experienced field geologist with mapping experience throughout the western U.S., in rocks ranging from Archean metasediments to Quaternary alluvial deposits.

James K. Burrell, EIT – Engineering Hydrologist - Water Resources Analysis (Surface water): MS, Civil Engineering and BS, Forest Management, Colorado State University; 21 years of experience.

Mr. Burrell is a hydrologist specializing in surface water hydrology, open-channel hydraulics, stream and watershed stabilization, and related erosion and sediment transport issues. His engineering background includes fieldwork and computer modeling for rainfall/runoff, channel discharges and flood hydraulics, stream stability and scour, and sediment transport and retention structures in the U.S. and overseas. He also spent several years developing and calibrating river basin-scale continuous rainfall/runoff models as a contractor to the National Weather Service (Office of Hydrology).

David Fetter – Surface Water Hydrologist - Water Resources Analysis (water resources): BS, Watershed Science, Colorado State University; 8 years of experience.

Mr. Fetter specializes in surface water hydrology. His responsibilities have included working directly with government agencies while acting as a state permit coordinator, conducting detailed hydrologic investigations and researching, writing and editing environmental sections for permits and project documents. His project work includes National Environmental Policy Act (NEPA) report preparation for the Bureau of Land Management and Federal Energy Regulatory Commission. Prior to joining AECOM, Mr. Fetter worked for the Wyoming State Engineer's Office, and also supported interdisciplinary studies of wetland ecology within Rocky Mountain and Yellowstone National Parks.

U.S. Forest Service – TEAMS Enterprise Unit

Larry Bright – Biologist - Aquatic Habitat, Fish and Wildlife Analysis: Graduated from Oregon State in 1964 in Fish and Wildlife Management. Worked 28 years with Oregon Department of Fish and Wildlife and retired while serving as the wildlife research program manager. Worked 10 years with the U.S. Forest Service after 3 years of ranch work and developing a fee fishery for a ranch in Washington.

Henry Eichman – Economist - Socioeconomic Analysis: B.A. in Biology from Colorado College and a M.S. in Agricultural and Resource Economics from Oregon State University. From 2000 to 2004, Henry worked with Federal and state agencies on raptor research efforts in Colorado and Arizona. Prior to joining TEAMS in 2007, Henry worked as an economist for BLM's Prineville District in Oregon.

Vickey Eubank – GIS Specialist - GIS analysis and maps: Associate of Science in Science and Business from Labette County Community College. Vickey is very experienced in using multiple GIS applications. She excels in creating or revising complex GIS processing to facilitate analysis, modeling, programming, and creating GIS tabular, statistical, spatial, and mapping products for an array of projects. Vickey has accomplished a variety of complex GIS assignments including: an oil and gas leasing environmental impact statement (EIS); classification of satellite imagery; developing range capability models; forest plan revision; and fireshed modeling. Prior to her tenure with TEAMS, Vickey worked for the Custer National Forest as a GIS specialist and for the Kootenai National Forest as a transportation planner. Vickey has worked with TEAMS since 2004.

Deborah McGlothlin – Environmental Coordinator - Interdisciplinary Team Leader and Document Preparation: Graduated from Northern Arizona University in 1992 with a BS in Biology and from Arizona State University in 1996 with a MS in Environmental Resource Management. Worked for the Tonto National Forest as a wildlife biologist from 1990 to 2000; for Grand Canyon National Park as an environmental coordinator from 2000 to 2008 and for U.S. Forest Service-TEAMS enterprise as an environmental coordinator since 2008.

Terry Miller – Botanist - Riparian Vegetation and Botany Analysis: Graduated from Southern Illinois University - Carbondale with a BA in Plant Biology and a MS in Forest Resources from the University of Idaho - Moscow. Worked with the Forest Service since 2001 including positions such as a SCEP student on the Fishlake National Forest in Utah, a district botanist on the Plumas National Forest in California, and as a forest botanist on the Hiawatha National Forest in Michigan. Terry has worked for TEAMS since October of 2008. He has experience working on a variety of projects including timber management, fuels treatment, noxious weed treatment, watershed restoration, grazing management, travel management, and a variety of special use projects. Terry has experience with rare plant habitat enhancement, rare plant monitoring, rare plant surveys, noxious weed treatment, grant proposal writing, native plant restoration, and NRIS.

Kristin Whisennand – Writer/Editor - Document Editing: Bachelor of Arts in Anthropology from Dartmouth College and a Bachelor of Science in Resource Conservation Management from the University of Montana, graduate study in archaeology and paleontology at the University of Montana. Kristin works as a technical writer/editor with TEAMS preparing environmental and technical documents. Prior to TEAMS, she worked for 5 years as a team leader with the Forest Service Content Analysis Team and for 9 years as an archaeologist with the Lolo National Forest. Kristin has been with TEAMS since 2002.

U.S. Forest Service – Centralized National Operations

Roger Congdon, PhD – Hydrogeologist - Water Resources Oversight: Bachelor of Science in Geology from Portland State University in 1983, Master of Science in Geology from the University of Utah in 1987, Doctor of Philosophy in Geology from Johns Hopkins University in 1991. Worked with the U.S. Geological Survey in Reston, Virginia, from 1991 to 1994; with the Bureau of Land Management in Elko, Nevada, from 1994 to 2002; with the Fish and Wildlife Service in Vero Beach, Florida, from 2002 to 2005; with the Fish and Wildlife Service in Las Vegas, Nevada, from 2005 to 2007; with the U.S. Forest Service from 2007 to the present. Supplemental training included hydrogeology at the University of Maryland in 1992 and miscellaneous short courses in groundwater modeling, aquifer testing, karst hydrology, and watershed modeling. He has experience with mine dewatering issues, well siting, groundwater modeling, and has been project manager for the Newmont Gold Quarry expansion EIS in Nevada. Roger is a member of the Washington Office hydrogeology team in the U.S. Forest Service.

U.S. Forest Service – Lincoln National Forest

Christina Thompson – District Recreation and Lands Staff - Water Rights Analysis: Graduated from the University of New Mexico in 2004 with a BA in Geography and from the University of New Mexico in 2006 with a Master of Water Resources with an emphasis in water policy and management. She has worked for the Lincoln National Forest (NF), Smokey Bear Ranger District as the recreation/lands/minerals assistant from 2006 to 2009; from 2009 to 2011 as the Gila and Lincoln NFs zone lands/minerals specialist; 2011–present as the Smokey Bear Ranger District recreation/lands staff.

Supporting IDT Members

Name	Affiliation and Position	Project responsibility
April Banks	Lincoln National Forest Hydrologist	Water resources input and oversight
Linda Cole	Lincoln National Forest GIS Coordinator	Forest data layers and shape files
Rebecca Cross	Forest Service Southwestern Region Assistant Group Leader for Lands Special Uses	Special use permitting input and oversight
Larry Cordova	Smokey Bear Ranger District Biologist	Wildlife, fisheries, and botany input and oversight
Ron Hannan	Lincoln National Forest Planning Staff Officer	NEPA input and oversight; project management
Kim Kuhar	Smokey Bear Ranger District Fire Ecologist	Fuels analysis and post-wildfire monitoring results and interpretation
Kristen Loughery	TEAMS Enterprise Unit Economist	Socioeconomic analysis input and review

Name	Affiliation and Position	Project responsibility
Diane Prather	Lincoln National Forest Archaeologist	Cultural resource input and tribal consultation
Peg Sorensen	Acting Lincoln National Forest Planning Staff Officer	NEPA input and oversight
Eric Turbeville	Smokey Bear Ranger District Recreation Specialist	Recreation input and oversight; district project coordination
Patti Turpin	Lincoln National Forest NEPA Coordinator	NEPA input and oversight; PALS data entry and updates
Dave Warnack	Smokey Bear District Ranger	Overall project direction and coordination; liaison with forest supervisor
Gary Ziehe	Lincoln National Forest Natural Resources Staff Officer	Overall resource input/oversight

Federal, State and Local Agencies, Tribes and Others

In February 2011, we released the notice of intent and proposed action and mailed a scoping letter with a detailed purpose and need and proposed action description to 174 stakeholders including private landowners, agencies, organizations, and tribes. We also posted information on the Lincoln National Forest Web site and published a news release in the Ruidoso News on February 15, 2011. We held a public open house at the Ruidoso Middle School on February 17, 2011, to provide project information and answer questions. As of November 2011, prior to release of the DEIS in 2012, we had received a total of 102 comment letters from you, the public—including agencies, organizations, individuals and elected officials—in response to our request for input.

We received comments from the following Federal, State, and local agencies, tribes and groups. We also received many additional comments from local citizens and private landowners and business owners. These scoping comments received and how we used them in preparation of both the 2012 DEIS and this document is described in appendix A.

Federal, State and Local Agencies; Tribes and Other Interest Groups

- Alto Lakes Water and Sanitation District
- County of Lincoln
- Eagle Creek Conservation Association
- Eagle Creek Summer Home Association
- New Mexico Environment Department

Federal, State and Local Agencies; Tribes and Other Interest Groups

- Pew Trusts
- Stevan Pearce, Congressman
- Upper Hondo Soil and Water Conservation District
- Village of Ruidoso
- Ysleta del sur Pueblo

We released the North Fork Eagle Creek Wells Special Use Authorization Project Draft Environmental Impact Statement (DEIS) on May 25, 2012. The notification of its availability for public comment was published in the Federal Register, a legal notice was published in the

Ruidoso News, and email and letter notifications were distributed to all those on the project mailing list. Comments were requested by July 9, 2012. We received several requests for extensions to the comment period and Forest Supervisor Trujillo granted an additional 60-day extension, requesting all comments be submitted no later than September 9, 2012.

The Little Bear Fire started on June 4, 2012 and encompassed approximately 98 percent of the project area. Because of the substantial impact this wildfire had on the project area analyzed in the DEIS, Forest Supervisor Trujillo decided to stop the comment period on the DEIS and begin the process to prepare a supplemental DEIS (SDEIS) that would address the changed conditions in the project area. This was published in the Federal Register on July 20, 2012. While we discontinued the formal comment period on the DEIS, we did invite any comments on the changed conditions in the project area by September 7, 2012.

We received comments from the following Federal, State, and local agencies, tribes and groups prior to the discontinuation of the comment period.

- Village of Ruidos Mayor
- Congressman Stevan Pearce
- Office of the State Engineer
- United States Geological Survey
- Environmental Protection Agency
- US Department of the Interior Office of Environmental Policy and Compliance

Appendix C includes a summary of the all comments that we received and how they were used in preparing this document.

Throughout the development of this project and EIS, we have met multiple times with the applicant, the Eagle Creek Conservation Association, and the United States Geological Survey. We have also had discussions with the Office of the New Mexico State Engineer, the New Mexico Game and Fish Department, and members of Congress from the State of New Mexico.

List of Agencies, Organizations and Persons to Whom Copies of the EIS Were Sent

This environmental impact statement has been distributed to individuals who specifically requested a copy of the document. In addition, copies have been sent to the following Federal agencies (or agencies otherwise notified of availability), federally recognized tribes, State and local governments, and organizations:

- Advisory Council on Historic Preservation
- Alto Lakes Water and Sanitation District
- APHIS
- Chief of Naval Operations
- County of Lincoln
- Department of Energy
- Eagle Creek Conservation Association
- Eagle Creek Summer Home Association
- Federal Aviation Administration
- Federal Highway Administration
- Hopi Tribal Council
- Hopi Cultural Preservation Office
- Mescalero Apache Tribe
- National Agricultural Library
- National Oceanic and Atmospheric Administration Fisheries Service – Southwestern Office
- Natural Resource Conservation Service
- New Mexico Environment Department
- New Mexico Department of Game and Fish
- OEPC
- Pew Trusts
- Pueblo of Zuni
- Stevan Pearce, Congressman
- United States Environmental Protection Agency
- United States Fish and Wildlife Service
- United States Army Corps of Engineers
- United States Coast Guard
- Upper Hondo Soil and Water Conservation District
- Village of Ruidoso
- Ysleta del sur Pueblo

Glossary of Hydrology and Water Rights Terminology

Acre-foot – Volume of water required to cover 1 acre to a depth of 1 foot; equivalent to a volume of 43,560 cubic feet, approximately 325,829 gallons, or approximately 7,758 barrels of water.

Adjudication – A legal process that can settle the rights of two water right holders with respect to one another or it can settle all the rights to water within a particular water system. This process does not create new water rights, it only confirms existing rights. The completion of adjudication results in a court decree outlining the priority, amount, purpose (determination of use), periods, and place of water use.

Alluvial – Pertaining to material or processes associated with transportation or deposition of soil and rock by flowing water (e.g., streams and rivers).

Alluvium – Unconsolidated or poorly consolidated gravel, sands, and clays deposited by streams.

Andesitic – Consisting of a gray, fine-grained volcanic rock.

Appropriate – To take the legal actions necessary to create a right to take water from a natural stream or aquifer for application to beneficial use.

Appropriation – The right to take water from a natural stream or aquifer for beneficial use at a specified rate of flow, either for immediate use or to store for later use. Usually confirmed by a water court decree.

Aquifer – A body of rock that is sufficiently permeable to conduct groundwater and to yield economically significant quantities of water to wells and springs.

Base flow – The volume of flow in a stream channel that is not directly derived from surface runoff.

Basin yield – The amount of water that will flow from a drainage or catchment area in a given time.

Bedrock – A general term for solid rock that lies beneath soil, loose sediments, or other unconsolidated material.

Beneficial use of water – The use of water by man for any purpose which benefits are derived, such as domestic, municipal, irrigation, livestock, industrial, power development, and recreation. Under the New Mexico Constitution beneficial use is the basis, the measure, and the limit of the right to use water; therefore, beneficial use of public water diverted or impounded by manmade works is an essential element in the development of a water right.

Borehole – The wellbore itself, including the open hole or uncased portion of the well. Borehole may refer to the inside diameter of the wellbore wall, the rock face that bounds the drilled hole.

Change (Water Right) - Process by which a water right is changed with respect to the point of diversion, place of use or nature of use.

Confined aquifer – An aquifer containing water between two relatively impermeable boundaries. The water level in a well tapping a confined aquifer stands above the top of the confined aquifer and can be higher or lower than the water table that may be present in the material above it. In some cases the water level can rise above the ground surface, yielding a flowing well.

Confluence – The act of flowing together; the meeting or junction of two or more streams; also, the place where these streams meet.

Conjunctive Water Use - Combined use of ground water and surface water.

Cretaceous – The geologic span of time between 145 and 65 million years ago.

Double-mass analysis – A technique where the cumulative volume is plotted to reveal changes in the slope of the line, which indicates a change in conditions.

Drainage – A region or area of no particular scale bounded peripherally by a water parting and draining ultimately to a particular watercourse or body of water.

Drawdown – The lowering of the elevation of the groundwater level from pumping wells. At the well, it is the vertical distance between the static and the pumping level.

Effluent – The water leaving a water or wastewater treatment plant.

Effluent exchange – The practice of using wastewater effluent as a replacement source for diversion of water upstream.

Evapotranspiration – The portion of precipitation returned to the air through evaporation and plant transpiration.

Flow frequency – statistical analysis that results in the percentage of time that specified discharges are equaled or exceeded. These results are often graphed in the form of an exceedance curve.

Formation – A body of rock that is sufficiently distinctive and continuous that it can be mapped. In stratigraphy, a formation is a body of strata of predominantly one type or combination of types; multiple formations form groups, and subdivisions of formations are members.

Groundwater – Generally, all subsurface water as distinct from surface water; specifically, that part of the subsurface water in the saturated zone (a zone in which all voids, large and small, ideally are filled with water under pressure equal to or greater than atmospheric).

Hydrograph – A graph showing stage, flow, velocity, or other hydraulic properties of water with respect to time for a particular point on a stream.

Intermittent stream – A stream that flows only part of the time or during part of the year.

Mitigate, mitigation – To cause to become less severe or harmful; actions to avoid, minimize, rectify, reduce or eliminate, and compensate for impacts to environmental resources.

Municipal Water - May come from either ground water or surface water. Once water has entered a municipal water system, it will be considered municipal water.

Nested wells – Multiple wells completed in a group that extend to differing elevations below the ground surface.

Perennial stream – A stream or reach of a stream that flows throughout the year.

Permeability – The capacity of soil, sediment, or porous rock to transmit water; the property of soil or rock that allows passage of water through it.

Point of Diversion (POD) - Point specified in a water right from which water is diverted from a source.

Porosity – The ratio (usually expressed as a percentage) of the volume of openings in rock or soil material to the bulk volume of the material. With respect to water, porosity is a measure of the water-bearing capacity of a formation.

Prior appropriation – The water law doctrine that confers priority to use water from natural streams based upon when the water rights were acquired. Water rights are confirmed by court decree; holders of senior rights have first claim to withdraw water over holders who have filed later claims.

Priority Date - Date of establishment of a water right.

Recharge – The introduction of surface water or groundwater to replenish groundwater storage in an aquifer.

Riparian – Pertaining to the banks of a river, stream, waterway, or other typically flowing body of water as well as to plant and animal communities along such bodies of water.

Runoff – That part of precipitation that appears in surface streams; precipitation that is not retained on the site where it falls and is not absorbed by the soil.

Storage coefficient – A measure of the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head or water level.

Supplemental well (from New Mexico Office of the State Engineer 1978) - The owner of a water right may drill and use a supplemental well upon making application but prior to the publication and hearing set out in Section 72-12-3 NMSA 1978, if:

> (1) the supplemental well is drilled into the same and only the same underground stream, channel, artesian basin, reservoir or lake as the well being supplemented; and
>
> (2) the supplemental well does not increase the appropriation of water to an amount above the existing water rights; and
>
> (3) an emergency situation exists in which the delay caused by publication and hearing would result in crop loss or other serious economic loss; and
>
> (4) the state engineer, after a preliminary investigation, finds that the supplemental well does not impair existing water rights, and grants him a permit authorizing the drilling and use of the supplemental well prior to publication and hearing.

Surface Water - All waters whose surface is naturally exposed to the atmosphere, e.g., rivers, streams, lakes, reservoirs, impoundments, ponds, springs.

Syenite – A light colored, coarse-grained igneous rock consisting mainly of feldspar.

Tertiary – The geologic span of time between 65 and 3 to 2 million years ago.

Unconfined aquifer – An aquifer containing water that is not under pressure; the water level in a well is the same as the water table outside the well.

Watershed – A drainage defined by the Watershed Boundary Dataset (NRCS et al. 2010) and identified by a 10-digit Hydrologic Unit Code (HUC-10).

Water diversion – May be measured at any number of locations: lake or stream intake structures, interim raw water meters, or at the raw intake meter at the beginning of a treatment plant.

Water production – Is always measured at the end of a treatment system, prior to release to the public as potable water.

Water Right - The right to use a specific quantity of water occurring in a water supply, on a specific time schedule, at a specific place and putting it to a specific beneficial use.

Water year – The 12-month period, October 1 through September 30. The water year is designated by the calendar year in which it ends. Therefore, the 2000 water year ended on September 30, 2000.

Well - Horizontal or vertical excavation or opening into the ground made by digging, boring, drilling, jetting or driving for utilizing or monitoring underground waters.

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Appendix A – Public Scoping Results

Responses to Scoping

Contact (Letter No.)	Last Name	First Name	Organization
1, 2, 13, 14, 47, 60, 69, 99, 101	Midkiff	Bill	Eagle Creek Conservation Association
3, 41	Sugarman	Steve	Attorney, Eagle Creek Conservation Association
4	No name given		Pew Trusts
5	Kennedy	John	
6	Ibarra	Tomas	
7	Rodgers	Jimmy	
8	Rosky	Ivonne	
9	Bryant	Dan	Attorney, Village of Ruidoso
10	Peery	Roger	
11, 59	Hutchens	Terrell	Eagle Creek Summer Home Association
12	Loera	Javier	Ysleta del sur Pueblo
15	Medlock	Justin	
16	Rehfeld	Debbie	
17	Maue	Lisa	
18	Taylor	Clark	
19	Tam	Joseph	
20	Foster	Ron	
21	Hardeman	Ron	
22	Hill	Larry and Dorothy	
23	Adamy	Earl	Alto Lakes Water and Sanitation District
24, 27	McMaster	Terry (8 others signed onto this letter)	
25	Roybal	Julie	New Mexico Environment Department
26	Elliott	Criss	
28	Potter	Frank	
29	Hamilton	Stacy	
30	Carpenter	Clark	
31	Loddy	Rushie	
32, 42, 52, 100, 102a	Alborn Lee Jones	Ray Debbie Alvin	Village of Ruidoso Village of Ruidoso Attorney, Village of Ruidoso
33, 53, 57	Rice	Steve	

Contact (Letter No.)	Last Name	First Name	Organization
34	Sarber	Mrs. Greg	
35	Hoyle	Anita and Lynn	
36	Sedillo	Eileen (3 other board members signed this letter)	County of Lincoln
37	Sawinski	B.	
38	Davenport	Martin	
39	Mussers	Larry and Barbara	
40	Pearce	Stevan	Member of Congress, 2nd District, NM
43	Brunells	Bert	
44	Pippen	Bill	
45	Richardson	Donda	
46	Ruddle	Rick	
48	Arrowsmith	Janet	
49	Brown	Dixie	
50	Karn	William	
51	No name provided		Upper Hondo Soil and Water Conservation District
54	Davis, Jr.	Lloyd	
55	Sayner	Franklin	
56	Galaska	Henry and Rita	
58	Johns	John	Prudent Associates
61	Cassels	Kelly	Attorney, SBCandW law
62	Murphy	Bob and Lorraine	
63	Hulme	Phyllis and Bernie	
64	Hiser	Tom and Eloise	
65	Salas	Rafael R.	
66	Salues	James and Amy	
67	Myers	Frank and Kathe	
68	Mauldin	Michael and Victoria	
69	Mayfied	Marlene	
70	Smith	Janet	
71	Townsend	John and Theresa	
72	Yankee	William and Dot	
73	Hoats	Dennis	
74	Plymale	Allen and Linda	

Contact (Letter No.)	Last Name	First Name	Organization
75	McCullough	Harold	
76	Newsom	Glenda and Charlie	
77	Rivers	The	
78	Roberson	Max and Marilyn	
79	Hancock	Flloyd and Joe Alice	
80	Mimoso	Nancy and JE	
81	Beaty	Brett (8 others signed this letter)	
82	Calhoun	Roland and Sydney	
83	Sawyer	Mary	
84	Wittenger	Bernie	
85	Buckley	Verna	
86	Kirkman	Sue	
87	Lutrell	Johnnie and Tom	
88	St. John	Don	
89	Barnett		
90	Enlol	Terrie	
91	Swier	EV	
92	Kinyon	Bill	
93	Perry	Kenneth	
94	Hickman	Fred and Betty	
95	Johnson	Bob	
96	Borthomyger	Richard A	
97	Beyer	Lucy P	
98	Montgomery	Weldon	

a – Letter 102 came from Alvin Jones, Henninghausen & Olsen, LLP, attorney for the Village of Ruidoso and enclosed comments from Roger Peery (John Shomaker and Associates hydrogeologist) and Jackie D. Atkins, P. E. (Atkins Engineering and Associates).

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Appendix B - North Fork, South Fork and Eagle Creek Photos

Figure B 1. Eagle Creek Gage (November 2010)

Figure B 2. North Fork Gage (November 2010)

Figure B 3. South Fork Gage (November 2010)


Figure B 4. North Fork Eagle Creek (during wet spring of 2008)

Figure B 5. North Fork Eagle Creek along road (November 2010)

Figure B 6. Eagle Creek near Eagle Creek gage – dry conditions versus wet conditions (courtesy of USGS: left picture was taken by Nathan Myers on May 30, 2006, and right picture was taken by Nathan Myers on September 28, 2006).

Figure B 7. Confluence of South Fork and North Eagle Creek (November 2010)

Figure B 8. North Fork Eagle Creek lower end (November 2010)

Figure B 9. North Fork Eagle Creek upstream of the North Fork wells (Nov 2010)

Figure B 10. North Fork Eagle Creek upstream from the North Fork wells (Nov 2010)

Figure B 11. Eagle Creek diversion dam downstream of Eagle Creek gage (Nov 2010)

Figure B 12. Eagle Creek downstream of diversion dam (November 2010)

Figure B 13. Eagle Creek downstream of Alto Lake (November 2010)


Figure B 14. North Fork Well 3 (August 2011)

Figure B 15. North Fork Well 4 (November 2010)

Figure B 16. North Fork Well 1 (November 2010)

Appendix C – Summary of Public Comments Received Since 2012 DEIS

Introduction

We (USDA Forest Service, Lincoln National Forest) released the North Fork Eagle Creek Wells Special Use Authorization Project Draft Environmental Impact Statement (DEIS) on May 25, 2012. The notification of its availability for public comment was published in the Federal Register, a legal notice was published in the Ruidoso News, and email and letter notifications were distributed to all those on the project mailing list. Comments were requested by July 9, 2012. We received several requests for extensions to the comment period and Forest Supervisor Trujillo granted an additional 60-day extension, requesting all comments be submitted no later than September 9, 2012.

The Little Bear Fire started on June 4, 2012 and encompassed approximately 98 percent of the project area. Because of the substantial impact this wildfire had on the project area analyzed in the DEIS, Forest Supervisor Trujillo decided to stop the comment period on the DEIS and begin the process to prepare a supplemental DEIS (SDEIS) that would address the changed conditions in the project area. This was published in the Federal Register on July 20, 2012. While we discontinued the formal comment period on the DEIS, we did invite any comments on the changed conditions in the project area by September 7, 2012.

This document includes a summary of the comments that were received and how they are being used in preparation of the Supplemental Information Report and the SDEIS.

We also received comments from primary stakeholders in 2014 while developing this SDEIS and these comments are summarized here as well.

DEIS Commenters

The following table includes all comments (email, letters, or phone calls) that were either received on the DEIS before the suspension of the comment period, or on the request for information on changed conditions due to the Little Bear Fire, or during subsequent stakeholder coordination efforts in 2014 while preparing this SDEIS.

Table C 1. Listing of comments that were received on the DEIS or on the request for information on changed conditions in the North Fork Eagle Creek Project Area

Number	Date	Name	Affiliation	Type
1	June 1, 2012	Ray Alborn, Mayor	Village of Ruidoso	Request for comment period extension
2	June 12, 2012	Todd Willens, Chief of Staff	Congressman Stevan Pearce	Request for comment period extension
3	June 13, 2012	Steven Sugarman, Attorney	Eagle Creek Conservation Association	Request for comment period extension
4	June 20, 2013	Alan Cuddy, Hydrology Bureau	Office of the State Engineer	Information Request
5	June 22, 2012	Ray Alborn, Mayor	Village of Ruidoso	Request for supplemental DEIS preparation

Number	Date	Name	Affiliation	Type
6	June 25, 2012	Ann Marie Matherne	United States Geological Survey	Phone call record – monitoring well vandalized
7	July 2, 2012	Deborah Rehfeld		DEIS comment
8	July 3, 2012	Scott Verhines, New Mexico State Engineer	Office of the State Engineer	Request for supplemental DEIS preparation
9	July 4, 2012	Jean Public		DEIS comments
10	July 5, 2012	Rhonda Smith, Chief, Office of Planning and Compliance	Environmental Protection Agency	DEIS comments
11	July 9, 2012	Ray Alborn, Mayor	Village of Ruidoso	Supporting information (Daniel B. Stephans and Associates, Inc) submitted - request for supplemental DEIS preparation
12	July 12, 2012	Meeting between Lincoln NF and Eagle Creek Conservation Association members	Meeting notes	DEIS comments and project status update
13	August 29, 2012	Jackie D. Atkins, PE, Atkins Engineering	Consultant for Village of Ruidoso	Comments on Changed Conditions
14	August 30, 2012	Don Stockstill, President and others	Eagle Creek Conservation Association	DEIS comments
15	September 4, 2012	Stephan Spencer, Regional Environmental Officer	USDI Office of Environmental Policy and Compliance	DEIS review – no comments
16	September 6, 2012	Paul Cassidy, Aquatic Consultants, Inc.	Consultants for the Village of Ruidoso	Comments on changed conditions
17	September 6, 2012	Roger Peery, John Shomaker & Associates, Inc.	Consultants for the Village of Ruidoso	Comments on changed conditions (also includes review of the WHAT modeling technique)
18	September 17, 2012	Steven Sugarman, Attorney	Attorney for Eagle Creek Conservation Association	Comments from Balleau Groundwater, Inc. (consultants to Eagle Creek Conservation Association) on DEIS and on changed conditions
19	September 12, 2012	Alvin Jones, Attorney	Attorney for Village of Ruidoso	Comments from Parametrix, Inc. (consultants to Village of Ruidoso) on DEIS and changed conditions

Comments Received in 2014

We received input from Balleau Groundwater, Inc. in May and June 2014; Village of Ruidoso (with attached written comments from Alvin Jones, Atkins Engineering Associates, and John Shomaker and Associates, Inc.) in June 2014; and U.S. Geological Survey in June 2014 in relation to the preparation of the SDEIS. These comments were shared with the Interdisciplinary Team, discussed at an Interdisciplinary Team meeting on July 30, and considered while preparing this document.

Comment Consideration

We reviewed each comment letter and categorized them into subjects, highlighting the overall key concern, issue or suggestion made, as shown below. We paid particular attention to those comments that suggested new alternatives or provided specific comments on the existing range of alternatives presented in the DEIS. We provided all original letters to all members of the interdisciplinary team so each resource specialist could review comments related to their particular analysis and use them in preparation of their revised analyses for the supplemental DEIS. Each specialist paid particular attention to comments on changed conditions so these could be used in preparation of revised existing condition analyses in the project area following the wildfire.

Because we will be providing the supplemental DEIS to all stakeholders and those on our project mailing list (including all those listed here who commented on the DEIS or provided comments on changed conditions), we did not go through the detailed process of coding each of these 19 letters to identify each individual comment/concern with a detailed response. We will however, use this more structured and detailed process following the comment period on the SDEIS and prior to preparation of the Final EIS and the draft Record of Decision.

Comment Summary

Comments on the DEIS

Background

1. Acknowledge that the Eagle Creek gage used to be located approximately 360 feet downstream from its present location and this has an impact on the pre- and post-pumping comparisons on streamflow.

Purpose and Need

1. The SDEIS should include a revised purpose and need for action; the existing one is not sufficiently defined to determine the degree to which any of the alternatives would meet it. The SDEIS should include a valid and sufficient case for the proposed action, since the existing DEIS does not do this.
2. The management objectives should be reconsidered. The first objective, “Recognizing the importance of the well field to municipal water supply by providing water to the applicant…”, is flawed, subjective, and carried greater weight during the analysis than the second objective, “minimizing impacts of groundwater drawdown…and protecting water dependent ecosystems.”

3. The need statement related to the contribution of the North Fork wells to municipal water supply is overstated.

Alternatives and Adaptive Management Strategies

1. The SDEIS must include a presentation of effects as a difference from the baseline involving no continued pumping. The baseline used (current condition following 25 years of pumping) is not valid.
2. The SDEIS should acknowledge that the proposed alternative 3 would severely reduce streamflow and lower groundwater. It is misleading to state otherwise. It does not contain an effective adaptive management strategy.
3. Alternative 3 should not be selected; it will not result in improved flow.
4. Eagle Creek gage data should not be used in any adaptive management strategy.
5. Provide scientific credibility for use of average depth to water as a trigger and that this results in a cone of depression from pumping.
6. Consider clear the land through thinning to help improve the water table.
7. Consider that the proposed action did not line up with specialist reports and scientific evidence with some evidence being dismissed.
8. Consider our previous comments on the threshold triggers under the adaptive management strategy – these comments were dismissed by the ID team without rigorous review and without scientific basis.
9. The SDEIS should not characterize the continuation of current well pumping as a ‘no action’ alternative; this is not legally a no-action alternative and distorts the analysis.
10. The SDEIS should not include use of the Eagle Creek gauge as a proxy for North Fork flows. This is a flawed assumption since this gauge reflects flow in the North and South Forks.
11. The SDEIS should consider in detail alternatives on non-Forest Service land and outside the North Fork watershed.
12. The SDEIS should include a revised adaptive management strategy that monitors bedrock saturation (not depth to groundwater) and ensures a more immediate response time between a discontinuation of pumping and amelioration of the adverse impacts associated with pumping.
13. The SDEIS should include a revised adaptive management approach that is based on the model provided to the Forest Service that quantifies the relationship between pumping and streamflow.
14. The SDEIS should be based on the results of the aquifer tests described in the adaptive management strategy so that the results can be used in modeling the permeability of the alluvial underflow. The deeper zone bedrock aquifer tests called for by Forest Service are less pertinent.
15. The Forest Service should solicit the comments from the U.S. Geological Survey on the adaptive management strategy, particularly the use of the 300 acre-feet per year threshold. There can be no confidence that 300 acre-feet per year is stable or sustainable by simple comparison to recharge amounts.

16. The preferred Alternative 3 from the DEIS was flawed for a number of reasons including the fact that the adverse impacts on surface and groundwater resources that resulted from increased vegetation density in the North and South Forks of Eagle Creek were not considered. The DEIS and supporting documents wrongly assumed that all adverse impacts to surfacewater flow were the result of the applicant's pumping.
17. The alternatives must also consider future USDA Forest Service actions needed to keep the forest watershed healthy by managing vegetation density and fuels that will in tum maintain favorable supplies of water.
18. Discard adaptive management and propose a modeled level of impact acceptable to Forest Service.
19. Remove trigger 1 since it would establish a minimum instream flow which the USDA Forest Service has no authority to do in New Mexico.
20. Remove or change trigger 3 related to riparian vegetation. Reductions in pumping have been shown to have no effect on alluvial water levels.
21. The SDEIS should consider stream augmentation (at least a pilot program as part of the Special Use Permit) and correct errors in the discussion of the National Pollutant Discharge Elimination System permit process in chapter 2.
22. The SDEIS should remove the discussion of added storage capacity since it was done incorrectly.
23. Remove reference to Monitoring Wells MW4-B and C. This is the well that was vandalized. Both well casings were filled with gravel and fence posts. Some efforts were made to recover the wells, but this wasn't successful, so these wells are no longer operational.
24. The SDEIS should consider in detail the Eagle Creek Conservation Association-suggested alternative that allows the Village of Ruidoso to operate the North Fork pumps when the bedrock in the streambed is fully saturated:
    - Install new gage on North Fork Eagle Creek above the confluence with South Fork Eagle Creek
    - Install electronic monitoring switches on pumps and gages
    - Establish a minimum instream flow (we suggest 1.2 cubic feet per second based on the U.S. Geological Survey study)
        - When flows are below the minimum instream flow measured at the new gage, stop pumping (the switches on the pumps will automatically shut off)
        - When flow is greater than the minimum instream flow, continue pumping
    - Add storage capacity to the system so that more water can be pumped and stored during high flows
    - Authorize for a 10-year permit term with options for renewal
25. The SDEIS should include an analysis of this alternative:
    - Allow the Village of Ruidoso to pump up to 70 percent of the annual quantity of groundwater recharge that will occur post-wildfire. The calculation of groundwater recharge must not be performed using the chloride mass-balance method, nor be based on the hydrophobic soil conditions that will exist for the several years. This is essentially the same percentage of recharge that the USDA Forest Service selected for its preferred

Alternate 3 using the low-end recharge value calculated using the chloride mass-balance method as previous described.

- Monitoring would include streamflow, groundwater levels, surface-water quality, and riparian vegetation as provided below.
- Monitor groundwater levels in North Fork monitoring wells MW-1A, MW-1B, MW-1C, MW-3A, and MW-5A, and North Fork production wells H-1979 (North Fork 1), H-1981 (North Fork 3), and H-1982 (North Fork 4). Modifications will need to be made to North Fork production wells to allow water levels to be collected.
    - Monitoring frequency: hourly
    - Reporting frequency: quarterly
- Monitor streamflow at North Fork Eagle Creek gage (08387550), South Fork Eagle Creek gage (08387575), and Eagle Creek below South Fork (08387600).
    - Monitoring frequency: real time data as currently performed by U.S. Geological Survey
    - Reporting frequency: as currently provided on U.S. Geological Survey website
- Monitor surface-water quality above and below the cabins upstream of the North Fork Well field.
    - Monitoring frequency: annually
    - Reporting frequency: annually
- Monitor riparian vegetation survey in the historically intermittent reach below the cabins.
    - Monitoring frequency: every 5 years
    - Reporting frequency: every 5 years

Analysis

General

1. Too many assumptions and much of the analyses were based on qualitative evidence and opinions rather than quantitative scientific evidence. Modeling should be used to predict impact of alternatives.
2. The SDEIS should include larger project areas for both direct and indirect impacts and cumulative impacts. Those identified in the DEIS are too small and incorrectly drawn to account for where effects would be noticed. The cumulative effects study area must be revised to extend much farther east, at least to Picacho and Snowy River Cave BLM land, than shown on DEIS Figure 4.
3. The SDEIS must be based on the best available scientific data and all available credible science.
4. The EIS should be revised to follow the guidance of the best modern science and to become more quantitative by using a model simulation acceptable to Forest Service as recommended by U.S. Geological Survey and directed in the Forest Service Manual.
5. A proper impact analysis must isolate the action effects from the baseline of “no action conditions”. Climate change is not part of the impacts of the Forest Service action, and should not be presented in the section on environmental consequences of “action” effects.

6. The SDEIS should not include any conclusions drawn from the effects of future climate changes related to pumping and riparian vegetation; they are not well understood.
7. Remove discussion of climate change as a consequence of each alternative, and put a discussion in the baseline description of future conditions unaltered by Forest Service action. State the allowance in changed aquifer water levels and stream flow that will be acceptable to Forest Service for this special use.
8. Follow CFR and FSM on treatment of incomplete and unavailable information including evidence that contraindicates the proposed action.

Hydrology

1. Acknowledge that bedrock is dry due to the cone of depression.
2. Acknowledge that the North Fork Eagle Creek remains dry most of the time and that it is the only dry stream in Lincoln County, most of the time.
3. Provide for the protection of water sources for wildlife.
4. Correlate depth to water in National Forest System lands wells with the day of no flow in North Fork Eagle Creek.
5. Quantify available stream flow for use by the Village of Ruidoso.
6. Acknowledge the requirement for saturated bedrock as a prerequisite for surface flow.
7. Acknowledge that absence of flow in North Fork Eagle Creek results in no contribution to the flow measured at the Eagle Creek gage.
8. Complete additional hydrologic analyses including calculating “dry days” for the last 10 years (this information is documented but not previously reported) and if possible, determined how long artesian flows last.
9. The SDEIS should include revised Tables 2 and 11 with added columns showing the net change in available water among the alternatives. Available models have better numbers and quantify the transition from aquifer storage to stream depletion sources supplying the well field.
10. The SDEIS should include updated references to the most current version of the U.S. Geological Survey report. The DEIS must be revised to cite the correct U.S. Geological Survey report version. Any climate-change findings that depend on that out-of-date version must be reconsidered and rewritten.
11. The SDEIS should be based on controlled testing, quantitative modeling and priority analysis, as required by Forest Service Manual Guidance. Modeling results are available and should be used.
12. The SDEIS should include a revised Figure 4 showing the greater extent of modeled groundwater drawdown; the existing figure is not based on all data and modeling provided to the Forest Service by Balleau Groundwater, Inc.
13. The SDEIS should contain actual historic flow data for North Fork and available modeling data. It should be based on efforts to characterize actual flow in the North Fork, a central issue in the settlement agreement.

14. The SDEIS should not focus exclusively on the upstream direct impacts of the proposed project and should address the direct impacts downstream, as required in the settlement agreement.
15. The SDEIS should not conclude that the cone of depression caused by pumping has anything to do with the lack of riparian species recruitment; there may be a number of reasons unrelated to pumping.
16. The historic and current condition of the South Fork of Eagle Creek is also important to consider because surface-water flow was perennial in 1963 (U.S. Geological Survey 1963), but was not during the time the DEIS was being prepared.
17. The failure to assess the adverse impacts on watershed basin yield from increased vegetation in the North and South Fork Eagle Creek watersheds was arbitrary, and unfortunately led U.S. Geological Survey to develop alternative 3 of the DEIS, which was based on the premise that the watershed remains static, with the exception of pumping from the Village of Ruidoso's wells.
18. Use of the Web GIS-Based Hydrograph Analysis Tool (WHAT) model as part of the hydraulic analysis for the DEIS was inappropriate.
19. The watershed conditions as classified by the USDA Forest Service "Watershed Condition Framework" and as included in the DEIS are no longer valid as a result of the Little Bear Fire. In fact, the watershed was impaired prior to the development of the DEIS as a result of the USDA Forest Service fire exclusion policy and the USDA Forest Service exclusion of thinning or timber harvesting projects.
20. Calculations of pumping drawdown from the applicant's wells and impacts on springs and seeps must be updated to include changes in the watershed basin yield. Drawdown impacts will ultimately be reduced as a result of increased basin yield (surface-water flow and groundwater recharge).
21. For the Supplemental Information Report and SDEIS, any model used to simulate effects from pumping the Village of Ruidoso's wells must developed to address the inadequacies of the existing Balleau model (2004) as identified by AECOM (2011). Additionally, a new model must take into account dynamic recharge to the groundwater system including leakage from the ephemeral channel of the North Fork of Eagle Creek to the well field area, and increased surface-water flows and increased recharge that will occur as a result of the Little Bear Fire. This modeling can be readily accomplished using the MODFLOW code that is readily available and commonly used by hydrologists and hydro geologists.
22. The trade-off of reduced diversions from North Fork wells and increased diversions from Eagle Creek surface water should be recognized.
23. Use a quantitative model to evaluate hydrologic conditions and changes in terms of projected volumes and rates due to the special use authorization. Discard the discussion of subjective qualitative effects.
24. Describe quantitatively the projected effects on downstream well and surface water rights due to the special use authorization.
25. Complete the field tests of alluvial aquifer permeability as a basis for quantifying flow to be routed via that material, expected to be a minor fraction of 1.2 cubic feet per second.

26. Discard the discredited idea that pumping a certain fraction of basin recharge is a “safe starting-point” in terms of drawdown and stream depletion.
27. Correct erroneous numbers on diversions, worst case scenarios, commitment of resources, and misstatements of the content of Balleau Groundwater references.
28. Remove reliance of the Balleau-modeled draw down contour for determining which springs and seeps may be affected

Wildlife and Aquatic Habitats

1. The SDEIS should acknowledge our specific review comments on the aquatic habitat section and the biological analysis (Letter 16, Aquatic Consultants, Inc.). Monitoring parameters on post wildfire perennial systems in the southwest (e.g., precipitation, stream profile, runoff, suspended sediment, water temperature, and pH) are long term in nature (up to ten years), and typically compiled to determined when systems can be re-populated. Aquatic Consultants, Inc. believes that these parameters can only be applied to perennial stream systems and any management triggers associated with the SDEIS should only be applied to perennial waters as intermittent waters are not viable fisheries.
2. Omit fish from the list of significant issues since pre-pumping conditions would not support fish due to the intermittent nature of the stream.

Riparian

1. The SDEIS should not be based on the assumption that pumping at current levels will result in a reduction of vegetation cover and species diversity; there is no evidence to support this. The existing record of pumping over the last 25 years has demonstrated conclusively that current pumping levels have not adversely affected riparian vegetation in the project area.
2. The SDEIS should not be based on any connections between riparian vegetation and pumping from the well field until this connection is firmly established. This can only be done with a multi-year survey that establishes baseline conditions of the riparian habitat in the project area, but also demonstrates measurable trends in vegetation density and diversity that correlate to annual pumping volumes.
3. The USDA Forest Service was asked to address the rooting depths of riparian vegetation adjacent to the intermittent and perennially portions of the North Fork Eagle Creek, vegetation need and timing for soil moisture, minimum groundwater depth for plant survival, and any other specific requirements needed for the survival of the riparian vegetation along the stream channel. The Supplemental Information Report and the SDEIS need to include all of the aforementioned specific requirements needed for riparian vegetation. Presumably the USDA Forest Service would have a qualified expert to provide this information. The Supplemental Information Report and SDEIS should note that after more than 20 years of pumping from the applicant's North Fork Eagle Creek wells that no adverse impacts to riparian vegetation were documented.

Socioeconomics & Water Rights

1. The SDEIS water rights analysis should be expanded to the area of cumulative impact seen in approved models in terms of drawdown contours and stream depletion, at least to the stream reach of plaintiff’s diversions at Picacho. A priority analysis of impacts on all senior water users, plus effects on the Pecos River Compact, due to Forest Service authorizing access to the conditional junior-most right on the Rio Hondo must be included.

2. The SDEIS must address the impacts on the Gerald Ford and Eagle Creek Conservation Association concerns about comprehensive rights.
3. The SDEIS should not understate the significance of adverse environmental and socioeconomic impacts and overstate the impacts on water supply and only selectively uses credible science.
4. The SDEIS needs to evaluate effects to environmental resources as well as senior water rights holders, and make distinctions between junior and senior water rights holders. This should be abdicated to the Office of the State Engineer.
5. The SDEIS should consider impacts to irrigation water supply.
6. The Supplemental Information Report and SDEIS must evaluate existing water rights and existing wells in more detail if the SDEIS intends to continue to address potential impacts from the applicant's wells in the cumulative impacts area outside of National Forest System lands. As previously mentioned by John Shomaker and Associates, Inc. and the applicant to the USDA Forest Service, most of these data are readily available at the New Mexico Office of the State Engineer website http://www.ose.state.nm.us/.
7. The SDEIS should correct errors in the reported current water right for the Village of Ruidoso.
8. The Forest Service, through the SDEIS should not establish a minimum instream flow because this is under the jurisdiction of the New Mexico State Engineer.
9. The SDEIS should not include an analysis of impacts to domestic wells since no data have been assembled or correlated, they are junior water rights holders.
10. The SDEIS should remove reference to streamside recreational use as a significant issue.

Comments on Changed Conditions

Resource Analysis

1. The Little Bear Fire has clearly altered the surface hydrology of the North Fork Eagle Creek basin, and to the extent surface hydrology is connected to groundwater hydrology, also altered the groundwater hydrology.
2. The effects of the Little Bear Fire are likely to further complicate the natural hydrological processes in the North Fork Eagle Creek basin, and therefore, further diminish the validity and usefulness of the DEIS.
3. The effects of the Little Bear Fire will make it nearly impossible to interpret the cause of near-term effects to riparian vegetation in the project area if changes are made to pumping levels during the next five to ten years. This is particularly true since no other sufficiently similar riparian habitats were found in the region to use as a reference or control.
4. The effects of the Little Bear Fire will result in reduced actual evapotranspiration from moist soil and from the riparian shallow water table. An increase in basin yield via surface runoff and water-table recharge is expected for the period until vegetation recovers to evapotranspiration levels associated with normal canopy volume.
5. The effects of the Little Bear Fire will include an increase in burn-associated ash and sediment that can affect surface diversions and reservoirs. Fire effects on the applicant,

however, are relatively short-term and are not a suitable basis for deciding on this long-term special use authorization.

6. Adverse impacts the wildfire has had on the applicant's ability to use its surface water and groundwater. The applicant's ability to exercise its surface-water rights has been adversely impacted as a result of the wildfire and the applicant must rely more heavily on its groundwater wells, both on and off National Forest System lands, to meet the demands of the community. These alternatives must account for the changes that will continue to occur in the watershed as the watershed begins to stabilize.
7. The Little Bear Fire destroyed a significant amount of the vegetation in the North and South Fork watersheds of Eagle Creek.
8. It is well documented that surface-water runoff and soil erosion dramatically increase after a wildfire such as the Little Bear Fire (DeBano et al., 1998; USDA, March 2003; USDA, 2005; Tillery et al., 2011; USDA Forest Service, 2012; Moody and Martin, 2004). USDA Forest Service BAER Team (2012) estimates a surface-water increase of 128 percent for the upper portion of the North Fork of Eagle Creek, and a 70- to 80-percent increase in runoff near the Eagle Lakes on the South Fork of Eagle Creek assuming only a 25-year 1-hour storm event. Runoff estimates in the lower portions of the watersheds below these points were not provided by the BAER Team (USDA Forest Service 2012).
9. Surface-water quality has been impaired due to the production of large quantities of ash and sediment (USDA Forest Service, 2012), and other constituents. The BAER Team report (USDA Forest Service, 2012) estimated a pre-wildfire soil erosion rate of 1 ton per acre and that the post-wildfire soil erosion will be up to 97 tons per acre.
10. The BAER Team (USDA Forest Service, 2012) indicates that geologic conditions within the burned area have already experienced changes. Changes identified (USDA Forest Service, 2012) include "gravitational slumping, soil movement, rock falls, and debris/mud flows." The BAER Team report (USDA Forest Service, 2012) also indicates that many areas are in jeopardy of mass wasting as indicated below. Areas within the North and South Forks of Eagle Creek are within the "cited areas" mentioned below.
11. The BAER Team report (USDA Forest Service, 2012) indicates significant risks are expected to riparian habitat including vegetation and channel morphology. The report also indicates that warming of the surface waters as a result of the loss of shade along the creek will have adverse "impacts to or loss of aquatic habitat for fish and macro-invertebrates."
12. The BAER Team report (USDA Forest Service, 2012) also indicates that there may be adverse impacts to wildlife, fish, and the habitat which the Threatened (Mexican Spotted Owl) and Sensitive (Northern goshawk and bald eagle) species rely upon.
13. The Supplemental Information Report and SDEIS must consider the effects of the fire on springs and seeps.
14. The cumulative effects from pumping the applicant's North Fork Well field are clearly masked by the cumulative effects of the Little Bear Fire. The Supplemental Information Report and SDEIS should acknowledge this fact and clearly define the cumulative effects of the fire on the North and South Fork watersheds and downstream users so that the effects from the wildfire can be analyzed separately from the applicant's pumping. The cumulative effects analysis should clearly document the wildfire impacts on the applicant's surface and

groundwater supplies in the Eagle Creek basin and the adverse impacts on the applicant's right to put its surface and groundwater rights to beneficial use.

15. Aquatic Consultants, Inc. would suspect that the brook trout population has been eradicated, or will be shortly, in the creek due mainly to the ash, sediment loads, and debris torrents from post fire flood events. Based on Aquatic Consultants, Inc. study of post fire effects to fish and fish habitats in New Mexico, we believe that the majority of these same effects will be experienced in the North Fork Eagle Creek.
16. The monthly calibrated Balleau Groundwater model remains available for use as offered in 2011. It is suitable for simulating watershed burn scenario
17. The water resource analysis should be updated since accessible available quantities of water changed.
    - Estimated duration of no flow conditions at Eagle Creek Gage changed.
    - Estimated occurrence of flows equal to or greater than 1.2 cubic feet per second at Eagle Creek Gage changed.
    - Water quality based on temperature: Anticipated occurrence of periods when midday streamflow temperatures during May-October would exceed 68 degrees Fahrenheit at the Eagle Creek Gage would change.
    - Impacts (if any) to springs, seeps and domestic wells based on drawdown would change.
    - Cumulative effects within the cumulative impact area would change.
18. The aquatic habitat and fish analysis should be updated since increased basin yield and recharge would result in changes in drawdown and less adverse effects to the water table and to streamflow conditions, resulting in less impact on aquatic habitat and fish.
19. The riparian vegetation analysis should be updated since increased streamflow as a result of increased basin yield would result in fewer impacts to riparian vegetation along the stream corridor.
20. The socioeconomics analysis should be updated because municipal diversions could possibly be substantially increased as a result of increased basin yield. The section of the EIS predicting future municipal water diversions availability based on the past streamflow gage data would be completely out of date and not applicable.
21. The water right analysis should be updated. Due to increased basin yield the Village of Ruidoso should be able to divert more municipal water for beneficial use. The increase in basin yield and increase in recharge is not predictable from the past Eagle Creek Gage data due to the changed evapotranspiration rates and could not be finally determined until the North Fork of Eagle Creek drainage area conditions stabilized after a number of years.
22. Due to the dynamic and changing nature of the basin yield, recharge and stream runoff and base flow conditions during the initial unstable condition in the North Fork drainage area, no realistic predictions can be made until the drainage area becomes somewhat stable. The time frame for evaluation of the changed water resources conditions necessary for the supplemental DEIS would need to extend into the final more stable conditions of basin yield and recharge/discharge conditions for the North Fork of Eagle Creek drainage area. Therefore, all of the other contemplated re-analysis of resources reports would also need to wait until the water resources report update in the future.

Purpose and Need & Alternatives

1. Given the changes in the watershed, the USDA Forest Service should eliminate existing Alternative 3 and develop new alternatives. As will be explained in more detail below, the management triggers (monitoring indicators) developed by the USDA Forest Service as part of Alternative 3 that would be used to limit pumping from the Village's North Fork well field are no longer applicable.
2. Nearly all aspects of the current DEIS need to be updated because of fire-related damage to the watershed.
3. The Supplemental Information Report and SDEIS must consider post-wildfire changes to streamflow quantity, and the fact that streamflow will continue to change as vegetation is re-established in the watershed. Changes in the streamflow will include initial quick peak flow responses to precipitation events (including flash flooding) with little baseflow for a period of time following the wildfire, and in fact, this has already occurred. The Supplemental Information Report and SDEIS must consider streamflow changes over time as the watershed begins to stabilize. Any alternative that uses minimum streamflow conditions as management triggers as a rationale to reduce the applicant's pumping are not appropriate until such time that watershed conditions stabilize and post-wildfire streamflow conditions can be evaluated.
4. The stream gauges are no longer reliable. The fact that the gages have not accurately represented streamflow in the Eagle Creek watershed must be taken into consideration as alternatives and associated management triggers are developed for the SDEIS.
5. Any comparisons to groundwater and surface-water conditions before pumping began in 1988 are now irrelevant. This is because the watershed has been severely altered by the Little Bear Fire and surface-water runoff and groundwater recharge will be vastly different than prior to the fire. As previously mentioned, it will take years before hydraulic conditions in the watershed begin to stabilize. The Supplemental Information Report and SDEIS will need to acknowledge this fact and develop other methods for assessing current and future conditions as mentioned in previous sections of this letter. Any triggers related to streamflow quantity or groundwater depths are inappropriate at this time.
6. Surface water temperatures proposed in the Draft EIS are no longer valid and must be reevaluated.
7. Surface water quality has been negatively impacted by the ash and increased sediment load (turbidity).
8. The post-wildfire impacts to water quality, including increased water temperatures, sediment load, ash, and other contaminants will adversely affect their ability to survive. The SIR and SDEIS must address these issues. Any management triggers related to water quality and water temperature must be removed from the SDEIS.
9. The purpose and need for action should be revised or changed based on the effects of the Little Bear Fire.
10. Monitoring parameters on post wildfire perennial systems in the southwest (e.g., precipitation, stream profile, runoff, suspended sediment, water temperature, and pH) are long term in nature (up to ten years), and typically compiled to determined when systems can be re-populated. Aquatic Consultants, Inc. believes that these parameters can only be applied to perennial stream systems and any management triggers associated with the SDEIS should only be applied to perennial waters as intermittent waters are not viable fisheries.

References Provided

Harris and Lindquist 2000. Harris, Richard R. and Donna Lindquist, Riparian vegetation establishment and survival on Caples Creek and Kirkwood Creek, Summer, 2000, October, 2000, online URL: http://www.project184.org/doc_lib/documents/2011/RVRMP-FINAL.pdf

BGW groundwater flow model files, with explanations, provided to the Forest Service in 2011

USGS Report Revision History from 2010

FSM 2540

Multiple references cited in Comment Letter 17 (Shomaker and Associates)

New Mexico Fish and Game Department fish stocking report data

2001 – 2012 North Fork Well production records with percent of total diversion

Revised State Engineer List of Rio Hondo-Bonito-Ruidoso Stream Surface Water Right Priorities (1987)

The interdisciplinary team used all of these comment letters, cited literature, and this summary provided here as important information in preparing the Supplemental Information Report (January 2014), revising individual resource reports and preparing the SDEIS. Meetings with both the Village of Ruidoso and Eagle Creek Conservation Association representatives continue to discuss overall project status and to gather any additional data or information they may be aware of that would inform our analysis in the SDEIS.

Next Steps

Once the SDEIS is released for the 45-day public comment period (expected fall 2014) and all comments are received, we will conduct a thorough comment analysis process at that time, coding, categorizing and providing a written response to all individual comments received by the end of the comment period. These comments will be used in preparation of the Final EIS and the draft Record of Decision. We anticipate continued contact and communication with project stakeholders throughout this process as the SDEIS and then the subsequent FEIS are prepared.

Appendix D – Photos of Post-Little Bear Fire Conditions

Figure D 1. The crossing of the North Fork of Eagle Creek near monitoring well MW-1 looking north (August 22, 2012)

Figure D 2. Just south of the North Fork crossing, above the North Fork gage, looking southeast (August 22, 2012)

Figure D 3. Looking southeast to the North Fork crossing upstream of the North Fork gage (August 22, 2012)

Figure D 4. View to the northeast of the North Fork, above the North Fork gage - the view is of debris in an unnamed drainage (August 22, 2012)

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