ACTION SHEET
PUBLIC UTILITES COMMITTEE MEETING OF 8/5/15

ISSUE NO. 20

Request for approval of the Cost Share Agreement between the City of Santa Fe and the USDA, Forest Service, Santa Fe National Forest (USFS), in the amount of $240,000.00 over four (4) years, for reimbursement of project costs and actual expenses incurred by the USFS in accordance to the vegetation management plan within the 2013 Santa Fe Municipal Watershed Management Plan, passed per Resolution No. 2009-87. (Alan Hook)

Public Utilities Committee – 8/5/15
Finance Committee – 8/17/15
City Council – 8/26/15

PUBLIC UTILITES COMMITTEE ACTION: Approved to forward to 8/17/15 Finance Committee.

SPECIAL CONDITIONS OR AMENDMENTS:

STAFF FOLLOW UP:

VOTE:	FOR	AGAINST	ABSTAIN
COUNCILOR RIVERA, CHAIR	X		
COUNCILOR MAESTAS	X		
COUNCILOR BUSHEE	X		
COUNCILOR DIMAS	Absent		
COUNCILOR IVES	X		

City of Santa Fe, New Mexico

memo

Date: July 28, 2015

To: Public Utilities Committee
Finance Committee

Via: Nick Schiavo, Public Utilities & Water Division Director NSA

From: Alan G. Hook, Water Resources Coordinator Assistant & Santa Fe Municipal Watershed Program Manager A.G.H.

Subject: Request for approval of the Cost Share Agreement between the City of Santa Fe and the USDA, Forest Service, Santa Fe National Forest (USFS), in the amount of $240,000 over 4 years, for reimbursement of project costs and actual expenses incurred by the USFS in accordance to the vegetation management plan within the 2013 Santa Fe Municipal Watershed Management Plan, passed per Resolution #2009-87

Background

Like many cities throughout the western United States, Santa Fe's water supply is dependent upon forest health and protection from catastrophic wildfire. This collection agreement acknowledges goals and recommendations described in the 2013 Santa Fe Municipal Watershed Management Plan, a plan jointly developed between the U.S. Forest Service, the City of Santa Fe and other stakeholders. The 2013 Santa Fe Municipal Watershed Management Plan was a revision of the 2009 Santa Fe Municipal Watershed 20 Year Protection Plan as approved by the governing body per Resolution #2009-87 (please, see Attachment III). Santa Fe Municipal Watershed Management Plan (WMP) provides a framework and funding mechanism for the needed long-term stewardship of the Watershed. The WMP provides recommendations for vegetation management, water resource management, public education/outreach, and funding for the work. It is unique in that it seeks to fund forest restoration activities using the Payment for Ecosystem Services model as an insurance policy against future threats, particularly of catastrophic fire, to the municipal water supply.

The purpose of this collection agreement (please, see Attachment I) is to document the cooperation between the parties to provide a means to support the protection of the Santa Fe Municipal Watershed, located on lands administered by the U.S. Forest Service and the City of Santa Fe in accordance with the provisions of the collection agreement and hereby incorporated within the Operating and Financial Plan (please, see Attachment II).

Furthermore, with passage of the collection agreement the City of Santa Fe Water Division will benefit from the NMFA Water Trust Board's award of $150,000 in funding toward the Watershed Restoration and Management Project. However, item #5 of the Readiness to Proceed Items, verification of executed cost share agreement with the US Forest Service is required by September 30, 2015 to receive this funding (please, see Attachment IV).

Recommendation

Water Division staff requests approval of the Cost Share Agreement between the City of Santa Fe and the USDA, Forest Service, Santa Fe National Forest (USFS), in the amount of $240,000 over 4 years, for reimbursement of project costs and actual expenses incurred by the USFS in accordance to the vegetation management plan within the 2013 Santa Fe Municipal Watershed Management Plan, passed per Resolution #2009-87.

CITY OF SANTA FE PROCUREMENT CHECKLIST

Contractor Name: USDA, US Forest Service, Santa Fe National Forest

Procurement Title: Cost Share Agreement between the City of Santa Fe and the USFS, Santa Fe National Forest in the amount of $240,000 over 4 years for vegetation management within the Santa Fe Municipal Watershed.

Solicitation RFP/RFB#: N/A

Other Methods: State Price Agreement X ***Cooperative*** ☐ ***Sole Source*** ☐ ***Exempt*** ☐ ***Other*** ☐

Department Requesting/Staff Member Public Utilities/Water Division/ Alan G. Hook

Procurement Requirements:
A procurement file shall be maintained for all contracts, regardless of the method of procurement. The procurement file shall contain the basis on which the award is made, all submitted bids and proposals, all evaluation materials, score sheets, quotations and all other documentation related to or prepared in conjunction with evaluation, negotiation, and the award process. The procurement shall contain a written determination from the Requesting Department, signed by the procurement officer, setting forth the reasoning for the contract award decision before submitting to the Committees.

SOLICITATION*

YES	N/A	
X	☐	*Project Beginning History (council requests, etc.)* ***Resolution 2009-87***
☐	X	*Budget Determination (FIR) attach*
☐	X	Solicitation document (RFP, IFB),
☐	X	Screen print of legal solicitation published in newspapers, web sites, etc.:
☐	X	Screen print of addendum(s) published on the IPB/RFP:
☐	X	Pre-Bid/Pre-Offer Conference attendance sheet and other documents
☐	X	If canceled, screen print of cancellation of solicitation notice
☐	☐	Other:

EVALUATION*

YES	N/A	
☐	X	Blank evaluation form
☐	X	Evaluator's names and profiles
☐	X	Evaluation procedures or evaluation instructions
☐	X	Conflict/Confidentiality Forms signed by all Evaluators, Technical Advisors, Reviewers, and any person who assists in regard to the bid/proposal, evaluation and/or award
☐	X	Bid or Offer opening sheet(s) (If RFP, then two offer opening sheets, one for technical and one for cost)
☐	X	Screen print of Bidder/Offeror's detailed information
☐	X	Responsiveness review sheet or other sheet documenting responsiveness for each Bidder/Offeror, attach requests for additional information to cure items
☐	X	Non-Responsive/Non-Responsibility Form and correspondence or letters from Department to vendor regarding disqualifications
☐	X	Oral presentations (sign-in sheets, presentation materials, etc.)
☐	X	Documentation sent to Bidders/Offerors and responses received regarding clarifications, decisions, negotiations, and/or best and final offers, etc.
☐	X	Reference Reviews/Reference Check Questionnaires
☐	X	Individual evaluations included for each RFP.

*

☐	X	Pricing evaluation
☐	X	Final overall evaluation matrix or summary of evaluator scores
☐	☐	Other: _____

AWARD*

YES	N/A	
X	☐	Fully executed Memo to Committees from the Department with recommendation of award
☐	X	Winning proposal (this is a copy that has all confidential/proprietary information excluded)
☐	X	Screen print of Contract Award Notice
☐	X	Screen print of Award Notice published on agency website
☐	X	Email or notification sent to all Bidders/Offerors that award was made
☐	X	Waiver or "No Action Taken" from Procurement Office
☐	X	Correspondence with Procurement Office regarding waiver
☐	X	If IFB and not awarded to lowest responsive, responsible bidder; written explanation
☐	☐	Other: _____

DISCLOSURES

YES	N/A	
		Contractor Disclosures & Conflicts of Interest
☐	X	Disclosures & Conflicts of Interest Form(s) (winning bidder(s)/offeror(s))
		Contractor –Conflicts of Interest
☐	X	Purchasing Office Letter or e-mail to designated individual regarding potential conflict
☐	X	Conflict of Interest Form signed by all parties
☐	X	Letter from Procurement Office regarding the potential conflict
		Subcontractor Disclosures
☐	X	Disclosures & Conflicts of Interest form of Subcontractor(s)
		Subcontractor –Conflicts of Interest
☐	X	Purchasing Officer Letter or email to designated individual regarding potential conflict
☐	X	Conflict of Interest form signed by all parties
☐	X	Letter from Legal Office regarding the potential conflict
☐	X	Other: _____

CONTRACT

YES	N/A	
☐	X	Copy of Executed Contract ***Still Pending***
☐	X	Copy of all documentation presented to the Committees ***Still Pending***
☐	X	Finalized Council Committee Minutes ***Still Pending***
☐	☐	Other: _____

MISCELLANEOUS FILE*

YES	N/A	
☐	X	Local Preference Form
☐	X	New Mexico Residence Form
☐	X	Veterans Exemption
☐	X	**Sole Source determination form approved by Procurement Officer**
☐	X	**Exempt determination memo approved by Procurement Officer**
☐	☐	Other: _____

*

Include all other substantive documents and records of communication that pertain to the procurement and any resulting contract.

Please, see the attached Memo and Attachments I-V related to the memo and the approval of the cost share agreement.

PROTEST (If applicable)*

YES	N/A	
☐	*X*	Documentation from protester filed with the Purchasing Office
☐	*X*	Letter from Department to Purchasing Office Providing response to protest
☐	*X*	Letter from Purchasing Officer to protester and Department on final outcome
☐	☐	Other: _____

Create a separate file folder which may contain any documents with trade secrets or other competitively sensitive, confidential or proprietary information.

YES	N/A	
☐	*X*	Original bid(s) or proposal(s) with no redactions.
☐	*X*	Documentation exempt - Proprietary, Confidential, Competitively Sensitive, or Trade Secret (i.e. e-mails, proposals, or letters)

Alan G. Hook, Water Resources Coordinator Assistant

Department Rep Printed Name and Title

Alan G. Hook

Department Rep Signature attesting that all information included

_____

Purchasing Officer attesting that all information is reviewed

*

FS Agreement No. 15-CS-11031000-003
Cooperator Agreement No. _____

CHALLENGE COST SHARE AGREEMENT
Between the
CITY OF SANTA FE
And The
USDA, FOREST SERVICE
SANTA FE NATIONAL FOREST

This Supplemental Project Agreement (SPA) is hereby made and entered into by and between the City of Santa Fe hereinafter referred to as "the City" and the USDA, Forest Service, Santa Fe National Forest hereinafter referred to as the "U.S. Forest Service," under the authority: Department of Interior and Related Agencies Appropriation Act of 1992, Pub. L. 102-154.

Background: Like many cities throughout the western United States, Santa Fe's water supply is dependent upon forest health and protection from catastrophic wildfire. This agreement acknowledges goals and recommendations described in the Santa Fe Municipal Watershed Management Plan (**2013**), a plan jointly developed between the U.S. Forest Service, the City of Santa Fe and other stakeholders. The Watershed Management Plan (WMP) provides a framework and funding mechanism for the needed long-term stewardship of the Watershed. The WMP provides recommendations for vegetation management, water resource management, public education/outreach, and funding for the work. It is unique in that it seeks to fund forest restoration activities using the Payment for Ecosystem Services model as an insurance policy against future threats, particularly of catastrophic fire, to the municipal water supply.

Title: **City of Santa Fe Watershed Projects**

I. PURPOSE:
The purpose of this agreement is to document the cooperation between the parties to provide a means to support the protection of the Santa Fe Watershed, located on lands administered by the U.S. Forest Service and the City of Santa Fe in accordance with the following provisions and the hereby incorporated Operating and Financial Plan, attached as Exhibit A.

II. STATEMENT OF MUTUAL BENEFIT AND INTERESTS:
The U.S. Forest Service and the City recognize that a large portion of Santa Fe's water supply is dependent upon forest health and protection from catastrophic wildfire. With a common vision as described in the Watershed Management Plan, the U.S. Forest Service and the City can most effectively marshal resources to support long-term management to provide for the health of the watershed through targeted prescribed burns within the Santa Fe Municipal Watershed.

In Consideration of the above premises, the parties agree as follows:

III. THE CITY SHALL:

A. LEGAL AUTHORITY. The City shall have the legal authority to enter into this agreement, and the institutional, managerial, and financial capability to ensure proper planning, management, and completion of the project, which includes funds sufficient to pay the nonfederal share of project costs, when applicable.

B. PAYMENT/REIMBURSEMENT. The City shall reimburse the U.S. Forest Service for the City's share of agreed upon project costs and actual expenses incurred, not to exceed **$240,000.00**, as shown in the Financial Plan (Exhibit A). The Department shall make payment upon receipt of the U.S. Forest Service's Bill for Collection.

C. AVAILABILITY OF FUNDS. The Department's funds in the amount of **$240,000.00** are currently available for performance of this agreement through **06/01/2019**. The Department's obligation for performance of this agreement beyond this date is contingent upon the availability of appropriated funds from which payment can be made. No legal liability on the part of the Department for any payment may arise for performance under this agreement beyond **06/01/2019** until funds are made available to the City and the U.S. Forest Service receive(s) notice of availability to be confirmed in a written modification by the Department.

D. Participate in the implementation of the Watershed Management Plan (WMP), including but not limited to developing the annual work plan, participating in the vegetation treatments, education/outreach, and other portions of the WMP.

IV. THE U.S. FOREST SERVICE SHALL:

A. Perform in accordance with the attached Financial Plan.

B. REIMBURSABLE BILLING. The U.S. Forest Service shall bill the City monthly as of June 30 for funds sufficient to cover the costs for the specific payment period. All reimbursement billings must be completed within the same fiscal year as U.S. Forest Service expenditures. Overhead is waived as a result of mutual benefit.

Billings must be sent to:

City of Santa Fe Water Division
Attn: Alan G. Hook or Maya Martinez
Water Resources & Conservation
Sangre de Cristo Water Division
801 W. San Mateo Rd.
Santa Fe, NM 87504

The U.S. Forest Service is required to issue bills for expenditures incurred under reimbursable agreements at the end of or prior to the end of each fiscal year. Therefore, an out-of-cycle bill may be received by the City.

If payment is not received to the satisfaction of the U.S. Forest Service by the date specified on the Bill for Collection (Form FS-6500-89), the U.S. Forest Service shall exercise its rights regarding the collection of debts owed to the United States. Conditions specified in an associated payment bond guaranteeing payment must also be met.

C. SPECIAL BILLING REQUIREMENTS – FINANCIAL DOCUMENTATION. The U.S. Forest Service shall provide an itemized statement of actual expenditures to the City with each Bill for Collection.

D. SPECIAL BILLING REQUIREMENTS – PROGRAM DOCUMENTATION. The U.S. Forest Service Program Manager shall provide the City with a written report that meets City's specific documentation requirements.

E. Perform in accordance with the attached Financial Plan.

F. Perform the necessary labor, purchase materials, and tools for the implementation of the work described in the WMP. There will be days when personnel overtime will be needed for prescribed burn preparation, ignition, monitoring, etc. However, expenditures will not exceed the allocated amount identified in the attached Financial Plan.

1) Targeted acres per calendar year are identified on lines a thru c by forest treatment type. Due to the time sensitivity of prescribed fire conditions, the targeted acres and related costs may change annually; however, expenditures will be utilized over a four year period according to the Financial Plan.
    a) 20 acres of thinning and piling vegetation.
    b) 20 acres of prescribed burn piles.
    c) 850 acres of prescribed broadcast burning

2) If the targeted acres on line 1.c are not available due to ecological or meteorological conditions, then more resources can be utilized to increase treated acres listed in part III, Section E, lines 1.a and 1.b to continue fuels reduction efforts.

3) Funds may be used for the Pecos Wilderness Prescribed Burn Project within the Municipal Santa Fe Watershed; however, not to exceed 20% of the total, four year Financial Plan and the amount of targeted acres identified on line 1 for the lower Santa Fe Municipal Watershed (non-wilderness area) will still have to be achieved, when prescribed burn conditions are available, by the termination date of the agreement.

4) Personnel listed on the attached Financial Plan may vary depending on availability of USFS & City staff, associated contractors, or any associated sub-contractors; however, personnel and other identified resource expenditures will not exceed the overall costs on the Financial Plan.

G. In cooperation with the City, develop an annual work plan and report for implementation of the WMP.

V. CONTACTS & TIME LIMITS:

A. PRINCIPAL CONTACTS. Individuals listed below are authorized to act in their respective areas for matters related to this agreement.

Principal Department Contacts:

Department Program Contact	Department Administrative Contact
Name: Alan G. Hook Address: 801 W. San Mateo Rd. City, State, Zip: Santa Fe, NM 87504 Telephone: (505) 955-4205 FAX: (505) 955-4205 Email: aghook@santafenm.gov	Name: Nick Schiavo Address: 801 W. San Mateo Rd City, State, Zip: Santa Fe, NM 87504 Telephone: (505) 955-4201 FAX: (505) 955-4205 Email: naschiavo@santafenm.gov

Principal U.S. Forest Service Contacts:

U.S. Forest Service Program Manager Contact	U.S. Forest Service Administrative Contact
Name: Sanford Hurlocker, District Ranger Address: P.O. Box 3307 City, State, Zip: Española, NM. 87533 Telephone: 505-753-7331 FAX: 505-753-9411 Email: shurlocker@fs.fed.us	Name: Kileen Mitchell Grants Management Specialist Address: 11 Forest Lane City, State, Zip: Santa Fe, NM 87508 Telephone: 575-758-6296 Email: kileenbmitchell@fs.fed.us

B. LIABILITY AND INDEMNITY. The United States shall not be liable to the City for any costs, damages, claims, liabilities, and judgments that arise in connection with the performance of work by the U.S. Forest Service or its contractors under this collection agreement, including but not limited to fire suppression costs and damage to any property owned by the City or any third party. The City shall indemnify, defend, and hold harmless the United States for any costs, damages, claims, liabilities, and judgments in favor of any third party that arise in connection with the performance of work by the U.S. Forest Service or its contractors under this cost share agreement.

C. NOTICES. Any notice given by the U.S. Forest Service or the City will be sufficient only if in writing and delivered in person, mailed, or transmitted electronically by e-mail or fax, as follows:

To the U.S. Forest Service Program Manager, at the address specified in the grant.

To the City, at the City's address shown in the grant or such other address designated within the grant.

Notices will be effective when delivered in accordance with this provision, or on the effective date of the notice, whichever is later.

D. PARTICIPATION IN SIMILAR ACTIVITIES. This agreement in no way restricts the U.S. Forest Service or the City from participating in similar activities with other public or private agencies, organizations, and individuals.

E. ENDORSEMENT. Any of the City's contributions made under this agreement do not by direct reference or implication convey U.S. Forest Service endorsement of the City's products or activities.

F. USE OF U.S. FOREST SERVICE INSIGNIA. In order for the City to use the U.S. Forest Service insignia on any published media, such as a webpage, printed publication, or audiovisual production, permission must be granted from the U.S. Forest Service's Office of Communications. A written request must be submitted and approval granted in writing by the Office of Communications (Washington Office) prior to use of the insignia.

G. MEMBERS OF U.S. CONGRESS. Pursuant to 41 U.S.C. 22, no United States member of, or United States delegate to, Congress shall be admitted to any share or part of this agreement, or benefits that may arise therefrom, either directly or indirectly.

H. NONDISCRIMINATION. The City shall comply with all applicable Federal statutes relating to nondiscrimination. This includes all applicable requirements of all other Federal laws, regulations, and policies. These include but are not limited to Title VI of the Civil Rights Act of 1964 as amended, which prohibits discrimination on the bases of race, color and national origin; Title IX of the Education Amendments of 1972 which prohibits discrimination based on sex in educational programs and activities; Age Discrimination Act of 1975, as amended, prohibiting age discrimination; and 504 of the Rehabilitation Act of 1973 as amended, which prohibits discrimination on the basis of disability.

I. ELIGIBLE WORKERS. The City shall ensure that all employees complete the I-9 form to certify that they are eligible for lawful employment under the Immigration and Nationality Act (8 USC 1324a). The City shall comply with regulations regarding certification and retention of the completed forms. These requirements also apply to any contract awarded under this agreement.

J. SYSTEM FOR AWARD MANAGEMENT REGISTRATION REQUIREMENT (SAM). The City shall maintain current information in the System for Award Management (SAM) until receipt of final payment. This requires review and update to the information at least annually after the initial registration, and more frequently if required by changes in information or agreement term(s). For purposes of this

agreement, System for Award Management (SAM) means the Federal repository into which an entity must provide information required for the conduct of business as a Cooperative. Additional information about registration procedures may be found at the SAM Internet site at www.sam.gov.

K. TERMINATION BY MUTUAL AGREEMENT. This agreement may be terminated, in whole or part, as follows:

1. When the U.S. Forest Service and the City agree upon the termination conditions, including the effective date and, in the case of partial termination, the portion to be terminated.

2. By 30 days written notification by the City to the U.S. Forest Service setting forth the reasons for termination, effective date, and in the case of partial termination, the portion to be terminated.

If, in the case of a partial termination, the U.S. Forest Service determines that the remaining portion of the agreement will not accomplish the purposes for which the agreement was made, the U.S. Forest Service may terminate the agreement in its entirety.

Upon termination of an agreement, The U.S. Forest Service shall not incur any new obligations for the terminated portion of the agreement after the effective date, and shall cancel as many outstanding obligations as possible. The City shall allow full credit to the U.S. Forest Servcie for the City's share of the non-cancelable obligations properly incurred by the U.S. Forest Service up to the effective date of the termination. Excess funds must be refunded within 60 days after the effective date of termination.

L. RETENTION AND ACCESS REQUIREMENTS FOR RECORDS. The City shall retain all records pertinent to this agreement for a period of no less than 3 years from the expiration or termination date. As used in this provision, records include books, documents, accounting procedures and practice, and other data, regardless of the type of format. The City shall provide access and the right to examine all records related to this agreement to the U.S. Forest Service Inspector General, or Comptroller General or their authorized representative. The rights of access in this section must not be limited to the required retention period but must las as long as the records are kept.

If any litigation, claim, negotiation, audit, or other action involving the records has been started before the end of the 3-year period, the records must be kept until all issues are resolved, or until the end of the regular 3-year period, whichever is later.

Records for nonexpendable property acquired in whole or in part, with Federal funds must be retained for 3 years after its final disposition.

M. FREEDOM OF INFORMATION ACT (FOIA). Public access to agreement records must not be limited, except when such records must be kept confidential and would have been exempted from disclosure pursuant to Freedom of Information regulations (5 U.S.C. 552).

Public access to culturally sensitive data and information of Federally-recognized Tribes may also be explicitly limited by P.L. 110-234, Title VIII Subtitle B §8106 (2009 Farm Bill).

N. TEXT MESSAGING WHILE DRIVING. In accordance with Executive Order (EO) 13513, "Federal Leadership on Reducing Text Messaging While Driving," any and all text messaging by Federal employees is banned: a) while driving a Government owned vehicle (GOV) or driving a privately owned vehicle (POV) while on official Government business; or b) using any electronic equipment supplied by the Government when driving any vehicle at any time. All recipients and subrecipients are encouraged to adopt and enforce policies that ban text messaging when driving company owned, leased or rented vehicles, POVs or GOVs when driving while on official Government business or when performing any work for or on behalf of the Government.

O. PUBLIC NOTICES. It is the U.S. Forest Service's policy to inform the public as fully as possible of its programs and activities. The City is encouraged to give public notice of the receipt of this agreement and, from time to time, to announce progress and accomplishments. Press releases or other public notices should include a statement substantially as follows:

"Forest Protection of the U.S. Forest Service, Department of Agriculture."

The City may call on the U.S. Forest Service's Office of Communication for advice regarding public notices. The City is/are requested to provide copies of notices or announcements to the U.S. Forest Service Program Manager and to the U.S. Forest Service's Office of Communications as far in advance of release as possible.

P. PROPERTY IMPROVEMENTS. Improvements placed on National Forest System land at the direction or with the approval of the U.S. Forest Service becomes property of the United States. These improvements are subject to the same regulations and administration of the U.S. Forest Service as would other National Forest improvements. No part of this agreement entitles the City to any interest in the improvements, other than the right to use them under applicable U.S. Forest Service Regulations.

Q. PURCHASE OF ASSETS. Any assets (such as equipment, property, or improvements) purchased by the U.S. Forest Service with the City's contributions shall become the property of the U.S. Forest Service.

R. OFFSETS, CLAIMS AND RIGHTS. Any and all activities entered into or approved by this agreement will create and support afforestation/ reforestation efforts within the

National Forest System without generating carbon credits. The U.S. Forest Service does not make claims of permanence or any guarantees of carbon sequestration on lands reforested or afforested through partner assistance. The U.S. Forest Service will provide for long-term management of reforested and afforested lands, according to applicable Federal statute regulations and forest plans.

S. ALTERNATE DISPUTE RESOLUTION – PARTNERSHIP AGREEMENT. In the event of any issue of controversy under this agreement, the parties may pursue Alternate Dispute Resolution procedures to voluntarily resolve those issues. These procedures may include, but are not limited to conciliation, facilitation, mediation, and fact finding.

T. DEBARMENT AND SUSPENSION. The City shall immediately inform the U.S. Forest Service if they or any of their principals are presently excluded, debarred, or suspended from entering into covered transactions with the federal government according to the terms of 2 CFR Part 180. Additionally, should the City or any of their principals receive a transmittal letter or other official federal notice of debarment or suspension, then they shall notify the U.S. Forest Service without undue delay. This applies whether the exclusion, debarment, or suspension is voluntary or involuntary.

U. APPROPRIATIONS. The parties acknowledge that the City's appropriations for reimbursement under this agreement will comply with the Bateman Act, NMSA 1978, § 6-6-11.

V. TORT CLAIMS. Any liability incurred by the City of Santa Fe in connection with this Agreement is subject to the immunities and limitations of the New Mexico Tort Claims Act, Section 41-4-1, et. seq. NMSA 1978, as amended. The City and its "public employees" as defined in the New Mexico Tort Claims Act, do not waive sovereign immunity, do not waive any defense and do not waive any limitation of liability pursuant to law. No provision in this Agreement modifies or waives any provision of the New Mexico Tort Claims Act.

W. MODIFICATIONS. Modifications within the scope of this award shall be made by mutual consent of the parties, by the issuance of a written modification signed and dated by all properly authorized, signatory officials, prior to any changes being performed. Requests for modification should be made, in writing, at least 30 days prior to implementation of the requested change.

X. COMMENCEMENT/EXPIRATION DATE. This award is executed as of the date of the last signature and is effective through **05/30/2019** at which time it will expire, unless extended by an executed modification, signed and dated by all properly authorized, signatory officials.

VI. APPROVAL

A. AUTHORIZED REPRESENTATIVES. By signature below, each party certifies that the individuals listed in this document as representatives of the individual parties are authorized to act in their respective areas for matters related to this agreement. In witness whereof, the parties hereto have executed this agreement as of the last date written below.

City of Santa Fe	
JAVIER GONZALES, Mayor City of Santa Fe d/b/a City of Santa Fe Water Division	Date
ATTEST: YOLANDA Y. VIGIL, City Clerk	Date
APPROVED AS TO FORM: KELLEY BRENNAN, City Attorney	Date 8/4/15
OSCAR S. RODRIGUEZ, Director of Finance Business Unit/Line Item 52359.510300	Date
U.S. Forest Service	
MARIA T. GARCIA, Forest Supervisor U.S. Forest Service, Santa Fe National Forest	Date 7/29/2015
The authority and format of this agreement have been reviewed and approved for signature.	
KILEEN B. MITCHELL U.S. Forest Service, Grants & Agreements Specialist P.L. 102-154 15C011031000-003	Date 7/28/2015

Burden Statement

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0217. The time required to complete this information collection is estimated to average 4 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call toll free (866) 632-9992 (voice). TDD users can contact USDA through local relay or the Federal relay at (800) 877-8339 (TDD) or (866) 377-8642 (relay voice). USDA is an equal opportunity provider and employer.

City of Santa Fe
Summary of Contracts, Agreements, & Amendments

Section to be completed by department for each contract or contract amendment

1 **FOR:** ORIGINAL CONTRACT ☑ or CONTRACT AMENDMENT ☐

2 Name of Contractor USDA Forest Service

3 Complete information requested ☐ Plus GRT

☐ Inclusive of GRT

Original Contract Amount: $240,000.00

Termination Date: June 1, 2019

☐ Approved by Council Date: Pending

☐ or by City Manager Date: _____

Contract is for: 15-CS-11031000-003 challenge cost share agreement watershed management plan

Amendment # _____ to the Original Contract# _____

Increase/(Decrease) Amount $ _____

Extend Termination Date to: _____

☐ Approved by Council Date: _____

☐ or by City Manager Date: _____

Amendment is for:

4 **History of Contract & Amendments:** (option: attach spreadsheet if multiple amendments) ☑ Plus GRT

☐ Inclusive of GRT

Amount $ _____ of original Contract# _____ Termination Date: _____

Reason: _____

Amount $ _____ amendment # _____ Termination Date: _____

Reason: _____

Amount $ _____ amendment # _____ Termination Date _____

Reason: _____

Amount $ _____ amendment # _____ Termination Date: _____

Reason: _____

Amount $ _____ amendment # _____ Termination Date: _____

Reason: _____

Amount $ _____ amendment # _____ Termination Date: _____

Reason: _____

City of Santa Fe
Summary of Contracts, Agreements, & Amendments

Total of Original Contract plus all amendments: $ 240,000

5 **Procurement Method of Original Contract:** (complete one of the lines)

RFP# _____ Date: _____

RFQ ☐ _____ Date: _____

Sole Source ☐ _____ Date: _____

Other government entity contract

6 **Procurement History:** _____
example: (First year of 4 year contract)

7 **Funding Source:** _____ **BU/Line Item:** 52359.5103

8 **Any out-of-the ordinary or unusual issues or concerns:**
none
(Memo may be attached to explain detail.)

9 **Staff Contact who completed this form:** Maya Martinez

Phone # 955-4271

10 **Certificate of Insurance attached.** (if original Contract) ☐

Submit to City Attorney for review/signature
Forward to Finance Director for review/signature
Return to originating Department for Committee(s) review or forward to City Manager for review and approval (depending on dollar level).

To be recorded by City Clerk:

Contract # _____

Date of contract Executed (i.e., signed by all parties): _____

Note: If further information needs to be included, attach a separate memo.

Comments:

Forest Service Agreement # 15-CO-11031000-003 Cooperator Agreement #

4 year Collection Agreement Financial Plan

Cooperator and FS Contributions

COST ELEMENTS and related data				Cooperator Contribution	FS Non-Cash Contribution	
Line Item Cost Subtotals				Subtotal	Subtotal	Combined Subtotals
PERSONNEL						
Resource Specialists (List all personnel):		# of Days	$/Day			
Santa Fe NF Fire & Fuel Employees		420.00	$263.90	$110,838.00		$110,838.00
Heritage Resource, Wildlife Biologist, etc.		24.00	$263.90	$6,333.60		$6,333.60
				$0.00		$0.00
				$0.00		$0.00
				$0.00		$0.00
Santa Fe NF Fire/Fuel Employees		420.00	$263.90		$110,838.00	$110,838.00
Heritage Resource, Wildlife Biologist, etc.		24.00	$263.90		$6,333.60	$6,333.60
					$0.00	$0.00
					$0.00	$0.00
					$0.00	$0.00
Subtotal, Personnel:		**888.00**		**$117,171.60**	**$117,171.60**	**$234,343.20**
TRAVEL						
Explanation of trips: From Where/To Where/For Whom	**Vehicle Mileage Cost or Airfare Cost**	**# of Trips**	**PerDiem and Lodging**			
				$0.00		$0.00
				$0.00		$0.00
					$0.00	$0.00
Subtotal, Travel:	**$0.00**	**0**	**$0.00**	**$0.00**	**$0.00**	**$0.00**
EQUIPMENT						
Name and Type of Equipment:		**Unit Cost**	**Quantity**			
Equipment Purchase and Repairs (UTV, Chainsaw,etc.)				$15,000.00		$15,000.00
						$0.00
Equipment Purchase and Repairs (UTV, Chainsaw,etc.)					$15,000.00	$15,000.00
Subtotal, Equipment:		**$0.00**	**0**	**$15,000.00**	**$15,000.00**	**$30,000.00**
SUPPLIES						
Name and Type of Supplies:		**Unit Cost**	**Quantity**			
Fuel, PSD Balls, Etc.				$11,828.40		$11,828.40
						$0.00
Fuel, PSD Balls, Etc.					$11,828.40	$11,828.40
Subtotal, Supplies:		**$0.00**	**0**	**$11,828.40**	**$11,828.40**	**$23,656.80**

CONTRACTUAL			
Describe Contracts that will most likely result from this project:			
Call When Needed Helicopter, Mechanical Thinning, and Line Contstruction	$50,000.00		$50,000.00
			$0.00
Call When Needed Helicopter, Mechanical Thinning, and Line Construction.		$50,000.00	$50,000.00
Subtotal, Contractual:	**$50,000.00**	**$50,000.00**	**$100,000.00**
OTHER			
Describe Other Costs of the Project:			
Overtime Costs	$46,000.00		$46,000.00
			$0.00
Overtime Costs		$46,000.00	$46,000.00
Subtotal, Other:	**$46,000.00**	**$46,000.00**	**$92,000.00**
TOTAL DIRECT CHARGES	**$240,000.00**	**$240,000.00**	**$480,000.00**
OVERHEAD ASSESSMENT (if applicable, see FSH 1909.13) — Insert Rate Here:	$0.00		
Total Party Costs	**$240,000.00**	**$240,000.00**	**$480,000.00**
COST ELEMENTS SUBJECT TO NATIONAL PASS-THROUGH RATES	**Cooperator Contribution**		
TOTAL CHARGES			**$0.00**
OVERHEAD ASSESSMENT (if applicable, see FSH 1909.13) — Insert Rate Here:			**$0.00**
Total Pass-Through Costs			**$0.00**
TOTAL PROJECT COSTS			**$480,000.00**

Burden Statement

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0217. The time required to complete this information collection is estimated to average 45 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

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CITY OF SANTA FE, NEW MEXICO

RESOLUTION NO. 2009-87

INTRODUCED BY:

Rosemary Romero

A RESOLUTION

APPROVING THE SANTA FE WATERSHED PLAN; AND AUTHORIZING THE IMPLEMENTATION OF THE SANTA FE WATERSHED PLAN.

WHEREAS, the Santa Fe Municipal Watershed provides water for approximately 30,000 households and businesses within the City of Santa Fe and surrounding communities; and

WHEREAS, a total of 5,285 acres in the lower area of the watershed have been treated with mechanical thinning and pile burns from 2003-2006; and

WHEREAS, there is currently a need for a framework and funding mechanism for long term maintenance, including protection from catastrophic fires, soil erosion and invasive plants; and

WHEREAS, in 2007 the City of Santa Fe Water Division and Fire Department along with the United Stated Forest Service (USFS) Espanola District of the Santa Fe National Forest, the Nature Conservancy, and the Santa Fe Watershed Association requested approximately $70,000 in grant funding from the USFS Collaborative Forestry Restoration Program (CFRP grant #27-07) for development of a comprehensive 20-year watershed management plan for the

Santa Fe municipal watershed; and

WHEREAS, in March of 2008 the USFS CFRP accepted, under the terms of the grant funding, the final draft of the Santa Fe Municipal Watershed Management Plan developed by the project partners; and

WHEREAS, the Santa Fe Municipal Watershed Plan addresses four areas critical to the maintenance of the watershed: (i) vegetation management and fire use; (ii) water management; (iii) public awareness and outreach; and (iv) financial management based on Payment for Ecosystem Services; and

WHEREAS, the Payment for Ecosystem Services model funds the maintenance of forest restoration activities as an insurance polity against future threats to the municipal water supply, while promoting awareness and education about watershed health and protection, building collaboration between water consumers and forest managers and providing long-term; and providing long-term funding of watershed maintenance costs; and

WHEREAS, the City Water Division has requested from the New Mexico Finance Authority (NMFA) Water Trust Board approximately $1.3 million to cover the City's obligations under the Watershed Management Plan during the first five years, and this funding was approved by the NMFA on July 29, 2009; and

WHEREAS, after the first five years the City will implement the payment for Ecosystem Services model which will result in an incremental increase in water rates to pay for long-term maintenance of the watershed.

NOW, THEREFORE, BE IT RESOLVED BY THE GOVERNING BODY OF THE CITY OF SANTA FE, MEXICO that the Governing Body approves the Santa Fe Watershed Plan and the City is authorized to implement the Santa Fe Municipal Watershed Management Plan. The Santa Fe Municipal Watershed Management Plan is attached to the original Resolution in the City Clerk's Office.

PASSED, APPROVED, and ADOPTED this 9th day of September, 2009.

DAVID COSS, MAYOR

ATTEST:

YOLANDA Y. VIGIL, CITY CLERK

APPROVED AS TO FORM:

FRANK D. KATZ, CITY ATTORNEY

Jp/ca/jpmb/2009 res/watershed management plan

NEW MEXICO
FINANCEAUTHORITY

June 26, 2015

Via First Class Mail and Email
naschiavo@santafenm.gov

City of Santa Fe
Attn: Nick Schiavo
801 San Mateo Rd.
Santa Fe, NM 87504

RE: Water Trust Board Project No. 349; Watershed Restoration and Management; Santa Fe Watershed Restoration

Dear Mr. Schiavo:

The Board of Directors of the New Mexico Finance Authority ("NMFA") met on June 25, 2015, to approve the final terms, structure and conditions of Water Project Funding in the amount of $150,000 to the City of Santa Fe for its Watershed Restoration and Management project. This action is a result of the Water Trust Board recommendations approved on June 3, 2015.

The approved funding structure consists of a 10% loan in the amount of $15,000, and a 90% grant in the amount of $135,000. The loan component is a 20-year term at a net effective interest rate of .25% (0% interest rate with an administrative fee component of ¼ of 1%). A match of $15,000 is also required as part of the funding structure.

The loan issued will be subordinate to the entity's existing debt, will be structured without an additional bonds test, and will provide for hardship waivers of annual principal payments as determined by the Department of Finance and Administration.

The loan and grant are to be used by the City of Santa Fe for the Watershed Restoration and Management, Santa Fe Watershed Restoration as presented, as described in the enclosed NMFA Board Approval Write-Up.

To secure the agreement of the Water Trust Board award, the City of Santa Fe must submit the following Readiness to Proceed items by **September 30, 2015**.

SUBMISSION OF READINESS TO PROCEED ITEMS

This **funding is conditional** and the City of Santa Fe must submit the following Readiness to Proceed ("RTP") items, as applicable, before the loan/grant agreement can be scheduled to close:

1. Copy of detailed final cost estimates for the project;
2. A monthly draw-down schedule of project expenditures (estimated);
3. Verification/update of detailed project description;
4. Verification/submission of AMP per WTB policy;

5. Verification of executed cost share agreement with US Forest Service;
6. Verification of 10% match requirement in the amount of $15,000 (items that may be submitted to fulfill this include signed funding agreements (other than state), and minutes of the board meeting in which action was taken to authorize the monies and the match component. The match requirement is separate from the loan component.);
7. All contingencies must be satisfied by **September 30, 2015**; and
8. Any additional information requested by the NMFA Board or Water Trust Board.

The RTP process is necessary to make the funds available to you to complete the project. When all of the RTP criteria has been submitted, outside counsel for NMFA will draft the funding agreement and will then contact you for closing arrangements.

I will be your contact to receive the RTP information and work with you in attaining these funds, as well as your contact as the project develops. In the meantime, if you have any questions or need further assistance, please contact me at (505) 992-9648 or WTBAdmin@nmfa.net. I look forward to working with you.

Sincerely,

Angela Quintana
Senior Program Administrator

cc: Alan Hook aghook@santafenm.gov
City of Santa Fe Water division- Robert Jorgenson rnjorgenson@santafenm.gov

Enclosure: New Mexico Finance Authority Board Approval Write-Up and Draft Debt Schedule

Santa Fe Municipal Watershed Plan, 2010-2029

Prepared with funding from the USFS Collaborative Forest Restoration Program

Revision April 2013

Plan Authors

Vegetation Plan: Ellis Margolis, University of Arizona and Melissa Savage, University of California, Los Angeles

Water Plan: Dale Lyons, City of Santa Fe Water Division

Outreach Plan: Eileen Everett, Santa Fe Watershed Association

Financial Plan: Laura McCarthy, The Nature Conservancy

Plan Compiled and Edited by Dale Lyons, City of Santa Fe Water Division

This master plan provides a framework and recommendations for long term management, outreach, and funding for the Santa Fe Municipal Watershed. The ongoing collaborative work in the municipal watershed is known as the Watershed Investment Program. The plan addresses four areas critical to the maintenance of the watershed: (i) vegetation management and fire use; (ii) water management; (iii) public awareness and outreach; and (iv) financial management based on Payment for Ecosystem Services. The cost to retain the restored forest condition over 20 years is estimated at $5.1 million, an average of $258,000 per year. In contrast, Fire suppression and rehabilitation costs associated with a 10,000 to 40,000 acre wildfire impacting some portion of the municipal watershed could be between $11.9M and $48M. The cost to dredge, haul and dispose of 2,000 acre-feet of sediment and ash from the City's reservoirs would likely be between $80M and $240M. Without forest treatment, the likelihood of such a wildfire is 1 in 5 in any given year.

Development of the original plan was funded from the USDA Forest Service Collaborative Forest Restoration Program with a collaborative grant (CFRP #27-07) that included the Española Ranger District of the Santa Fe National Forest, the Santa Fe Watershed Association, the City of Santa Fe Water Division, City of Santa Fe Fire Department and the Nature Conservancy.

Santa Fe Municipal Watershed Plan
2010-2029

Executive Summary

About this Plan

Like many cities throughout the western United States, Santa Fe's water supply is dependent upon forest health and protection from catastrophic wildfire. This master plan provides a framework and recommendations for long term management, outreach, and funding for the Santa Fe Municipal Watershed. The ongoing collaborative work in the municipal watershed is known as the Watershed Investment Program. The plan addresses four areas critical to the maintenance of the municipal watershed: (i) vegetation management and fire use; (ii) water management; (iii) public awareness and outreach; and (iv) financial management based on Payment for Ecosystem Services (PES). This plan is unique in that it seeks to fund forest restoration activities using the Payment for Ecosystem Services model as an insurance policy against future threats, particularly of catastrophic fire, to the municipal water supply.

About the Watershed

The Santa Fe Municipal Watershed provides water for approximately 30,000 households and businesses within the City of Santa Fe and surrounding communities. The municipal watershed comprises the upper 17,384 acres of the Santa Fe river basin. Two reservoirs in the municipal watershed have a combined storage capacity of 4,000 acre feet, which is about one-third of the water used annually in the Santa Fe water system. The upper 10,000 acres of the municipal watershed, dominated by mixed conifer and spruce-fir woodlands, are contained within the Pecos Wilderness Area. The lower 7,270 acres of the municipal watershed is dominated by ponderosa pine and piñon pine-juniper woodlands.

The greatest threat to the ecosystem services provided by the municipal watershed is wildfire, which could significantly impact the City's water utility and environmental monitoring infrastructure. Congress has spent $7 million in federal earmarks for planning and restoration of forest conditions in the lower, non-wilderness portion of the municipal watershed, resulting in over 5,459 acres being treated with mechanical thinning and pile burns between 2003 and 2009. Since 2009, the City of Santa Fe, with support from the New Mexico Finance Authority Water Trust Board, has spent over $1 million in environmental monitoring infrastructure improvements, education and outreach and forest treatments. To date, no forest treatments have been conducted in the wilderness area above McClure Reservoir to address critical fuel loads which pose a risk the City's water supply. Once areas that present the greatest wildfire risk to municipal water supply are addressed through forest treatment, the challenge is to provide a framework and funding mechanism for long term maintenance, including protection from catastrophic fire, soil erosion, and invasive plants. This plan provides a framework for achieving these goals.

The Need for Long Term Maintenance

One hundred years of fire suppression have rendered Southwestern forests overcrowded, vulnerable to pests and highly prone to stand replacement fires that strip steep slopes of soil protecting vegetation. The loss of forest cover decreases a watershed's capacity to regulate flow and control soil erosion. Research of the Los Alamos Canyon Reservoir following the 2000 Cerro Grande fire (in which one third of the basin's mixed conifer forest were severely burned) measured a dramatic spike in the sedimentation rate. One year after the fire, reservoir sediment accumulation was 140 times higher than the previous 57 years combined, and remained significantly elevated throughout the five-year study period (Lavine et al. 2005). Reservoir sedimentation caused by soil erosion reduces the quantity and longevity of water supplies and substantially increases filtration costs. In the case of Strontia Springs Reservoir in Colorado, Aurora Water and Denver Water utilities' annual production of municipal water supply from the reservoir has been decreased by approximately the same storage volume lost through sedimentation (15%) that resulted from the Hayman (2002) and Buffalo Creek (1996) fires in Colorado (Mike McHugh, Aurora Water, 2013). A 2002 study of 27 water suppliers across the U.S. demonstrated that water treatment costs increased significantly with progressive loss of forest cover (Ernst 2004).

Vegetation management is critical to restoring forests, reducing the risk of fire and maintaining water quality throughout the western U.S. Without fuel reduction and ongoing maintenance efforts, forests within the municipal watershed would pose a wildfire risk to the Santa Fe's water supply. It is estimated that a 10,000 to 40,000 acre wildfire impacting some portion of the municipal watershed would result in significant amounts of erosion and sediment and ash accumulation in the City's reservoirs, with the actual accumulated volume being highly dependent on the severity and duration of storm events within the first year after the fire. Estimates of the volume of debris and sediment range from 415 acre-feet up to 2,000 acre-feet for the maximum storm event in the first year following a severe wildfire, the latter resulting in a loss of more than 60 % of the reservoir capacity. The sediment loading would not only reduce the capacity of the reservoirs, but the turbidity and suspended ash of the water would impair use of the water for an extended period until the watershed healed and erosion rates decreased to near-normal levels. The estimated cost to dredge, haul and dispose of 2,000 acre-feet of sediment and ash from McClure Reservoir would likely be between $80M and $240M, based on the cost estimate from the 2001 Santa Fe Watershed EIS ($25/yd^3 or $40,000/acre-foot) and Strontia Springs Reservoir dredging costs ($75/yd^3 or $120,000/acre-foot) in Colorado following the 1996 Buffalo Creek Fire and the 2002 Hayman Fire (Mike McHugh, Aurora Water, 2013). Although the Strontia Springs Reservoir project was originally budgeted for $30M to dredge and dispose of 685 yd3 ($44/yd^3) of sediment and ash, significant technical problems have thus far prevented project completion and resulted in additional costs. Specifically, the presence of large diameter granitic debris among the accumulated sediment has proven highly destructive to available dredging equipment and slurry pipelines. The high likelihood of similar conditions being present in the municipal watershed following a large wildfire suggests that successfully dredging large volumes of material from McClure Reservoir would be, for all intents and purposes, impractical within a 5- to 10-year time frame.

Fire suppression and rehabilitation costs associated with a 10,000 to 40,000 acre wildfire impacting some portion of the municipal watershed could be between $11.9M and $48M. The cost to dredge, haul and dispose of 2,000 acre-feet of sediment and ash the City's reservoirs would likely be between $80M

and $240M. These costs exclude increased water treatment costs, increased water utility operating costs associated with production of water from different water sources and impacts to the local economy from loss of tourism income. In comparison to these avoided costs, the cost to treat and maintain forests within the municipal watershed is expected to be $5.1 million over 20 years, an average of $258,000 per year.

Payment for Ecosystem Services

Ecosystems naturally produce resources that are important for humans, such as water, wood, clean air, and insects that pollinate garden and fruit plants. "Ecosystem services" refer to these resources and the natural processes that produce them. Typically, these services are not paid for, nor are they included in conventional markets or economic analyses. Surface water for municipal use is an example of an ecosystem service that is neither paid for by the city nor individual water users. Water users pay for the services of capturing, treating, and delivering water, but they do not currently pay for the ecosystem services that produce this water which may be preserved through watershed restoration and protection efforts. By attaching an economic value to these natural processes and services, water districts and municipalities can access a new source of revenue to support needed watershed protection. Payment for Ecosystem Services provides clear economic incentives for maintaining watershed health. This model of watershed protection has been implemented in major U.S. cities such as Salt Lake City, UT, Eugene, OR, and Denver, CO, and has been shown to save millions of dollars in capital outlay and annual operating costs. The Santa Fe Municipal Watershed Plan is unique in that it seeks to use the Payment for Ecosystem Services model to fund ongoing forest restoration activities as an insurance policy against future threats to the municipal water supply. The advantages of having beneficiaries pay for ecosystem services are (i) awareness and education about municipal watershed health and protection; (ii) genuine collaboration between upstream land managers (USFS) and downstream water consumers; and (iii) long term funding of true municipal watershed maintenance costs.

Collaborative Planning

This plan was developed in collaboration with the Española Ranger District of the Santa Fe National Forest, City of Santa Fe Fire Department, City of Santa Fe Water Division, The Nature Conservancy, and the Santa Fe Watershed Association. The Española Ranger District of the Santa Fe National Forest consulted with contractors who were responsible for preparing a watershed management plan, including vegetation management, fire use, and monitoring, in conjunction with consultants from the University of California Los Angeles, and University of Arizona Tree Ring Laboratory. The City of Santa Fe Wildland Urban Interface Specialist also participated in the vegetation management and fire use plans to ensure consistency with Santa Fe's Community Wildfire Protection Plan. The City of Santa Fe Water Division prepared the water management plan, and The Nature Conservancy designed the original financial management plan. The Santa Fe Watershed Association was responsible for the education and outreach plan. A Technical Advisory Group comprised of independent scientists also met with project collaborators and consultants to review draft plans and provide input into the structure and content of the plan. In 2013, the City of Santa Fe Water Division and the Española Ranger District of the Santa Fe National Forest finalized revisions to the plan which the reflect updated cost information and the Proposed Action in the wilderness area.

Recommendations

1. Vegetation Management

Recommendations for vegetation management within the Santa Fe municipal watershed are provided for three areas of the municipal watershed: (i) the non-wilderness municipal watershed, comprised of 7,270 acres of ponderosa pine and piñon pine-juniper woodlands; (ii) the wilderness municipal watershed; and (iii) riparian areas within the municipal watershed.

The overly dense mid-elevation ponderosa pine forests of the municipal watershed were prioritized for restoration and crown fire hazard reduction due to the importance of the municipal watershed to the water supply of Santa Fe. A crown fire in the municipal watershed would overload the Canyon Road Water Treatment Plant with ash and potentially threaten the two dams and reservoirs used for water storage. Initial mechanical treatments of 5,285 acres of upland, pine-dominant forests in the municipal watershed temporarily reduced the risk of crown fire, but maintenance treatments are vital for future forest health and protection of the water supply. The 10,000 acres of the municipal watershed located within the Pecos Wilderness have not been treated. The riparian corridor was not thinned, and is in relatively good functioning condition.

Recommendations for Non-Wilderness Municipal Watershed

Initial mechanical treatments of 5,285 acres of upland, ponderosa pine dominant forests have temporarily reduced the risk of crown fire, but maintenance treatments are vital for future forest health and protection of the water supply. The Española Ranger District of the Forest Service has already burned slash piles within treated areas as well as conducted broadcast prescribed burns on over four thousand acres to prevent fuel accumulation within this range of the municipal watershed. If approximately 1,000 acres are broadcast burned each year, the entire municipal watershed will be burned every 7 years.

- Prescribed fire in the treated areas of the municipal watershed, with 4 proposed burn entries (1 pile burn and 3 maintenance burns). Pile burns are proposed between 2003 and 2013. Maintenance burns are proposed at three intervals between 2005-2012; 2013-2019; and 2019-2029;
- Continue current smoke management practices as well as public outreach;
- Evaluate piñon-juniper woodland density and soil conditions and develop recommendations for future management;
- Protect Southwestern white pine during prescribed burns;
- Monitor for cheat grass and other invasive species.

Recommendations for Wilderness Municipal Watershed

The portion of the municipal watershed located within the Pecos Wilderness contains at least 10 vegetation classes, from alpine grasslands to pine and oak with yucca and cactus. For the purposes of fire management, the Wilderness Area can be divided into two vegetation zones: (i) lower elevation (<10,000 feet) mixed conifer forests (comprised of Gambel oak, ponderosa pine, and piñon pine), and

(ii) the upper elevation (>10,000 feet) spruce-fir dominant forests. While this division into two zones is more accurately described as a gradient, the two types can be used as general guides for fire regimes.

- No treatment in the 4,107 acres of spruce-fir forest
- Prescribed fire in approximately 2,900 acres of mixed conifer, ponderosa pine, and Gambel oak

Recommendations for the Riparian Area

The riparian community along the Santa Fe River above Nichols Reservoir is reasonably intact relative to other southwestern riparian zones, and relative to the pre-treatment conifer forest of the municipal watershed. There are approximately 10 miles of stream from the headwaters to McClure Reservoir, and three miles of stream between the two reservoirs.

- No treatment from McClure Reservoir to Wilderness boundary
- Consider refining seasonal water release from McClure Reservoir
- Remove non-native tree species growing below Nichols Dam
- Continue monitoring for integrity of riparian function and for non-native species using the Proper Functioning Condition methodology.

2. *Water Management*

Crown fire within the municipal watershed could degrade the storage capacity of the water supply reservoirs and cause irreparable damage to the forested areas of the municipal watershed. The focus of the water management plan is to provide sustainable water yields from the municipal watershed, maintain water quality, and protect the longevity of Nichols and McClure Reservoirs. The water management plan provides a framework for long term monitoring that addresses three critical objectives for water management:

- Maintain a Reliable Water Supply
- Maintain a High Quality of Water
- Enhance Wildlife Habitat and Ecosystem Function.

For each of these objectives, the plan also recommends (i) critical parameters for regular analysis; (ii) secondary parameters if critical parameters exceed a threshold; and (iii) parameters considered, but not recommended. In addition, the plan outlines necessary water quality/quantity monitoring infrastructure improvements as well as recommendations for stream habitat assessment and restoration.

3. *Outreach*

Outreach will target residents of the City and County of Santa Fe, water customers of the City of Santa Fe Water Division, and Santa Fe youth with a focus on two areas:

- Providing general watershed education, including forest and riparian ecology, natural and cultural history, and water issues, and
- Building and maintaining support for the Payment for Ecosystem Services model.

The plan recommends offering watershed education to the general public and school children through educational hikes within the municipal watershed, public presentations, a self-guided interpretive trail overlooking the municipal watershed, a video offering a virtual experience of the municipal watershed, water utility bill educational inserts, a website, and other brochure and publications. The plan recommends providing youth education through single classroom visits to all 4th and 5th grade students in Santa Fe, multiple visit programs with a field trip for a smaller number of 4th and 5th graders, and watershed monitoring with middle and high school students. The plan also recommends conducting a survey with Santa Fe residents to assess the attitudes and knowledge of Santa Fe residents toward watershed management and the Payment for Ecosystem Services model, staffing information tables, writing articles for existing organizational newsletters, developing public service announcements and 30-second television spots, and placing an information page in the phone book.

4. Financial Management

Congress has spent $7 million in federal earmarks for planning and restoration of forest conditions in the lower, non-wilderness portion of the municipal watershed, resulting in over 5,459 acres being treated with mechanical thinning and pile burns between 2003 and 2009. In addition, the Santa Fe National Forest has allocated a portion of its budget for municipal watershed restoration before and since these appropriations. Since 2009, the City of Santa Fe, with support from the New Mexico Finance Authority Water Trust Board, has spent over $1 million in environmental monitoring infrastructure improvements, education and outreach and forest treatments. Annual maintenance with prescribed fire is needed to keep fuels at the reduced level. The cost to retain the restored forest condition over 20 years is estimated at $5.1 million, an average of $258,000 per year, depending on the level of maintenance needed in any given year, with diminishing cost over time.

In contrast, fire suppression and rehabilitation costs associated with a 10,000 to 40,000 acre wildfire impacting some portion of the municipal watershed could be between $11.9M and $48M. The cost to dredge, haul and dispose of 2,000 acre-feet of sediment and ash the City's reservoirs would likely be between $80M and $240M. These costs exclude increased water treatment costs, increased water utility operating costs associated with production of water from different water sources and impacts to the local economy from loss of tourism income. The likelihood of such a fire in the municipal watershed is estimated to be 1 in 5 in any given year.

While federal funding has supported hazardous fuel reduction through earmarks and Forest Service appropriations, much of the Forest Service's budget has been and likely will increasingly be focused on fire suppression. As funding declines, cost-share agreements that leverage federal funding by providing matching funds will become more important. A Payment for Ecosystem Services agreement between the City of Santa Fe and the Santa Fe National Forest will ensure that the Forest Service will be able to continue its management activities at a higher rate within the municipal watershed than might be possible otherwise, even as funding declines in the region.

Beginning in May of 2013, following expiration of the New Mexico Finance Authority Water Trust Board grant, City of Santa Fe water utility's rates will cover the City's obligations under this plan. The City may choose to itemize municipal watershed project fees as a separate item public utility bills.

In order for the cost-share arrangement between the City and the U.S. Forest Service to continue, the Collection Agreement will need to be renewed every 5 years. Annual review of work plans, budgets, and project implementation per the terms of the Collection Agreement should also be done.

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Santa Fe Municipal Watershed Plan
Introduction and Context

Throughout the western United States, more than 100 years of fire suppression, grazing, and timber harvesting have led to changes in the structure of many forests of the western United States and have increased the risk for catastrophic crown fire. Many municipal watersheds are dependent upon these same forests for sustained ecosystem services, such as water quantity and quality. These watersheds are vulnerable to crown fires that could strip steep slopes of soil-protecting vegetation and overload reservoirs with sediments. In cities impacted by severe crown fire, such as Los Alamos, New Mexico and Denver, Colorado, sediment loads following fire showed dramatic spikes in sedimentation rates, with the Cerro Grande fire leading to sedimentation rates 140 times higher than the previous 57 years. Increased sedimentation within reservoirs reduces the quantity and longevity of water supplies and substantially increases filtration costs. Protection of municipal water supplies thus is linked to forest health in many western cities, including the Santa Fe Municipal Watershed.

Congress has spent $7 million in federal earmarks for planning and restoration of forest conditions in the lower, non-wilderness portion of the municipal watershed, resulting in over 5,459 acres being treated with mechanical thinning and pile burns between 2003 and 2009. In addition, the Santa Fe National Forest has allocated a portion of its budget for watershed restoration before and since these appropriations. Since 2009, the City of Santa Fe, with support from the New Mexico Finance Authority Water Trust Board, has spent over $1 million in environmental monitoring infrastructure improvements, education and outreach and forest treatments. Annual maintenance with prescribed fire is needed to keep fuels at the reduced level. The cost to retain the restored forest condition over 20 years is estimated at $5.1 million, an average of $258,000 per year, depending on the level of maintenance needed in any given year, with diminishing cost over time.

In contrast, fire suppression and rehabilitation costs associated with a 10,000 to 40,000 acre wildfire impacting some portion of the municipal watershed could be between $11.9M and $48M. The cost to dredge, haul and dispose of 2,000 acre-feet of sediment and ash the City's reservoirs would likely be between $80M and $240M. These costs exclude increased water treatment costs, increased water utility operating costs associated with production of water from different water sources and impacts to the local economy from loss of tourism income. The likelihood of such a fire in the municipal watershed is estimated to be 1 in 5 in any given year.

While federal funding has supported hazardous fuel reduction through earmarks and Forest Service appropriations, much of the Forest Service's budget has been and likely will increasingly be diverted to fire suppression. As funding declines, cost-share agreements that leverage federal funding by providing matching funds will become more important. A Payment for Ecosystem Services agreement between the City of Santa Fe and the Santa Fe National Forest will ensure that the Forest Service will be able to continue its management activities within the municipal watershed, even as funding declines in the region.

Beginning in May of 2013, following expiration of the New Mexico Finance Authority Water Trust Board grant, City of Santa Fe water utility's rates will cover the City's obligations under this plan.

This master plan provides a framework and recommendations for long term management, outreach, and funding for the Santa Fe Municipal Watershed Investment Project. The plan addresses four areas critical to the maintenance of the municipal watershed: (i) vegetation management and fire use; (ii) water management; (iii) public awareness and outreach; and (iv) financial management based on "Payment for Ecosystem Services." This plan seeks to fund forest restoration activities using the Payment for Ecosystem Services model as an insurance policy against future threats, particularly of catastrophic fire, to the municipal water supply.

Santa Fe Municipal Watershed Plan
Vegetation Management Plan

Background and Context

More than 100 years of fire exclusion from suppression and grazing have altered forest structure and increased crown fire hazard in many forest types throughout the Western United States. Ponderosa pine forests have experienced particularly dramatic changes and have been the primary focus of forest restoration in the Southwest (Allen et al. 2002). However, other forest types, such as spruce-fir or aspen/mixed conifer, are naturally dense, historically burned in crown fires, and may not require restoration (Margolis et al. 2007). Recent crown fires in ponderosa pine forests have resulted from increased forest density combined with warming temperatures (Westerling et al. 2006). These crown fires have caused extensive and severe hydrologic damage in many watersheds across the region. Post-crown fire flooding can be orders of magnitude greater than pre-fire flows (e.g., Veenhuis 2002) and has resulted in catastrophic debris flows in some locations (e.g., Cannon and Reneau 2000). Climate change is predicted to further threaten water supplies and forests through drought induced forest die-off (Breshears et al. 2005), longer fire seasons with more large fires (Westerling et al. 2006), and reduced snowpack and altered stream flow (Barnett et al. 2008).

The overly dense ponderosa pine forests of the Santa Fe Municipal Watershed were prioritized for restoration and crown fire hazard reduction because of the importance of the municipal watershed to the water supply of Santa Fe. A crown fire in the municipal watershed would overload the City's Canyon Road Water Treatment Plant with ash and potentially threaten the two dams and reservoirs used for water storage. Initial mechanical treatments of 5,285 acres of upland, pine-dominant forests in the municipal watershed temporarily reduced the risk of crown fire, but maintenance treatments are vital for future forest health and protection of the water supply. The 6,600 acre Wilderness Area in the upper reaches of the municipal watershed has not been treated and prior to conducting fire history studies and stand exams, very little was known about the forests and potential for treatment in this area. The riparian corridor within the municipal watershed also has not been treated, and is in relatively good functioning condition.

Scope of this Plan

This plan presents an integrated set of recommendations for vegetation management for the municipal watershed, upstream of the City's Canyon Road Water Treatment Plant, summarized in Table 1 below. The municipal watershed is divided into two management areas: (1) the non-wilderness portion of the municipal watershed, and (2) the wilderness portion of the municipal watershed (Figure 1). Management recommendations focus on somewhat different objectives for the two areas. For the non-wilderness area the objective is long-range maintenance of the restored part of the forest. For the wilderness area and the riparian corridor we present potential strategies for management of these untreated portions of the forest. These recommendations emphasize the use of thinning, fire management, and other tools to both maintain forest health and reduce the impact of severe fire on the water supply. In addition to providing recommendations for managing the municipal watershed, the

model proposed here can also contribute to the broader pool of forest management knowledge, as there is little post-thinning forest management experience in the region.

Summary of Recommendations

Table 1. Summary of Recommendations for Vegetation Management	
Non-Wilderness Area in Municipal Watershed	• Prescribed Fire in Treated Areas of municipal watershed, with 4 proposed burn entries; • Continue current smoke management practices as well as public outreach and education; • Evaluate fire hazard and post-fire erosion potential in piñon juniper woodlands within lower watershed and adjacent properties; • Protect Southwestern white pine during prescribed burns; and • Continue current post-treatment monitoring, paying special attention to invasive species (i.e., cheat grass).
Wilderness Area in Municipal Watershed	• No treatment in 4,017 acres of spruce-fir; and • Potential for fire in approximately 2,900 acres of mixed conifer, ponderosa pine and Gambel oak vegetation in the lower portion of the Wilderness Area above McClure Reservoir.
Riparian Area in Non-Wilderness Municipal Watershed	• No treatment from McClure Reservoir to Wilderness boundary; • Consider refining seasonal water release from McClure Reservoir; • Remove non-native tree species growing below Nichols Dam; and • Continue monitoring for integrity of riparian function and for non-native species using the Proper Functioning Condition methodology.

Vegetation Management Plan for the Non-Wilderness Municipal Watershed

Ecological Context

The primary tool for managing the non-wilderness municipal watershed is fire, through both naturally occurring wildfires and prescribed burns, with the objective of minimizing the risk of high intensity fire by reducing fuel loads. Maintenance burning is necessary for two reasons. First, burning will reduce the fuel loads that were produced during thinning. Second, burning will maintain the reduced risk of high intensity fire by preventing the re-accumulation of biomass in treated forest stands.

Ideally, the long-term burn periodicity in the municipal watershed should be similar to the historical fire regime return interval. Balmat and others (2005) reconstructed fire intervals in the non-wilderness municipal watershed from 1600 through 1849 using fire scar data. They found a median fire interval of 15 years, minimum of 3 years and a maximum of 40 (20% scarred). A study by Finney and others (2005) found that fuel treatments significantly reduced fire severity when the treatments occurred between 3 and 9 years before a wildfire, with fire severity increasing with time since treatment. They suggest that the history of the fuel treatments is less important than the time since last treatment. The study also makes the case that it may take repeated prescribed burns before wildland fire can play its desired role in forest management. In order to prevent a return to stand conditions that support a crown fire, prescribed fire should be reintroduced into thinned forests early and often.

The long-term goal is to burn the entire treated area in the municipal watershed at a burn interval that will prevent fuel accumulation, especially the establishment of thickets of young trees that increase crown fire hazard. An approximate schedule of an average of 700 acres of broadcast burn per year will accomplish a prescribed burn of the entire municipal watershed every 10 years. This fire interval falls within range of historical fire frequency for natural fires in the municipal watershed, and is near the 3 to 9 year return interval suggested by Finney and others (2005). The clock on the period of burn interval begins as soon as thinning treatments are complete in any particular area.

A primary concern of burning more than 1,000 acres per year is the issue of increasing runoff and sedimentation to the Santa Fe River. However, paired basin monitoring of municipal watershed treatments to date have shown no increase in sedimentation or ash-laden runoff after mechanical thinning or pile burning (Grant 2004). Now that mechanical treatments are complete on over 5,459 acres, sedimentation is not predicted even with modeling of natural fire events in the non-wilderness municipal watershed under extreme weather conditions. Based on these predictions of sedimentation, no threshold is set to define the maximum number acres that can be burned if suitable conditions exist.

Restoration and Treatment History

Of the 7,270 acres comprising the non-wilderness municipal watershed, an area of 5,285 acres was treated by mechanical thinning and pile burning between 2002 and 2006. Between 2007 and 2012, approximately 174 additional acres have been mechanically thinned and pile burned and prescribed burns have occurred on over four thousand acres which were previously thinned. The *Prescribed Fire Plan,* prepared by the USFS Española Ranger District Office of the Santa Fe National Forest, covers the non-wilderness municipal watershed. The treated area lies between 7,400 and 9,800 feet in elevation with an average slope of 45%. Trees have been thinned to a density ranging between 50 and 100 trees per acre. Fuel loads are estimated at 2 to 6 tons/acre on south aspects with limited thinning, 10 to 36 tons/acre on south aspects with heavy thinning, 40 to 50 tons/acre on north aspects with heavy thinning, and 18 to 27 tons/acre in masticated areas. The fire suppression goals for this phase of prescribed burning are to control 90% of the high intensity wildfires at 10 acres or less and 90% of the low intensity wildfires at 20 acres or less.

Smoke

The USFS Prescribed Fire Plan outlines multiple smoke monitoring and mitigation options to ensure compliance with New Mexico Environment Department-Air Quality Bureau (NMED – AQB) standards for smoke emissions from prescribed fire. These include:

- *Smoke monitoring.* Smoke monitoring of volume, lifting and dispersal to be recorded on standard forms required by NMED – AQB that is reported hourly to the burn boss. Trigger point: the burn boss must consider a change in action (including shutting down the burn) if the smoke monitoring device (located on Upper Canyon Rd) exceeds the 24hr EPA smoke limit.
- *Identification of sensitive areas.* The City of Santa Fe and surrounding areas, the I-25 corridor and the Pecos Wilderness area are all listed as areas sensitive to smoke.
- *Smoke mitigation options.* Seven management options are listed in the burn plan to help the burn boss reduce smoke dispersal to sensitive areas, including adjusting the daily burn window, reduced burn block sizes, and taking breaks after days with heavy smoke production.

A separate smoke monitoring plan (USFS 2002) describes detailed visual and instrumented smoke monitoring and mitigation, and lists an additional 10 smoke sensitive areas extending as far away as Taos and the Wheeler Peak Wilderness, NM. Smoke dispersion modeling (SASEM) is outlined (Hudnell 2000) for multiple burn prescriptions and results indicate that National Ambient Air Quality Standards are not expected to be exceeded during any prescribed burn scenario. This is in contrast to the modeled wildfire scenario, which does predict that air quality standards would be exceeded.

These preparations for potential air quality problems due to smoke seem to have been effective based on the monitoring report for April – December 2003 (Barkmann 2003). During this period the 24-hr average recorded by the real-time instrumentation never exceeded the federal standard (for particulates less than 2.5 microns in diameter) and the 1-hr average reached the "unhealthy for sensitive groups" threshold for only six 1-hr periods. These data cover 17 burn days and 650 acres of pile burning.

Recommendations

It is recommended that the Forest Service perform four prescribed fire entries into the municipal watershed to modify stand conditions to the point where natural, low-intensity fires may be allowed to burn. The first entry should burn piled dead and down woody fuels within a broadcast burn perimeter. The second and third entry should be broadcast burns using backing fires, and the fourth entry using a head fire.

Prescribed burning has already occurred in the thinned portion of the municipal watershed (Table 2). Of the 5,459 acres mechanically thinned, two-thirds were cut by chainsaw and the resulting debris gathered into piles. Areas that have been shredded into chunks by masticator machines, rather than cut by hand, do not leave fuels that require piling and burning, and can be broadcast burned directly after treatment. As of the end of 2012, 102 acres of piles have been burned and 4,553 acres have been broadcast burned.

The method of broadcast burning for the second and third fire entries uses a "backing fire" to maximize fire control in what are sometimes moderate to heavy horizontal surface fuels and ladder fuels. At this point, fuels are sufficiently reduced such that the fourth entry fire can be a "head fire," which is faster and is less expensive to conduct than the backing fires.

Table 2. Summary of Treatments in Non-Wilderness Municipal Watershed (acres are approximate)

Treatment Type	Time Frame	Completed Acres	Remaining Acres
Mechanical Treatment	2003-2006	5,285	174
Cut and Pile	2003-2006	3,994	0
Masticated	2003-2006	1,291	0
1st Entry Pile Burn	2003-2011	1,548	2,446
Supplementary Mechanical Treatment	2006-2012	174	0
2nd Entry Broadcast Burn: backing fire	2005-2011	200	7,070
3rd Entry Broadcast Burn: backing fire	2012-2019	0	7,270
4th Entry Broadcast Burn: head fire	2019-2026	0	7,270

Prescribed burning must be conducted when weather and fuel conditions are safe: dry enough to adequately burn the fuels, yet wet enough to prevent an escaped wildfire, and during proper wind direction and dispersal conditions so that areas sensitive to smoke are minimally affected. Burn-season weather conditions will affect the pace at which the burn schedule is accomplished. Individual dry years or a prolonged drought may significantly hamper the pace of burning. Under optimal weather and smoke dispersal conditions, about 100 acres can be broadcast burned per day. At least 13 days of appropriate burning conditions will be needed each year to reach 1,000 acres of burning. The burn schedule must be flexible enough that more acres can be burned in suitable weather to make up for the lack of burning in unsuitably dry periods.

Burn Seasonality

The Prescribed Fire Plan calls for burning at three times of year: "Broadcast burning with piles will occur when fuel and moisture conditions allow, but will generally be in fall, winter, or after summer monsoons have begun. First entry broadcast burning will occur in the late summer or fall when environmental parameters can be met." Considering the fuel loads still on the ground, these are the safest seasons for prescribed burning in this municipal watershed. Climatic conditions are unstable in the spring, with the potential for sudden, high winds followed by a predictably dry and warm early summer pre-monsoon period. There also tends to be an abrupt transition from very snowy conditions, preventing an efficient burn, to risky dry conditions with unpredictable winds.

Understory plants in low-intensity fire adapted forests recover quickly after fire, and although there is some evidence that response of understory plants varies by burn season, there is not yet a consensus on which seasons are likely to produce the best response. Historical fires (1600-1849) occurred predominantly in the late spring and early summer before the onset of the monsoon rains (Balmat et al. 2005). Fall burns can encourage the growth of exotics, such as Dalmatian toadflax and cheatgrass (Abella and Covington 2004). Monitoring to detect changes in abundance of non-native invasive species should be focused on areas burned in the fall.

Smoke

To mitigate the effects of smoke from fire management in the municipal watershed, it is recommend that the USFS continue current smoke management practices combined with public outreach.

Other Long-term Maintenance Concerns

- *Post-treatment monitoring.* Monitoring treatment (prescribed fire) effects on the flora and fauna occurred within the non-wilderness municipal watershed from 2002 through 2009, per the contract between RMRS and USFS Espanola District. The following variables were monitored: small mammal populations, avian populations, vegetation (canopy cover, tree density by species and size, fuel loads, ground cover, shrub cover). It is recommended that an evaluation be conducted to assess the need for future monitoring of the effects of the maintenance burns in the municipal watershed, including in the wilderness area (2012 – 2029). This evaluation should address whether the monitoring data already collected is sufficient to describe negative effects of the treatments on the forest and watershed, and could be used to guide future adaptive management.

- *Evaluate piñon-juniper stands in the low elevation zone of the non-wilderness municipal watershed.* At the *low elevation zones of the non-wilderness municipal watershed*, piñon-juniper predominates and poses a separate set of management challenges. A plan for the treatment of the piñon-juniper stands in the lower part of the municipal watershed should be considered, including prescribed burning if deemed necessary. These woodland stands should be inventoried to evaluate their condition, including whether density is within a historical range of variability, whether a fire occurring in the piñon-juniper stands could carry into the untreated stands above

or into the city. An assessment of whether the understory is robust enough to minimize soil erosion should also be made, and if needed, some lop and scatter treatments should be considered to improve grass and forb cover in order to reduce soil erosion. Collaboration with adjacent landowners (TNC and others) containing relatively large proportions of the *piñon-juniper* zone will be necessary to accomplish effective evaluations, planning and treatments.

- *Continue to protect Southwestern white pine.* During planning of restoration treatments a concern was expressed for the fate of Southwestern white pines in the municipal watershed, because populations have suffered in the West in recent years due to the exotic white pine blister rust. White pines in the municipal watershed have been reproducing successfully in spite of the threat of blister rust and thus the municipal watershed has been identified as a possible sub-regional refugia for this tree species. The protection of southwestern white pines should continue to be an objective throughout long-term prescribed burning maintenance.

- *Protect against invasive grasses and forbs.* A lag in the population expansion of undesirable invasive species into restored forests has been reported in some treatment areas. In particular, the establishment of cheat grass (*Bromus tectorum* L.) is a concern, due to the ability of cheat grass stands to significantly alter fire regimes. Most notably, cheat grass can compete vigorously with native grasses during a drought, and forest restorations that occur during a dry period should be aware of the potential for cheat grass invasion.

Vegetation Management Plan for the Wilderness Area within the Municipal Watershed

Ecological Context

Forest Vegetation

For purpose of fire management, the vegetation of the Wilderness Area can be divided into two general types: 1) the lower elevation (<10,000 ft) mixed conifer forests and 2) the upper elevation (>10,000 ft) spruce-fir dominant forests (Figs. 1 & 2).[1] The general difference in vegetation types was very evident from on-the-ground field reconnaissance. This "division" is more accurately described as a gradient that varies with aspect and slope position. These two variables affect the local radiation and moisture balance that ultimately determines which tree species can survive at a particular site in the absence of disturbance. The two general vegetation types defined above are used in subsequent discussions of vegetation and fire regimes.

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[1] The best existing vegetation map contains 10 vegetation classes present in the Wilderness Area (Figure 2). The relatively coarse scale of the map combines vegetation types that may in fact have differing fire regimes. For example, Gambel oak, ponderosa pine and piñon pine are all combined into a mixed conifer type. The map thus should be used with caution when trying to identify areas for fire management.

Spruce-Fir Zone

The dominant trees in this zone are roughly 150-300 yrs old, with the peak number of trees establishing between 1760 and 1800 (Margolis et al. 2007b). Age data for the sub-dominant, smaller diameter trees is not available. Without these data we cannot assess whether there have been changes in stand-density, and consequently crown fire hazard, which may have resulted from forest management over the last century. It appears likely, however, that fire suppression effects on stand-density in the spruce-fir have been minimal for three reasons: (i) there are relatively few successful ignitions in this zone; (ii) crown fires burning in spruce-fir are virtually impossible to suppress; and (iii) sub-alpine, spruce-fir vegetation types naturally increase in tree density with time following stand-replacing disturbance. Thus, the human induced increase in crown fire hazard that has been problematic in ponderosa pine forests (Allen et al. 2002) is less likely to have occurred in these upper elevation spruce-fir forests (Sibold et al. 2006).

Mixed-Conifer Zone

Tree age data are not available for the mixed-conifer zone. Without these data or other quantitative measures of forest structure we relied upon aerial photos to make a qualitative assessment of whether there has been a change in the mixed conifer forests from historical conditions. The photos revealed a visually striking increase in tree cover on south-facing slopes in the mixed conifer forest from 1935 to 2005 (Figure 4). The cessation of surface fire due to fire suppression, similar to what occurred in the adjacent ponderosa pine forests, provides the most likely mechanism for the observed increase in tree cover. The changes evident in these photos provide the best available data for justification of treatments in the mixed conifer zone of the Wilderness Area based on the objective of forest restoration, while also serving to reduce crown fire risk and protecting municipal water supply.

Fire Regimes

All ignitions within the Wilderness Area are managed with the appropriate suppression response. Active suppression began when the US Forest Service began managing the area as a closed municipal watershed in 1932. Six lightning ignitions have been reported between 1961 and 2000 and were suppressed (unpublished USFS GIS records). Since 2006, there have been approximately two lightning caused fires annually within or threatening the Santa Fe Municipal Watershed. No wildfire greater than 5 acres have burned in the Wilderness Area for at least 50 years. Coarse-scale (1km resolution) fire regime condition class data indicate that 30% of the Wilderness Area is in class 3 (high departure from historical vegetation and disturbance regime conditions) (Table 3) (Hann et al. 2003). However, the coarse scale of this remotely sensed model and the lack of local ground truthing is a limitation.

Table 3. Fire Regime Condition Classes for the Santa Fe Watershed Wilderness Area. (Minimum mapping unit is 1km^2)		
Fire Regime Condition Class	**Area (acres)**	**% of total area**
0-35 yrs; Condition Class 1	1326	20
0-35 yrs; Condition Class 2	140	2
0-35 yrs; Condition Class 3	290	4
35-100+ yrs; Condition Class 1	2738	42
35-100+ yrs; Condition Class 2	383	6
35-100+ yrs; Condition Class 3	1719	26

Historical Conditions

Historically, fire was a relatively common, important ecological process in the Wilderness Area (Margolis et al. 2007b). The tree-ring record reveals two types of historical fire regimes: (i) a stand-replacing fire regime with no evidence of surface fire and (ii) a mixed-severity fire regime with evidence of surface fire and smaller patches of stand-replacing fire. These two types of fire regimes were generally separated along vegetation and elevation boundaries.

The historical fire regime in the upper elevation (>10,000 ft) spruce-fir dominated forests was characterized by relatively widespread stand-replacing fire. The last widespread fire in these upper elevation vegetation types burned as a stand-replacing fire in 1685. Due to the stand-replacing nature of this type of fire regime, which kills and burns tree-ring evidence of prior fires, no fire return interval statistics could be derived for historical fire in the spruce-fir zone.[2]

Fire-climate analyses suggest that an extreme single-year drought was associated with the last large stand-replacing fire. Similar forest types in the adjacent Tesuque watershed burned in two stand-replacing fires in the late 19th century (Margolis et al. 2007a). This may suggest that sufficient fuel existed over 100 years ago in the upper elevations of the municipal watershed to support a large fire (assuming that the forest was similar in age to the Tesuque watershed at the time of the last fire) and that an additional 120 years of fuel has accumulated in the Wilderness Area since then.

The historical fire regime in the lower elevation (<10,000 ft) pine and mixed-conifer forests in the Wilderness Area was characterized by both repeated surface fire (as evidenced by individual trees with multiple fire scars) and stand-replacing fire in small (<100 acres) patches in some locations. The last fire documented by fire scars was in 1879 and the last widespread fire was in 1842. Widespread surface fire in the Wilderness Area occurred less frequently (estimated average interval of 33 years, see Table 4)

[2] Methods do exist to reconstruct landscape-scale fire frequency estimates (natural fire rotation) in crown fire regimes, but this requires more forest age data than is currently available.

than in the mid-elevation ponderosa pine dominated forests of the lower-upper municipal watershed (estimated average fire interval is 16 yrs, Balmat et al. 2005).

Table 4. Santa Fe Municipal Watershed Wilderness Area Mixed-Conifer Fire Interval Statistics, 1595-2006

Filter	Number of intervals	Mean fire interval	Median fire interval	Weibull median fire interval	Minimum interval	Maximum interval
all scars	18	15.56	15.5	13.56	1	31
10%	9	31.11	30	29.69	15	71
20%	7	34.71	30	33.31	16	71
25%	6	40.5	31	37.18	16	94

Tree ring analysis of the historical fire regime indicates that the frequency of fire varied considerably over the last 400 years (Table 4). Small fires (recorded only by single trees) occurred somewhere within the study area as frequently as one year apart (all scars, minimum interval = 1 yr), whereas widespread fires (scarring >25% of recording trees) were not recorded during a 94 year fire gap between 1748 and 1842. This range of fire intervals emphasizes the need to consider variability during fire restoration. Strong relationships between variability in reconstructed measures of climate (drought, precipitation and El Niño) and fire occurrence indicate that much of the historical variability in fire frequency was driven by the inherent variability of climate in the Southwest. This relationship breaks down in the 20th century, when no fires were recorded in the study area. Future, managed fire regimes would be most natural if these two processes (fire occurrence and climate variability) were re-coupled.

Restoration and Treatment History

The Wilderness Area within the municipal watershed has not received any restoration treatments.

Recommendations

This section identifies the criteria and general locations where treatments are recommended. The criteria cover the two primary objectives of the forest management in the municipal watershed: (i) reduce the risk of catastrophic crown fire for protection of the water resource and (ii) maintain or restore forest health. Decisions regarding the criteria are based on available forest structure and age data (presented above), current and historical fire regime data (presented above), and general knowledge of fire behavior in southwestern montane forest types (Table 5). Recommendations are partly based on the concept of historical range of variability (HRV): the ecological conditions, and the spatial and temporal variation in these conditions that are relatively unaffected by people (Landres et al. 1999), to determine where areas were in a "natural state" (based on HRV) when considering the objective of forest health. Two treatment types were considered: (i) fire and (ii) hand thinning within the Wilderness boundary. Because embers from wildfires occurring on lands adjacent to the municipal watershed can travel several miles, fuel reduction treatments along the municipal watershed boundary would not prevent wildfire from entering the municipal watershed and were therefore not considered as part of this analysis and not included in the Santa Fe Municipal Watershed Plan. A summary of recommendations for the Wilderness Area is illustrated in Figure 3.

Table 5. Summary of Criteria for Treatment Recommendations	
Fire Treatment **not recommended**	• Forests are in natural state (based on HRV of fire regime) OR • Forests are in unnaturally dense state and crown fire is likely if burned without prior treatment OR • Forests naturally burned in crown fire and will likely do so if burned now
Hand thinning **not recommended**	• Forests are in natural state (based on HRV of forest age and structure) OR • Site access for work crews is problematic OR • Presence of steep slopes result in safety hazards for work crews
Fire treatment **potential**	• Forests are in unnaturally dense state (based on HRV of forest age and structure) and can be safely burned during seasonally optimal periods. Evidence of 20th century increase in forest density, based on field observations and aerial photos.
Hand thinning **potential**	• Forests are in unnaturally dense state (based on HRV of forest age and structure) AND • Site access for work crews is practical for work crews to efficiently perform the work. • Absence of steep slopes, allowing for work crews to safely perform work

Summary of the Wilderness Area recommendations

- *Wilderness Area spruce-fir zone*

It is not recommend to treat the 4,017 acres of spruce-fir vegetation in the upper municipal watershed wilderness area due to the natural state of the forest and fire regime as compared to the historic range of variability derived from tree-rings. However, it must be recognized that this forest naturally burns as catastrophic fire and the predicted warmer future climate will likely increase the fire risk in this forest (e.g., Westerling et al. 2006). To address the potential post-fire watershed effects a hydrologic model should be used with differing crownfire scenarios. The GIS-based hydrology model AGWA is recommended for this post-fire risk assessment: http://www.tucson.ars.ag.gov/agwa/index.php?option=com_frontpage&Itemid=1

- *Wilderness Area mixed conifer zone*

It is recommended that prescribed fire be used to treat approximately 2,900 acres of mixed conifer, ponderosa pine and Gambel oak vegetation in the lower portion of the Wilderness Area, above McClure Reservoir. These potential treatments would be aimed at breaking up contiguous fuels to reduce crown fire risk within the mixed conifer zone and maintain or restore areas with historical evidence of frequent surface fire regimes. Identified areas immediately upstream of the main water supply reservoir are of highest priority. These treatments would further reduce the risk of post crown-fire effects on McClure Reservoir. Some areas in the mixed conifer zone are likely too steep, dense and inaccessible to burn efficiently and without the risk of escaped crown fire into the adjacent spruce-fir zone. Due to the steep terrain and remote access presenting significant problems for work crew safety and work efficiency, hand thinning in this area is not recommended.

Monitoring

It is recommended that new treatments be monitored for the purpose of adaptive management. Monitoring should occur before the treatment, immediately after the treatment, and 3 and 7 yrs following the treatment. Monitoring in each of these treatment areas should include (but not be limited to) the following variables:

- Fuel load
- Tree density
- Canopy cover, and
- Understory cover.

Monitoring plots that are representative of the treated area (i.e., similar aspect, slope, and forest type) should be permanently established at a ratio of 1 plot per 20 acres of treatment, not to exceed 20 plots per treatment area. In addition, to control for forest changes due to climate variability, additional control plots should be established in adjacent untreated forest with similar vegetation and physiographic characteristics (3 control plots per vegetation and physiographic setting – not to exceed 6 plots per treatment area). We recommend that all monitoring data be placed in a publicly accessible permanent archive in the New Mexico Forest and Watershed Restoration Institute at Highlands University.

Vegetation Management Plan for the Riparian Corridor of the Municipal Watershed

Ecological Context

Riparian zones comprise the vegetation systems adjacent to rivers where dynamic processes of erosion, deposition, and water flow occur. Typically, riparian communities occupy a small portion of the landscape, but contain the majority of plant diversity in the landscape. There are approximately 10 miles of stream from the headwaters to McClure Reservoir, and three miles of stream between the two reservoirs. The riparian community along the Santa Fe River above Nichols Reservoir is reasonably intact relative to other southwestern riparian zones, and relative to the pre-treatment conifer forest of the municipal watershed. The 1998 Tolisano study of the riparian zone stated that "the overall hydrologic and ecological features suggest a resilient and healthy riparian ecosystem." Several prior studies have characterized existing conditions of the riparian community in the municipal watershed. Their salient findings are summarized below and in Appendix 1.

- The upper reach of the Santa Fe River is fairly undisturbed and near historical conditions (Tolisano 1998).
- The middle reach of the Santa Fe River (from the McClure Reservoir to a point within the Wilderness Area) is periodically recharged with overbank surface flows, has a shallow ground water table, and supports more species and structural diversity (Tolisano 1998).
- The lower reach of the Santa Fe River used the BLM's Proper Functioning Conditions methodology to assess riparian health. Tolisano described the reach between dams as "properly functioning hydrologic and ecologic features" with "adequate levels of biological diversity" and "highly diverse in composition and structure." However, below Nichols Reservoir, Tolisano observed more degraded conditions, with little overbank flooding and presence of non-native invasive species (Tolisano 1998).
- Though vegetation communities are fairly diverse throughout the riparian corridor, five species account for 90% of the trees sampled: aspen, ponderosa pine, mountain alder, white fire, and Douglas fir (RMRS nd).
- Flooding has been reduced below the McClure Dam enough that the upper portions of the floodplain have become drier and more suitable for conifer establishment than riparian vegetation (Blue Earth 2000).

Restoration and Treatment History

Various agencies and scientists have made recommendations for the riparian community over the history of the restoration project for the municipal watershed. The merits of these recommendations are discussed below. To date, there have not been any treatments to the riparian corridor.

1. Fuel reduction/thin conifers to reduce fire risk. One potential restoration treatment is the thinning of ponderosa pine trees and other conifers within the riparian community in order to lower the threat of crown fire. The Forest Service Record of Decision (2001) calls for creating openings in the riparian community between the two reservoirs. A Forest Service document by Cassidy (2000) suggest that in both the riparian zone between the reservoirs, and above McClure to the Wilderness boundary, that the density and size of conifer trees, especially ponderosa pines, suppress riparian species' regeneration and

present a crown fire threat. Cassidy suggests that the removal of smaller conifer trees (12 to 16" dbh) and a burn-only scenario are inadequate to address the problem; and proposes removal of conifer trees up to 24" dbh and the reintroduction of cool fires into the riparian zone. Given the need to remove the biomass from the site and the impact of skidding or other surface removal, he suggested helicopter removal of trees as the best treatment option (Cassidy 2000).

What the historical structure and composition of tree species in the riparian was like in its historical range of variability is unclear. It is our assessment that the historical structure of the riparian community below the Wilderness boundary was sufficiently disrupted by human activities, especially by fuel wood cutting and intensive domestic grazing, that it is not possible to usefully reconstruct reference structures through tree-ring analysis. Pittinger (2000) suggests that the current riparian community established only 50 to 60 years ago. Given the human disruption of the past, it is more advisable to base 'restoration' on current conditions, than on reconstructed pre-settlement conditions.

The question of the desirable ratio of conifer trees to riparian vegetation is probably best asked in relation to fire risk. In terms of reduction of overall fire risk, the riparian zone is now effectively isolated from a spreading crown fire by thinning of the surrounding ponderosa pine forest. The likelihood of fire originating in the riparian zone and spreading into adjacent stands of conifers is low. Thinning conifers and removing the biomass would involve practical difficulties, considerable time and money, and disturbance impacts on the riparian community.

Moreover, given the low densities of adjacent thinned stands, the riparian zone offers an important refuge for wildlife seeking high density vegetation stands. Dodd et al. (2006), for example, recommend maintenance of such refuges of high-quality habitat in restored ponderosa pine forests for Abert squirrel (*Sciurus aberti*) populations. Since the riparian zone has been documented as largely within proper functioning conditions, and given the difficulties of removal of biomass, we do not recommend removal of any conifer trees from the riparian zone in the near term.

2. *Planting trees and shrubs.* The Forest Service Record of Decision (2001) calls for planting additional trees and shrubs in the riparian zone, while retaining all willow, alder and cottonwoods in the riparian community. The Tolisano report also recommended planting of deciduous riparian species such as cottonwoods, alders, maple and box-elder trees below McClure Reservoir.

The riparian community appears to be in recovery from human impacts that were historically quite severe. Cutting of firewood and domestic grazing resulted in the past in nearly denuded areas around the Santa Fe River, as documented in photographs taken of the area early in the 20th century. Since there is insufficient information on species composition prior to human activities, and since the community is functioning well, it seems advisable to allow natural processes to shape the composition of the riparian community rather than artificially alter composition. Continued monitoring of riparian species populations should guide the decision to plant native species. We do not recommend planting in the riparian zone at this time.

3. *Burn areas within the riparian community.* The "Monitoring Forest Treatments in the Santa Fe Municipal Watershed" (2003), discusses the TAG proposal that the effects of fire on riparian ecosystem be explored, including the suggestion of a small-scale study of the effects of fire on riparian sites. The TAG concluded that the study should be postponed until the main municipal watershed thinning was

complete. Now that the thinning is largely accomplished, is it appropriate to conduct a controlled experiment that tests the effect of fire on the current structure of the riparian community?

The probability of high-intensity fire entering the riparian corridor from adjacent forests is low, now that the matrix of conifer forest surrounding it has been thinned to a low density. The effects of fire on upland riparian zones in the West is poorly characterized (Reeves et al. (2006). However, the moist conditions of the riparian zone, and the presence of deciduous trees such as aspen with lower levels of volatile compounds than conifer trees, makes it less likely that fire would travel up the corridor under most climatic conditions. If portions of the riparian corridor were to burn naturally, they are likely to recover rapidly (Reeves et al. 2006). If there is a prolonged and severe drought, the vulnerability of the riparian zone to crown fire should be reassessed, particularly with regard to dead and down fuel load. We do not recommend burning with prescribed fire within the riparian zone at this time.

4. Down trees to mimic windfall. Dead trees often falls across streams in complex patterns that enhance stream condition. Downed logs partially lying across streams can protect banks from erosion, dissipate stream energy, form pools, and store sediment. Stream banks can thereby store more moisture and nutrients. Cutting and dropping some ponderosa pine trees into the streambed has been suggested in order to introduce debris into the river.

The Tolisano Report documented fallen branches, whole trees, and other woody debris along the stream throughout the municipal watershed, and characterized the dead and down load as "representative of properly functioning or optimal ecological conditions." Pittinger (2000) indicates the value of large woody debris, and the beaver dams that exist between the two reservoirs, in creating pools for trout. It was Tolisano's opinion that there is already enough downed wood to represent a potential fire threat during a drought.

There appears to be no critical need for changing the structure of debris in the stream at this time, since the riparian community was recently given high marks for function. In addition, the RMRS sampling documented the presence of a number of dead standing trees, which will be falling in the future, some of which may fall into the stream. We believe it is preferable to let natural processes of tree mortality and fall help to shape the streambed in the future, and we do not recommend felling additional trees for this purpose.

5. Bring back the river otter. The suggestion has been made, in the Tolisano report and elsewhere, to reintroduce the river otter to the Santa Fe River. The NM Department of Game and Fish is now in the midst of an effort to restore otters to the Rio Grande and Gila Rivers. The Santa Fe River, however, falls very short of an adequate prey base or an adequate flow to support an otter population, which would be isolated from other populations in the State in any case (Stuart 2006). We do not recommend otter reintroduction.

6. Release water from McClure Reservoir. Spring flooding is a key natural process in southwestern riparian communities. On a regular basis, flooding brings sediment and nutrients, both of which encourage seedling germination. Flooding can favor species that require a mineral seedbed, and disperse seeds, such as those of cottonwoods.

The City Water gauge above McClure Reservoir, which measures the pulse of flow in spring from snowmelt, provides information that reflects the natural streamflow unaltered by dams. This gauge documents a fairly long record of year-round water flows, which, as expected, reach a maximum in spring during snowmelt (City of Santa Fe data). The average flow over this period, which contains some data reconstructed from reservoir levels and releases from the lower dam, is 425 acre feet per month, with a minimum of 0 acre feet per month, and a maximum of 4,820 acre feet per month (May, 1973). Although the latter value is an extreme value from a wet period, monthly flows in spring in the 2-3,000 acre feet per month value range are not uncommon. During dry periods maximum monthly values do not usually exceed ~ 1,000 acre feet per month at high flow in spring, and can be much lower. Stream flows are greatest, in general, during the three months that reflect snowmelt, i.e., April, May and June.

Streamflow modification is the most common form of restoration in southwestern riparian systems, as restoration of natural process is favored over structural modification (Follstad Shah 2007). One goal of restoration is to reestablish the natural processes that keep communities within their natural range of variability over time. This approach reduces the uncertainty that accompanies human choices in restoration work. The upper gauge streamflow data can be used to shape the release of water from the upper dam into the reach between the two reservoirs. Such a release of water in the spring period when snowmelt would have naturally occurred, would mimic a natural process that helped shape the riparian community in that stream reach. We recommend refining the spring release from McClure, a release of water from the upper dam that mimics the annual peak flows in springtime. The benefits to riparian features should be used as a guide to timing and quantity of releases.

One benefit of higher peak flows between the reservoirs should be a reduction in conifer seedling establishing within the floodplain. Sustained flows throughout the growing season between the reservoirs should also benefit riparian species establishment. In addition, fires appear to have occurred in upland riparian zones with a frequency similar to the ponderosa pine forest matrix (Arno and Peterson 1983). Peak flows may sweep away and accelerate decay of the high fuel loads in parts of the riparian zone, and sustained summer flows would keep dead and down fuels moist throughout the natural fire season. Higher peak flow may also destabilize and, in time, fell some of the large established conifer trees in the riparian zone.

In the long-run, it would also be advisable to consider the ecological impacts of releases from Nichols Dam on the riparian zone below. Although there are water storage considerations that are not an issue for between-reservoirs release, the more degraded riparian corridor below Nichols Dam may benefit also from spring water releases.

Changing the pattern of springtime releases from the reservoirs, however, must be considered carefully. Tolisano, while noting the benefit of natural levels of flooding in springtime for the riparian community, also pointed out that current release levels appear to be adequate to produce a healthy community. Any adjustment of release flows should be accompanied by intensive monitoring of PFC parameters, especially bank stability.

6. Remove Invasive Species. A final riparian issue is the presence of non-native invasive tree species below Nichols Reservoir. Russian olive and Siberian elms are currently growing around the

decommissioned Two-Mile Dam, and populations of the invasive forb Toadflax have been observed in this area (Tolisano 1998, Pittenger 2000). Without treatment, it is likely that invasive non-native species that occur in the lower reach of the municipal watershed riparian zone will soon disperse and establish farther up the river. It is not altogether clear what the role of these invasive trees is in the riparian ecosystem, for example, whether or not they are deleterious or beneficial to native bird populations. Nevertheless, it seems best to err on the side of caution in regard to the spread of non-native trees farther into the upper municipal watershed.

Recommendations

The riparian community in the municipal watershed is, on the whole, in relatively good condition. Judged by both the standard of crown fire risk and general ecological integrity, the riparian community is in need of little treatment. The lowest portion of the riparian community in the municipal watershed is the most degraded. We recommend the following:

- *The reach from McClure Reservoir to the Wilderness Boundary*
  No treatments are necessary in this reach of the river, but continued monitoring of structural conditions and proper functioning condition are recommended.

- *From Nichols to McClure Reservoirs*
  Consider refining the pattern of seasonal water release from McClure Reservoir based on ecological impacts to the riparian community. Variability in annual streamflow, as reflected in the gauge above McClure Reservoir, should be reflected in variability in the releases. This action should be accompanied by continuing monitoring to ensure that PFC values are not negatively affected over time.

- Below Nichols Reservoir
  Remove non-native tree species found growing below Nichols Dam. Below Nichols Dam (below the water supply intake), treat stumps of Russian olive with short-lived herbicide to prevent resprouting; periodically revisit the treatment to prevent reestablishment of non-native tree species.

- *Monitoring*
  On-going monitoring of the ecological integrity and functioning of the riparian community is essential. Virtually all documents created for the restoration treatment plan suggest that monitoring be part of the long-range management of the municipal watershed. We recommend continued use of the Proper Functioning Condition methodology, particularly since there is existing baseline data. Two system components need on-going monitoring attention: 1) the integrity of riparian function, and 2) the populations of non-native tree and other invasive plant species, which can disperse and establish quickly, and destabilize riparian communities along the length of the river above Nichols Reservoir. We also recommend that monitoring track changes in riparian conditions that may result from drought and warming trends. We recommend that all monitoring data be placed in a permanent archive in the New Mexico Forest and Watershed Restoration Institute at Highlands University.

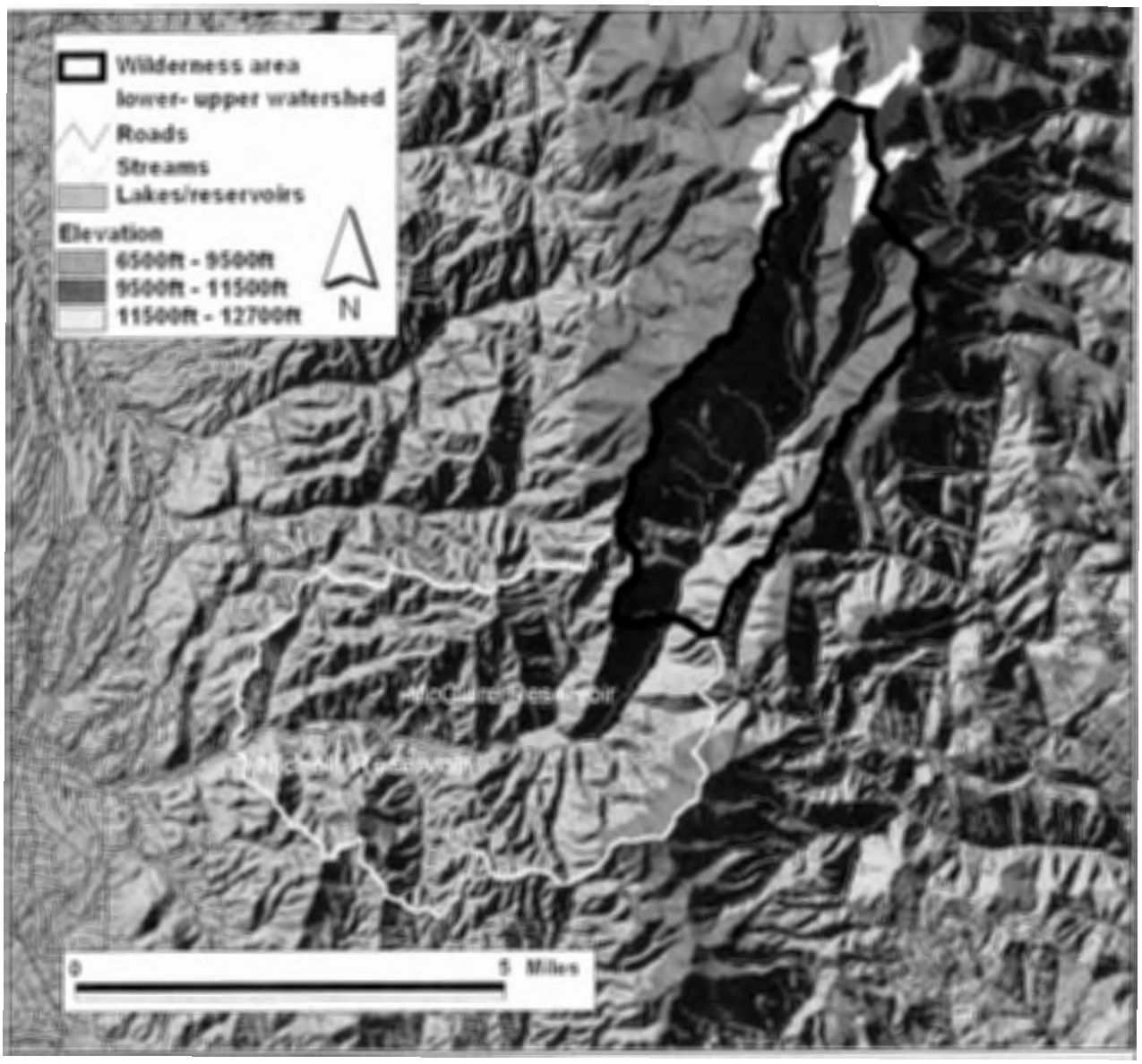

Figure 1. Shaded relief digital elevation map of the upper Santa Fe Municipal Watershed. The two management areas discussed in the text are delineated in black (the wilderness area) and white (the lower-upper municipal watershed).

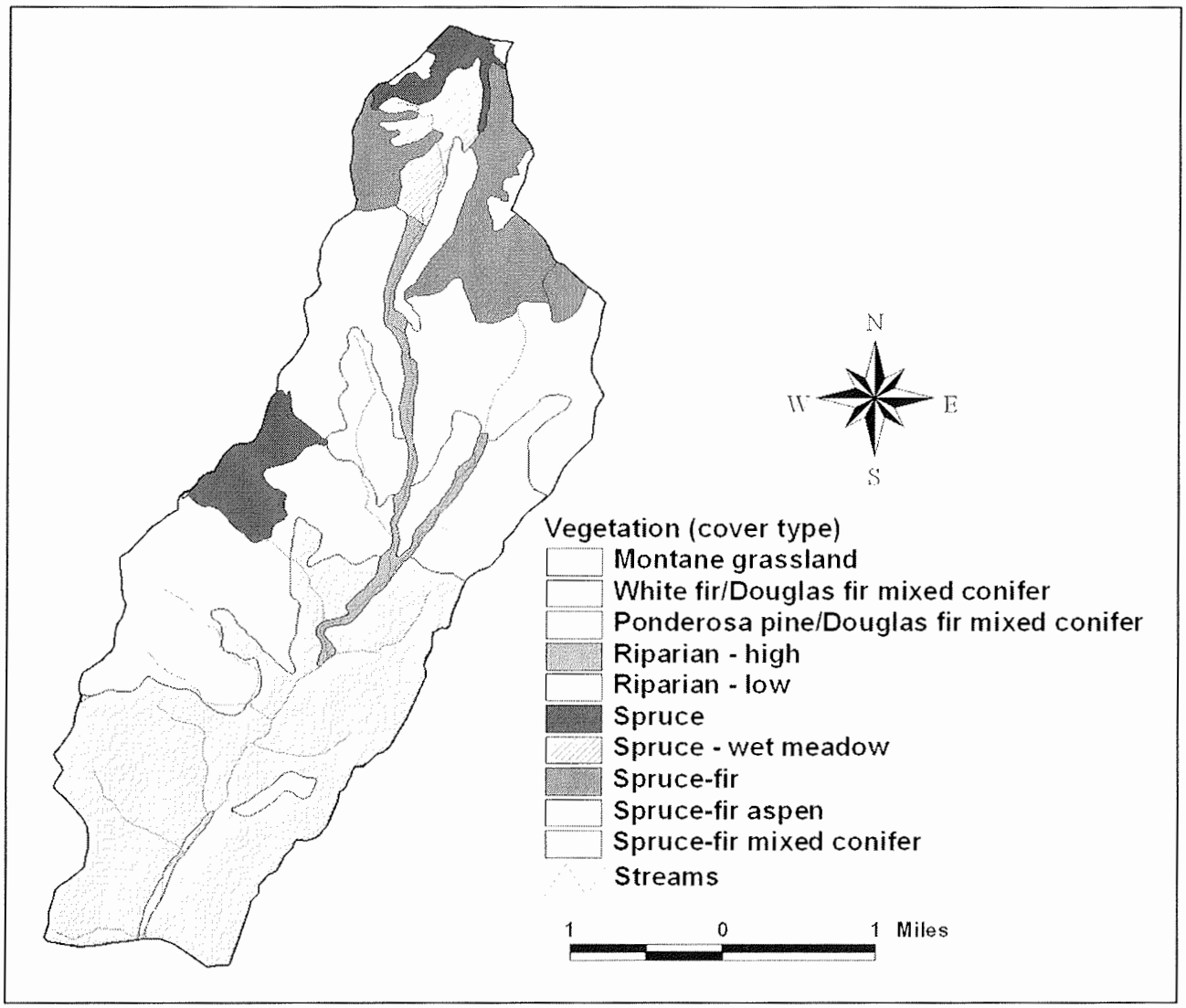

Figure 2. Vegetation types of the Santa Fe Municipal Watershed Wilderness Area.

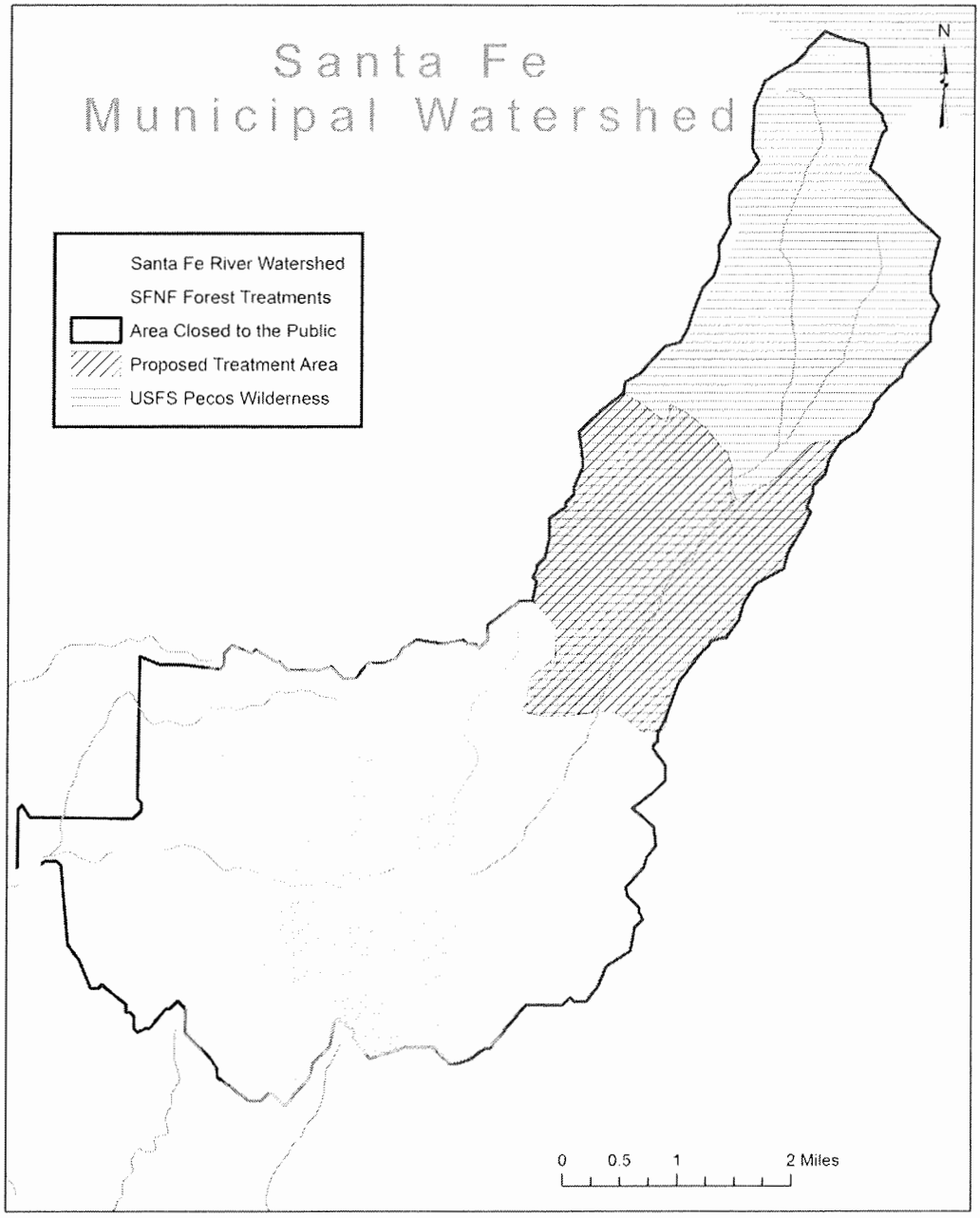

Figure 3. Recommended forest treatment area in the mixed-conifer forest above McClure Reservoir, within the Santa Fe Municipal Watershed Wilderness Area.

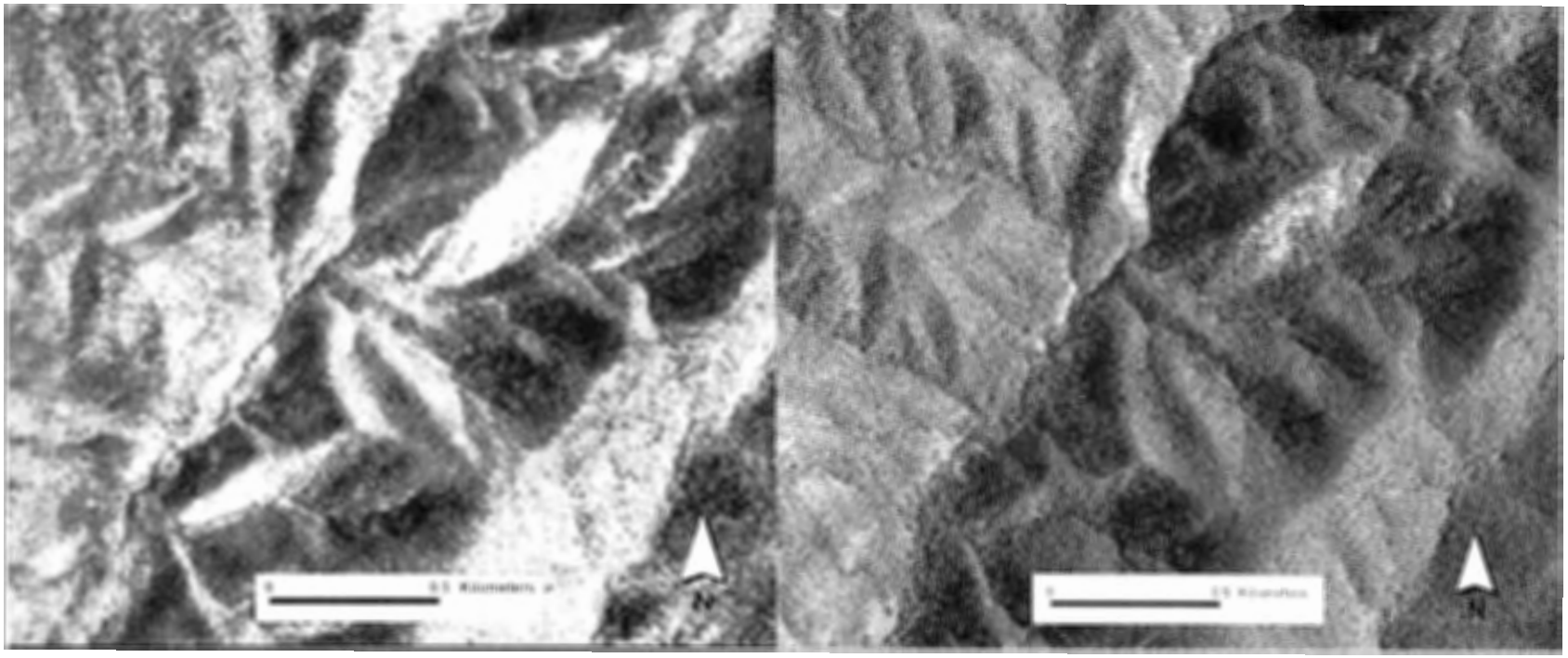

Figure 4. Comparison of aerial photos (1935 on the left, 2005 on the right) from the mixed conifer zone of the Santa Fe Municipal Watershed Wilderness Area indicates increased forest cover on south and east-facing slopes over the 70-year period. Photos from the U.S.F.S. Santa Fe National Forest S.O., courtesy of Julie Luetzelschwab.

Appendix 1: Background Information on the Riparian Zone

This appendix presents a summary of recent findings regarding ecological conditions in the Riparian Zone of the Santa Fe Municipal Watershed.

Tolisano report. The Tolisano Report (1998) characterized existing conditions in three stretches of the Santa Fe River: lower, middle and upper. The upper reach of the river courses through the very steep portion of the municipal watershed, where canyon walls dip steeply to the river, confining the riparian zone to a narrow strip. This part of the riparian community is fairly undisturbed and likely near historical conditions. The middle reach of the river was defined by Tolisano as the reach from McClure Reservoir to a point within the Wilderness, thus encompassing the reach from McClure to the Wilderness boundary and extending above it. The river in this reach emerges from the steeply cut canyon, and spreads out into a wider floodplain. In this section, the floodplain is recharged with overbank surface flows periodically, has a shallow ground water table, and supports more species and higher structural diversity.

The reach between the reservoirs, Tolisano's 'lower reach,' was characterized by "a mix of properly functioning riparian conditions." Tolisano used the BLM's Proper Functioning Conditions (PFC) methodology to measure riparian community health (BLM 1993). For the reach between the dams, the PFC ratings for canopy cover, vegetation width, structural diversity, ground diversity, were all graded as "properly functioning hydrologic and ecological features"—reflecting "adequate levels of "biological diversity, ecological structure and resilience, growth, vigor, and regenerative capacity to ensure the long term viability of the ecosystem", and site diversity, channel stability and canopy cover ranked at "optimal condition"—reflecting "high levels" of those traits. Tolisano described this portion of the riparian community as "highly diverse in composition and structure," with a wide riparian zone with multiple canopy layers, numerous shrubs and an abundant understory of saplings, shrubs and herbaceous plants. River banks are "highly stable" and sediment effectively dispersed downstream. Tolisano notes that the riparian zone between the two reservoirs is dependant upon the timing and quantity of water releases from McClure, and that the condition of the riparian community in this reach seems to reflect an adequate release pattern.

Below Nichols Reservoir, however, Tolisano observed more degraded conditions. There is little overbank flooding in this reach, although the width of the riparian zone continues to be reasonably wide, reflecting an adequate water table. Non-native invasive species, such as Russian olive and Siberian elms, have moved into the riparian community below Nichols Reservoir. Tolisano notes that these species could easily travel upstream and invade the upper river communities, and that this would significantly reduce the quality of wildlife habitat of the riparian community.

Rocky Mountain Research Station data. Rocky Mountain Research Station sampled vegetation in the riparian community as part of the monitoring effort that accompanied forest treatments. The data documents that, although the community is fairly diverse,

five species account for 90% of the trees found in the sampled riparian community: aspen (Populus tremuloides) (113/acre - 27% of all trees), ponderosa pine (Pinus ponderosa) (89/acre - 21%), mountain alder (Alnus tenuifolia) (70/acre - 17%), white fir (Abies concolor) (64/acre - 15%), and Douglas fir (Pseudotsuga menziesii) (44/acre - 10%). Other tree species found on the site in smaller numbers include narrowleaf cottonwood (Populus angustifolia) (16/ac), Rocky Mountain maple (Acer glabrum) (8/ac), limber pine (Pinus flexilis) (6/ac), Rocky Mountain juniper (Juniperus scopulorum) (4/ac), Gambel oak (Quercus gambelii) (3/ac), chokecherry (Prunus virginiana) (1/ac), piñyon pine (Pinus edulis) (1/ac) and snowberry (Symphoricarpos spp.) (1/ac).

The study documented dead standing trees in the riparian zone, 26/acre for snags larger than ~ 5" and 93/acre for snags smaller than ~ 5". Aspen are the most numerous snags (average dbh 9" [diameter breast height]), ponderosa pine (average dbh 6"), Doug fir (average dbh 5"), cottonwood (average dbh 11"), and white fir (average dbh 7"). Most are relatively small size snags, which tend to fall more rapidly than larger snags.

The largest live trees on the site are ponderosa pine, with 20% of trees over 16" dbh. Of the other four most common trees, there were few large trees: only 7% of white fir, 3% of Douglas fir, and 5% of aspen were larger than 16" dbh; no mountain alder trees were larger than 5" dbh. Nearly 75% of the aspen are smaller than 8" dbh. In general, especially in moist sites, size reflects age, and, together with what we know about human impacts in the past, the data support the case that most trees in the riparian community established fairly recently.

Blue Earth Existing Conditions Report (Pittenger 2000). This report documented in detail the species composition and distribution of the various types of riparian communities found in the municipal watershed. The author discusses the issue of water release from McClure Dam and its effect on the community. He notes that flooding has been reduced enough that the upper portions of the floodplain have become drier and more suitable to conifer establishment than riparian vegetation: "The floodplain has essentially become abandoned and now comprises a terrace." In addition, sampling was conducted in August, at which time there was no water flowing in the riverbed, and water occurred in isolated pools only. The report points out both the benefits of flow regulation—reduced destructive effects of flooding, such as destruction of beaver dams at peak flow—and the disadvantages—reduced overbank flows that favor establishment of riparian species.

Appendix 2: Summary of NEPA Monitoring in the Santa Fe Municipal Watershed, as of October 2006

NEPA implementation monitoring in the Santa Fe Municipal Watershed, revised 10/06							
Resource or Issue	**Parameters**	**Methods**	**Timing & Frequency**	**Responsible Group**	**Funding**	**Annual Cost**	**Baseline Data**
Water: Are treatments adversely affecting water quality such that we are not in compliance with Federal/State and Forest Plan standards, and Clean Water Act regulations? Are treatments resulting in beneficial increases in water yield or unacceptable peak flow events that may alter the stream channel morphology?							
Water Quality	Stream flow, turbidity, temperature, precipitation	Paired Basin Study	15 mins at gauging stations. Precip. at 2 higher elevations. TSS data limited	City of Santa Fe	City of Santa Fe	$30,000	3 years pre-treatment data
Water Chemistry	pH, temp, turbidity, conductance, dissolved oxygen, metals, ammonia, nitrate, nitrogen, phosphorus, suspended & dissolved solids, major cations and anions, organic compounds, fecal coliform bacteria, radionuclides, cyanide.	3 sites on SF river, per approved Quality Assurance Project Plan	3x per year (spring, summer, fall)	NMED	NMED	$4,500	NMED
Peak Stream Flows in Side Drainages	Stream flow	Use Parshall flume and flow gauge in paired subdrainages (treated & untreated). Rain gauge between drainages	15 min. intervals, March-Oct	City of Santa Fe	City of Santa Fe	See "water quality" above	
SF River geomorphology	Stream width, depth, cross-section, area, entrenchment, channel bottom, particle size, bank erodibility, hazard index, relative elevations of thalweg, water's edge, bankful at each habitat unit (pools, riffles, runs, glides), cross section area of pools	Use Rogsen method. Record measurements at 2 cross-sections and along 1 stream reach	Annually each summer	NMED	NMED	See "water quality"	Blue Earth 2000

SOIL: Are treatments adversely affecting the soil such that we are not in compliance with Forest Plan standards for acceptable soil loss and maintenance of long-term soil productivity?							
Soil Erosion, Loss	Erosion rate (tons/acre/yr)	RUSLE at data collection points from RMRS wildlife study	Annually	Santa Fe National Forest, Española Ranger District	SFNF	$1-2,000	RMRS pre-treatment data
Ground Vegetation: Are treatments meeting the objective of increasing vegetative ground cover, in order to stabilize the soil, filter sediment runoff, improve nutrient cycling, increase biological diversity and carry future surface fires?							
Understory Ground Cover	Grasses, forbs, shrubs	% vegetative ground cover, RMRS plots; species info on woody veg only. Photo points	Annually	RMRS	See "Wildlife habitat & diversity" below		RMRS pre-treatment data
Fire: Are prescribed burns resulting in escaped crown fires outside fire lines? Are they staying within burn prescriptions and behaving as predicted in the EIS? Are mitigations being followed?							
Escaped Crown Fires resulting from prescribed burns; unexpected fire behavior	Unexpected fire	Recorded observations of fire behavior	During and after burn, until fire is out	SFNF Española Ranger District	SFNF	Part of normal fire monitoring budget	Data since project start
Prescribed fire	Energy Release Component (ERC), fuel moistures, Palmer Drought Index (PDI)	Record 3-5 day ERC, fuel moistures and PDI; other weather.	Just prior to ignition	SFNF Española Ranger District	SFNF	Part of normal fire monitoring budget	Data since project start
Air: Are prescribed burns adversely affecting air quality such that we are not in compliance with Federal/state and Forest Plan standards and Clean Air Act regulations? Is smoke from prescribed burning resulting in adverse impacts to public health or visibility?							
Smoke from Burning; Environmental Compliance	Particulate matter (PM-10), TEOM, and smoke (visual)	PM-10 monitors along Upper Canyon Road, visually monitor smoke plume	Daily during burns until smoke subsides	SFNF Española Ranger District	SFNF	Approx. $400 extra from normal burn monitoring	Data since project start
Smoke from Burning: Health and Safety	Air quality warnings; alerts or travel way visibility impacts	Record air quality alerts and visibility impacts	During burns until smoke subsides	SFNF Española Ranger District	SFNF	See above	Report and EIS data
Fuels & Forest Vegetation: Are treatments effective in meeting the fuel reduction objectives by breaking up fuel continuity in the overstory and reducing the density of understory ladder fuels?							
Fuel Hazard: Dense ladder fuels and canopy cover	Basal area, trees/acre, diameter class distribution, % canopy cover	Stand exam plots, stratified random sample	Annually for 2 years after thinning & burning	SFNF Española Ranger District	SFNF	$1,000/year	USFS 1998 stand exam

Forest & Riparian Vegetation: Are invasive non-native plants increasing in the riparian areas where treatments caused soil disturbance? Are bark beetles infesting the cut trees on the forest floor and posing a threat to live trees?							
Invasive plants	Exotic species, herbaceous & woody	Sample treated areas, count and map invasive plants. Note observations on map, report to field biologist	Survey at appropriate seasons for ID. Report as species observed	SFNF Española Ranger District	SFNF	$2,000	Tolisano 1998
Insect infestations	Ips beetles in cut/down logs; infested standing trees	Observation by qualified specialist		SFNF Española Ranger District	SFNF	Part of project costs	Data since project start
Wildlife Habitat & Diversity: Are treatments resulting in a loss of key habitat features such as large snags, down logs or riparian hardwood species, or reducing vegetative cover in the drainage bottoms/corridors? Are treatments resulting in an increase or decrease of existing aquatic insects, fish, beavers, birds, or small mammals, which may indicate an improvement or decline in biological diversity?							
Key Wildlife Habitat Features	Large snags, down logs and hardwoods	Stand exam plots, stratified random sample; include MSO restricted habitat	Annually for 2 years after thinning & burning	SFNF Española Ranger District	SFNF	Part of stand exams	1998 stand exam
Key Wildlife Habitat Features	Canopy cover in drainage bottoms	Stand exam plots, stratified random sample; MSO restricted habitat	Annually for 2 years after thinning & burning	SFNF Española Ranger District	SFNF	Part of stand exams	1998 stand exam
Overstory and Understory	Overstory tree species; Woody understory species at RMRS points, species; other understory species not recorded.	Stand exams for appropriate area	Annually for 2 years after thinning & burning; Veg data collected annually	SFNF Española Ranger District; RMRS ground vegetation	SFNF; RMRS	Part of stand exams	1998 stand exam; RMRS data since 2002
Aquatic insects & fish	Species richness, composition, % Ephemeroptera, tolerance/intolerance, % filterers,% clingers	Multi-habitat approach, EPA rapid bioassessment, 3 sites on upper SF River	Annually in summer	NMED	NMED	See "water quality"	Tolisano 1998, NMED 2000, Blue Earth 2000, SFHS 1996-2000
	Trout numbers, size, and condition by species	EPA rapid bioassessment, record #, size, weight by species on 3 sites	Annually each summer	NMED	NMED	See "water quality"	Tolisano 1998, NMED 2000, Blue Earth

		upper SF River					2000, SFHS 1996-2000
Wildlife populations; biological diversity	Abundance and species richness of breeding birds & small mammals	RMRS	Multiple measurements spring/summer	RMRS	RMRS	$100,000	Baseline 2 years pre-treatment
Wildlife populations; biological diversity	Abundance of active beaver colonies	Count active beaver dams	Annually	SFNF Española Ranger District	SFNF	$1,000	Baseline 3 yrs pre-treatment
Heritage Resources: Are treatments adversely affecting heritage resources such that we are not in compliance with Forest Plan standards and National Historic Preservation Act regulations?							
Site preservation	Heritage resource sites	Sampling 20% of known sites	Annually after thinning & burning	SFNF Española Ranger District	SFNF	$3,000	Arch. Survey

Monitoring & Communication Added to the Santa Fe Municipal Watershed Project through the Process of Adaptive Management							
Social: What is public perception of the project? How has public perception changed since project was first proposed?							
Public perception	Change in Approval/disapproval of project among interested public.	30-50 Interviews w/ persons identified by SF, SFNF, Watershed group; snowball sample, interviews of DEIS commentator	As soon as possible and after project completion			$3-5,000 estimate	Comments on DEIS; Citizen complaints
Collaborative Forestry: How do we maintain open communication between the scientific community, the larger community, and the Santa Fe National Forest regarding the conduct of the Santa Fe Municipal Watershed project?							
Entity	**Function**	**Composition**	**Meetings**	**Public Outreach Opportunities**	**Funding**		
Santa Fe Watershed Association	Observes project, feeds issue questions to TAG to provide feedback to SFNF, provides public outreach	Non-profit with professional staff and broad membership	For those related to this project, see below	website www.santafewatershed.org provides frequent updates on project.	Foundations, donations, etc.		
Technical Advisory Group	Scientific panel oversees data collection and interpretation, observes treatments and provides feedback to	Volunteers with appropriate background invited by SFWA	Every six months	Part of meeting is open to public	None. Partners provide endorsement for grant seeking efforts.		

	SFWA						
Implementation Team	Forum for regular communication between resource managers, monitors and other stakeholders	SFNF, SFWA, agencies performing monitoring, staff of elected representatives, City	Monthly	None: purpose is to provide forum for open communication among named participants, decide collectively who to provide public outreach on a given issue and how	Individual agencies/ organizations		

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Santa Fe Municipal Watershed Plan
Water Management Plan

Background and Context

The Santa Fe Municipal Watershed provides critical surface water to city residents' water supply. Protection of water quantity and quality is a shared goal of the City of Santa Fe and the Santa Fe National Forest, which manages the upper 17,000 acres of the municipal watershed. The City and Forest Service both recognize that high-intensity fire risk and overgrown dense forests are strong threats to municipal watershed health and the long term viability of water supplies.

The overly dense ponderosa pine forests of the municipal watershed were prioritized for restoration and crown fire hazard reduction because of the importance of the municipal watershed to the water supply of Santa Fe. A crown fire in the municipal watershed would overload the water treatment plant with ash and potentially threaten the two dams and reservoirs used for water storage. Initial mechanical treatments of 5,800 acres of upland, pine-dominant forests in the municipal watershed temporarily reduced the risk of crown fire, but maintenance treatments are vital for future forest health and protection of the water supply.

Monitoring of water quantity, quality, and ecosystem health to date, beginning with the previous municipal watershed restoration project in 2002, demonstrates a healthy watershed. Paired basin monitoring within the municipal watershed has shown a moderate increase in streamflow and no increase in turbidity as a result of thinning activities. While the Santa Fe River water quality hasn't been impacted adversely from past management activities, continual assessment of Santa Fe river water supply requires ongoing monitoring to assess the impacts of management activities and allow adaptive management.

Scope of this Plan

This water management plan provides a framework for long term monitoring that will help the City maintain a reliable, high quality water supply. Because ecosystem health of the upper municipal watershed riparian corridor is directly related to both water quality and quantity within in the Santa Fe River within the upper municipal watershed, this plan also specifies measures for ecosystem monitoring and potential habitat enhancement within the riparian corridor. The monitoring proposed in this plan will help address three critical objectives for water management:

- Maintain a Reliable Water Supply
- Maintain a High Quality of Water
- Enhance Wildlife Habitat and Ecosystem Function.

For each of the above objectives, we provide recommendations for three categories of monitoring parameters:

1. Critical parameters recommended for regular analysis
2. Secondary parameters recommended if critical parameters exceed a threshold, and
3. Parameters considered, but not recommended

Summary of Recommendations

Table 1. Summary of Recommendations for Water Management	
Maintain a Reliable Water Supply	• Regularly monitor stream flow, precipitation, reservoir level, and reservoir bathymetry.
Maintain a High Quality of Water	• Regularly monitor 10 critical parameters for water quality below the Nichols Reservoir and/or at the water treatment plant.
Enhance Wildlife Habitat and Ecosystem Function	• Utilize the Rapid Stream Riparian Assessment methodology to identify areas and criteria for habitat enhancement

Recommendations

Maintain a Reliable Water Supply

Monitoring History

As part of the forest thinning project, a paired basin study was established to evaluate the impacts of forest management activities on stream flow. In this study, discharge and other parameters such as turbidity were measured in two adjacent basins for a period of four years; one basin served as a control, while the other was thinned to the prescribed level of tree density and composition. The monitoring data showed a moderate increase in stream flow, while stream turbidity was not affected as a result of thinning activities. While the Santa Fe River hasn't been impacted adversely from past management activities, continual assessment of Santa Fe river water supply an monitoring of future management activities requires ongoing monitoring of stream flow, as well as expanded monitoring of precipitation.

There are a number of established stream gage stations within the municipal watershed with substantial discharge records and proposed additional precipitation monitoring will be conducted at some of these same locations. The following is a summary of stream gage stations currently or previously operated in the municipal watershed, as well as the extent of the discharge record:

- Santa Fe River Above McClure Reservoir (automated, 1998-current)
- Santa Fe River Near Santa Fe, below McClure Reservoir (automated, 1930-current)
- Santa Fe River Below Nichols Reservoir (automated, 1998-current)
- North Paired Basin Study (automated, 2001-2004)
- South Paired Basin Study (automated, 2001-2004)

The Following is a summary of precipitation and weather stations operated in the municipal watershed, as well as the extent of the data records:

- NRCS SNOTEL snow pillow site near Santa Fe Ski Area (automated with telemetry, 1996-current)
- NRCS SNOTEL snow pillow site at Elk Cabin, above McClure Reservoir (automated with telemetry, 1996-current)
- Paired Basin Study Precipitation Gages (automated, 2002-2004)
- Nichols Reservoir Precipitation Gage (manual, 1996-current)
- Water Treatment Plan Precipitation Gage (manual, 1996-current)
- McClure Reservoir Precipitation Gage (automated, 2012-current)
- Nichols Reservoir Precipitation Gage (automated, 2012-current)

All monitoring activities will be documented. If monitoring results indicate that laws, regulations, standards aren't being observed, objectives are not being met, or mitigations are not effective, the activity will be modified to remedy or ameliorate the problem. During forest management activities, monitoring results will be evaluated at a minimum on a monthly basis to provide feedback to resource managers. Annually, monitoring data will be consolidated and available for review by interested parties including technical science advisors. The Forest Service and the City will evaluate the monitoring results along with advice and comments received. The Forest Service and the City will periodically update the Water Management Plan, as it is important that any new relevant research be integrated into this adaptive monitoring strategy.

Recommendations

We recommend a monitoring system that will provide information to help the City Water Division answer the following questions:

- How much water do we have in our reservoirs?
- How much water do we expect given the snowpack?
- How much of our annual water of 5040 ac-ft do we expect to use this year?

- Do we project either Nichols or McClure Reservoirs to spill? And if yes, approximately by how much?
- Do we need to operate the reservoirs to mitigate flood flows?
- Are we in a local drought (how does the precipitation to date compare to the average and to other drought years?
- How much water is being released to the Santa Fe River?
- Is forest management impacting on water quantity?
- How much sediment has filled Nichols and McClure Reservoir?
- Should we dredge the reservoirs?
- What is the size of the reservoir 'deadpool'?
- What municipal watershed management strategies can maintain (perhaps improve) water quantity?
- Are there unexpected observed water quantity effects?

Table 2. Summary of Water Supply Monitoring Recommendations

Parameter	Location	Frequency	Method	Agency Responsible
Stream Flow	Above McClure, Below McClure, below Nichols	Continuous, 15 minute	Field	City Water Division
Precipitation	SNOTEL (SF Lake & Elk Cabin), Above McClure, WTP	Continuous, 15 minute	Field	City Water Division
Reservoir Level	McClure and Nichols	Continuous, 1 hour	Field	City Water Division
Reservoir Bathymetry	McClure and Nichols	Every 20 years	Field	City Water Division

Critical parameters for regular analysis

Critical parameters that require regular analysis for assessing water quantity include stream flow, precipitation, reservoir level, and reservoir bathymetry.

Stream Flow

Stream flow is important to assess the quantity of Santa Fe River supply, both for near and long-term management of the City's water utility, as well as assessing the impact of management activities on the stream system. There are several deficiencies at the existing

gages within the municipal watershed that should be resolved to improve the ability of these gages to provide adequate data. The Santa Fe River above McClure gage is submerged when the reservoir level nears maximum capacity, and as a result doesn't record discharge during these periods. We recommend that a new gage be installed further upstream in order to avoid submersion problems. All three of the primary stream gages have automated data recording, but none of them are equipped with telemetry to transmit data for satellite uplink and subsequent on-line posting. To resolve this, SCADA telemetry should be installed at all three gages.

Precipitation

The majority of Santa Fe River discharge on most years is derived from snow melt runoff. As such, monitoring snow pack is a critical component to assessing and forecasting Santa Fe River water supply on an annual and seasonal basis. Although precipitation as rainfall has contributed significantly to reservoir storage on several occasions, and the rarity of these events preclude their incorporation in water supply planning scenarios, monitoring precipitation as rainfall is important for safe operation of the reservoirs.

In order to increase the quality and usefulness of precipitation data, we recommend that locations where precipitation as rainfall is currently being recorded be upgraded from manual measurements to automated logging with SCADA telemetry. In addition, the precipitation gages should be equipped to measure both snowfall and rain. The collected snowfall data will be used to complement snowfall already being collected by the NRCS at the snow pillow sites, while rainfall data will be used to compile an on-going record for identifying trends and future planning.

Reservoir Level

Reservoir level information is critical for proper management of the reservoirs, compliance with water right permits, and for delivery of adequate treated water the City water customers. In the past, reservoir levels were determined by visual inspection of a staff gage located on the reservoir outlet tower using a telescope, and reported in 100th of feet. Reservoir level monitoring has since been upgraded to an automated system using an ultrasonic sensor with SCADA telemetry to transmit real-time measurements to the water treatment plant for logging and reporting, however, there are currently some problems with telemetry signals reaching the water treatment plant from McClure Reservoir. We recommend that the water utility install a SCADA repeater in order to ensure accurate transmittal of reservoir level data to the water treatment plant.

Reservoir Bathymetry

City's water utility has conducted several bathymetric surveys of the reservoirs in order to assess changes in storage capacity over time. The most recent reservoir bathymetry study was conducted in 1993. Reservoir bathymetry studies should be continued in the future in order to protect reservoir capacity and ensure safe operation of water utility works. In absence of a catastrophic runoff/erosion event that is deemed to have deposited

significant material in either of the reservoirs, a regular interval for bathymetric studies should be approximately every 20 years. In the event that significant material is deposited within a reservoir, then the water utility will conduct a bathymetric study at the earliest time afterward to asses impact to reservoir storage.

Secondary parameters necessary if critical parameters exceed a threshold

There are no water quantity parameters in this parameter.

Parameters considered, but not recommended

Chloride Concentration as Proxy for Reservoir Evaporation

Chloride concentrations among surface water can be used to estimate reservoir evaporation. Due to the climate regime, latitude and relative elevation of the reservoirs, the forested topography surrounding the reservoirs, as well as a lack of obvious evaporation mitigation strategies, reservoir evaporation is not deemed a significant concern that requires regular monitoring.

Maintain a High Quality of Water

Monitoring History

According to the Surface Water Quality Bureau (SWQB) Assessment Protocol (NMED 2008) conventional parameters that are monitored to assess the quality of the water in terms of supporting aquatic life are: temperature, turbidity, pH, dissolved oxygen, specific conductance and total phosphorus. The water treatment plant operators measure the first three parameters and also monitor total organic carbon at the outfall from Nichols Reservoir. The NMED SWQ Bureau conducted extensive sampling of the Santa Fe River three times a year at three locations: the wilderness boundary, above McClure Reservoir and above Nichols Reservoir from 2000 to 2007 (except for 2005). The site above Nichols Reservoir was initially at the Santa Fe near Santa Fe USGS gage, but was moved downstream to 500 ft above the reservoir to capture more of the drainage area of the municipal watershed (particularly, the tributary Agua Sarca). An EPA contractor sampled Santa Fe Lake for a full suite of parameters in August of 2007. Results of the previous sampling by NMED were provided by Abe Franklin, NMED and are discussed for each parameter.

The 7 years of sample results show that the municipal watershed is meeting all water quality standards, except for aluminum, which is naturally occurring and common in mountain streams. While the Santa Fe River has been healthy over the monitoring period, if a new activity occurs, such as additional forest treatments, the Santa Fe River quality should be monitored for the basic parameters to assess ecosystem health. Baseline data should be collected with the data loggers prior to the activity to determine diurnal fluctuations in pH, DO, EC and temperature that have not been characterized to date. All other parameters are monitored as part of the requirements for operating the Water Treatment Plant (WTP) on Upper Canyon Road.

Recommendations

We recommend a monitoring system that will help the City Water Division answer the following questions about water quality:

- Is forest management impacting water quality?
- Is the system's high water quality stable?
- Have project objectives been met, or movement made toward desired resource conditions?
- Were the assumptions, hypotheses or predictions made at the outset of the project close to the actual result?
- Do new water quality regulations impact current municipal watershed management policies and actions?
- Are there unexpected observed water quality effects?
- What water management strategies can maintain (or perhaps improve) water quality?
- Are reservoir inversions or algal blooms occurring in the reservoirs? If yes, what water quality indicators may be used to anticipate the changes?

Table 3. Summary of Recommendations for Water Quality Monitoring					
Parameter	**Location**	**Frequency**	**Method**	**Agency Responsible**	**Timing**
Total Organic Carbon (TOC)	Below Nichols Reservoir	Once per month	Sample to lab	City Water Treatment Plant (WTP)	Current
Dissolved Organic Carbon (DOC)	Below Nichols Reservoir	Once per month	Sample to lab	WTP	Current
E. Coli, Giardia, Cryptosporidium	Below Nichols Reservoir	Once per month	Sample to lab	WTP	Until 3/09 and again between 2015-2017
Temperature	Intake before treatment and 2 field sites	Continuous, 15 minute	Field	WTP/USFS/City	intake current, 2 field sites proposed
Dissolved oxygen	2 sites*	Continuous, 15 minute	Field	USFS/City	Proposed**
pH	Intake before treatment and 2 field sites	Continuous, 15 minute	Treatment plant and field	WTP/USFS/City	intake current, 2 field sites proposed
Electrical conductivity	2 field sites*	Continuous, 15	Field	USFS/City	Proposed
Turbidity	Intake before treatment and below Nichols, plus 2 additional field sites	Continuous, 15 minute at intake, Weekly after treatments	Treatment plant and field	WTP/USFS/City	intake current, 2 field sites proposed
Alkalinity	Below Nichols Reservoir	Once per month	Sample to lab	WTP	Current
PCBs	2 field sites*	Verify if present	Sample to lab		Proposed

* Two sites: USGS gage above McClure Reservoir and 500 meters above Nichols Reservoir

** Conditionally proposed if new activity occurs in upper municipal watershed

Critical parameters for regular analysis

Critical parameters that require regular analysis for water quality include a total of 10 parameters, and monitoring will occur below the Nichols Reservoir or at the water treatment plant.

Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC)
TOC and DOC are important to water treatment operators because of the potential for organic carbon to form trihalomethanes (THMs) as a disinfection byproduct during chlorination. THMs are carcinogens and regulated by EPA. TOC and DOC are sampled once a month in raw water by the WTP below Nichols Reservoir as required by the EPA. DOC is more difficult to remove. Results of 89 TOC samples collected by NMED SWQB at three sites on the Santa Fe River from 2000 to 2007 averaged 4.8 mg/L with a max of 13.1 mg/L. While no specific standard is set for TOC, the standard for THMs is 80 μg/L. Although the Santa Fe River is usually low in turbidity, Total Organic Carbon (TOC) levels can be high during runoff events resulting in an increase in turbidity from biological growth or the presence of significant natural color. No additional monitoring of TOC or DOC beyond the sampling conducted by the WTP is recommended.

E. coli, Giardia and Cryptosporidium
E. coli, Giardia and Cryptosporidium in raw water have been sampled monthly by the WTP since April 2007 as required by the EPA Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). Monthly samples are collected at the outlet from Nichols Reservoir and submitted to a laboratory, which will continue until March 2009. Results of the sampling will determine the level of treatment required at the City WTP. If the mean concentration is less than .075 oocyst/L, then minimal treatment will be required and the two-year monthly sampling cycle will be repeated six years later (in 2015). Results to date, show very low detections of cryptosporidium. One sample in December of 2007 had 0.071/liter and a sample in September of 2008 had concentration of 0.08/liter. All other samples had no detection of cryptosporidium. These concentrations will not require additional treatment.

E. Coli samples have been collected by NMED SWQB at three locations on the SF River which show very low concentrations. The water quality standard (NMAC 20.6.4.121) for E. coli is 235 cfu/100 mL in a single sample and 126 cfu/100 mL for a monthly geometric mean. The highest concentration of E. coli detected was 5 cfu/100 mL in the SF River at the Wilderness Boundary in August of 2001 which is well below the standard. No additional monitoring of E. coli, Giardia or Cryptosporidium beyond the sampling conducted by the WTP is recommended.

Temperature
Water temperature impacts the "metabolism, behavior and mortality of fish and other aquatic organisms" (NMED 2008). Continuous measurement of temperature is necessary to determine the maximum daily temperatures, the duration of excessive temperatures and the diurnal and seasonal fluctuations of temperature that effect aquatic life. NM

Water Quality Standards (20.6.4.121.B1) for temperature is less than 20 °C for aquatic cold water fisheries.

Temperature is measured in raw water at the intake to the treatment plant continuously by the WTP. However, this location monitors the temperature of Nichols Reservoir (at the lake depth that the water is released) and is not characteristic of the condition of the Santa Fe River in the municipal watershed. The maximum temperature measured in the upper Santa Fe River by NMED SWQB was 17 °C in August of 2006 above Nichols Reservoir, however these periodic measurements did not characterize the diurnal and seasonal fluctuations that are important. A continuously recording data logger for temperature should be installed at the inflow to McClure Reservoir and at the gage between the reservoirs to assess the fluctuations in temperature. The data logger should be installed a year prior a proposed activity that could impair water quality to collect baseline data.

Dissolved Oxygen (DO)

Cold water aquatic species, particularly embryos and larvae, are more sensitive to dissolved oxygen concentrations than warmwater species. DO concentrations need to be at least 6 mg/L for healthy aquatic systems. Because DO is impacted by temperature and elevation, the percent saturation of DO is also important and it should approach 100%. Cold water can hold more oxygen than warm water.

DO and percent saturation has been measured at three sites in the municipal watershed by NMEDSWQ Bureau three times a year (Franklin, 2008). Average DO measured in the municipal watershed is about 11 mg/L, well above the standard that requires DO to be greater than 6 mg/L (NMWQCC 2007). The lowest DO concentration measured out of 134 samples collected in three sites in the municipal watershed was 6.7 mg/L in April 2002 when percent saturation was 60%. However, the previous day and the following day DO was measured at 7.4 and 7.6 mg/L respectively. The percent saturation has averaged 87%. The NMED assessment protocol for DO (NMED 2008 Appendix F) provides minimum values of percent saturation for coldwater fisheries which ranges between 75 and 85 percent for early life stages. While the DO values have all met the water quality standards, the percent saturation is not always meeting the requirements for aquatic life. Two continuous recording devices to monitor dissolved oxygen at the inflow to McClure Reservoir and the gage between the two reservoirs are recommended. The data logger should be installed a year prior a proposed activity that could impair water quality to collect baseline data. The percent saturation can be estimated from the temperature and DO concentration.

pH

The water treatment plant and aquatic life are both sensitive to the pH of water. The treatment plan operators need to know the pH to adjust the alkalinity of the water to achieve good coagulation and produce stabilized water. The pH is measured continuously by the City WTP at the intake before treatment (out of Nichols Reservoir). NMED SWQ Bureau has also measured pH in Santa Fe River water in three locations, three times a year. The pH should remain between 6.6 and 8.8 (NMWQCC, 2007).

Measured pH at the three sites in the municipal watershed average 7.3, with a maximum observed at 8.7 in the fall at the inflow into McClure and a minimum of 6.1 measured several times in the spring at the wilderness boundary and at the inflow to McClure Reservoir. The low alkalinity of the water results in a lack of buffering capacity for the water which allows the pH to be unstable.

The NMED SWQB Assessment Protocol (Appendix G) recommends continuous recording devices to monitor pH because, while fish can tolerate some fluctuation in pH, the duration of that change is important for assessing the impact. Two pH recording devices at the inflow to McClure Reservoir and at the gage between the two reservoirs are recommended. The data logger should be installed a year prior a proposed activity that could impair water quality to collect baseline data.

EC (Conductivity)
The specific conductance or electrical conductivity of water is an indicator of the total dissolved solids. It is a very inexpensive field check on water quality and could be used to indicate significant changes in water quality. EC has been recorded in the field by NMED SWQB at three sites, three times a year. EC measurements have ranged from 31 to 187 μmhos/cm in the municipal watershed, less than the numeric criteria of 300 μmhos/cm or less (NMWQCC, 2007). An exceedence of this criteria would indicate a dramatic change in water quality and the need to test for parameters in the second category, including major cations and anions, TDS, heavy metals and nutrients. Two EC recording devices at the inflow to McClure Reservoir and at the gage between the two reservoirs are recommended. The data logger should be installed a year prior a proposed activity that could impair water quality to collect baseline data.

Turbidity
Turbidity is a principal physical characteristic of water and is an expression of the relative clarity of a liquid. It is caused by suspended matter or impurities that interfere with the clarity of the water. These impurities may include clay, silt, finely divided inorganic and organic matter, soluble colored organic compounds, and plankton and other microscopic organisms.

Clarity is important when producing drinking water for human consumption and in many manufacturing uses. Excessive turbidity, or cloudiness, in drinking water is aesthetically unappealing, and may also represent a health concern. Turbidity can provide food and shelter for pathogens. If not removed, turbidity can promote regrowth of pathogens in the distribution system, leading to waterborne disease outbreaks, which have caused significant cases of gastroenteritis throughout the United States and the world. Although turbidity is not a direct indicator of health risk, numerous studies show a strong relationship between removal of turbidity and removal of protozoa. (EPA 1999). Turbidity is measured in raw water at the intake to the treatment plant continuously by the WTP. Under EPA's Interim Enhanced Surface Water Treatment rule turbidity must be less than 1 NTU after filtration in any one sample.

Turbidity was measured at three sites three times a year in the municipal watershed by the NMED SWQB from 2000 to 2007. The average turbidity from the samples collected by the NMED SWQB was 3.5 and the maximum was 41 NTU in August of 2006 at a site above Nichols Reservoir. NMED Water Quality Standards do not set specific numeric standards for turbidity, but state that "turbidity shall not exceed 10 NTU over background turbidity when the background turbidity is 50 NTU or less…" The NMED SWQB Assessment Protocol states that if turbidity is exceeding the standard in more than 15% of samples (for at least 7 samples), then the water is not fully supporting aquatic life. Except for the one high value of 41 NTU, all other samples (128) were at or below 10.2 NTU.

For monitoring the impact of forest treatments (thinning and prescribe burns) on water quality, turbidity is the parameter most likely to be impacted. However, two turbidity sensors were maintained in the paired watershed study from 2001 to 2006 and no significant increase in turbidity was noted in the treated watershed (WW and Ice Nine Consulting 2008). Turbidity did not exceed 50 NTU in the treated basin, but was as high as 200 NTU in the control (untreated basin).

Turbidity could be monitored at the two sites above McClure Reservoir and above Nichols Reservoir either with a turbidity meter or with field measurements weekly following prescribed fire or thinning activities. The data logger should be installed a year prior a proposed activity that could impair water quality to collect baseline data.

Alkalinity (Total Hydroxide, Carbonate, Bicarbonate)
Alkalinity is a measure of the ability of a solution to neutralize acids to the equivalence point of carbonate or bicarbonate. In affect, it is a measure of the buffering capacity of the water. Alkalinity is important to monitor for municipal water supplies because of its affect the amount of chemicals needed to achieve coagulation and also impacts the corrosion in distribution systems. Alkalinity is measured once a month by the City WTP below Nichols Reservoir.

NMWQCC does not have a standard for alkalinity, but EPA's national recommended water quality criteria for non priority pollutants lists a freshwater standard of 20 mg/L or more for alkalinity (EPA, 2006), except where natural concentrations are less. Of the 57 samples collected in the municipal watershed, alkalinity ranged from 8 to 59 and averaged 19 mg/L. Bicarbonate ranged from 10 to 72 and averaged 23 mg/L in 57 samples collected in the municipal watershed. No additional monitoring is recommended beyond the sampling already occurring by the City WTP.

PCBs
PCBs were detected in the outfall from Nichols Reservoir on May 3, 2007 at concentrations totaling 0.235 μg/L, which is above the standard of .064 μg/L for domestic water supply and 0.014 μg/L for aquatic life and wildlife habitat. No other locations were sampled. We recommend that surface water be sampled for PCBs at the two locations above each reservoir to verify these results and determine if further assessment is necessary. If samples show no detection of PCBs, then no further sampling

is recommended. If PCBs are detected, the NMED should be contacted to investigate the extent and source of contamination.

Secondary parameters necessary if critical parameters exceed a threshold

Nutrients such as nitrogen and phosphorus impact aquatic plant growth, which in excess can be harmful to fish. Nutrient loading in run-off could change with the reduction of forest vegetation to consume nutrients (Arvidson, 2006). The nutrient thresholds for mountain streams (NMED SWQB 2008 Appendix E) are 0.25 mg/L for total nitrogen and 0.02 mg/L for phosphorus. While these thresholds have been exceeded in samples collected by NMED between 2000 and 2007, it is only recommended that further sampling be conducted if exceedences of DO, pH and turbidity are identified (which would occur if excessive algal growth is impacting water quality). Therefore, nutrients of nitrate, nitrite, TKN and phosphorus are listed as secondary parameters.

Total Nitrogen (TN)
Total Nitrogen, including nitrate, nitrite, and TKN, is a nutrient for aquatic vegetation, such as algae. Excessive amount of aquatic vegetation is not beneficial to most streams because of the impact on dissolved oxygen, pH and turbidity. The NMED SWQB Appendix E Nutrient Assessment Protocol for Wadeable, Perennial Streams sets a nutrient threshold for total nitrogen (TN) at 0.25 mg/L. Many (27) of the samples (123) collected in the municipal watershed for TKN had concentrations above this threshold and as high as 0.86 mg/L. If temperature, DO, EC and pH changes are significant water samples should be collected for TN.

All of the nitrate + nitrate samples are below the drinking water standard of 10 mg/L.

Total Phosphorus (TP)
Phosphorus is a nutrient for aquatic vegetation, such as algae. Excessive amount of aquatic vegetation is not beneficial to most streams because of the impact on dissolved oxygen, pH and turbidity. The NMED SWQB Appendix E Nutrient Assessment Protocol for Wadeable, Perennial Streams sets a nutrient threshold for phosphorus at 0.02 mg/L. This is below the detection limit of most of the phosphorus samples collected by NMED. Of the 22 samples analyzed for phosphorus with a low enough detection limit, 11 of the samples exceeded 0.02 mg/L. Most of the concentrations were below 0.1 mg/L and the highest was 0.87 mg/L. If temperature, DO, EC and pH changes are significant samples should be collected for TP.

Ammonia
Ammonia is toxic to aquatic species at concentrations that vary based on the pH and temperature of the water. The ammonia standard is lower at higher temperatures and higher pH values. In the Santa Fe River, the highest temperature recorded was 17 ^{o}C and the highest pH was 8.7 which would result in an ammonia criteria of 0.622 mg/L ammonia as N. Most of the 133 samples analyzed for ammonia were below detection

and the highest concentration reported was 0.35 mg/L. Because no waste stream enters the Santa Fe River in the municipal watershed, ammonia is not a concern.

Major Cations and Anions (Na, K, Ca, Mg, Cl, SO4) and Total Dissolved Solids (TDS)
Major cations, anions and TDS are important for establishing the general quality of the water. The principal cations in surface water are usually calcium, magnesium, sodium and potassium. Principal anions include chloride, sulfate and carbonates. Of the 138 TDS samples collected at the three sites in the municipal watershed, the maximum concentration of TDS was 194 mg/L and the minimum was 38, with an average of 88 mg/L. Because the TDS is low, the concentrations of major cations and anions are also low and do not pose a threat to aquatic life or human health. NMED Water Quality Standards for TDS for domestic use is 1,000 mg/L. No standard for TDS for aquatic life has been established because freshwater fish can tolerate a wide range of TDS values (up to 10,000 mg/L) (EPA 1986).

The drinking water standard for sulfate is 600 mg/L which is well above the highest sulfate concentration measured in the municipal watershed of 26 mg/L. Sulfate fell below the detection limit in most samples. The drinking water standard for chloride is 250 mg/L, which was not detected in any samples collected in the municipal watershed.

While the general chemistry is not a concern for the objectives of monitoring, the concentrations of major anions and cations can help scientists understand the source of water and changes in contributions of flow. If the EC levels change dramatically, a full suite of major cations and anions and TDS should be measured to help discern the source of the change.

Hardness (calcium and magnesium)
Hardness is important to measure in order to calculate water quality criteria for metals for aquatic life. Hardness has been measured by NMED SWQB at three sites, three times a year and the values are very stable. Unless a dramatic change in EC occurs, hardness does not need to be measured.

Metals – ICP (including Al, Ag, As, Ba, Be, Cd, Cr, Cu, Fe, Pb, Mn, Ni, Se, Sb, Vn, Zn)
Metals such as aluminum (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), selenium (Se), silver (Ag) and zinc (Zn) are harmful to aquatic life. Metals such as antimony (Sb), arsenic, barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), selenium (Se), uranium (U), and zinc (Zn) are toxic to humans.

The metals toxicity for aquatic life is based on the hardness of the water for Cd, Cr, Cu Pb, Ni and Zn. The average hardness measured in Santa Fe River water above McClure Reservoir was 18 mg/L. Using the equations for criteria, where necessary, in the Water Quality Standards for New Mexico (NM WQCC, 2007) the metals standards were calculated as shown in Table 1. Aluminum is the only criteria which is consistently exceeding the standard of 87 μg/L. Aluminum is naturally occurring in the Santa Fe

River and commonly occurs in these concentrations in mountain streams (Michael 2008). No further sampling for metals is recommended unless a significant shift in EC is detected.

Table 4. Numeric criteria for heavy metals in the municipal watershed based on a hardness of 18 mg/L

Criteria	Domestic water supply criteria (µg/L)	Aquatic acute criteria (µg/L)	Aquatic chronic criteria (µg/L)	Highest concentration detected in the municipal watershed (µg/L)
Aluminum	NA	750	87	1,800
Arsenic	2.3	340	150	ND
Dissolved Cadmium	5	0.4	.08	ND
Dissolved Chromium	100	142	18	7
Dissolved Copper	1300	2.7	2.1	ND
Iron	1000		NA	900
Dissolved Lead	50	0.4	0.4	ND
Mercury (dissolved for aquatic)	2	1.4	0.77	ND
Dissolved Nickel	100	111	12	30
Dissolved Selenium (total for aquatic)	50		20	5.0
Dissolved Silver	NA	.17	NA	ND
Dissolved Zinc	7,400	28	28	40

NA= Not Available in NMWQCC Standards; ND = Not Detected

No domestic water supply or aquatic life criteria are established for molybdenum (Mo) which only has a criteria for irrigation. Cobalt (Co) and vanadium (Vn) only have criteria for irrigation and livestock watering. None of these uses occur in the municipal watershed.

Parameters considered, but not recommended

Soil Moisture
Soil moisture will be measured with a cosmic ray probe as part of the paired watershed study. It is not generally included for water quality assessments, and no criteria or implications for soil moisture measurements are available. Soil moisture will vary depending on the slope aspect, degree of vegetation cover, recent precipitation events and proximity to stream.

Total Coliform and Standard Plate count
EPA uses E.Coli as a better indicator of human health hazards. Fecal coliform bacteria sampling usually applies to waste effluent that is discharging to surface water bodies. The standard is 500 c/100 ml for effluent entering the Rio Grande Basin (NMWQCC 20.3.2102)

Bio-Chemical Oxygen Demand (BOD)
BOD is a parameter usually measured in waste effluent that is discharging to a water body. The standard is 30 mg/L for effluent entering the Rio Grande Basin (NMWQCC 20.3.2102)

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Chemical Oxygen Demand (COD)
COD is a parameter usually measured in waste effluent that is discharging to a water body. The standard is 80 mg/L for effluent entering the Rio Grande Basin (NMWQCC 20.3.2102).

pE (Redox)
The reduction-oxidation process that may occur in the Santa Fe River will be monitored for their impact on dissolved oxygen, the primary concern for aquatic life. No other monitoring is recommended for Redox.

Radionuclides, including gross Alpha and Beta
Gross Alpha measured in 31 samples collected in the municipal watershed averaged 1.9 pCi/L with a maximum of 4.8 pCi/L, below the standard of 15 pCi/L for domestic water supply. No standard is established for aquatic life. The NMWQCC (2007) standard for Combined Radium 226 and Radium 226 is 30pCi/L. EPA recommends a standard of 5pCi/L (http://www.epa.gov/safewater/radionuclides/index.html). The highest concentration of Radium 226 or 228 in 34 samples collected in the municipal watershed was 0.9 piC/L, well below both limits. No standards are available for aquatic life and because the measured values are well below drinking water standards, monitoring for radionuclides are not recommended.

Enhanced wildlife habitat and ecosystem function

Recommendations

We recommend a monitoring system that will help the City Water Division answer the following questions about wildlife habitat and ecosystem function:

- What are the species of interest for ecosystem analysis and potential habitat enhancement?
- What is the current level of ecosystem health, generally and for the species of interest?
- What water management strategies can maintain (or perhaps improve) ecosystem health?
- How have changes in watershed management affected ecosystem health?
- Is the cutthroat trout population thriving?
- How is the cutthroat trout population impacting water quality?
- Are there unexpected observed ecosystem effects?

Critical parameters for regular analysis

The first goal with habitat enhancement is to identify and define the species of interest within the project area for which further habitat assessment and enhancement activities will be carried out, and to define the optimum functioning capacity for the riparian and aquatic zones within the project area, which will be accomplished largely through the first round of ecological monitoring, using Rapid Stream-Riparian Assessment (RSRA) methods. Based on results of ecological monitoring and evaluation of functional assessment of the riparian corridor, specific deficiencies in the riparian zone and in the stream course will be identified. The following a list of six geomorphologically distinct riparian areas along the Santa Fe River within the municipal watershed where ecological monitoring will be conducted:

- Two reaches of the upstream of McClure Reservoir
- Three reaches downstream of McClure Reservoir
- One reach downstream of Nichols Reservoir

The Rapid Stream-Riparian Assessment (RSRA) utilizes a primarily qualitative assessment based on quantitative measurements. It focuses upon five functional components of the stream-riparian ecosystem that provide important benefits to humans and wildlife, and which, on public lands, are often the subject of government regulation and standards. These components are: 1) water quality and pollution, 2) stream channel and floodplain morphology and the ability of the system to limit erosion and withstand flooding without damage, 3) the presence of habitat for native fish and other aquatic

species, 4) vegetation structure and composition, including the occurrence and relative dominance of exotic or non-native species, and 5) suitability as habitat for terrestrial wildlife, including threatened or endangered species. Within each of these areas, the RSRA evaluates between two and seven variables which reflect the overall function and health of the stream-riparian ecosystem (Appendix B) (Stacey et al 2007).

To address the deficiencies, specific habitat enhancement recommendations will be developed and compiled in a Habitat Enhancement Plan (HEP). With input form the City's partners and riparian and aquatic habitat experts, these recommendations will identify passive and active methods to affect measurable change in functioning capacity. Habitat enhancement activities in the riparian corridor and the stream course will be coordinated, as potential work in the stream course will necessitate removal or thinning of established vegetation along the banks of the river, modification of bank slope, and possible creation of new channel meanders which will require bank revegetation.

The HEP will consider methods that involve active work in the channel like installation of rock step and/or log plunge structures, riffles and pools, bank revetment, and induced meanders. More passive methods that may be effective in the channel involve operational changes in the way the City's water utility can release water from McClure and Nichols Reservoirs, Specifically, releases of larger pulses of water may mimic pre-dam snowmelt and high intensity short duration storm flows, which have the potential to create some beneficial stream bank erosion and other deposits that will enhance overall aquatic habitat features. The HEP will also evaluate methods to enhance riparian habitat, like removal of invasive species, thinning of existing vegetation, and additional plantings to control erosion and improve habitat in disturbed areas.

Any active channel and riparian work called for in the HEP will require a survey, hydrologic analysis, possibly engineering drawings, and permit approval from regulatory agencies including the USACE and NMED.

Secondary parameters necessary if critical parameters exceed a threshold

No ecological monitoring parameters are in this category.

Parameters considered, but not recommended

No ecological monitoring parameters are in this category.

Appendix 1: Recommended Monitoring Parameters for Water Management

	Parameter	Purpose	Location	Sample Frequency	Method	Responsible Agency	Monitoring Status	Water Quality Standard	Reference/Explanation
1	**Critical Parameters for Regular Analysis**								
1.1	Stream Flow	Quantity	Above McClure, Below McClure, below Nichols	Continuous, 15 minute	Field	City WTP	Current	NA	
1.2	Precipitation	Quantity	SNOTEL (SF Lake & Elk Cabin), Above McClure, WTP	Continuous, 15 minute	Field	City WTP	Current	NA	
1.3	Reservoir Level	Quantity	McClure and Nichols	Continuous, 1 hr	Field	City WTP	Current	NA	
1.4	Reservoir Bathymetry	Quantity	Nichols and McClure Reservoirs	Once per 5-10 years	Field	City WTP	Current	NA	
1.5	TOC (Total Organic Carbon)	Quality	Below Nichols Reservoir	Once per 1 month	sample to lab	City WTP	Current	NA	Robert Gallegos, 2008
1.5 (cont.)	DOC (Dissolved Organic Carbon)	Quality	Below Nichols Reservoir	Once per 1 month	sample to lab	City WTP	Current	NA	Robert Gallegos, 2008

1.6	E. coli count	Quality	Below Nichols Reservoir	Once per 1 month	sample to lab	City WTP	Until 3/09, then another 2-year round of sampling in 6 years (2015)	<235 cfu/100 mL in single sample for surface water (NMAC 20.6.4.121),	Robert Gallegos, 2008
1.6 (cont.)	Giardia/ Cryptosporidium	Quality	Below Nichols Reservoir	Once per 1 month	sample to lab	City WTP	Until 3/09, then another 2-year round of sampling in 6 years (2015)	< .075 oocysts/L no further sampling required for 6 years	Robert Gallegos, 2008
1.7	Temperature	Quality	intake before treatment	Continuous, 15 minute	Field	City WTP	Current	< 20 C	Robert Gallegos, 2008
1.7 (cont.)	Temperature	Ecological/BMP for forest treatments	2 Sites*	Continuous, 15 minute	Field	USFS/City	conditionally proposed**	<20 C	NMED SWQB 2008 Assessment Protocol
1.8	DO	Ecological/BMP for forest treatments	2 Sites*	Continuous, 15 minute	Field	USFS/City	conditionally proposed**	> 6	NMED SWQB 2008 Assessment Protocol
1.9	pH	Quality	intake before treatment	Continuous, 15 minute	Treatment Plant	City WTP	Current	6.6-9.0	Robert Gallegos, 2008
1.9 (cont.)	pH	Ecological/BMP for forest treatments	2 Sites*	Continuous, 15 minute	Field	USFS/City	conditionally proposed**	6.6-8.8	NMED SWQB 2008 Assessment Protocol
1.10	EC (elec. cond.)	Ecological/BMP for forest treatments	2 Sites*	Continuous, 15 minute	Field	USFS/City	conditionally proposed**	300 umhos/cm	NMED SWQB 2008 Assessment Protocol
1.11	Turbidity	Quality	intake before treatment and below Nichols	Continuous, 15 minute	Field	City WTP	Current	10 NTU	Robert Gallegos, 2008

			once a month						
1.11 (cont.)	Turbidity	Ecological/BMP for forest treatments	2 Sites*	Measure after prescribed fire or other thinning weekly or with data logger	Field	USFS/City	conditionally proposed**	10 NTU above background	NMED SWQB 2008 Assessment Protocol
1.12	Alkalinity (Total Hydroxide, Carbonate, Bicarbonate)	Quality	Below Nichols Reservoir	Once per 1 month	sample to lab	City WTP	Current	20 mg/L for freshwater	Robert Gallegos, 2008
1.13	PCBs	Quality and Ecological	2 Sites*	Once to verify, if present, then need more exhaustive study	sample to lab		conditionally proposed**	0.064 ug/L	NMSWQB data shows PCBs detected at Nichols Outfall
1.14	Riparian Ecological Assessment	Ecological	6 Sites	Once per 2 years	Field	City WTP	Proposed	NA	Peter Stacy, 2008

2	**Secondary Parameters necessary if critical parameters exceed a threshold**								
2.1	Total Nitrogen (TN) Nitrate + Nitrite and TKN	Ecological/BMP for forest treatments	2 Sites*	if change in DO, EC, turbidity	sample to lab	USFS/City	Previous sampling 3 times a year from 2000 to 2007	0.25 mg/L threshold for aquatic life, 10 mg/L for public water supply	NMSWQB data shows no detect or < 1 mg/L

2.2	Total phosphorus	Ecological/BMP for forest treatments	2 Sites*	if change in DO, EC, turbidity	sample to lab	USFS/City	Previous sampling 3 times a year from 2000 to 2007	0.02 mg/L threshold for aquatic life	NMSWQB data shows exceedance of the phosphorus threshold, but TN is low
2.3	Ammonia	Ecological/BMP for forest treatments	2 Sites*	if change in DO, EC, turbidity	sample to lab	USFS/City	Previous sampling 3 times a year from 2000 to 2007	< 0.622	NMSWQB data shows highest concentration at 0.35 mg/L
2.4	Major Anions and Cations (Na, K, Ca, Mg, Cl, SO4) and TDS	Ecological/BMP for forest treatments	2 Sites*	if order of magnitude change in EC	sample to lab	USFS/City	Previous sampling 3 times a year from 2000 to 2007	TDS 1,000 mg/L, SO4 600 mg/L, Cl 250 mg/L	NMSWQB data well below standards
2.5	Hardness (calcium and magnesium)	Ecological/BMP for forest treatments	2 Sites*	if order of magnitude change in EC	sample to lab	USFS/City	Previous sampling 3 times a year from 2000 to 2007	NA	used in establishing metals criteria
2.6	Heavy Metals	Ecological/BMP for forest treatments	2 Sites*	if order of magnitude change in EC	sample to lab	USFS/City	Previous sampling 3 times a year from 2000 to 2007	See Table 2	NMSWQB data shows aluminum exceeds standard, but common element with very low standard, Zn exceeded standard once

3	**Parameters considered, but not recommended**								
3.1	Chloride, as proxy for evaporation	Quantity	None						Reservoir evaporation not significant loss
3.2	Soil Moisture	Quantity	None	Continuous, 15 minute	Cosmic Ray Probe		part of paired watershed study		
3.3	Total Coli form	Quality	None	Past	sample to lab		NA	NA, use E. coli now	NMSWQB data show no exceedences
	Standard Plate count	Quality	None	Past	sample to lab		NA	NA, use E. coli now	NMSWQB data show no exceedences
3.4	BOD	Quality	None				NA	NA	Applicable to waste streams
3.5	COD (chemical Oxygen Demand)	Quality	None				NA	NA	Applicable to waste streams
3.6	pE (Redox)	Quality	None				NA	NA	Applicable to waste streams
3.7	Radionuclides including gross Alpha and Beta	Quality	None	Past	sample to lab		Previous sampling 3 times a year from 2000 to 2007	15 pCi/L for Gross Alpha, 30 pCi/L for Radium 226 and 228.	NMSWQB no exceedences

Notes for Tables 1-3

***Two sites: USGS gage above McClure Reservoir and 500 meters above Nichols Reservoir**

** Conditionally proposed if new activity occurs in upper municipal watershed, such as forest treatments in the Wilderness or other activity that could increase nutrient load
HQWS = High Quality Water Supply
EH = Ecosystem Health
References: Robert Gallegos, Personal Communication with Amy Lewis Oct 22, 2008
New Mexico Environment Department Surface Water Quality Bureau (NMED SWQB) 2008. Procedures for Assessing Use Attainment for the State of New Mexico Integrated Clean Water Act §303(d)/§305(b) Water Quality Monitoring and Assessment Report: Assessment Protocol. January 23, 2008.

Appendix 2: Rapid Stream Riparian Analysis Indicator Variables and Reasons for Including them in the Protocol

CATEGORY AND VARIABLE	JUSTIFICATION FOR INCLUSION IN RSRA ASSESSMENT
Water Quality: **Algal growth**	Dense algal growth may indicate nutrient enrichment and other types of pollution which may result in decreased dissolved oxygen in the water column and affect invertebrates and the ability of fish to spawn.
Water Quality: **Channel shading and solar exposure**	Solar exposure affects stream temperature and productivity. Decreased streambank vegetation cover, increased channel width, and reduced stream depth increases exposure, raises water temperatures and impacts aquatic life. Native trout usually require cool stream temperatures.
Hydrogeomorphology: **Floodplain connection and inundation frequency**	Channels that are deeply downcut or incised result in a reduced frequency of overbank flooding into the adjacent flood plain during peak runoff or stream flows. The absence of flooding lowers water tables, reduces nutrient availability in the floodplain, decreases plant germination, growth and survivorship, and may lead to the loss of riparian vegetation and the invasion of upland species.
Hydrogeomorphology: **Vertical bank stability**	Steep and unstable vertical banks dominate many southwestern streams, limiting the physical dynamics of aquatic ecosystems and increasing erosion and sediment loads through sloughing off of soils during high flow events. Steep banks may limit wildlife access to water.
Hydrogeomorphology: **Hydraulic habitat diversity**	Fish and aquatic invertebrate diversity and population health is related to habitat diversity. Features such as oxbows, side channels, sand bars, gravel/cobble bars, riffles, and pools can provide habitat for different species or for the different life stages of a single species.
Hydrogeomorphology: **Riparian area soil integrity**	Riparian soils reflect existing stream flow dynamics (e.g., flooding), management practices, and vegetation. It affects potential vegetation dynamics and species composition, as well as wildlife habitat distribution and quality.
Hydrogeomorphology: **Beaver activity**	Beavers are keystone species in riparian systems because they modify geomorphology and vegetation, and reduce variance in water flows and the frequency of floods. Beaver dams and adjacent wet meadows provide important fish and plant nursery habitat.
Fish/Aquatic Habitat Qualifier: **Loss of perennial flows**	Fish and most aquatic invertebrates require perennial or constant flows to survive. Streams that were originally perennial but are now ephemeral no longer provide habitat for these species unless there are refuges that never dry out (e.g., permanent pools).
Fish/Aquatic Habitat: **Pool distribution**	Fish use pools, with reduced current velocity and deep water, to rest, feed and hide from predators. Many species use gravel-bottomed riffles to lay their eggs. The number, size, distribution, and quality of pools, and pool to riffle ratios indicate the quality of fish habitat. 1:1 pools to riffle ratios are generally considered to be optimum.
Fish/Aquatic Habitat: **Underbank cover**	Underbank cover is an important component of good fish habitat, used for resting and protection from predators. A number of aquatic invertebrates also use these areas. Underbank cover usually occurs with vigorous vegetative riparian growth, dense root masses, and stable soil conditions.
Fish/Aquatic Habitat: **Cobble embeddedness**	Low levels of gravel and boulder embeddedness on the channel bottom increase benthic productivity and fish production. The filling of interstitial spaces between rocks with silt, sand, and organic material reduces habitat suitability for feeding, nursery cover, and spawning (egg to fry survival) by limiting space and macroinvertebrate production. Increased embeddedness often reflects increased sediment loads and altered water flow patterns.
Fish/Aquatic Habitat: **Diversity of aquatic macro invertebrates**	The density and composition of aquatic invertebrates are strong indicators of stream health, including temperature stresses, oxygen levels, nutrients, pollutants, and sediment loads. Larvae and adult macroinvertebrates provide critical food for fish and other invertebrate and vertebrate species in stream-riparian ecosystems.

CATEGORY AND VARIABLE	JUSTIFICATION FOR INCLUSION IN RSRA ASSESSMENT
Fish/Aquatic Habitat: **Large woody debris**	The amount, composition, distribution and condition of large woody debris (LWD) in the stream channel and along the banks provides important fish habitat for nursery cover, feeding, and protective cover. Streams with adequate LWD generally have greater habitat diversity, a natural meandering shape and greater resistance against high water events.
Fish/Aquatic Habitat: **Overbank cover and terrestrial invertebrate habitat**	Overhanging terrestrial vegetation is essential for fish production and survival, providing shade, bank protection from high flows, sediment filtering, and input of organic matter. Overbank cover also is important for terrestrial insect input (drop) into streams, which is a key source of food for fish.
Riparian vegetation: **Plant community cover and structural diversity**	High cover and structural diversity of riparian vegetation generally indicates healthy and productive plant communities, high plant species diversity and provides direct and secondary food resources, cover, and breeding habitat for wildlife. This affects avian breeding and foraging patterns in particular. Good structural diversity can also reduce flood impacts along banks.
Riparian vegetation: **Dominant shrub and tree demography (recruitment and age distribution)**	The distribution of size and age classes of native dominant species indicates recruitment success, ecosystem sustainability, and wildlife and fish habitat availability. When one or more age classes of the dominant species are missing, it indicates that something has interrupted the natural process of reproduction and individual plant replacement. In time, this may lead to the complete loss of the species in the area as older individuals die off and are not replaced by younger plants.
Riparian vegetation: **Non-native herbaceous and woody plant cover**	Non-native plant species profoundly influence ecosystem structure, productivity, habitat quality, and processes (e.g., fire frequency, intensity). Strong dominance by non-native plants may eliminate key attributes of wildlife habitat quality, and may limit ungulate and livestock use.
Riparian vegetation: **Mammalian herbivory impacts on ground cover**	Ungulate herbivores can affect riparian soils, ground cover, and general ecosystem condition. Utilization levels >10% in riparian zones retard vegetation replacement and recovery. Moderate and higher levels of grazing almost always increase soil compaction and erosion.
Riparian vegetation: **Mammalian herbivory impacts on shrubs and small trees**	Ungulate herbivores can affect recruitment of woody shrub and trees by clipping or browsing the growing tips of the branches. Continued high levels of utilization lead to the death of the plant and over time can cause the loss of all shrubs and trees in a local area.
Terrestrial Wildlife Habitat: **Riparian shrub and tree canopy cover and connectivity**	Riparian shrubs and trees often grow in dense patches that provide food, thermal cover, predator protection and nesting or breeding habitat for terrestrial wildlife, including many invertebrates, amphibians, reptiles, birds and mammals. These patches are often absent in riparian areas that have been heavily utilized by livestock and other ungulates, or that have been damaged by other human activities. As a result, many native wildlife species may no longer be able to survive in the area. Patches of dense vegetation, both native and exotic, also plays a key role in trapping sediment during periods of over-bank flow.
Terrestrial Wildlife Habitat: **Fluvial habitat diversity**	Natural processes create a diversity of fluvial landforms, including terraces, bars, oxbows, wet marshes and fluvial marshes, that provide habitats for different species of terrestrial wildlife. Conversely, in a highly degraded system with extensive erosion and downcutting, there may be only a single fluvial form: a straight and single-depth channel and steep banks without vegetation.

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Santa Fe Municipal Watershed Plan
Outreach Plan

Background and Context

Numerous non-profit groups, such as the Trust for Public Lands, Forest Trends and the Katoomba Group, offer guidelines for incorporating Payment for Ecosystem Services (PES) into watershed management plans. Open communication and accountability are critical in developing and maintaining public confidence in water supply and management. For this reason, most publications recommend that proposed PES fees be made explicit to the public, following an aggressive outreach campaign. This underscores the importance of demonstrating to stakeholders that the benefits of the program are (or will be) greater than or equal to the costs of implementation.

The Santa Fe Municipal Watershed supports more than 75,000 water users in the greater Santa Fe area. While the Santa Fe Municipal Watershed Plan has engaged key agency and non-profit organizations in its development process, success of the overall watershed plan also is dependent upon community and political support. The Santa Fe Municipal Watershed is closed to the public, and at the beginning of the implementation of this plan, little was known about the attitudes and knowledge of Santa Fe water users toward municipal watershed management or a Payment for Ecosystem Services model for supporting management activities. The Outreach plan will gather information about community perspectives toward municipal watershed management while simultaneously providing education and outreach to residents, both youth and adult, of the City and County of Santa Fe along with water customers of Sangre de Cristo Water Division. Outreach will help water consumers understand the interactions between forest and fire and their impacts on water quantity and quality. Additionally, outreach efforts will address the threats to Santa Fe's water supply and demonstrate that proactive municipal watershed protection costs significantly less than addressing municipal watershed degradation issues after catastrophic fire. Issues related to fire in the municipal watershed, including concerns about smoke associated with prescribed fire will be covered. Outreach efforts will be provided and shared by and among all cooperating agencies including the City of Santa Fe Fire Department, Sangre de Cristo Water Division, the Española Ranger District of the Santa Fe National Forest, and the Santa Fe Watershed Association.

Scope of Plan

This plan targets residents of all ages of the City and County of Santa Fe, specifically water customers of Sangre de Cristo Water Division, with a focus on two areas:

- Providing general watershed education, including forest and riparian ecology, natural and cultural history, and water management and conservation, and
- Building and maintaining support for the Payment for Ecosystem Services model.

Summary of Recommendations

Table 1. Summary of Recommendations for Outreach	
Watershed Education – General Public	• Offer 5 tours within the municipal watershed annually which will include 4 educational hikes and 1 van tour • Provide a self-guiding interpretive brochure for the Santa Fe National Forest Black Canyon nature trail, which overlooks the municipal watershed • Develop a 24 minute video tour discussing water management of the municipal watershed for forest health, with a 6 minute version to be made available on YouTube • Build a website page on the City's website that hosts the details and results of this project • Develop an informational sheet to be included with utility bills two times per year
Watershed Education – Youth	• Offer 50 My Water, My Watershed programs that includes a pre- and post-visit to the classroom along with a full school day field trip to the municipal watershed for 4th and 5th grade students in Santa Fe annually • Provide 6 programs per year for middle and high school students in watershed monitoring including classroom visits and field work in the municipal watershed
Support for Watershed Management and Payment for Ecosystem Services	• Gather information about residents' knowledge and attitudes about the municipal watershed and PES through a random survey of water users • Provide and staff an information table at community events and provide presentations to local community groups • Write articles for organizational newsletter • Provide an informational book to citizens on understanding and protecting their watershed

Community Context

According to the 2010 U.S. Census, the city of Santa Fe has a population of 67,000 with an ethnic diversity of 48% Hispanic and 2.1% American Indian. Since 2000, the population has increased by 15% and it is expected to continue to grow. The median household income is $50,000 with 16.5% of the population below the poverty level (48 in state ranking). Sangre de Cristo water users include the population of the City as well as 10,000 users outside of the City limits.

Outreach History

The Santa Fe Watershed Association has a history of community outreach having organized over 40 public meetings for the Upper Watershed Thinning project, the San Ysidro River Restoration Project, and the Santa Fe River Trail. The Association is actively involved in community and school education with programs in the classroom, after school and on the weekends.

Recommendations

The goals of outreach to the Santa Fe community are to create greater awareness and a sense of connection with the watershed, while fostering appreciation and support for municipal watershed management and the proposed Payment for Ecosystem Services financial model. The plan outlines strategies for providing clear, consistent information about municipal watershed management and the proposed Payment for Ecosystem Services financial model by creating opportunities for residents to learn more about the municipal watershed's ecology and management and for youth to become stewards of the entire watershed. Outreach should focus on three key messages:

- Watershed ecology, including forest systems change over time and management of these resources, as proposed in this plan improves the health of the forest and reduces the threat of catastrophic wildfire.
- Reducing the threat of catastrophic wildfire helps secure the City of Santa Fe's water supply, thus and ensuring the quality of this water supply.
- The Santa Fe Municipal Watershed provides valuable ecosystem services that benefit residents and the community as a whole, and that protecting those ecosystem services requires community financial support.

Proposed outcomes from outreach include:

- Increased awareness of and increased understanding of the concept of a watershed, specifically understanding the Santa Fe Municipal Watershed and it relation to the community and the Santa Fe River watershed as a whole.
- Increased understanding of forest ecology and management including fire, drought, and smoke education.
- Increased knowledge of the sources, quality, and quantity, of the City's domestic water supply.
- Increased support for City's Payment for Ecosystem Services financial model and municipal watershed management.

- Increased appreciation of the quality of water in the municipal watershed.
- Increased accountability on the part of the City to residents for municipal watershed management.

Outreach will be provided collaboratively by the City of Santa Fe Fire Department, Sangre de Cristo Water Division, the Española District of the Santa Fe National Forest, and the Santa Fe Watershed Association.

Community Education about the Municipal Watershed

Watershed Tours

The Santa Fe Municipal Watershed has been closed to the public since 1932. However, one of the easiest ways to get people interested in and educated about the municipal watershed is to have them see and experience it first-hand. We recommend offering five days of municipal watershed tours, preferably between June and October that would focus upon forest and water management. Four municipal watershed tours would be hiking tours; one would be a driving tour with two vans available for those that are not physically able to hike the five miles. These tours would be open to the public and would be limited to 20 participants on a first come, first served basis. Each tour would provide an overview of the municipal watershed's natural and cultural history, fire ecology, vegetation and water management, as follows:

- Natural and cultural history: basic ecology with a focus on local flora and fauna, and human impacts upon these systems.
- Fire ecology: fire history and fire regimes of forest types within the municipal watershed, the role of prescribed fire in the system today.
- Vegetation management: a historical perspective on how vegetation, biodiversity, and management has changed over time along with the current need for thinning; prescribed fire; smoke education; management strategies in different vegetation zones and in the Wilderness Area
- Water management: sources of drinking water supply including upstream reservoirs, river health, and mechanisms for preserving water quality.

A handout with basic information on each subject would be available for all participants. The handout would be developed in collaboration with all partners, with the Forest Service providing information on fire ecology and vegetation management, and the City providing information about water management. Tours would be cooridinated and led by the Santa Fe Watershed Association, with participation and support from City and Forest Service partners.

Black Canyon Nature Trail Brochure

The Black Canyon trail in the Santa Fe National Forest is accessible to the public, and overlooks the Santa Fe municipal watershed. We recommend creating a self-guiding interpretive trail brochure that helps the public understand the local geography and geology of the Santa Fe River Watershed. Beginning at the Black Canyon Campground, the trail would have numbered

markers correlating the brochure that highlights various details of the area. This brochure will be available at the trailhead along with a copy available on the Santa Fe National Forest's and Santa Fe Watershed Association's websites. Unlike interpretive panels, a brochure can be easily updated and is not subject to vandalism.

Municipal Watershed Video

Most Santa Fe residents have never visited the municipal watershed, which is closed to the public. We recommend creating a twenty-four minute video along with a shorter six minute video of the municipal watershed that allows residents to learn about its management. Information available on this video will align with the information provided during the municipal watershed tours. The video will be used at community events, public meetings and possibly public access television, and on . Copies of this video will also be available for distribution to the public with a focus on distributing to teachers participating in the My Water, My Watershed program described below.

Municipal Watershed Website

Websites currently are one of the most used public information sources. We recommend that the City of Santa Fe host a municipal watershed website that would provide information about the watershed management plan, prescribed burns and smoke education, current monitoring data, scheduled outreach activities, video links, and contact information for all project partners.

Utility Bill Inserts

To specifically target Sangre de Cristo Water Division customers, two informational bill inserts will be included in water bills annually. Each of these inserts will describe basic information about the municipal watershed and its management to include topics such as defining the concept of watersheds, the role of prescribed fire in forest management, the dangers of drought, and smoke management. These inserts would reach all Sangre de Cristo Water Division customers directly.

Youth Education about Watershed

My Water, My Watershed Program

Youth are the future stewards of the entire watershed. We propose offering an intensive three-part program to 50 Santa Fe Public School fourth and fifth grade classrooms annually. The My Water, My Watershed program will consist of a one hour pre- and post-visit to the classroom along with a full school day field trip to the municipal watershed. All activities will be aligned with Santa Fe Public School and New Mexico science standards and. In the classroom, we will cover watershed definitions, ecosystem design, and water conservation.

During the field portion of the program, students will hike in the municipal watershed and see Nichols Reservoir and its dam first-hand, identify different types of trees and other vegetation, learn about dendrochronology, , and collecting and identifying aquatic macroinvertebrates. Each field trip will also include a reflective piece for students to begin to make the connections between humans, water, and forests in our community.

Each program will be evaluated by pre- and post-tests for the students and a written evaluation from the teacher. Additional activities would be made available for teachers prior to and/or following the classroom visits. Adult chaperones and teachers also gain insights through these field days.

Monitoring Program

On the ground monitoring is an effective strategy to engage middle and high school students in municipal watershed management along with increasing their knowledge about forest management, water systems, and general ecology. We propose to work with six middle and high school classes yearly . We would provide a one hour pre-visit to their classroom and a full school day field trip in the municipal watershed. Through scientific studies, students will gather data on water chemistry, vegetation, aquatic macroinverterates, and wildlife indicators. Students will analyze this data and results will be made available on the watershed website..

Support for Watershed Management and Payment for Ecosystem Services

Survey

There is currently very little information about Santa Fe residents' knowledge and attitudes about the watershed. We recommend gathering this information through a survey that would help us identify the issues of greatest concern to residents, and to learn what information would be most helpful for them to make informed choices. We recommend using a stratified random telephone survey along with focus groups to reach the various demographics of Santa Fe.

Community Events and Presentations

We recommend speaking at community events as another means of reaching diverse audiences within Santa Fe. Potential presentations could be held at regular community groups such as with civic groups and faith groups. Each presentation will include a showing of the upper watershed video. We recommend conducting6 events per year.

Newsletter Articles

Articles in the Santa Fe Watershed Association's newsletter would extend public outreach. We recommend publishing a newsletter twice per year.

Informational Book

We recommend creating a high-quality book, the Santa Fe Blue Pages, for residents that explains the best home environmental practices for living in a fragile, high desert region. This book would include information on all topics covered during the watershed tours along with concrete ideas of how citizens can be good stewards of their community. The language used in this book would be understandable to the general public and scientific concepts would be worded in a way that is interesting to the common citizen of the Santa Fe River Watershed.

Santa Fe Municipal WatershedPlan
Financial Management Plan

Background and Context

The Santa Fe Municipal Watershed provides critical surface water to city residents' water supply. Protection of water quantity and quality is a shared goal of the City of Santa Fe and the Santa Fe National Forest, which manages the upper 17,000 acres of the watershed. The City and Forest Service both recognize that high-intensity fire risk and overgrown dense forests are strong threats to watershed health and the long term viability of water supplies.

The greatest threat to the ecosystem services provided by the Santa Fe Municipal Watershed is fire in unmanaged forest. Congress has spent $7 million in federal earmarks for planning and restoration of forest conditions in the lower, non-wilderness portion of the municipal watershed, resulting in over 5,459 acres being treated with mechanical thinning and pile burns between 2003 and 2009. In addition, the Santa Fe National Forest has allocated a portion of its budget for municipal watershed restoration before and since these appropriations. Since 2009, the City of Santa Fe, with support from the New Mexico Finance Authority Water Trust Board, has spent over $1 million in environmental monitoring infrastructure improvements, education and outreach and forest treatments. Annual maintenance with prescribed fire is needed to keep fuels at the reduced level. The cost to retain the restored forest condition over 20 years is estimated at $5.1 million, an average of $258,000 per year, depending on the level of maintenance needed in any given year, with diminishing cost over time.

In contrast, fire suppression and rehabilitation costs associated with a 10,000 to 40,000 acre wildfire impacting some portion of the municipal watershed could be between $11.9M and $48M. The cost to dredge, haul and dispose of 2,000 acre-feet of sediment and ash the City's reservoirs would likely be between $80M and $240M. These costs exclude increased water treatment costs, increased water utility operating costs associated with production of water from different water sources and impacts to the local economy from loss of tourism income. The likelihood of such a fire in the municipal watershed is estimated to be 1 in 5 in any given year.

To date, federal funding has supported the most expensive work to restore forest health in the municipal watershed. This funding, through hazardous fuel reduction earmarks and appropriations, is subject to changing Congressional priorities and approval. Funding for upkeep of the treated forest areas is contingent upon annual Forest Service appropriations, and these appropriations have been declining because of the rising cost of fire suppression. As funding is directed to fire suppression, cost-share agreements that leverage federal funding by providing matching funds will become more important. A Payment for Ecosystem Services (PES) agreement between the City of Santa Fe and the Santa Fe National Forest would more likely ensure that the Forest Service will be able to continue its management activities within the watershed, even as available funding declines in the region.

PES programs provide clear economic incentives for stewardship of watersheds and promote greater awareness about the benefits provided by healthy watersheds, such as flood control and

flow timing, water purification, sediment retention, fire protection and carbon storage. Studies of water utilities across the United States show that every dollar invested in watershed protection can save tens to hundreds of dollars in costs for new water treatment facilities (Johnson et al. 2000).

Research shows that the most effective PES programs engage and inform a variety of stakeholders. Key elements to effective PES programs include defining and valuing the ecosystem services, developing an agreement that guarantees those services to customers, and establishing a payment mechanism (Forest Trends and Katoomba Group 2008). A Payment for Ecosystem Services program in the Santa Fe watershed would pay for vegetation management, water management, and outreach through a partnership between the City of Santa Fe and the Santa Fe National Forest.

The City of Santa Fe has recently instituted a five-year utility service rate increase to pay for construction of the Buckman Direct Diversion Project and other water utility infrastructure improvements. Because gaining public support for an additional rate increase associated with Watershed Management Plan PES would be difficult at this time, the watershed management partners requested and were awarded New Mexico Finance Authority Water Trust Board funding to cover the City's PES obligations for the three years of project implementation. Beginning in May of 2013, following expiration of the New Mexico Finance Authority Water Trust Board grant, City of Santa Fe water utility's rates will cover the City's obligations under this plan. The City may choose to itemize municipal watershed project fees as a separate item public utility bills.

In order for the cost-share arrangement between the City and the U.S. Forest Service to continue, the Collection Agreement will need to be renewed every 5 years. Annual review of work plans, budgets, and project implementation per the terms of the Collection Agreement should also be done.

Scope of this Plan

The purpose of the financial management plan is to develop a financing framework to support forest management, water management, and outreach activities outlined in each respective plan. The financial management plan outlines the Payment for Ecosystem Services approach, whereby beneficiaries of the watershed (Santa Fe water consumers) will knowingly pay for ecosystem services. The financial plan also provides the economic context for previous watershed management activities, describes anticipated costs for all components of the plan, describes costs from catastrophic fire that can be avoided through fire and fuels management, and suggests agreements and mechanisms for payment necessary to finance the plan.

Summary of Recommendations

Table 1. Summary of Recommendations for Financial Management	
Payment for Ecosystem Services	Use the Payment for Ecosystem Services (PES) model to develop a local, sustainable source of funding that accounts for true costs of watershed management.
Income Sources for PES	Phase 1: New Mexico Water Trust Board pays for Watershed Investment Program costs for first 3 years. Phase 2: Beginning in May of 2013, existing City water utility rates will cover Watershed Investment Program costs.
Agreements and Mechanisms for Payment	Draft a new Memorandum of Understanding between the City and USFS for watershed management. Develop a collection agreement between City and USFS every five years. Review work plans, budgets, and project implementation annually.

Payment for Ecosystem Services

General Context

Ecosystems naturally produce resources that are important for humans, such as water, wood, clean air, and insects that pollinate gardens and fruit trees. "Ecosystem services" refer to these resources and the natural processes that produce them (Table 2). Typically, these services are not paid for, nor are they included in conventional markets or economic analyses. Surface water for municipal use is an example of an ecosystem service that is neither paid for by the city nor individual water users. Water users pay for the services of capturing, treating, and delivering water, but they do not currently pay for the ecosystem services that ensure that clean water is available. By attaching an economic value to these natural processes and services, water districts and municipalities can access revenue to support needed watershed management. Payment for Ecosystem Services provides clear economic incentives for maintaining watershed health, and creates greater visibility and support for watershed management by asking water consumers to

knowingly pay for the ecosystem services the watershed provides (McGrath and Greenwalt 2008).

Payment for Ecosystem Services provides clear economic incentives for maintaining watershed health. This model of watershed protection has been implemented in major U.S. cities such as Salt Lake City, UT, Eugene, OR, and Denver, CO, and has been shown to save millions of dollars in capital outlay and annual operating costs. The Santa Fe Watershed plan seeks to use the Payment for Ecosystem Services model to fund the maintenance of forest restoration activities as an insurance policy against future threats to the municipal water supply. The advantages of having beneficiaries pay for ecosystem services are (i) awareness and education about watershed health and protection; (ii) genuine collaboration between water consumers and forest managers; and (iii) long term funding of true watershed maintenance costs (McGrath and Greenwalt 2008).

Table 2. Ecosystem Services for Santa Fe

Provisioning Services	**Description**
Fresh water	Supplies 40% of water used in City of Santa Fe and auxiliary supply to County users in dry years
Regulating Services	
Flood control and flow timing	Forest cover maintains snowpack and, combined with dams, ensures year-round water
Water purification	Forest and woodland cover provide natural filtration of water
Sediment regulation	Plants and forest ground cover keep soil in place
Fire protection	Healthy lower elevation forests will burn at low-intensity and reduce possibility of catastrophic wildfire and sedimentation
Invasive species regulation	Healthy forests have no/very few sources for invasive species introduction
Climate regulation	Healthy forests store carbon and low-intensity fires prevent a massive release of carbon

Calculating Avoided Costs from Watershed Protection

Fire protection is a critical ecosystem service for the Santa Fe watershed and is achieved through the fuels treatments already completed and a proposed annual controlled burn program. The Payment for Ecosystem Services model acts as an insurance policy against threats to the water supply from catastrophic fire. One of the best ways to illustrate the value of a PES program is to compare the costs of maintenance and long term management with the alternative costs that would result from a catastrophic fire. A catastrophic wildfire in the Santa Fe watershed would result in four significant costs (Table 3):

- *Fire suppression and rehabilitation of burned areas.* Fire suppression costs include those expended up to the time of containment. Rehabilitation costs include those incurred as part of Burned Area Emergency Response (BAER) actions taken to minimize mass soil erosion, runoff, and flooding and to mitigate other environmental hazards. Costs excluded from the rehabilitation category are those associated with repairing or replacing homes destroyed by the fire, medical expenses incurred by firefighters or residents, and other indirect socioeconomic costs. Based on average costs per acre for fire suppression and BAER rehabilitation associated with the 2000 Cerro Grande Fire, the 2011 Pacheco Fire, and the 2011 Las Conchas Fire, a 10,000 to 40,000 acre wildfire impacting some portion of the municipal watershed would likely incur fire suppression costs of approximately $6.4 to $25.7 million and BAER rehabilitation costs of approximately $5.5 to $22.3 million.

- *Shut down of water treatment plant and providing alternate source of supply.* Experience from other fires has shown that filtration systems of water treatment plants become clogged with ash after fire and typically have to shut down for at least 4 months in order to clear the system. The water division estimates a projected cost of $2 million that would result from shutting down the water treatment facility for 4 months and providing an alternate supply of water from City wells.

- *Reservoir dredging and upland disposal of accumulated sediment.* Typically, reservoirs also need to be dredged following catastrophic wildfires in order to remove sediment and ash. Following the Cerro Grande fire, reservoir sedimentation in Los Alamos was 140 times higher than the previous 57 years, and remained significantly elevated throughout a five year study period (Lavine et al. 2005). It is estimated that a 10,000 to 40,000 acre wildfire impacting some portion of the municipal watershed would result in significant amounts of erosion and sediment and ash accumulation in the City's reservoirs, with the actual accumulated volume being highly dependent on the severity and duration of storm events within the first year after the fire. Estimates of the volume of debris and sediment range from 415 acre-feet up to 2,000 acre-feet for the maximum storm event in the first year following a severe wildfire, the latter resulting in a loss of more than 60 % of the reservoir capacity. The sediment loading would not only reduce the capacity of the reservoirs, but the turbidity and suspended ash of the water would impair use of the water for an extended period until the watershed healed and erosion rates decreased to near-normal levels. The estimated cost to dredge, haul and dispose of 2,000 acre-feet of

sediment and ash from McClure Reservoir would likely be between $80M and $240M, based on the cost estimate from the 2001 Santa Fe Watershed EIS ($25/yd^3 or $40,000/acre-foot) and Strontia Springs Reservoir dredging costs ($75/yd^3 or $120,000/acre-foot) in Colorado following the 1996 Buffalo Creek Fire and the 2002 Hayman Fire (Mike McHugh, Aurora Water, 2013). Although the Strontia Springs Reservoir project was originally budgeted for $30M to dredge and dispose of 685 yd3 ($44/yd^3) of sediment and ash (Denver Post 2008), significant technical problems have thus far prevented project completion and resulted in additional costs. Specifically, the presence of large diameter granitic debris among the accumulated sediment has proven highly destructive to available dredging equipment and slurry pipelines. The high likelihood of similar conditions being present in the municipal watershed following a large wildfire suggests that successfully dredging large volumes of material from McClure Reservoir may be impractical within a several year time frame. The Forest Service estimates an additional $500,000 would be required to complete NEPA for actions required to restore sediment regulation.

Taken as a whole, the fire suppression and rehabilitation costs associated with a 10,000 to 40,000 acre wildfire impacting some portion of the municipal watershed could be between $11.9 million and $48 million. The cost to dredge, haul and dispose of 2,000 acre-feet of sediment and ash the City's reservoirs would likely be between $80 million and $240 million. The additional water treatment costs and costs to produce water from other sources while municipal watershed water utility infrastructure is impacted for a significant fire would be approximately $2 million. In contrast to these avoided costs, the cost to treat and maintain forests within the municipal watershed is expected to be $5.1 million over 20 years, an average of $258,000 per year.

Table 3. Costs of ecosystem services provided by the Santa Fe Municipal Watershed	
Provisioning Service	**Cost**
Fresh Water	**$5.1 million over 20 years** (approximately $258,000 per year) for management of 17,000 acres of watershed
Regulating Services	**Cost**
Fire suppression and rehabilitation	**$6.4 to $25.7 million** for fire suppression costs and **$5.5 to $22.3 million** for BAER rehabilitation costs estimated total avoided cost from a 10,00 to 40,000 acre fire
Water purification	**$2 million** avoided cost of shutting down water treatment plant for 4 months after fire
Sediment regulation	**$80 to $240 million** avoided cost of dredging the City reservoirs to remove sediment and ash; **$500,000** for NEPA compliance to restore sediment regulation
Invasive species regulation	**$500,000** avoided cost to control invasive species spread after wildfire

Lessons from other watersheds impacted by severe fire show that it is far more cost effective to maintain the watershed than to pay for costly remediation following fire (McGrath and Greenwalt 2008). In fact, studies of water utilities across the United States show that every dollar invested in watershed protection can save tens to hundreds of dollars in costs for new water treatment facilities (Johnson et al. 2000).

Financial History

More than $7 million of Congressionally-directed funding has already been spent for planning and restoration of forest conditions in the watershed. Between 2003 and 2006 the United States Congress earmarked $1.5 million per year of hazardous fuels reduction funding to thin 5,285 acres. Funds were also earmarked for an EIS to analyze the impacts of the treatment plan.

Funding for the Santa Fe National Forest follows trends that affect the Forest Service nationally. The Congressional Budget Office requires that the Forest Service allocate funds for fire suppression before other programs, basing that amount on a 10 year rolling average of actual expenditures. The percent of the agency budget that is directed to fire suppression increased from 13% in 1991 to 46% in 2008. In three of the last ten years, Forest Service spending on suppression topped $1 billion, and from 2008 to 2009, the 10 year rolling average will increase by $158 million. The effect of those reductions will be felt across the Forest Service and there is no projected end in sight to the increases in fire suppression funding. At the current rate of increase, the Forest Service is expected to spend 100% of its budget allocation on fire suppression in 15-20 years.

Each year Hazardous Fuel Reduction appropriations allocate funding to the Southwest Region of the Forest Service. The Southwest Region then allocates this funding to the 11 national forests in New Mexico and Arizona. Funding for fuels treatments was consistent through 2008, even as funding for other programs declined and as fire suppression costs increased. However, the prospect of sustained funding at a level sufficient to fully fund the management needs is doubtful, because an increasing proportion of the Forest Service must be spent on fire suppression rather than resource management programs. As funding for treatments becomes scarce and competition between projects on each national forest intensifies, cost-share agreements that will leverage federal funding by providing matching funds become more important. A Payment for Ecosystem Services agreement between the City of Santa Fe Water Division and the Santa Fe National Forest makes it more likely that the Forest Service will be able to continue funding management of the municipal watershed even as its funding allocation declines.

Recommendations

We recommend the following as a framework for financing the watershed management plan:

- Phase 1: New Mexico Water Trust Board pays for Watershed Investment Program costs for first 3 years.
- Phase 2: Use the Payment for Ecosystem Services model to develop a local, sustainable source of funding that accounts for true costs of watershed management. Beginning in May of 2013, existing City water utility rates will cover Watershed Investment Program costs.

- List fees as a separate item on the water bill. During Phase 1, the fee will appear as a credit, with funding from the New Mexico Water Trust Board. During Phase 2, the fee will be assessed back on water usage. Other Payment for Ecosystem programs have found that open communication and accountability are critical in maintaining public confidence in water supply and management. For this reason, most publications recommend that proposed PES fees be made explicit to the public, following an aggressive outreach campaign (McGrath and Greenwalt 2008). It is recommended that the City include the PES fee as a separate line item in the water bill. This would promote the understanding and visibility of the PES program and would contribute to a more educated public about the true cost of maintaining ecosystem services in the watershed.
- Create agreements and mechanisms for payment between the City of Santa Fe and the U.S. Forest Service. These would include: a new Memorandum of Understanding for watershed management; a Collection Agreement that would be re-established every 5 years; and an annual review of work plans, budgets, and project implementation, based on the terms of the Collection Agreement.

Projected Costs

Vegetation Management

The $7 million in federal earmarks for hazardous fuel reduction in the Santa Fe watershed represents a considerable public investment. Annual maintenance with controlled fire will keep fuels at the reduced level. The cost to retain the restored forest condition over the first 3 years is nearly $640,000, with an additional $2.6 million over the remaining 17 years. Costs range from $158,000 and $254,000 per year, depending on the level of maintenance needed in any given year, with diminishing cost over time.

From 2013 forward, cost estimates are intended to show projected cost changes over 17 years within the entire municipal watershed. The estimates do not reflect Forest Service equipment, indirect, or overhead costs, many of which are covered out of the Fire Preparedness line item in the Interior and Related Agencies Appropriations Bill.

Beginning with Phase 2, following expiration of NMFA Water Trust Board funds, costs for fuels management will be shared equally between the Forest Service and the City of Santa Fe. This cost share agreement will help continue the leveraging of federal earmarks for hazardous fuel reductions.

Water Management

Cost for water management activities will be $434,749for the first 3 years of the plan and $118,000 over the following 17 years. Within the first three years (Phase 1), critical quantity monitoring infrastructure was built, including automated precipitation gages and a new stream gage above McClure Reservoir, as well as ecological monitoring and habitat restoration along the Santa Fe River between the two reservoirs.

Education and Outreach

Education and Outreach activities cost $406,849 for the first 3 years of plan implementation, and will cost $2.4 million over the following 17 years. In 2011, the City's Governing Body s elected to significantly expand the education and outreach, including the goal of having all of Santa Fe's public school 5th grade students participate in municipal watershed and classroom educational programs.

Phase 1 Costs

The total cost associated with implementation during Phase 1 (Years 1-3) of the Santa Fe Municipal Watershed Plan is $1,479,351 (Table 4). Income sources for this phase include the Water Trust Board ($1,252,063), the US Forest Service ($0), and the City of Santa Fe ($227,288) (Table 4, Figure 1).

Table 4. Total Costs for Phase 1 Implementation of Santa Fe Municipal Watershed Plan

Year	Subtotal	WTB	USFS	City
2011	$291,294	$291,294	$0	$0
2012	$427,586	$376,298	$0	$51,288
2013	$760,471	$584,471	$0	$176,000
Total 3-yr Costs	$1,479,351	$1,252,063	$0	$227,288

Within Phase 1, this money will be allocated to vegetation management, water management and education & outreach according to Table 5, below.

Table 5. Phase 1 Cost Breakdown for of Santa Fe Municipal Watershed Plan

Year	Vegetation Management			Water Management			Education and Outreach		
	WTB	City	USFS	WTB	City	USFS	WTB	City	USFS
FY10/11	$142,868	$0	$0	$61,385	$0	$0	$87,040	$0	$0
FY11/12	$240,627	$0	$0	$53,891	$0	$0	$81,781	$51,288	$0
FY12/13	$254,258	$0	$0	$319,472	$0	$0	$10,740	$176,000	$0
Total 3-yr Costs	$637,753	$0	$0	$434,749	$0	$0	$179,561	$227,288	$0

Phase 2 Costs

The total investment in watershed maintenance over 20 years will be $5.1 million, an average of $258,000 per year. Table 6 below summarizes Phase 2 implementation costs for the Santa Fe Municipal Watershed Plan through 2029, following expiration of the NMFA Water Trust Board funds (Phase 1).

Table 6. Total Costs for Phase 2 Implementation of Santa Fe Municipal Watershed Plan

Year	Subtotal	City	USFS
FY11/12	$51,288	$51,288	$0
FY12/13	$176,000	$176,000	$0
FY13/14	$351,210	$262,210	$89,000
FY14/15	$329,210	$240,210	$89,000
FY15/16	$319,210	$230,210	$89,000
FY16/17	$319,210	$230,210	$89,000
FY17/18	$319,210	$230,210	$89,000
FY18/19	$319,210	$230,210	$89,000
FY19/20	$299,210	$220,210	$79,000
FY20/21	$299,210	$220,210	$79,000
FY21/22	$299,210	$220,210	$79,000
FY22/23	$299,210	$220,210	$79,000
FY23/24	$299,210	$220,210	$79,000
FY24/25	$299,210	$220,210	$79,000
FY25/26	$299,210	$220,210	$79,000
FY26/27	$299,210	$220,210	$79,000
FY27/28	$299,210	$220,210	$79,000
FY28/29	$299,210	$220,210	$79,000
TOTAL 20-YR COST	$5,176,648	$3,852,648	$1,324,000

Within Phase 2, this money will be allocated to vegetation management, water management and education & outreach according to Table 7, below.

Table 7. Phase 2 Cost Breakdown for of Santa Fe Municipal Watershed Plan

Year	Vegetation Management		Water Management		Education and Outreach		
	City	USFS	City	USFS	City	USFS	SFWS
FY11/12	$0	$0	$0	$0	$51,288	$0	$0
FY12/13	$0	$0	$0	$0	$176,000	$0	$0
FY13/14	$89,000	$89,000	$28,000	$0	$145,210	$0	$0

FY14/15	$89,000	$89,000	$6,000	$0	$145,210	$0	$0
FY15/16	$89,000	$89,000	$6,000	$0	$135,210	$0	$0
FY16/17	$89,000	$89,000	$6,000	$0	$135,210	$0	$0
FY17/18	$89,000	$89,000	$6,000	$0	$135,210	$0	$0
FY18/19	$89,000	$89,000	$6,000	$0	$135,210	$0	$0
FY19/20	$79,000	$79,000	$6,000	$0	$135,210	$0	$0
FY20/21	$79,000	$79,000	$6,000	$0	$135,210	$0	$0
FY21/22	$79,000	$79,000	$6,000	$0	$135,210	$0	$0
FY22/23	$79,000	$79,000	$6,000	$0	$135,210	$0	$0
FY23/24	$79,000	$79,000	$6,000	$0	$135,210	$0	$0
FY24/25	$79,000	$79,000	$6,000	$0	$135,210	$0	$0
FY25/26	$79,000	$79,000	$6,000	$0	$135,210	$0	$0
FY26/27	$79,000	$79,000	$6,000	$0	$135,210	$0	$0
FY27/28	$79,000	$79,000	$6,000	$0	$135,210	$0	$0
FY28/29	$79,000	$79,000	$6,000	$0	$135,210	$0	$0
Total 20-yr Costs	$1,324,000	$1,324,000	$118,000	$0	$2,410,648	$0	$0

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