Appendix

to

Continuing Studies of the Effects
Of Increased Flows on Riparian Communities
At Eccles Canyon Creek & Mud Creek

\- A Study Plan -

Contains excerpts from:

USDA Forest Service. March 1992. Integrated riparian evaluation guide. Intermountain Region. Ogden, UT.

Chapter 4. LEVEL III RIPARIAN AREA EVALUATION

A. Objectives

1. Provide detailed quantitative site information for riparian complexes to:

   a. *Describe current status.*

   b. *Quantify potential.*

   c. *Provide data for defensible management decisions.*

   d. *Validate Forest Standards and Guidelines.*

   e. *Develop design criteria for riparian and aquatic habitat improvement projects.*

   f. *Quantify management effects.*

   g. *Identify factors limiting achievement of potential or management goals.*

2. Provide a monitoring framework to evaluate management activities.

The decision to complete a Level III evaluation is *issue* driven. There must be a need for the information detail that Level III generates. A number of resource surveys are described in this Chapter. Each Forest will identify by project area which surveys to use. Surveys that are not included in this handbook may also be used.

B. Guidelines

Identify specific objectives for conducting a Level III riparian evaluation and the information needs to address those objectives. Identify and apply suitably efficient and reliable techniques to provide the needed information. Data forms for Level III vegetation, channel morphology, and aquatic community habitat surveys are included in Appendix A. Other resources are to be inventoried using existing procedures and forms. Assessment of some resource attributes may require development of new methodology and data forms. If an undocumented technique is used, the Forest should document the assumptions and procedures used. All forms used in Level III riparian evaluation need to include the Key ID number described in Level II so that eventual data base linkages may be made.

Guidelines related to the two principal purposes for Level III riparian evaluations follow.

1. Complex Characterization

Level III riparian evaluations employ methods to quantitatively describe the physical and biological characteristics of a riparian complex. Data collection for characterization often involves use of subsampling techniques within a complex.

A variety of resource attributes must be examined to adequately characterize riparian complexes. All resource surveys including channel morphology, fish habitat, vegetative cross section, green line, soils, and foliage height/volume information should be conducted in a manner that allows them to be tied to specific sample locations within the complex. Some resource attributes, such as those associated with vegetation, will be surveyed only at the specific sample locations. Others will be sampled over the entire complex. For example, if soil information is lacking, a soil map for the entire complex will be produced to the Order 1 or 2 intensity level. Channel morphology and aquatic community habitat attributes will be evaluated over the length of the stream in the complex using a calibrated ocular estimation (COE) survey approach described by Hankin and Reeves (1989) (see Appendix H).

2. **Monitoring**

Forest Service policy recognizes three types of monitoring: Implementation, effectiveness, and validation. These strategies are to be applied to monitor Forest Plan implementation. They are also useful in determining if requirements of the Clean Water Act, as administered by the State water quality agencies, are being met (i.e., applied best management practices are protecting beneficial uses).

Implementation monitoring documents whether or not management practices were applied as designed. Project and contract administration is a part of implementation monitoring. During riparian projects, the project administrator or contracting officer documents proper implementation and reasons for variance from design.

Effectiveness monitoring documents how well the management practices meet intended objectives for the riparian area. The Riparian ID Team reviews projects on-site during or after implementation to evaluate design adequacy and to provide feedback on needed additions or changes. Monitoring evaluates the cause and effect relationships between management activities and condition of the riparian dependant resources. Terrestrial and in-stream methods together constitute monitoring that evaluates and documents the total effectiveness of site-specific actions.

Validation monitoring determines if predictive model coefficients and assumptions are appropriate. A long-term commitment to data collection is often required to establish an adequate data base. If the standard requires utilization of no more than 50 percent of streamside herbaceous forage for example, and this fails to achieve the desire instream habitat condition, the standard would have to be modified, for less forage consumption for the riparian complex(s).

A fourth type of monitoring, sometimes referred to as "baseline monitoring," also has application to riparian monitoring. Baseline monitoring is conducted to determine long term trends, natural variability, and/or to provide a benchmark for comparison purposes. Recurring inventory of "reference complex" characteristics is an example of a common type of baseline monitoring. In this case, baseline monitoring is used to define "potential" and "natural variability" for specific riparian complexes. These "reference conditions" provide the basis of comparison for effectiveness monitoring.

Selection of physical and biological attributes for monitoring riparian conditions should be based on Forest Plan standards and guidelines, desired future conditions, state water quality standards (related to protection of beneficial uses such as salmonid spawning, cold water biota, primary and secondary contact recreation, and domestic, municipal, and agricultural water supply), and on specific project objectives for the riparian area. Methods used to monitor and evaluate these attributes should be well documented, replicable between years and observers, and result in quantitative data with known reliability (i.e., confidence intervals).

C. Methods

This section briefly describes some techniques for characterization and monitoring of riparian complexes. The methods are listed under these two objectives by functional area for organizational purposes. However, the results need to be assessed in an interdisciplinary framework to draw conclusions and make management recommendations.

In addition to the methods listed below, photographs may be used to visually represent the data being collected. Although photographs may not be used to provide quantitative data, they can be an important aid in information transfer and understanding. Photographs should be taken in the same locations that data are being collected. If photographs are to be used to document changes through time, the photo location should be monumented and the compass bearing of the photo documented. Photographs taken with 35mm color print film is best suited for reports and small documents. Black and white print film is best suited for publications. Some may desire to use slide film and have prints made from the slides, while others may choose to use two cameras - one for slides and one for prints.

1. Complex Characterization

a. **Aquatic Community Habitat**: Some suitable techniques and recommendations for their application follow.

(1) **Calibrated Ocular Estimation (COE) Survey**: The COE survey approach can be used to efficiently provide quantitative information on current aquatic conditions within a complex or over several complexes. This approach provides the means to assess complex conditions and evaluate dispersed and cumulative land use effects. Because aquatic habitat types are the basic sample unit of this approach, COE surveys generate information useful for identifying environmental features limiting fish production and developing project design criteria. See Hankin and Reeves (1989) and Appendix H for additional information.

(2) **Macroinvertebrate Survey**: Macroinvertebrate community composition and relative species abundance can be effectively used to evaluate the overall health or condition of aquatic community habitat. GAWS Macroinvertebrate survey procedures and data forms are referenced in R-4 FSH 2609.23. EPA Rapid Bioassessment procedures may also be employed (Plafkin, et. al., 1989).

(3) **Instream Flow Survey**: The Region's GAWS instream flow survey methodology can be used to estimate the quantity and quality of aquatic community habitat available at flow levels other than those measured at the time of survey. It may be appropriate to apply the inventory technique where activities are proposed that would depleat or supplement natural flow regimes. Survey procedures and data forms are referenced in R-4 FSH 2609.23. Where litigation related to the findings is anticipated, it is recommended that the U.S. Fish and Wildlife Service's "Instream Flow Incremental Methodology" be applied. Regardless of the methodology applied, it is important that a COE survey of the stream or stream reach be completed prior to selection of instream flow study sites.

(4) **Fish Population Survey**: A variety of standard fish population survey methods may be used to inventory and monitor fish population characteristics. Fish population surveys must be coordinated with and/or performed by state fish and wildlife management agencies. Where water clarity and stream size permit, visual estimation techniques described by Hankin and Reeves are recommended. Where visual estimation is not possible, it may be necessary to employ removal-depletion or mark-recapture electrofishing techniques to estimate fish species/life stage composition and abundance. Because of wide natural fluctuations in year-class strength, a paired comparison to reference (i.e., control) will be necessary to assess fish density trends over time.

b. **Soils Data and Inventory**:

The kinds of soils and soil materials play a key and important role in the riparian area. The particle size distribution and sequences in which soil materials have been deposited during fluvial processes directly effect riparian area function. Riparian soils may be both saturated and unsaturated. During the Level III riparian evaluation, soil data is collected on depth of soil mottles, texture, color, structure, cohesiveness, stratification of parent materials, boulders and cobbles, percent of coarse fragments in the dominate soils, buried organic horizons, thickness of organic surface, ground water table and other soil parameters. The soil inventory report generally provides information on geomorphic, process, soil parent material, soil substrata, landforms, soil temperature and moisture regimes and other soil related factors in the landscape.

Soil information is analyzed and interpretative information can be provided for such key areas as:

Surface erosion
Stream bank stability
Soil compaction
Soil productivity potentials
Soil revegetation potential
Area extent of riparian area (based on free and unbound soil water)
Influence on ground water movement

Orders of intensity in soil inventory are necessary to designate the detail of soil information on which management decisions will be based. Detailed soil information is needed if stream structures are to be constructed to raise the water table and stabilize the banks of a severely eroding riparian area. This would require refined distinctions among small, homogeneous areas of soil. The orders of intensity are intended to obtain only the necessary detail and no more, to answer these questions about soils. See Soil Survey Manual, Chapter 2, page 2-14, for Key for Identifying Kinds of Soil Surveys which compares the five orders of soil survey. The number of map units, their composition, and the detail of mapping vary with the complexity of the soil patterns and the specific needs of the user. Thus the soil survey intensity is matched to the needed uses and the soil-related problems of the area. The soils mapped in an inventory will be identified by names that serve as references to a national system of soil taxonomy.

(1) ***Order 1 Surveys:*** First order surveys are made for very intensive land uses requiring very detailed information about soils, properties for generally small areas. The information can be used in planning for land drainage, construction sites, materials for streams or streambank protection, Habitat Type management prescriptions, and other management uses that require very precise site-specific knowledge of the soils and their variability.

Field procedures permit observations of soil boundaries throughout their length. The soils in each delineation are identified by transecting or traversing. Remote sensing is used as an aid in boundary delineation. Map units are mostly; consociations with some complexes, and are phases of soil families, soil series, or are miscellaneous areas. Delineations have a minimum size of about 1 hectare (2.5 acres) or less, depending on the map scale, and contain a minimum amount of contrasting inclusions within the limits permitted by the kind of map unit used. Soil map base scale is generally 1:15,840 or larger.

(2) ***Order 2 Surveys:*** Second order surveys are made for intensive land uses that require detailed information about soil resources for making predictions of suitability for use and of treatment needs. The information can be used in planning for general land disturbances, construction of roads and bridges, vegetative manipulation, or some broader Habitat Type prescriptions, and similar uses that require precise knowledge of the soils and their variability.

Field procedures permit plotting of soil boundaries by observation and by interpretation of remotely sensed data. Boundaries are verified at closely spaced intervals, and the soils in each delineation are identified by transecting or traversing. Map units are mostly consociations and complexes. Occasional undifferentiated groups or associations are also used. Components of map units may be phases of soil families. Delineations are variable in size, with a minimum of 0.6 to 4 hectares, (1.5 to 10 acres) depending on landscape complexity and survey objectives. Contrasting inclusions vary in size and amount within the limits permitted by the kind of map unit used. Base map scale is generally 1:12,000 to 1:31,680, depending on the complexity of the soil pattern within the area.

An accompanying report describes, defines, classifies, and interprets the soils. Interpretations predict the behavior of soils under different uses and the soils' response to management.

(3) ***Soil Compaction***: Compaction of soil increases soil bulk density and decreases porosity as a result of the application of mechanical forces such as weight and vibration or animal trampling. Soil compaction is determined by ocular estimating and volumeteric core sampling. Compaction sampling is accomplished along the vegetative cross-section transects, with two or three samples taken for each dominant soil type where they support dominant vegetative community types. Samples are needed for both disturbed and undisturbed sites for comparison. (Reference, Interim Guidelines For Sampling Soil Resource Conditions, USDA Forest Service, R-6, 1981.)

Soils differ in their inherent ability to resist compaction. Important factors needing evaluation include: soil texture, soil structure, organic matter content, and rock fragment content.

(4) ***Soil Puddling:*** This condition occurs under wet-soil conditions when the exerting force mechanically destroys the soil structure by compression and shearing. It results in total deformation of the soil particle process. It is usually a problem in soils with a clay content greater than 35 percent or with a moisture content at or greater than field capacity (35-53 percent moisture by weight, depending upon texture.) Bearing strength of the saturated soil under compression approaches zero. The saturated soil cannot support vehicle traffic or trampling by animals or humans without sustaining damage. A puddled soil inhibits root, air and water movement. The natural restoration period is not specifically known but, field evidence indicates that it may persist somewhat less than compaction because the puddled zone is relatively thin (Moehring, 1970).

c. **Hydrology and Stream Dynamics:**

Although riparian evaluation is not intended to be the vehicle for completing Water Resource Inventory, it is often necessary to conduct a water resource investigation to provide answers to specific questions or resolve problems identified by the Level I or Level II Riparian Evaluations.

The appropriate Order of Water Resource Inventory for Level III riparian evaluations depends on the questions to be answered or project(s) being proposed. Order 2 inventory would be used to evaluate watershed level influences on the riparian complex(es) of concern. Order 1 inventory may be used for site-specific design purposes.

Water Resource Inventory for Level III riparian evaluations must ultimately identify any watershed level phenomenon that is influencing the complex(es) of concern, including watershed condition, upland hydrology, off-site erosion, water quality, landform processes, base level changes, flow regime, and management influences. The Water Resources Inventory Handbook (FSH 2509.16) should be consulted to design and execute the inventory.

In addition to the hydrologic measurements taken in the aquatic community habitat section, the following hydrologic evaluations should be considered. The issues driving the Level III riparian evaluation may require specific types of water resource investigations. These may be:

(1) ***Channel Maintenance Instream Flow Quantification***: (used when dewatering, stream diversions, hydropower, water rights, etc. are issues.)

(2) ***Floodplain (and Wetland) Delineation and Analysis***: (when facilities development, peak flows, management influence on peak flows, etc. are issues. See FSH 2509.17, Chapt. 20 for details.)

(3) ***Water Quality Investigations:*** (see FSH 2509.16 for references concerning water data acquisition.)

(4) ***Channel Morphology***: (when channel and floodplain hydraulics, aquatic habitat, etc. are issues, and monitoring is desired. Use standard channel cross-section survey procedures.)

(5) ***Channel Stability***: For sediment erosion in meadow streams, see example figure 6. When evaluating forested streams, see Channel Stability Evaluation Chart (Appendix F).

For the bulk of riparian complexes evaluated at Level III, the hydrologist will further refine the information gathered in previous levels. This will include verification of the ocular stream typing from Level II using a Wolman pebble count and possibly a description of stream sub-types present in the complex. See the Interpretations and Applications Section of this Guide for how this information is used.

A number of interpretations from water resource inventory information are made by extrapolating relationships to similar watersheds. Level III riparian evaluation may be used to verify those relationships for site-specific conditions on the Forest or derive new relationships. A well designed monitoring program is required to derive these relationships.

d. **Vegetation:**

Several inventory processes are available to gather intensive vegetation information at Level III. Any or all of the following approaches may be used, depending on specific needs.

Each riparian complex is usually composed of a mix of 4 to 10 community types. A measurement of the percent each type covers within a complex (community type composition) can provide an indication of potential or ecological status. The percent of the complex covered by community types which are indicators of unnatural disturbances, such as heavy grazing and trampling or soil compaction from recreational activities, provides an indication of impact. These measurements can be used to determine if management has been suitable for achieving the predetermine desired condition on areas where desired future condition has been identified based on presence or absence of specific community types.

If there is a set kind and number of community types within a complex in "natural" condition, and if new types enter the scene when "unnatural" disturbing factors are present, we can measure the percent composition change in the types through two different line intercept processes.

(1) ***Cross-Section Composition***: Several pace transects (at least five) are established perpendicular to the riparian complex in such a way as to cross the entire riparian area (Figure 2). Beginning and ending points for each transect are permanently marked with stakes that should be placed far enough back into the non-riparian area to allow subsequent measurements in case the riparian area expands. Community type composition is obtained by tallying the number of steps encountered for each type in relation to the number of total steps used in all transects. A hand held tally whacher (counter) will aid in this sampling process. Note, since different individuals have distinct step lengths each person should test themselves with a measured transect so that steps can be converted to feet. For Cross Section Composition and Cross Section Composition Summary Sheet (Level III), see Appendix A. Photographs will be taken at each of the permanent starting point cross section stakes. The photographs will depict the setting of the cross section. Photographs are also taken at the location(s) where the cross section crosses the stream channel. Optional photos can be taken from each stake.

Percent composition for each community type is calculated as follows: (Assumes examiner's step equals 2.5 feet):

Total number of feet for the Kentucky bluegrass community type

	Steps	Feet
$= T_1$	20	50'
$= T_2$	18	45'
$= T_3$	18	45'
$= T_4$	24	60'
$= T_5$	32	80'
	112	280'

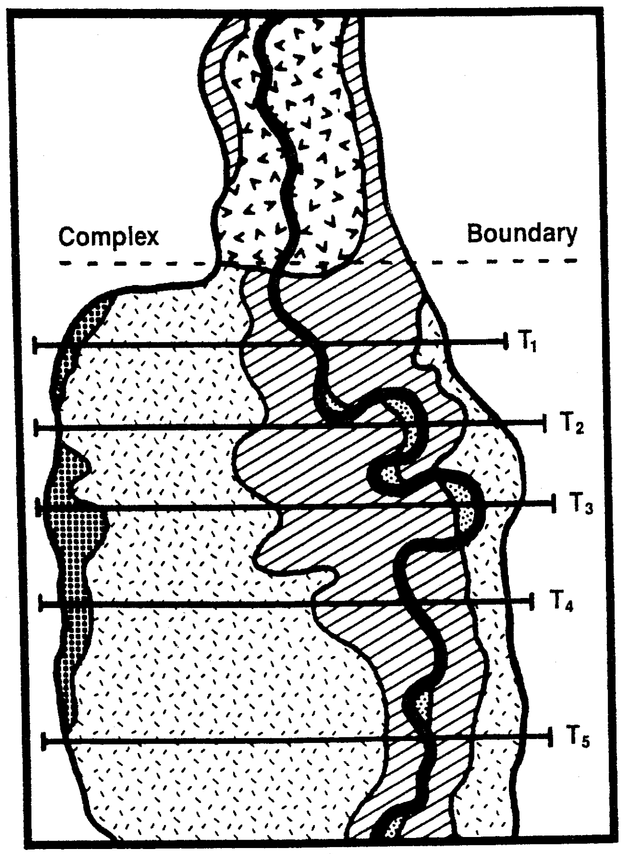
Total number of feet sampled in all transects

	Steps	Feet
$= T_1$	40	100
$= T_2$	40	100
$= T_3$	40	100
$= T_4$	40	100
$= T_5$	40	100
	200	500

Composition of Kentucky bluegrass for the complex = 280/500 = 56 percent similarly, the composition of redtop for the complex = 30/500 = 6 percent (Figure 2).

Composition of all community types encountered in the complex should total 100 percent.

VEGETATION COMPOSITION WITHIN A COMPLEX



	T_1	T_2	T_3	T_4	T_5	% Comp.
Alder/ Dogwood						
Willow/ Beaked Sedge	40	45	35	25	20	(33)
Kentucky Bluegrass	50	45	45	60	80	(56)
Redtop		10	5	15		(6)
Catgrass	10	T	15			(5)

Percent Disturbed = 62

FIGURE 2. Use of the line intercept method to measure amount of change in community type composition after unnatural disturbances.

If the presence of Kentucky bluegrass and/or red top represents disturbance types in a complex, 62 percent of the area indicates disturbance (56 percent Kentucky bluegrass plus 6 percent red top).

The willow/beaked sedge and oatgrass community types which makeup 38 percent of the complex and are known to be natural to the area, indicate the complex is in a early-seral status.

Natural Types	**Ecological Status**	
Willow/beaked sedge	= 33	0 - 15 = very early seral
Oatgrass	= 5	16 - 40 = early seral
	38 percent	41 - 60 = mid seral
		61 - 85 = late seral
		85 + = PNC

(2) ***Green Line Vegetation Composition***: Sampling community type composition along edges of live water can provide additional information over that collected by the cross-section process. Presence of permanent water in the plant rooting zone allows more rapid recovery of vegetation after disturbances. This permits a land manager to make an earlier evaluation of management geared to improve riparian condition. Also, measurement of this portion of the riparian area provides an indication of short-term trend for the riparian area. This is where the forces of water, as influenced by total watershed condition, play their most prominent role. Additionally, there is a strong relationship between amount and kind of vegetation along the water's edge and bank stability. Natural plant species in this permanently watered area have developed rooting systems which enhance bank stability. An evaluation of the vegetation in this area can thus provide a good indication of the general health of the entire watershed.

The green line is defined as that specific area where a more or less continuous cover of perennial vegetation is encountered when moving away from the perennial water source (Figure 3).

At times, the green line may be at the water's edge. Or, it may be part way back on a gravel or sandbar. The green line may be only a foot or two wide, or may be many feet wide, depending on soil and water features. Natural plant species forming the green line (e.g., beaked sedge or water sedge) are generally good buffers of water forces. Disturbance activities, such as overgrazing or trampling by animals or people, result in changes to species such as Kentucky bluegrass or red top, both of which have a reduced ability to buffer water forces.

In most riparian settings, there is a continual effort by nature to form this green line of vegetation, even where the adjacent community types are composed of the more shallow-rooted species. Well developed green line vegetation stabilizes channel banks and buffers water forces. This enhances channel stability, even for inherently unstable stream types. Therefore, an evaluation of the community type composition of the green line can provide a good indication of the general health of the riparian area.

The following procedure is used for the green line transect. The green line transect begins on the right-hand side of the stream (looking downstream) at the point where the cross section composition transect intercepts the green line (Figure 3). In settings where the stream has multiple channels, use the current most dominate channel. Sampling proceeds down the green line using a step transect approach as described in the cross-section composition measurement. Enough steps should be taken to total 363 feet lineal distance. A temporary marker is placed at the end of the transect for location of subsequent shrub measurements. The sampler then crosses the stream and repeats the sampling process for 363 feet upstream.

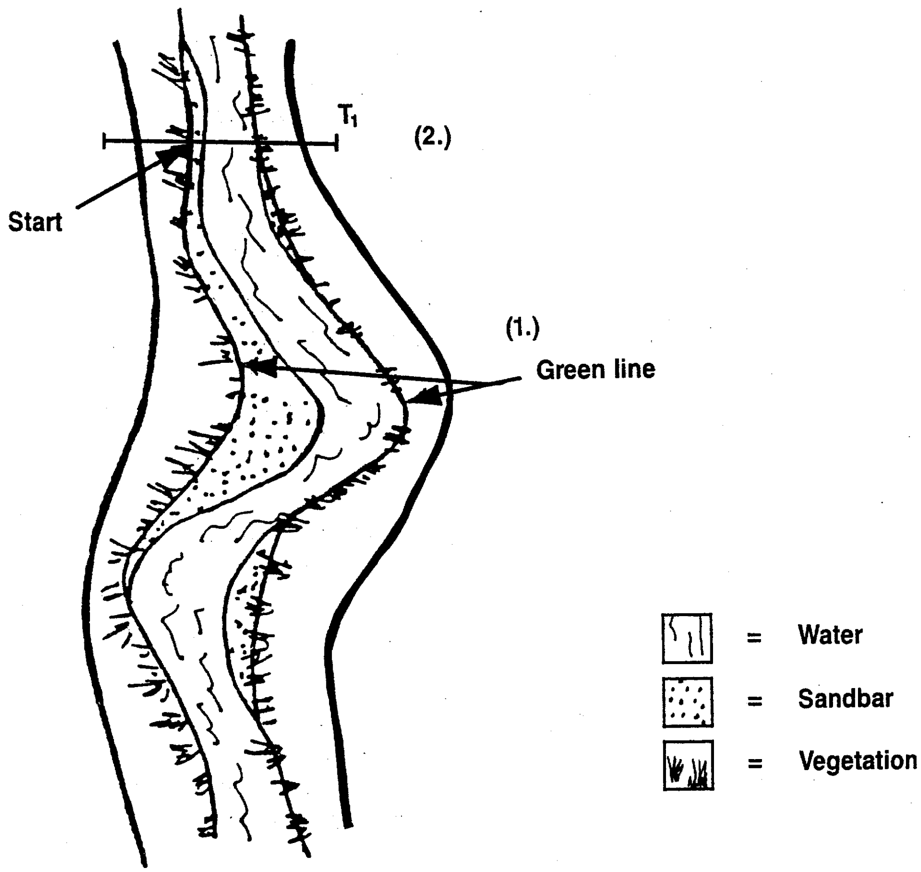
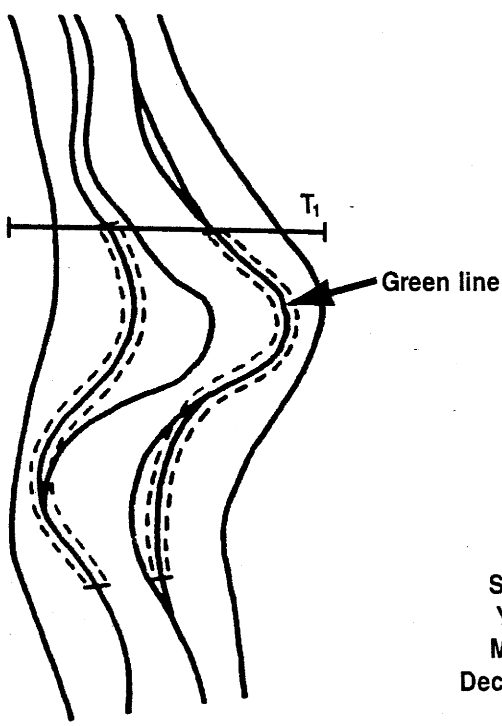


FIGURE 3. Location of (1) the green line in relation to the water's edge and to sandbars and (2) location of the green line transect in relation to the cross-sectional transect.

SHRUB COUNTS
(by Age Class)

363 ft. each side (726' total)
3 ft. each side of green line =6 ft. wide belt } = 1 / 10 Acre



Example

Sprouts	3	
Young	21	
Mature	12	= Healthy Reproduction
Decadent	10	
Dead	2	

FIGURE 4. Example of woody species status using a tally of individual plants, by age class, in a 6-foot wide belt along the green line. A belt transect six feet wide by 726 feet long equals one-tenth acre sampled.

NOTE: The stopping point may not coincide with the initial starting point on the other side of the stream due to difference in lengths of meanders on each side of the stream. It is important to measure both sides of the stream since activities (grazing pressures or water forces) may be different on each side.

On certain streams, especially those with steep gradients, the number of feet of large anchored rocks or large logs should be tallied in place of the vegetation. Rocks and logs must be large enough to withstand the forces of water and must appear stable in the setting being measured. The number of feet of rocks and logs would be counted as a natural stable percentage of the green line.

The total number of feet of each community type encountered along the green line is tallied and composition for each type computed as described in the cross section composition measurement.

e.g., $\dfrac{\text{Total feet of each type (left and right side)}}{\text{726 feet (363 feet minimum each side)}}$ = Community Type Composition

An evaluation of percent of disturbance types in relation to percent of natural types (see cross-section computation) provides an indication of ecological status.

A comparison of settings where the complex is as close to PNC as possible may be used as a standard or reference to evaluate ecological status of the green line communities. Additionally, subsequent measurements of the same area will provide a measurement of trend for that complex.

A photograph can be taken at the starting point of the green line transect, looking downstream. Additional photos may be taken along the transect if desired. These photographs should contain some reference point or marker (boulder, large tree, etc.) so the photograph can be re-established in the future.

(3) ***Woody Species Regeneration***: A measurement of woody species regeneration is made along the same green line transect (Figure 4). The sampler uses a 6-foot pole which has the center marked. Measurements are made by walking 363 feet on each side of the stream with the center of the pole held directly over the edge of the green line adjacent to the waterbody. Use of the green line edge as the center of the measurement helps to assure that the sampling is done in a setting where regeneration is most likely.

A modification of the above procedure may be necessary for narrow water bodies. In these settings do not allow the left tip of the pole to extend beyond the center of the waterbody. When that would occur, align the left tip of the pole on the waterbody (the pole is no longer centered on the green line edge. This modification eliminates double sampling when measuring from both sides, yet insures that a full one-tenth acre area is sampled.

All woody species rooted within the ends of the pole (3 feet either side of green line) are tallied based on the following age class categories.

Number of Stems		Age Class
1. Number stems =	1	- sprout
2. Number stems =	2 to 10	- young
3. Number stems =	>10, >1/2 alive	- early, mature
4. Number stems =	>10, <1/2 alive	- late, mature
5. 0 stems alive =		- dead or decadent

A tally of shrubs by age class provides a preliminary indication of regeneration of shrubs in that complex. A high proportion of plants recorded in the sprout, young, and early mature categories would indicate the shrub component in this complex is in an upward trend. Conversely, low numbers of plants in the sprout and young categories would indicate current management may be suppressing woody species. A comparison of settings where the complex is in as close to PNC as possible may be used as a standard to evaluate overall shrub status. Subsequent measurements on the same area will provide a measurement of woody species regeneration trend.

For smaller statured species such as *Salix wolfii*, change the number of stems from ten to five. And, for single stemmed species such as *Salix exigua*, *Betula* spp., and *Alnus* spp., count each stem that occurs 12 or more inches from each other as a separate plant. Place these into age classes based on overall size and health.

Not all riparian areas are well suited for growing woody species. This appears to be especially true where the complex has a low gradient and a limited amount of natural stream channel movement. In these settings, understory sedges and rushes are able to buffer the forces of water without the addition of woody species. It must be noted that most of the woody riparian species in the Intermountain Region regenerate best on settings where there is minimal competition from herbaceous species.

(4) ***Nested Frequency***: See Range Analysis Handbook.

(5) ***Production***: See Range Analysis Handbook.

e. **Terrestrial Habitat**:

The wildlife habitat data and vegetation data collected during the Level II evaluation should be used during Level III as a basis for developing and observing wildlife relationships to the riparian areas and adjacent upland. Observations about wildlife use patterns and presence of various wildlife species should be noted; wildlife species generally respond to vegetation and in Level III, species/habitat relationships should be established; non-game species such as songbirds should be noted.

Biologists are frequently so enthusiastic about wildlife that when presented with the opportunity to study a riparian area, they immediately begin thinking of ways to census them. Although important, highly desirable, and needed, this is probably the last step that should be taken.

Approved standardized censusing technique for fauna will be used. The wildlife/habitat relationships are developed when good wildlife data is compared with good vegetation data within a homogenous land unit. The importance of censusing in *one* complex can not be over emphasized. The relationship of adjacent upland vegetation should also be taken into account.

2. **Monitoring**

A primary use of Level III riparian evaluation is for monitoring changes in riparian conditions. Data are derived in a manner which permits repeated measurement over time. Remeasurements provide defensible trend data and can be used to assess whether the goals for a particular riparian area are being reached.

a. **Aquatic Community Habitat**: Some suggested monitoring applications and techniques follow.

(1) **Cumulative Effects**: Two techniques are identified as possible means to assess cumulative effects and monitor trends in aquatic community habitat over time. They may be employed separately or in concert.

(a) **Bioassessment Survey**: Aquatic insect and fish community composition and relative species abundance can be effectively used to assess cumulative effects and trends in aquatic community habitat condition and water quality. GAWS Macroinvertebrate Survey procedures and data forms are referenced in R-4 FSH 2609.23.

(b) **COE Survey:** The COE survey approach of Hankin and Reeves (1989) is particularly well suited to assessing cumulative effects and monitor trends in aquatic community habitat over time. Data are collected over the entire complex (or over all the complexes in a watershed), are relational in nature and can be collected with known precision and accuracy. Select attributes that (1) are likely to be limiting production capabilities, (2) are likely to be influenced by management activities; and (3) have a "low" natural variability.

(2) **Site-Specific Effects:** A number of techniques may be used to assess site-specific effects and trends in aquatic community habitat over time. Among the most commonly employed technique is the GAWS Level III transect approach. General methods and data forms are referenced in Region 4 FSH 2609.23. For monitoring purposes, it is recommended that transect study sites encompass at least four stream meander cycles, and include 10 to 20 equi-distantly spaced transects. All transect locations should be "monumented" (i.e., staked and mapped).

Use of site-specific transect data to extrapolate changes in aquatic community habitat condition over larger areas such as riparian complexes or stream reaches should be done with caution. If such use is planned for the findings, it is important to complete a COE habitat survey of the entire area prior to location of the transects, to make sure that the monitoring site is representative of the larger area.

b. **Soils:**

Soils monitoring is conducted using soil data collected during Level II and III riparian evaluation. Soil factors commonly used are: soil puddling, changes in soil bulk density, presence of platy structure, amount of bare surface soil, extent of soil erosion, and area extent of present riparian soil as related to potential riparian area.

Implementation monitoring evaluates if soil conservation practices, reduced use, grazing management system change, or other soil enhancing practices were implemented as planned. It identifies needed changes in the Forest Plan implementation process and subjectively evaluates soil conservation practice application to determine if effectiveness monitoring is needed. The results of implementation monitoring will be documented and filed with project plans.

Effectiveness monitoring quantitatively measures how effectively soil conservation practices have limited detrimental changes in soil properties. A soil scientist who understands the relationships of soil conservation practices to various soil properties should be involved in effectiveness monitoring. Effectiveness monitoring can be designed to measure the beneficial effects of site restoration, site rest, grazing systems, reduced erosion as well as detrimental changes.

It is not possible to monitor effectiveness on all the different riparian complexes within a project area. Therefore, monitoring should be focused on the most critical soil qualities or most limiting riparian complexes within that project area. Results may then be extrapolated to other similar riparian complexes. Reliable high-quality data from a few projects is better than poor quality data from a larger number.

c. **Hydrology and Stream Dynamics:**

Some watershed level aspects of the riparian evaluation may not be directly monitored as part of riparian monitoring. For instance, changes in flow frequency would have to be intensively monitored over long time periods. Longitudinal channel morphology (meander amplitude and wavelength) does not lend itself to monitoring and changes may occur over long time periods.

The hydrologist should be involved in the ID Team evaluation of the implementation of management activities to see that stream and water quality protection measures are correctly applied.

(1) **Specific Water Quality Attributes:** Use EPA standard methods to monitor chemical, biochemical, and bacteriological parameters. Monitoring may be designed to define Forest-specific relationships between stream types and:

-sediment yields

-sediment transport characteristics - bedload vs. suspended sediment

-bank stability

-composition of hydric riparian species on the greenline

These monitoring designs may be data intensive and only a limited number of sites should be involved. These are considered as validation monitoring.

d. **Vegetation:** Repeated application of the techniques employed to determine vegetation characteristics for a complex (e.g., cross section composition, green line composition, and woody species regeneration surveys) provide the basis for assessing trends in vegetation condition over time.

e. **Terrestrial Habitat:** Repeated application of the techniques employed to determine vegetation characteristics for a complex provide the basis for assessing trends and management effects in terrestrial habitat condition over time.

Continuing Studies of the Effects Of Increased Flows on Riparian Communities At Eccles Canyon Creek & Mud Creek

- A Study Plan -

(2)

by
Patrick D. Collins, Ph.D.
July 4, 2002

INTRODUCTION

Excess stream flows have been generated from coal mining activities at the Skyline Mine located in central Utah. Continuing studies will be conducted in the plant communities of Eccles Canyon Creek and Mud Creek as an attempt to monitor changes in the riparian communities as a result of these flows.

The studies began in 2001. More studies will be conducted for two additional years beginning in 2002 and being completed in 2003. Results of the studies will evaluated following that time period to determine whether or not additional studies will be needed.

STUDY OBJECTIVES

The purpose of the study will be to conduct research in an attempt to determine the impacts to the riparian plant communities from the increased flows that have occurred in Eccles Canyon Creek and Mud Creek. Primary study objectives for these communities will be to: 1) describe the current status, 2) quantify riparian complexes, 3) assess current condition of the plant communities, 4) assess impacts of increased flows on these communities, 5) provide defensible data with regard to community changes, and 5) provide a database and structure for more intensive studies if needed in the future.

METHODS

With some changes, the basic design and methods for the studies will follow the Level III format as described by the U.S. Forest Service (USDA Forest Service. March 1992. Integrated riparian evaluation guide. Intermountain Region. Ogden, UT). *Pertinent sections of this document have been included in the Appendix of this study plan.*

Quantitative and qualitative data will be recorded in the field. Fieldwork will be conducted in July and August. Final sample design will be determined in the field, but generally, sample locations will be placed in a regular-random fashion every 300 - 600 ft in the Eccles Canyon Creek and 600 - 1200 ft. in Mud Creek. At these locations permanent line transects were placed across (or perpendicular to) the stream channel. By design, the line transects will vary in length based on several factors. Although sometimes limited by topographical features such as bedrock outcrops, it will be our intent to make the transects long enough to cover the entire stream and its riparian communities, plus an additional 10-15 ft on each side of the stream to record the current adjacent upland communities. Monitoring the total extent of the riparian plant communities including some upland community information should provide information about possible increases or decreases of the riparian communities relative to the adjacent upland communities. When a transect is placed, the line-intercept method will be employed to measure the extent of each plant community. The plant communities will be named by the dominant two plant species or if only one species dominated the community by a wide margin, the plant community will named by this single species.

Qualitative data will also recorded at each sample location including the dominant upland communities on each side of the stream and general notes about each sample location. Color photographs were taken at each sample location. The sample locations and extent of the line transects will be permanently marked using wooden stakes, flagging and/or blue pin flags.

C/007/005

WORK PLAN TO EVALUATE MINE-WATER DISCHARGE IMPACTS IN ECCLES CREEK AND MUD CREEK

CANYON FUEL COMPANY
Skyline Mine
Scofield, Utah

July 2002

Prepared by

EARTHFAX ENGINEERING, INC.
Engineers/Scientists
Midvale, Utah

EarthFax

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WORK PLAN TO EVALUATE MINE-WATER DISCHARGE IMPACTS IN ECCLES CREEK AND MUD CREEK

1.0 INTRODUCTION

In early August 2001, a fractured channel sandstone was encountered in the Skyline Mine, resulting in a significant inflow of groundwater to the mine. In an effort to minimize environmental impacts and meet effluent limitations, much of the water encountered was initially pumped to inactive sections of the mine for temporary storage.

It was assumed that the water encountered would have a high inflow for a short duration and then decrease with time, as frequently occurs in the area. However, rather than decreasing significantly with time, the inflow has remained fairly constant. Once available underground areas for water storage were filled, the mine began pumping both the inflow water and the stored water to the surface to prevent mine flooding and allow continued operation. Since early September 2001, discharges from the mine to Eccles Creek have ranged between about 10,000 and 15,000 gpm, compared with an average discharge for the prior 18 months of about 4,000 gpm.

On October 11, 2001, EarthFax Engineering, Inc. conducted a reconnaissance geomorphic evaluation of Eccles Creek to assess potential impacts of the discharge on the stability of the stream channel. The results of this evaluation were combined with an assessment of potential water-quality impacts in a letter report to Canyon Fuel Company dated October 24, 2001. Additional information regarding potential impacts to phosphorus concentrations was provided on December 3, 2001 and December 13, 2001.

On November 26, 2001, EarthFax conducted a more extensive field evaluation of the impacts of mine-water discharges on Eccles and Mud Creeks. Samples of the bed and bank materials were collected to allow an assessment of the structural and erosional stability of the stream channels. In addition, subsequent analyses were conducted to determine the potential effects of mine-water discharges on peak annual flows in the streams and the potential impacts to man-made structures in the streams. An evaluation of alternative discharge points was also conducted. The results of these investigations were presented in a letter report to Canyon Fuel Company on February 27, 2002.

Following a review of the submitted information, Canyon Fuel Company and EarthFax met with representatives of the Utah Division of Oil, Gas and Mining to discuss the results. In these meetings, the Division requested additional information to better quantify and monitor potential impacts to Eccles and Mud Creeks. The objective of gathering this additional information is to:

1. Quantify whether or not increased flows may be causing erosion and/or sediment deposition in quantities that are adverse to the hydrologic regime of Eccles Creek and Mud Creek.

2. Quantify the degree to which the increased flows may be contributing to sediment and phosphorus loads in Scofield Reservoir.

3. Provide a means for monitoring potential long-term impacts to the morphology of Eccles and Mud Creeks.

4. Quantify whether or not changes are occurring in the elevation of the water table in the alluvial deposits adjacent to Eccles and Mud Creeks due to the increased flows.

5. Collect data to determine whether or not an Alluvial Valley Floor exists adjacent to Mud Creek.

6. Quantify whether or not changes are occurring to the vegetation adjacent to the stream corridor due to the increased flows. Also, quantify whether or not vegetative changes occur as a result of the potential future decrease in present discharge rates from the mine.

The purpose of this document is to present a work plan for the collection of data to address items 1 through 5 above. A separate work plan will address item 6.

2.0 WORK PLAN

2.1 Establish and Characterize Reference Sites

Reference sites will be established on Eccles and Mud Creeks at the approximate locations shown on Figure 1. Sites EC-1, 2, and 3 as well as MC-1, 2, and 3 correspond to cross sections used in previous investigations (EarthFax Engineering, 2002). Sites MC-4 and MC-5 will be established to evaluate conditions on Mud Creek within a section of agricultural pasture and upstream from the Eccles Creek confluence, respectively.

All reference sites will be established in general conformance to the recommendations of Harrelson et al. (1994). This will involve the following:

- Establishing benchmarks at each site. Benchmarks will consist of cement or boulder monuments, with a metal marker stamped with the site number. Photographs will be taken and descriptions provided to allow others to return to the sites in the future.

- Establishing monumented cross sections. The endpoints of cross sections will be marked with roof bolts or steel reinforcing bar that has been driven into the ground. If roof bolts are used, the bars will be painted to increase visibility. If steel reinforcing bars are used, plastic survey end caps will be placed on the bar ends. The locations of the cross section endpoints with respect to the benchmarks will be measured, using a tape and Brunton compass, with the measurements noted in the field log book. The location of another permanent feature (e.g., embedded boulder, long-lived tree, etc.) will also be measured and noted, to provide triangulation.

- Surveying the channel cross section at each site. A measuring tape will be attached to one of the cross section monuments and stretched tight and level across the stream to the other monument. The level of the tape will be checked with an attached bubble level. Surveying will be performed using a survey level and rod. Elevations will be shot at each important feature or change in elevation (e.g., slope breaks, channel banks, bankfull stage, etc.). The survey will be closed by re-shooting the station benchmark.

- Surveying the longitudinal profile at each site. The profile will extend a distance of at least 20 times the channel width (half upstream and half downstream from the cross section location). At a minimum, data to be collected from the profile will include the channel bottom, the water surface, indications of bankfull stage, and the top of the stream bank. Measurements will be collected on intervals approximately equal to the channel width. Data will be collected using a survey level and rod, with the location of the starting and endpoints being measured as noted above.

- Establishing photo points. As recommended by Harrelson et al. (1994), convenient locations will be selected to take photographs upstream, downstream, and across the channel at each cross section location. These locations will be noted in the field book, with respect to the benchmark.

- Collecting streamflow data. The flow will be measured at each site, using standard procedures, with a rotating-cup flow meter.

Samples of the bed and bank materials will be collected at the newly established stations (MC-4 and MC-5) to evaluate geomorphic and stability relationships at those locations. Similar samples were collected in February 2002 at the remaining sites (EarthFax Engineering, 2002) and are still considered valid.

2.2 Determine Depth to Groundwater

The depth to groundwater will be determine at each of the reference sites on Mud Creek. This will be accomplished by installing two temporary piezometers in the alluvium on each side of the stream. The piezometers will be installed using portable flighted augers and a hammer drill. Perforated PVC pipe will be installed in the hole and the water table allowed to stabilize for a period of at least 4 hours prior to measuring the depth to water. The relative elevation of the piezometer will be established by standard surveying techniques from the previously-established benchmark at each site. Within the constraints offered by each site, the locations of each piezometer will be sited in an attempt to determine the slope of the water table perpendicular to the stream channel at each reference site.

2.3 Gather Available USGS Flow Data

Flow data on file with the U.S. Geological Survey will be gathered for Eccles Creek near Scofield, Utah (station 09310600) and for Mud Creek below Winter Quarters Canyon at Scofield, Utah (station 09310700). If these data are available electronically, they will be provided to the Division in electronic form. Otherwise, paper copies will be provided.

2.4 Gather and Evaluate Historic Aerial Photographs

Historic aerial photographs will be gathered of Pleasant Valley between the town of Scofield and the confluence of Mud Creek and Eccles Creeks. Both private sources (on file with aerial photography companies) and government sources (USDA, USGS, EROS) will be searched. These photographs will be evaluated to assess historic land use in this reach of Pleasant Valley. Use this information, together with the additional data collected as part of this study, to evaluate whether or not Pleasant Valley can be classified as an Alluvial Valley Floor.

2.5 Collect Additional Water-Quality Data

Water-quality samples will be collected at monitoring points MC-2 through MC-5. In addition to the collection of flow data as indicated in Section 2.1, these samples will be analyzed for total dissolved solids (TDS), total suspended solids (TSS), and total phosphorus.

2.6 Evaluate Bank Stability Indexes

As field information is gathered, sufficient data will be gathered to determine the bank erodibility hazard (Rosgen, 1996; 2001) for each reference site. These data will include measurements of the following values:

- Bank height
- Bankfull depth
- Rooting depth
- Root density
- Bank slope
- Degree of surface protection of the bank

The in-stream velocity gradient (between the core of maximum velocity and the stream bank) and the ratio of average hydraulic stress and near-bank hydraulic stress will also be calculated. Each of these indexes will be compared with typical values provided by Rosgen (1996; 2001) to provide another assessment of bank stability in addition to that provided previously (EarthFax Engineering, 2002).

2.7 Long-Term Monitoring

Flow and water-quality data (TDS, TSS, total phosphorus) will be collected at monitoring points MC-2 through MC-5 four times per year (i.e., seasonally), when accessible, for a period of one year following a sustained reduction in mine-water discharge to a rate of 5,000 gpm or less (i.e., pre-September 2001 levels). Channel cross sections and longitudinal profiles will be collected from each reference site annually during the same period. Flow and water-quality data will also be collected any time there is an increase in discharge rates from the mine of at least 25% above the average rate for the prior month.

2.8 Review Past Studies

The records of State and Federal agencies (e.g., Utah Department of Natural Resources, Utah Department of Environmental Quality, U.S. Geological Survey, etc.) will be searched to obtain copies of past studies performed on Eccles and Mud Creeks. These reports will be reviewed for additional baseline information regarding the streams.

2.9 Prepare Project Report

Once the initial data are collected and evaluated, a report will be prepared and submitted to the Utah Division of Oil, Gas and Mining for review. This report will include drawings of the cross sections and longitudinal profiles, copies of photographs collected during the field investigation, copies of data collected, results of data evaluations, and copies of field notes.

3.0 REFERENCES

EarthFax Engineering, Inc. 2002. Hydrologic and Channel-Stability Evaluation of Eccles and Mud Creeks. Letter report submitted to Canyon Fuel Company. Midvale, Utah.

Harrelson, C.C., C.L. Rawlins, and J.P. Potyondy. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique. General Technical Report RM-245. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, Colorado.

Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology. Pagosa Springs, Colorado.

Rosgen, D.L. 2001. A Practical Method of Computing Streambank Erosion Rate. Proceedings of the Seventh Federal Interagency Sedimentation Conference. U.S. Geological Survey. Reno, Nevada.

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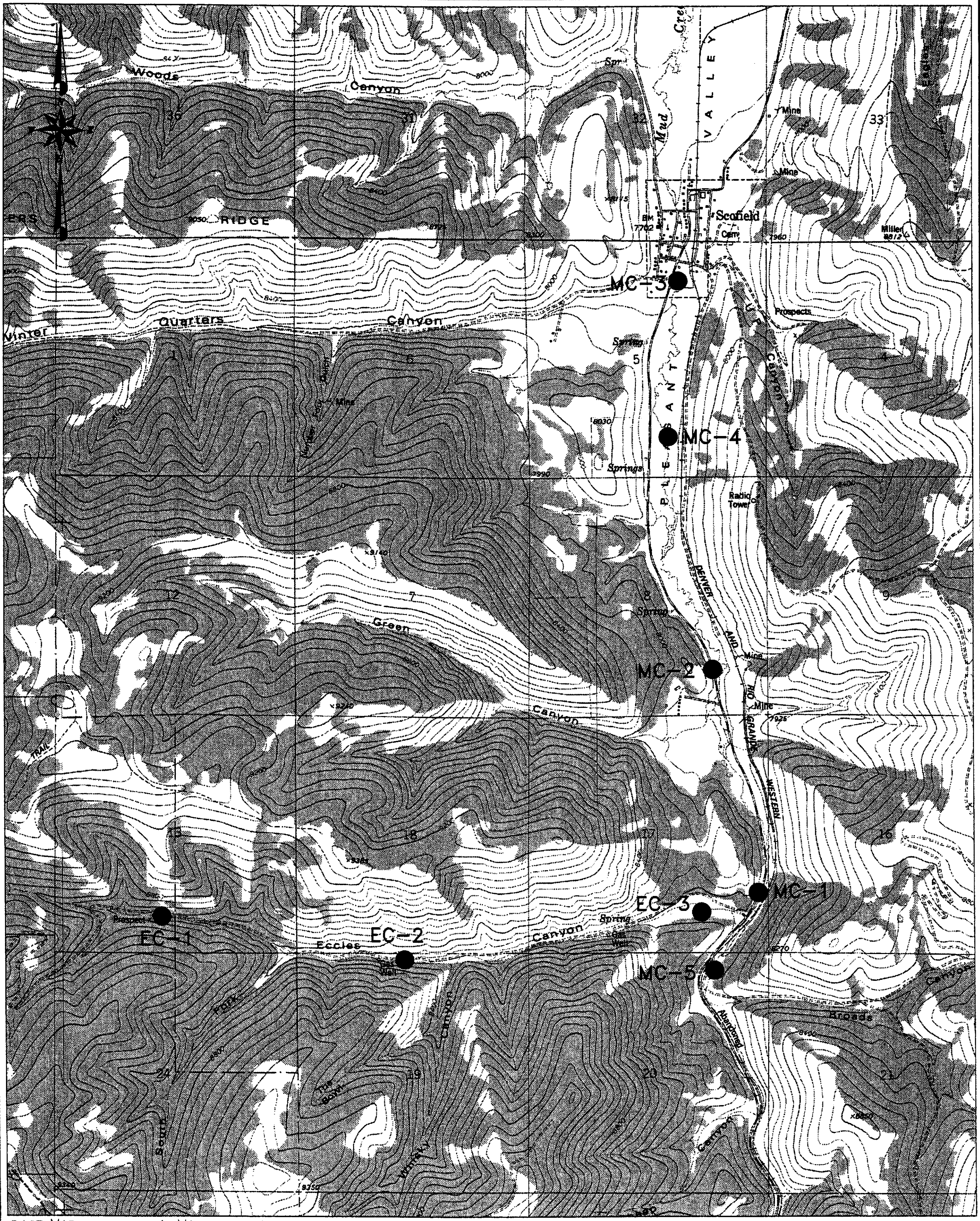

BASE MAP: USGS 7-1/2 MIN. QUADRANGLE
SCOFIELD, UTAH (1979)

0' 3000'

FIGURE 1. LOCATION OF REFERENCE SITES

EarthFax