THE TECHNICAL BASIS FOR DELINEATION OF HUMAN GEOGRAPHIC UNITS

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INTRODUCTION

The Human Geographic Unit mapping system being developed by the SRM Corporation grew out of the necessity to clarify and understand the new human dynamics brought forth by a post-industrial, information-age society.

Maps in the western world historically have been based on, and display physical, biological and administrative (states, counties, etc.) boundary systems. Some attempts have been made at economic boundary displays such as trade centers, but few attempts of major significance to develop a boundary system using well selected and business tested human social and cultural descriptions have been made. SRM Corporation is the first to undertake mapping of the United States into Human Geographic Units on a large scale.

Human Geographic Units are defined and used as a framework for comprehensive planning, decision making, marketing and a variety of other community and human resource related functions. They clarify the social, cultural and economic realities of a specific area and the physical resources that sustain it. Boundaries of these human or cultural areas pay no attention to artificial jurisdictional boundaries such as county and state lines or congressional districts - just as natural physical and resource boundaries ignore them (1)[1]

The term Human Geographic Unit was not selected by chance. It expresses three distinct elements in the framework within which humanity exists, interacts, makes judgments and takes action - either favorably or unfavorably - on long term commitments or day to day happenings.

The word HUMAN was selected because Human Geographic Units are organized around people and their cultural system. The word GEOGRAPHIC was selected to link the cultural system of a people to the territorial or geographic area over which their system dominates. That is, the territory a given group of people recognize as "ours", and other territories as belonging to someone else - or at least "not ours".

[1] Refers to a publication listed in the Reference Section of the Appendix.

The third word in the term might have been "area" rather than UNIT as the word "area" conveys a sense of territorial extent. However, the word UNIT was used to identify the third significant element around which the framework of the Human Geographic Unit is organized. This third element is the concept- and reality- of the oneness or uniqueness of a cultural system. A Unit being a body or group considered as a single whole among a plurality of similars (19).

People in social groups all over the globe exhibit similar needs, wants and desires. This is what is meant by “plurality of similars". The Human Geographic Unit identifies where there is a group of people who can be generally classed as a "single whole". It delineates the geographic area over which they consider themselves a part. Each Unit is viewed holistically as an individual entity interacting with its internal and external environments (3).

A progression of Human Geogra phic Units occurs within society. Any look at the earth from space dramatically illustrates the realization that our earth is but one large Human Geographic Unit and, from the Apollo B mission came its name- "Spaceship Earth". From this global perspective, ever smaller Units of the progression can be defined until the smallest, from a human perspective, is identified- one's own being.

II. THE PROGRESSION OF HUMAN GEOGRAPHIC UNITS

Development of human societies is influenced in one way or another bythe natural conditions under which they live. This connection between people and the physical environment is the basis of human geography, the science which deals with the adaptation, in the widest sense, of human groups to their natural environment (4).

SRM Corporation, along with previous research by the Foundation for Urban and Neighborhood Development (FUND), has developed a structure and nomenclature for defining Human Geographic Units at significant levels of the progression (5). As stated by FUND in their 1981 publication *"Social Resource Management: An Overview":*

> "Grounded in environmental law and sociology's human ecology tradition, FUND maintains that human and physical resources are ecologically unified When this basic principle is combinedwith the ... principles of personal efficacy and citizen participation, a new form of human resource mapping emerges based upon natural geographic patterns of cultural values, social affiliations, and human interactions." (5).

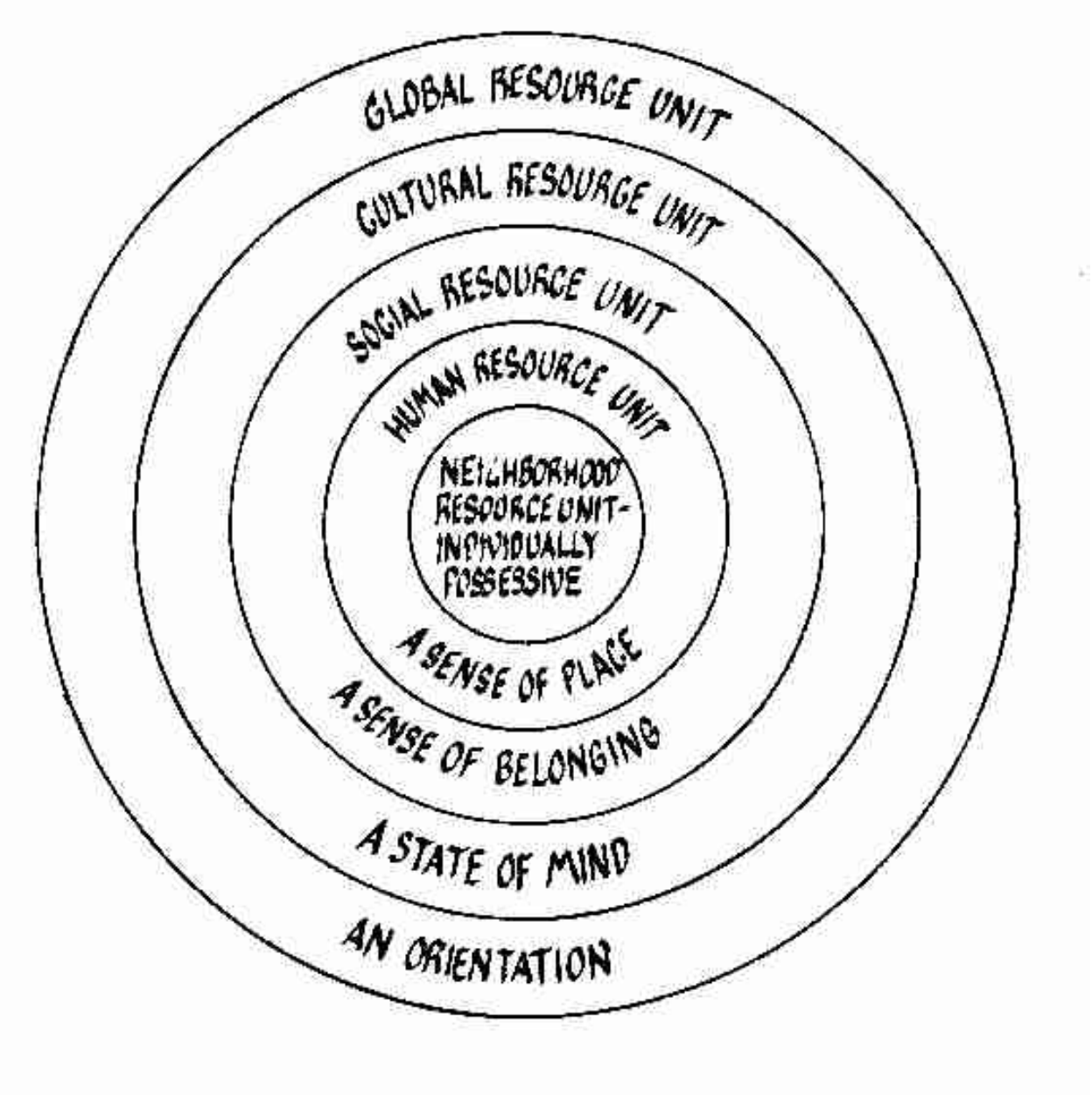
Based upon these principles, the boundaries of Human Geographic Units so delineated are sometimes contiguous with official boundaries, but most often are not. The territorial area recognized by human communities is usually quite different than the more arbitrarily scribed administrative districts. This is particularity true in the Western United States.

Human Geographic Units are defined by regularized patterns of daily human activity rather than by administrative or political lines on a map. These are the patterns or routines we all recognize: those of working, shopping, neighboring, recreating, and so on, all of which take place in particular geographic spaces readily understood and agreed upon locally, usually bordered by natural topography, climate or physical structures.

When this form of social mapping is done, new geographical units of patterned cultural and social behavior arise which define specific levels in the progression of Human Geographic Units, and for which there are no generally agreed-upon terms.

The progression of Human Geographic Units, the progression within which people live out their daily human activities, is illustrated in Figure 1.

Figure 1
The Human Geographic Concept



At the center is the individual person, the smallest Human Geographic Unit. Beginning at the center, the individual's cultural and territorial relationship progresses outward through his or her patterned relationships with family, friends, communication networks and neighborhoods, and outward to become a part of ever larger human geographic cultural patterns.

It is from this framework, based upon field experience, that FUND established a structure and nomenclature for defining Human Geographic Units at significant levels of the progression. These Units, moving outward from the individual as illustrated in Figure 1 are:

Neighborhood Resource Units (NRU)
Human Resource Units (HRU);
Social Resource Units (SRU);
Cultural Resource Units (CRU); and
Global Resource Units (GRU).

This structure forms the central basis of the pro-active management system of SRM Corporation which recognizes that people's identity with their various Human Geographic Units is real, that each Unit represents a powerful and separate cultural force, and that each cultural system insists on being involved in predicting, participating in and controlling the environment within which they live.

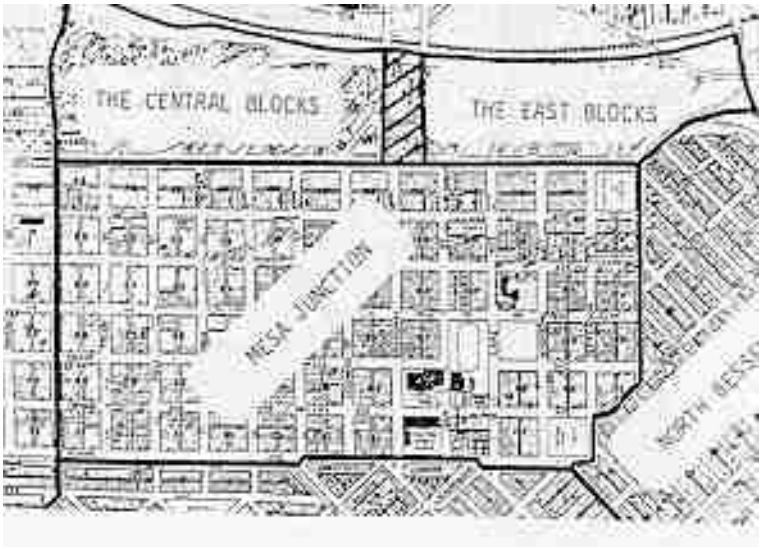
Neighborhood Resource Unit (NRU)

A Neighborhood Resource Unit is characterized by an individually possessive perspective. The individual identifies with "my house", "my street", "my neighbor", backyards and the local park. There is a high degree of familiarity with one's Neighborhood Unit and who lives where. An individual who is part of this culture may not know the name of every resident of the Unit, but does know generally the types of people who live there and their differences.

A Neighborhood Resource Unit is quite small. In urbanized areas it usually covers a few city blocks such as the Mesa Junction Neighborhood Resource Unit in Pueblo, Colorado (6). Because of its closeness, the individuals intensity of perception as to where his neighborhood boundary lies is clearly defined in his mind and strongly held.

In rural areas, small towns and villages may represent a Neighborhood Resource Unit. Outside of these small towns and villages NRUs may cover even larger geographic areas, encompassing neighboring farms or ranches where most frequent communication and interaction occurs.

Some Neighborhood Resource Units
in
Pueblo, Colorado



Most residents travel outside their Neighborhood Resource Unit to their place of work, to do their shopping, and for most of their other day to day activities.

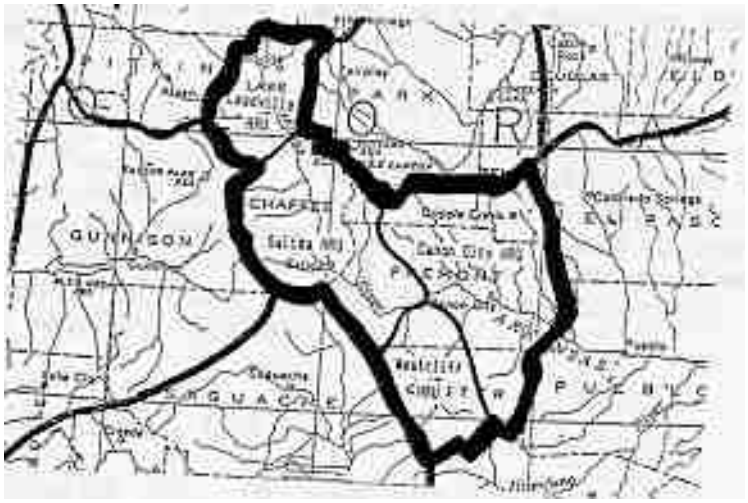
Neighborhood Resource Unit physical characteristics include race, income, housing type, age, subdivision development etc., but they are not defined on this basis. Neighborhood Resource Units are defined through a social process on a very personal basis by those living within them. Neighborhood Resource Units aggregate to form Human Resource Units in the SRM Corporation mapping system. Human Resource Unit (HRU)

Human Resource Units (HRU)

Human Resource Units are larger and encompass a number of Neighborhood Resource Units within them. Rather than a perception of personal ownership, as is the case in Neighborhood Units, people at the Human Resource Unit level have more of a perception of ownership as a group, i.e., “our open space".

This territorial level is characterized by a sense of place; a sense of identity with the land and the people- a sense of a common understanding of how the resources of their Unit should be managed; and a common understanding of how things are normally done.

Human Resource Units
in the
Upper Arkansas SRU



Human Resource Units are characterized by frequent and customary interaction. People's daily activities occur primarily within their HRU including work, school, shopping, social activities and recreation. Health, education, welfare and other public service activities are highly organized at this level with a townor community almost always as its focal point.

The regularity of interaction within an HRU reinforces a recognition and identification by the residents of natural and man-made features as "home". Because of this familiarity, boundaries between Human Resource Units, as with Neighborhood Resource Units, are clearly defined in the minds of those living within them. Human Resource Units aggregate to form Social Resource Units in the SRM Corporation mapping system.

Social Resource Unit (SRU)

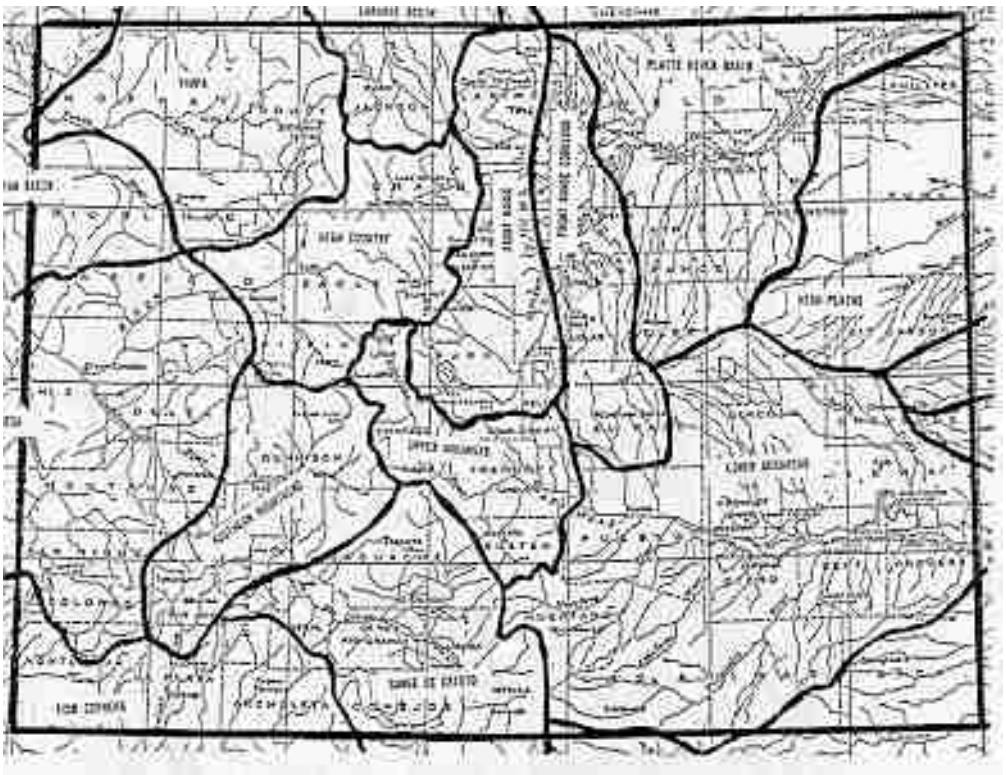
A Social Resource Unit is best characterized by a sense of belonging. These are rather large areas and one's intensity of perception as to the Unit's boundary is much more general than at the Human Resource Unit level. A general feeling of "oneness" is held by those who are a part of this regional Unit; and a general understanding and agreement on values and the attributes of being a part of the Unit.

The physical and biological environment has a large role in development of the cultural pattern at this level of the progression because, to a large degree, they determine the kinds of basic industries available for people to develop their culture around, and how the industries function in the most effective manner to preserve and strengthen the cultural pattern of the Unit.

Population density is also a factor which defines and delineates Social Resource Units. Large areas of high population density separate Social Resource Units from surrounding areas of lesser population, but they still reflect in their cultural pattern the broad physical and biological environment within which they occur.

Social Resource Units are usually larger than single cities (the Front Range Corridor SRU, for example, is larger than the metropolitan area of Denver), but are smaller than most states. However, a Social Resource Unit will sometimes include portions of several states as is the case with the Four-Corners SRU which includes portions of Colorado, New Mexico, Arizona and Utah. The megalopolis of New York City, which includes portions of New Jersey and Massachusetts is another example of how Social Resource Units are not confined by administrative or legal boundaries. Social Resource Units aggregate to Cultural Resource Units in the SRM Corporation mapping system.

Social Resource Units
of
Colorado



Cultural Resource Unit (CRU)

Beyond the Social Resource Unit is the still larger Cultural Resource Unit. This expansive Unit is most accurately described as a state of mind. Cultural Resource Units exhibit common cultural patterns of interest, values and ' lifestyles organized and molded around broad expanses of the physical and biological environment.

Others have also recognized this phenomena, and different types of "Cultural Units" have been described. Garreau, in his book, *"The Nine Nations of North America"* defines what he considers a Human Geographic Unit at this higher level of the progression quite well:

> "Consider...the way North America really works. It is Nine Nations. Each has its capital and its distinctive web of power and influence. A few are allies, but many are adversaries. Several have readily acknowledged national poets, and many have characteristic dialects and mannerisms. Some are close to being raw frontiers; others have four centuries of history. Each has a peculiar economy; each commands a certain emotional allegiance from its citizens. These nations look different, feel different, and sound different from each other, and few of their boundaries match the political lines drawn on current maps." (8).

Cultural Resource Units aggregate to Global Resource Units in the SRM Corporation mapping system.

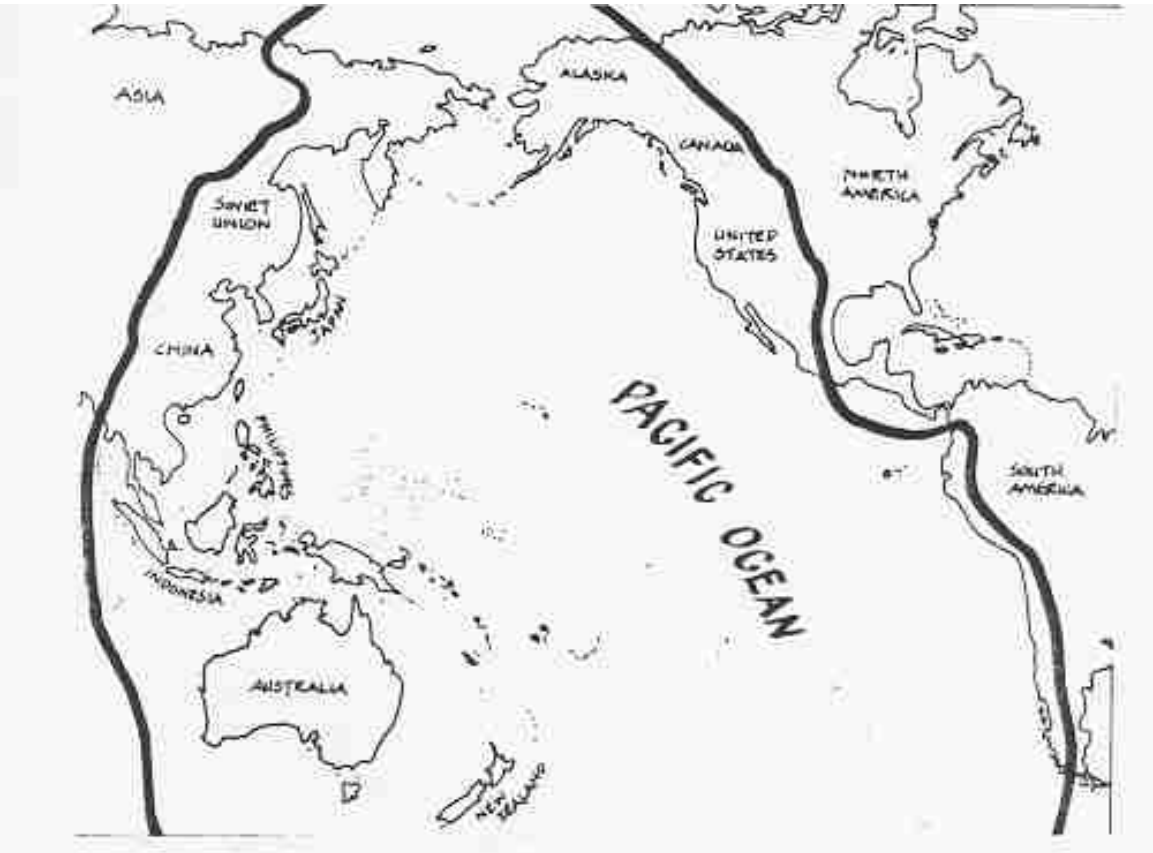
Cultural Resource Units
of the
Western United States

Global Resource Unit (GRU)

The Global Resource Unit was a recent discovery of SRM Corporation's Human Geographic Unit mapping efforts. Global Resource Units distinctly separate the globe into functioning value Units based on settlement, history, geography and cultural reference values. An example from Dr. James A. Kent's article; *"The Pacific Rim"* (18) illustrates the power of Global Resource Unit recognition:

> "We had just finished a five-year process of mapping the Western United States up through the Cultural Resource Unit level. When we looked at our maps, we realized that an almost straight line camesouth from the Canadian border at about the 100th meridian. It left approximately one-third of North and South Dakota, Nebraska and Kansas on the eastern side of the line. Further analysis of the Social, cultural and political realities surrounding thisline revealed that people on the eastern side related to Minneapolis-St. Paul, Omaha, Kansas City and Chicago etc., while those on the western side related to the west.
>
> "The eastern side of the line was settled by wetland farmers who stopped at the "uninhabitable" Great Plains. Settlers crossed the plains to settle the west. Fifty to 75 years later when the major settlement of the Great Plains occurred, it came from the west, not the east. The 100th meridian became the first boundary to distinguish the Pacific Rim world from the Western Alliance world. We had defined our first Global Resource Unit."

The Pacific Rim Global Resource Unit



Global Resource Units are key to understanding the world dynamics from a fresh perspective. SRM Corporation has identified five preliminary Global Units. The map of the Pacific Rim shows the significance of this Unit. It is clear that the Western United States is participating in an "economic and social" revolution in the Pacific Rim. The Western Alliance policies of "confrontation and containment", based on a Washington-London-Moscow post -World War II strategy does not "work" in the Pacific. Understanding of the reality of the Global Resource Unit allows international policy making, marketing, etc., to be developed within the cultural system of the Unit and reduces the chance of unwittingly dragging alien and destructive concepts from one Unit to the next. Global Resource Units aggregate to "Spaceship Earth" in the SRM Corporation mapping system.

III. RESEARCH OBJECTIVES AND METHODOLOGY

A. Objectives:

The present system employed by FUND and SRM Corporation for describing Human Geographic Units and determining their boundary includes the use of seven cultural descriptors:

Publics
Networks
Settlement Patterns
Work Routines
Supporting Services
Recreational Activities
Geographic Boundaries

In addition, the description of an area and its boundaries is validated and refined through extensive interaction with local residents and others familiar with the area. This system is qualitative in nature, is time consuming, and is expensive because of its heavy reliance on field observation and interviewing (7).

A Small Business Innovative Research Grant was provided SRM Corporation by the U.S. Department of Agriculture to develop a new method for efficient mapping of human geographic boundaries in rural areas (9). The study objectives were to:

- Develop a model, composed of statistical or other quantitative measures, that is capable of validation and that will replicate human geographic boundaries previously determined through qualitative methods.

and;

- Determine within which boundary level (of the progression) the model is reliable.

B. Research Methodology

Research methodology was divided into six main tasks as follows:

1. Select Test Site.
2. Update and Refine Boundaries.
3. Determine Statistical Correlates.
4. Perform Comparative Analyses.
5. Account For the Variations.
6. Set up Program to Extend Study to Other Areas.

Tasks 1 through 5 are discussed in this report. Task 6 is presented in SRM Corporation's Phase II SBIR Grant Proposal.

Task 1: Select Test Site:

Selection of the Social Resource Unit to serve as the "Test Site" was based on criteria set forth in the Grant Solicitation:

a. An area already know from previous FUND work;

b. Quality of information relative to the seven Cultural Descriptors is available for the area;

c. A diversity of population and a range of rural related densities;

d. Minimal expense with any data update required relative tothe seven Cultural Descriptors; and

e. Potential for future development project impacts so as to enhance practical usefulness.

Fifteen Social Resource Units, located in the states of Wyoming, Utah, Colorado, Idaho, Washington, California, Nevada and Texas, were considered for selection. The Upper Arkansas Social Resource Unit (Figure 2)in southeastern Colorado was selected. Of the Fifteen SRUs considered, it suited the criteria best:

Knowledge of the area from previous FUND work was good to excellent.

The quality of information was good, although it was better for the mountainous areas than the area of the SRU on the Great Plains.

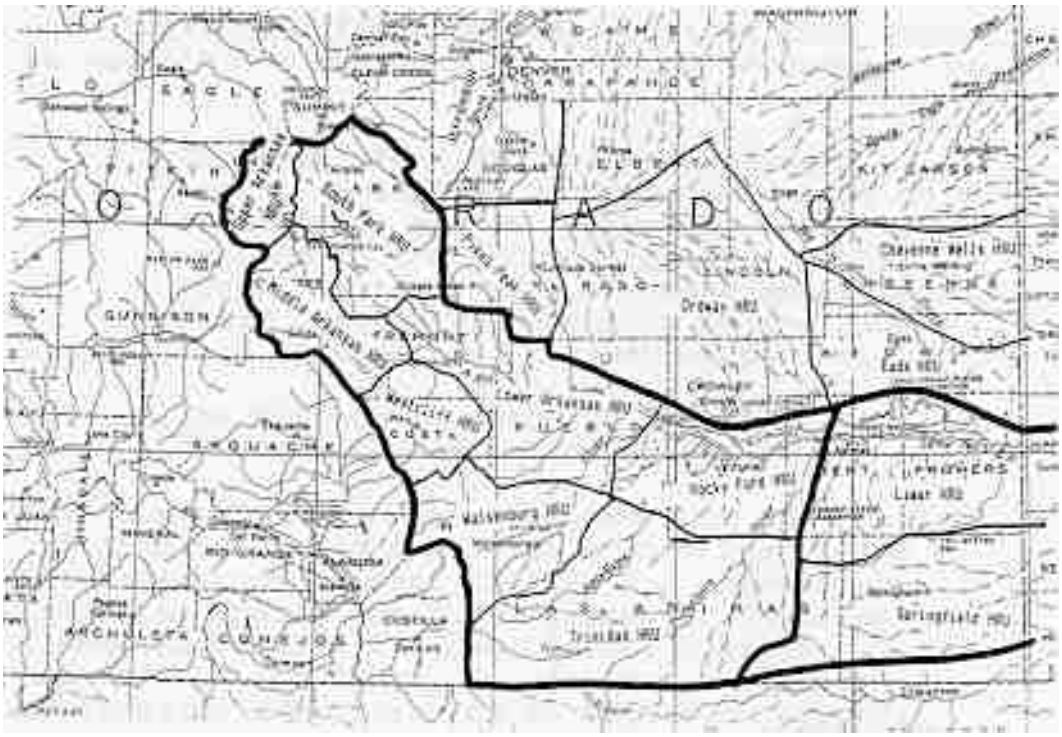
The diversity of population was good to excellent. Population centers ranged from metropolitan areas such as Pueblo, to rural towns.

The SRU was near Denver, and staff was present in the area.

Future development potential was considered good to excellent.

In addition, mapping had been done at the Social Resource Unit and the Human Resource unit level. Neighborhood Resource Units had not been mapped, but this was the case for all SRUs considered. At best, only partial mapping at the
Neighborhood Resource Unit level had been accomplished in any SRU.

The Upper Arkansas SRU Test Site



Task 2: Update and Refine Boundaries:

The qualitative system established by FUND (2), was used to determine the corrections of the boundaries of the Upper Arkansas SRU and its Human Resource Units for this research effort. The qualitative system as established by FUND is reproduced as Appendix C. The Task was designed to:

- Update the Cultural Descriptors of the Upper Arkansas SRU and the Human Resource Units within it;
- Determine quantitative characteristics which distinguishes one Unit from surrounding Units;
- Update and refine boundaries between Units;
- Specify the reasons for deciding that the HRUs and SRUs represent different cultures; and

- Specify the reasons for deciding where the boundary between the Units should be placed.

This Task identified two modifications that should be made in the boundary of the Upper Arkansas SRU:

1. The South Park HRU which shows as a part of the Upper Arkansas SRU based on the qualitative system (Figure 2) actually belongs to the Front Range SRU to the north. This finding was also confirmed by fieldwork being conducted in the South Park area as part of another project.

2. The Eastern boundary of the Upper Arkansas SRU is shown too far to the east.

Five Quantitative Human Resource Unit delineation criteria and their application were identified bythe field team as part of Task 2. These five criteria-- Population Hubs, Travel Distance and Times; Hydrologic Divides; School District Boundaries, and County Boundaries, and their application are presented in detail in Appendix D.

Field crews also investigated portions of Pueblo, Colorado to identify Neighborhood Resource Units and the criteria that led to their delineation in the field. These criteria were based on the characteristics that residents mentioned in their descriptions of their neighborhood. Six criteria surfaced as the most important characteristics:

1. Physical barriers such as the Arkansas River, major thoroughfares and ditches;

2. Non-residential land uses such as parks and schools and commercial or industrial uses;

3. Housing conditions;

4. Safety/crime;

5. Long-term friendships; and

6. Family ties.

A detailed report of this field investigation can be found in Appendix E.

Task 3: Determine Statistical Correlates:

This Task of the research effort began concurrently with Task 2. Results of Task 2 were fed into this Task and became part of the final set of variables, or "Statistical Correlates" analyzed in the remainder of the research effort.

Quantitative measures from readily available data sources were selected as analysis variables. These analysis variables were identified as to whether they were measures of the physical, biological, social or economic environment, and then which of the seven Cultural Descriptors they were intended to measure. Definitions of the seven Cultural Descriptors used in the qualitative system as developed by FUND is presented in Appendix C and in Figure 3.

Table 1 displays the list of variables considered in detail. Those on the list marked with an asterisk (*) were carried forward into Task 4 and formed the basis for the quantitative boundary delineation models that were eventually developed.

Figure 3
Seven Cultural Descriptors
Leading to Social Boundary Formation

Publics: Segments of the population or a group of people having common characteristics, interests, or some recognized demographic feature. Sample publics include agriculturalists, governmental bodies, homemakers, industries, landowners, loggers, miners, minorities, newcomers, preservationists, recreationalists, senior citizens, small businesses and youth.

Networks: A structured arrangement of individuals who support each other in predictable ways because of their commitment to a common purpose, their shared activities, or similar attitudes. there are two types of networks, those that are informal arrangements of individuals who join together as a way to express their interests, and those that are formal arrangements of individuals who belong to an organization to represent their interests. Networks functioning locally as well as those influencing management from regional or national levels are included in this descriptor. Examples of citizen networks include ranchers who assist each other in times of need, grassroots environmentalists with a common cause, or families who recreatetogether. Examples of formal organizations include a cattlemen's association, or a recreational club.

Settlement Patterns: The distribution of a population in a geographic area, including the historical cycles of settlement. This descriptor identifies where a population resides and the type of settlement categorized by its centralized/dispersed, permanent/temporary, and year-round/seasonal characteristics. It also describes the major historical growth/non-growth cycles and the reasons for each successive wave of settlement.

Work Routines: The way in which people earn a living, including where and how. The types of employment, the skills needed, the wage levels, and the natural resources required in the process are used to generate a profile of a population's work routines. The opportunities for advancement, the business ownership pattern and the stability of employment activities are also elements of this desciptor.

Supporting Services: Any arrangement people use for taking care of each other, including the institutions serving a community and the caretaking activities of individuals. This descriptor emphasizes how supporting services and activities are provided. Commercial businesses, religious institutions, social welfare agencies, governmental organizations, and educational, medical and municipal facilities are all examples of support services. Caretaking activities include the ways people manage on a day-to-day basis using family, neighborhood, friendship or any other support system.

Recreational Activities: The way in which people use their leisure time. The recreational opportunities available, seasonality of activities, technologies involved, and money and time required are aspects of this descriptor. The frequency of local/non-local uses of recreational resources, the preferences of local/non-local users, and the location of the activities are also included.

Geographic Boundaries: Any unique physical feature that defines the extent of a population's routine activities. Physical features generallyseparate the cultural identity and daily activity of a

population from those living in other geographic areas. Geographic boundaries include geologic, biologic, and climatic features, distances, or any other characteristic that distinguishes one area from another. Examples of geographic boundaries include topographic features that isolate mountain valleys, distances that separate rural towns, or river basins that shape an agricultural way of life. Geographic boundaries may be relatively permanent or short-lived; over time, boundaries may dissolve as new settlement patterns develop and physical access to an area changes.

Table 1
Analysis Variables Considered

	ELEMENT OF THE ENVIRONMENT / Cultural Descriptor / Analysis Variable	Considered for SRU	HRU	NRU	DATA SOURCE CODE
	PHYSICAL ELEMENTS:				
	Geographic Boundary				
*	Major Physiographic Division.	x			1
*	Physiographic Province.	x			1
*	Regional Watershed.		x		2
*	Subregional Watershed.	x			2
	Elevation.		x		3
	Precipitation.		x		4
	Temperature		x		4
	Rivers.			x	NA
	Major Thoroughfares.			x	NA
	Ditches.			x	NA
	BIOLOGICAL ELEMENTS:				
	Potential Natural Vegetation		x		3
	Land Resource Regions and Land Resource Areas of the U.S.		x		8
	SOCIAL ELEMENTS:				
	Publics and their Networks				
	Percent of Population by Race.	x	x		5
	Percent Spanish Origin - All Races.		x	x	5
	Percent with 4 or More Years of College.	x	x		5
	Median Age of Population.		x		5
	Percent of Population 65 Years or More.		x		5
	Mean Family Income.		x		5
	Long-term Friendships.			x	NA
	Family Ties.			x	NA

ELEMENT OF THE ENVIRONMENT / Cultural Descriptor / Analysis Variable	Considered for SRU	HRU	NRU			DATA SOURCE CODE
Settlement Patterns						
Percent Urban Population.		x	x			5
Percent Rural, Non-Farm Population.		x	x			5
Percent Rural Farm Population.	x	x			5	
* Population Density.	x				5	
Housing Conditions.				x	NA	
* Population Hubs.			x			5
Recreation Activities:						
Travel Time.		x	x			6
Percent of Population Employed in Recreation Services.			x			5
Supporting Services:						
*School District Boundaries.			x			7
Safety/Crime.				x		NA
Parks and Schools.				x		NA
ECONOMIC ELEMENTS:						
Work Routines:						
Percent Employed in Agriculture.		x	x			5
Percent Employed in Manufacturing.	x	x			5	
Percent Employed in Business Services.	x	x			5	
Percent Employed in Other Services.		x	x			5
Percent Employed in All Services.		x	x			5
Percent Employed in Mining.		x	x			5
Ratio of Business Services to Agriculture.		x	x			5
Ratio of Business Services to Mining.	x	x			5	
Ratio of Business Services to Manufacturing.		x	x			5
Commercial/Industrial Use Areas.				x		5

Data Source Code

1. Physiography of the Western United States.
2. Hydrologic Units of Colorado.
3. Base Map of Colorado; U.S.G.S.
4. Annual Average Climatic Maps of the U.S.: NOAA.
5. County level Census Data.
6. Calculated from Colorado Highway Map: Road Class, Distance and topography.
7. Colorado Department of Education.
8. USDA, Soil Conservation Service.
9. Variables used further in this report.

Initial analysis focused on the county level Census Bureau variables. Data for all counties in Colorado was obtained and then sorted, on individual variables and in various combinations of variables. Results of the statewide county sorts were then compared with listings of counties within each Social Resource Unit in the State. Results were analyzed to see if a pattern of any variable or combination of variables repeated itself across all or most of the Social Resource Units. No "comfortable" patterns emerged from this analysis.

Tests for similarities between counties using the Census Bureau data were also run using the Bray-Curtis Similarity Index using their formula:

$$\text{Similarity Index} = \frac{2(\text{Sum(minimum of (Xia,Xiba)))}}{\text{Sum(Xia Xib)}} \Big/ \text{Number of Variables}$$

Where: Xia = value of each variable in county a.
Xib = value of each variable in county b.

A Similarity Index of 1.0 represents complete similarity between the counties analyzed . An Index of 0.0 represents complete dissimilarity. A series of similarity tests were conducted using all counties in the State. The purpose was again an attempt to isolate a variable or combination of variables that provided a high Similarity Index between counties within individual SRUs that could be used to make initial SRU boundary delineations. Similarity Indices were also developed specifically for the Upper Arkansas and Lower Arkansas SRUs. Again, no pattern emerged. Indices between counties consistently ranged from highs in the 0.900's to lows in the 0.400's within the same SRU. There also was no clear pattern to breaks in the indices within this range.

There may be a number of reasons that no consistent pattern emerged. Data aggregrated to the county level may not be sensitive enough to show differences of this nature. The methodology used in analyzing the data may not be the most appropriate. Use of some form of gravitational, factoring or multivariant analysis model might provide more meaningful results. It may also be that these types of variables result from the physical makeup and patterns of an area rather than forming the pattern. Any society, regardless of size (Social Resource Unit level, Human Resource Unit level, etc.) requires a certain "critical mass" of truck drivers, typists, food stores, etc., to function as a cultural group. A group may be formed more by the physical and biological characteristics of an area and its social and economic characteristics result more from how the group uses its physical and biological resources to survive and prosper.

Variables associated with the physical element of the environment seemed to tie more closely and consistently with boundaries of the Social Resource Units and Human Resource Units in the initial analysis. These then formed the foundation of the quantitative boundary delineation models that were eventually developed in Task 4. After the new quantitative models were developed, Bray-Curtis Similarity Indices were determined for the Upper Arkansas SRU Test Site and the adjacent Lower

Arkansas SRU. Bray-Curtis Similarity Indices were also determined for the Upper and Lower Arkansas SRUs as delineated using the original qualitative system. Table 2 shows the range in Indices between counties within each SRU. The Table also compares the Indices between the SRU' delineated by the original qualitative system and the new quantitative model.

Table 2

Comparison of Similarity Indices

	Qualitative System		Quantitative Model	
Item	Upper Arkansas *SRU*	Lower Arkansas *SRU*	Upper Arkansas *SRU*	Lower Arkansas *SRU*
Index Range:				
High	.907	.607	.817	.928
Low	. 481	.607	.502	.354
SRU Average Index	.684	.607	.699	.684

Table 2 indicates that there is a wide variation in Similarity Indices between counties within a Social Resource Unit regardless of which method of delineation is employed. The Table also shows essentially the same average Index for an SRU regardless of the method of delineation.

The inference is that the Bray-Curtis Similarity Index, with the variables used, does not organize county level data into groups which can be used in a quantitative boundary delineation model. Such variables may instead be good descriptors of the diversity of the culture within an area that has been delineated by other means.

Tasks 4. "Perform Comparative Analysis", and Task 5, "Account For the Variations" are presented in detail in the following Chapter (Chapter IV). Section A of Chapter IV discusses the variables used to develop a quantitative model for delineation of SRU boundaries and then compares the boundaries delineated with those of the original qualitative system. Section B discusses similar material for the HRU level model. Neighborhood Resource Unit delineation is discussed in Section C.

IV. DELINEATION VARIABLES AND RULES OF APPLICATION

A set of variables, using data and information from readily available sources, has been identified. These variables, when used in conjunction with specified rules of application, delineate Human Geographic Unit boundaries at the Social Resource Unit and the Human Resource Unit level. Different variables and rules of application are applied at each level of delineation.

The variables and rules are structured in such a manner that their application results in either YES or NO answers. Decision logic employing IF, THEN, AND, and ELSE is embodied in the rules leading to the YES or NO answer or in instructions on how to proceed in the delineation process based on a YES or NO answer.

Establishing this type of criteria requires that one separate him or herself from "feeling" and "intuitive thinking" and rely entirely on hard information or data. However, one's "feeling" and "intuitive thinking" are needed in the search for those elements of hard data or information that can be used as criteria.

A manual process for delineation of Human Geographic Units is presented here. A manual process is more appropriate to highlight the strengths and weaknesses of the process in its current stage of development.

There are other reasons for presenting a manual process. Manually delineating the various levels of the progression following the rules of application establishes an understanding of which rules work in a clear, straight forward manner. Those which are cause for concern also become apparent. This helps focus on what factors need further refinement, or, if used in its current stage of development, which Unit boundaries are most questionable and where field examination should be concentrated.

The manual process also provides an understanding of the basis upon which computer-generated boundary lines are drawn. This insures that the appropriate amount of reliability is ascribed to the lines rather than assuming they are all correct simply because they have been generated by a "black box".

Variables and rules of application for delineating Human Geographic Units at the Social and Human Resource Unit levels are described and illustrated separately below. Social Resource Unit delineation is discussed first. When using the model, it is **not** necessary to delineate Social Resource Units before Human Resource Units. Each is a separate model and each is a separate delineation process.

However, if Human Resource Units are delineated first, then the various boundaries will be known, but their relationship to the SRU boundaries will not be clear. The HRU delineation process described herein assumes that the SRU boundary has been delineated prior to the start of the HRU delineation process.

A. Social Resource Unit Delineation

Social Resource Units are delineated for the State of Colorado in this example. A map scale of 1:2,500,000 (approximately 1 inch - 40 miles) is used. Selection of the proper map scale is important in the modeling process, especially if delineation is being done manually. Large scale maps only confuse and confound when Social Resource Units or higher level Units are delineated. Large scale maps simply show too much detail for delineating higher level Human Geographic Units. Also, if large scale maps are used to draw higher level Unit boundary such as a Social Resource Unit boundaries, the drafter tends to make the wrong turn and follow some lower level boundary line. This is particularity a problem when the drafter has some familiarity with the area.

Variables from the physical environment are used to create a First SRU Approximation Map. This map is then tested against a set of a criteria, i.e., Rules of Application, which results in a "Second SRU Approximation Map". Population and travel time variables are then employed to create the Final Preliminary Social Resource Unit Map.

1. Social Resource Unit Delineation Variables:

   Major Physiographic Divisions is the first variable employed in delineation of Social Resource Units. Major Divisions are the highest level of land form delineated by Fanneman. As stated in the Preface of his book *"Physiography of the Western United States":*

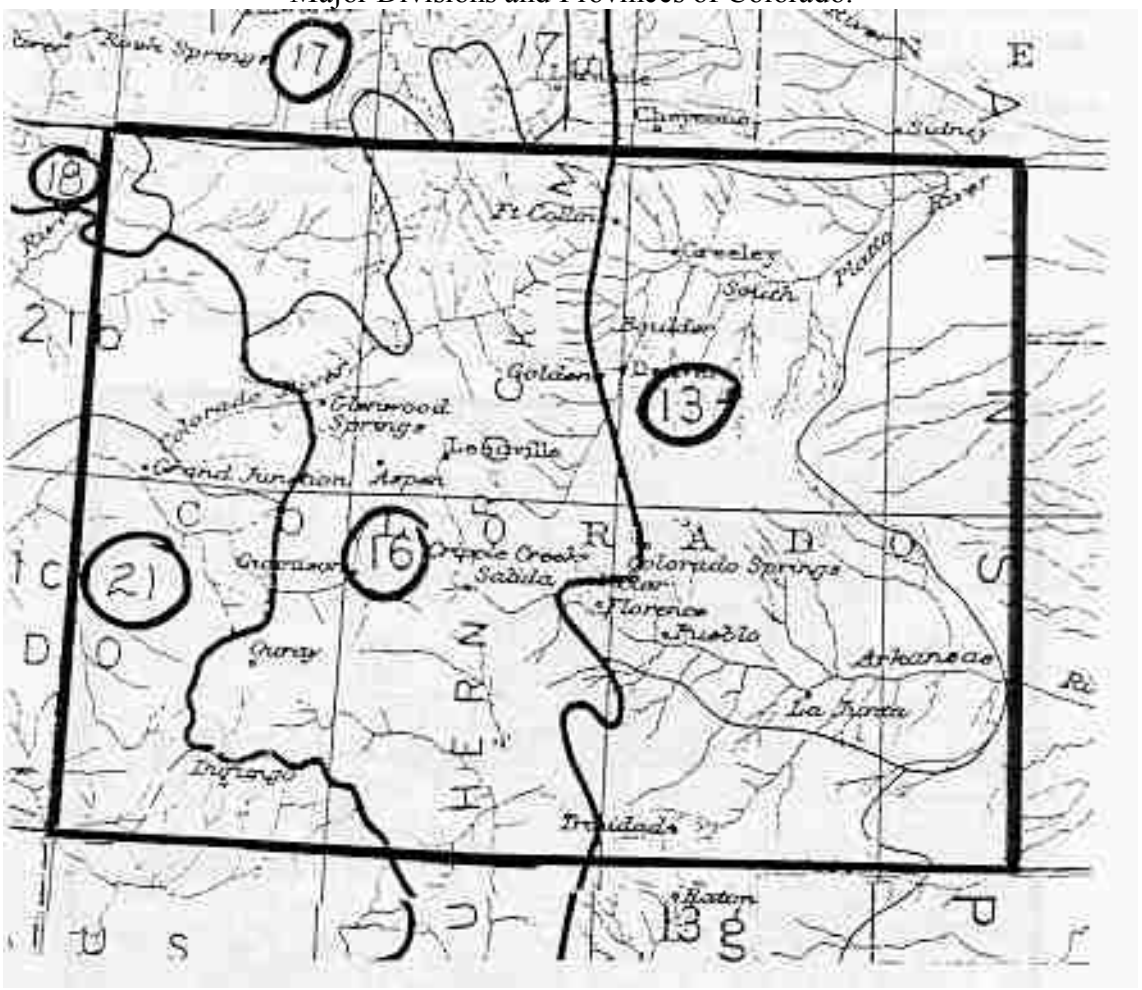
   > "It may be assumed that geologists and geographers have equal interest in land forms, but the quality of their interests is very different. To the geologist land forms are a kind of final product, the end of a story. To the geographer they offer a beginning, a point of departure. To the former, land forms depend on all the physical processes of geology." (10)

In the delineation of Social Resource Units, land form is the beginning, the point of departure in the modeling process.

Fenneman subdivides the United States into seven major Divisions. Each Division is further subdivided into Provinces. Figure 4 shows the Major Divisions and Provinces in Colorado as drawn by Fenneman.

The Interior Plains Division occurs in the eastern portion of the State, and in Colorado, this Division contains only one Province, the Great Plains Province, which is coded as "13", in Figure 4.

Figure 4
Major Divisions and Provinces of Colorado.



The Rocky Mountain System covers the mountainous central portion of the State, with the Southern Rocky Mountain Province ("16") covering most of the area. A small portion of the Wyoming Basin Province ("17") and Middle Rocky Mountain Province ("18") also occur.

The Colorado Plateaus Province ("21") of the Intermountain Division covers the western quarter of the State.

Regional and Subregional Watersheds:

The second variable employed in the Social Resource Unit delineation process is Regional and Subregional Watershed boundaries. The source of this variable is the Water Resources Council's delineation of Regional and Subregional watersheds (11).

This criteria is employed because natural barriers are a major factor in people's perception of territory. A mountain range rising 3000 to 4000 feet above the valley floorforms both a physical and psychological barrier. Also, water is so important to life and living that

people take responsibility for it as water and its use is a resource to which they have access and can control. Control of water that runs downhill into and through the area tends to tie it together as a unit. On the "other side of the mountain", water flows away from the area, with no control of what happens to that water and its use in "another" area, creates a feeling of separation rather than unification

Figure 5
Regional and Subregional Watersheds of Colorado

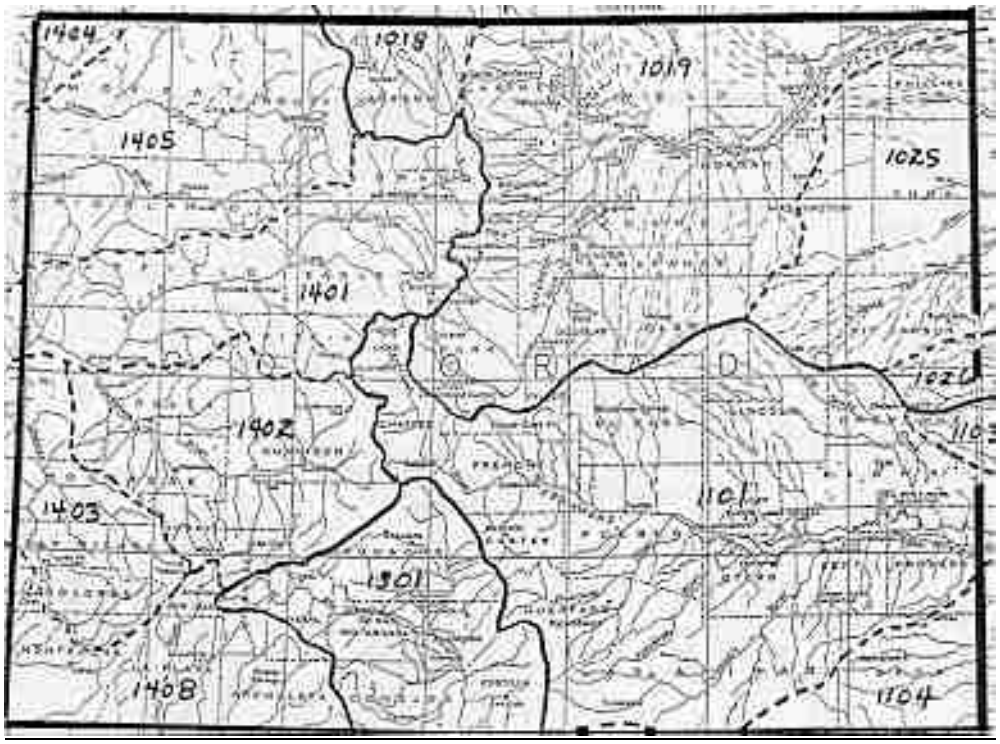


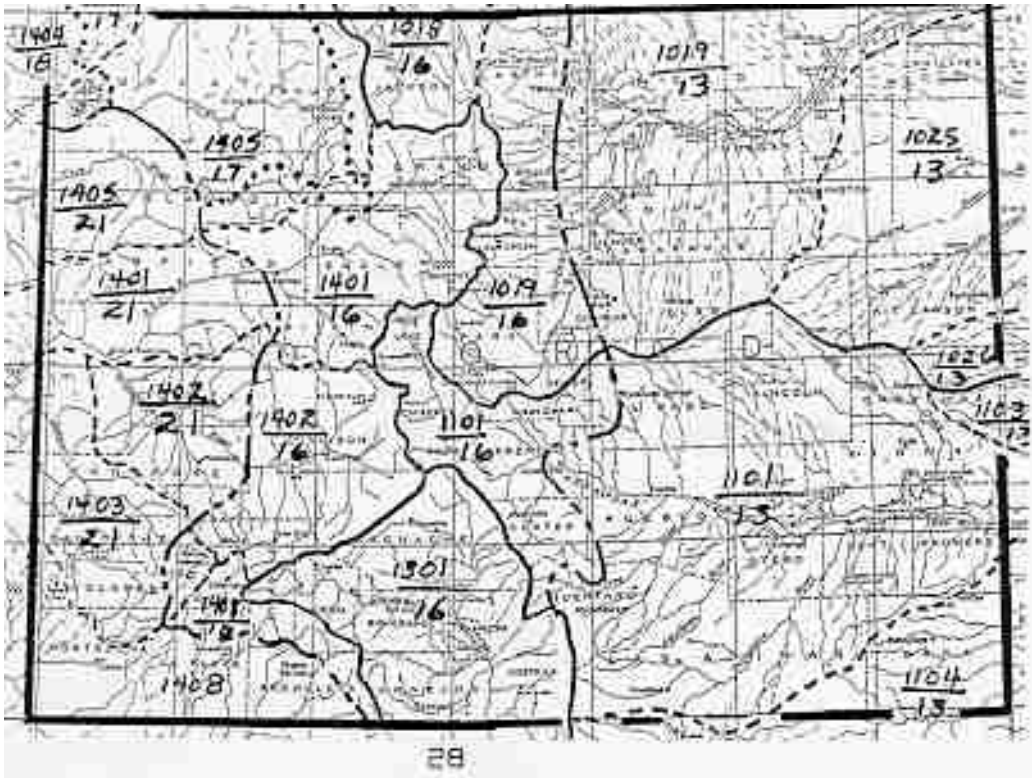
Figure 5 shows Regional and Subregional watersheds delineated for the State of Colorado. Regional Watersheds are shown in solid lines, Subregional watersheds within them by dashed lines. The four-digit code located within each watershed delineation indicates the Regional watershed (first two digits) and the Subregional watershed (last two digits).

Regional watersheds encompass large areas and normally transcend State boundaries. In Colorado, portions of four Regional watersheds are represented; the Platte River Watershed in northeastern Colorado (coded "10"); the Arkansas River Watershed in the southeast ("11"); the Rio Grande River Watershed in south-central Colorado ("13"); and, the Colorado River Watershed ("14"), which covers the entire State west of the Continental Divide.

Without exception, Regional Watershed boundaries represent some segment of some Social Resource Unit boundary. Subregional Watersheds may or may not represent a Social Resource Unit boundary.

Regional and Subregional Watersheds are overlaid onto the Major Divisions and Provinces to create an Intermediate Map from which a First SRU Approximation Map is made. This Intermediate Map is shown in Figure 6. Map codes for each area show the Regional and Subregional Watershed code as the numerator and the Major Division or Province as the denominator.

Figure 6
Intermediate Map



Rules of Application:

The map created by overlaying Major Divisions and Provinces with Regional and Subregional Watersheds is tested against five delineation rules (labeled S-1 through S-5) to create a First SRU Approximation Map (Figure 7). This map is then tested by an additional rule (S-6) to arrive at a Second SRU Approximation Map (Figure 8). A Preliminary SRU Map is then created by the application of Rules S-7 through S-11. The

"S" prefix identifies these as SRU delineation rules as opposed to HRU delineation rules which carry an "H" prefix.

Rule S-I: Are Regional Watershed boundaries present?

No: Go to Rule S-2.

Yes: Delineate SRU boundary along Regional Watershed boundary, Then go to Rule S-2.

Rule S-2: Are Major Division boundaries present?

No: Go to Rule S-3.

Yes: Are Major Division Boundaries within 25 miles of a Regional Watershed boundary?

No: Delineate SRU boundary along Major Division boundary, Then go to Rule S-3.

Yes: Regional Watershed boundary controls. Do not, delineate SRU boundary.

If the Major Division Boundary and Regional Watershed boundary become separated by 25 miles or more, Then delineate a SRU boundary between the two lines following the most direct line along a hydrologic divide, then go to Rule S-3; Otherwise, go to Rule S-3.

Rule S-3: Are Subregional Watershed boundaries present?

No: Go to Rule S-4.

Yes: Delineate SRU boundary along Subregional Watershed boundary, Then go to Rule S-4.

Rule S-4: Are Province Boundaries present?

No: Go to Rule S-5.

Yes: Are Province boundaries within 25 miles of a Subregional Watershed boundary?

No: Delineate SRU boundary along Province boundary, Then go to Rule S-5.

Yes: Subregional boundary controls.

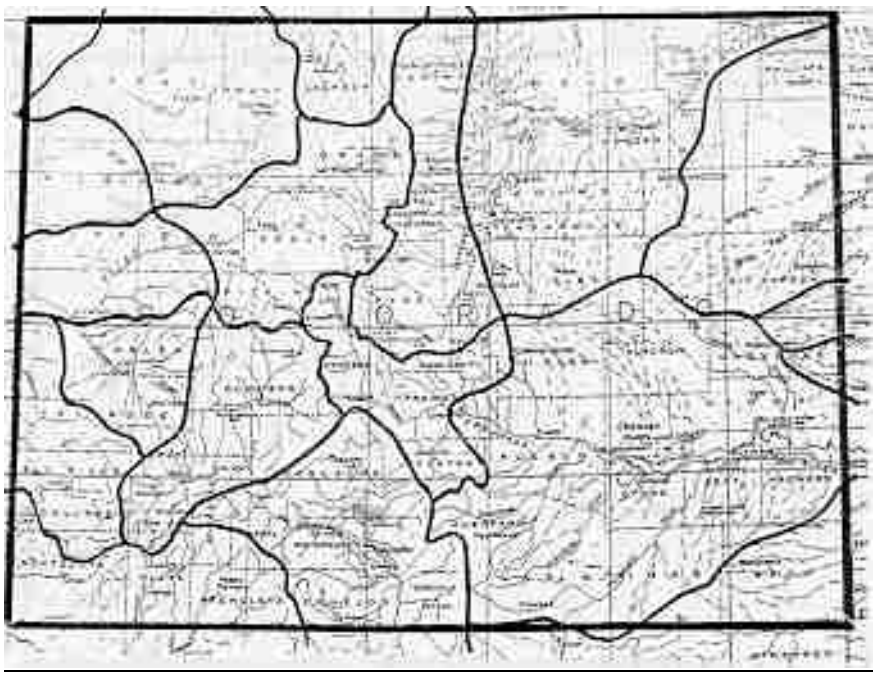
Do not delineate SRU boundary.

If Province boundary and Subregional boundary become separated by 25 miles or more, then delineate a SRU boundary between the two lines following the most direct line along a hydrologic divide, then go to Rule S-5; Otherwise, go to rule S-5.

Rule S-5: First SRU Approximation Map is competed.

The SRU Approximation Map for Colorado, created by the above rules, is shown in Figure 7. At this point, a number of small areas, delineated as a result of applying Subregional Watershed boundary delineation criteria (Rule S3) occur on the western portion of the State. Note on FIGURE THREE that most Regional and Subregional Watershed boundaries extend for 150 miles or more before they intersect. Note also that the dashed lines representing Subregional Watershed boundaries between areas 1401/21 and 1402/21, and between areas 1402/21 and 1403/21 are relatively short, traversing a distance of less than 100 miles. These boundaries create the small areas shown on the First SRU Approximation Map (Figure 7). Application of Rule S-6 erases the boundary lines between these three areas to create one larger Unit on the Second SRU Approximation Map (Figure 8).

Figure 7
First SRU Approximation Map of Colorado



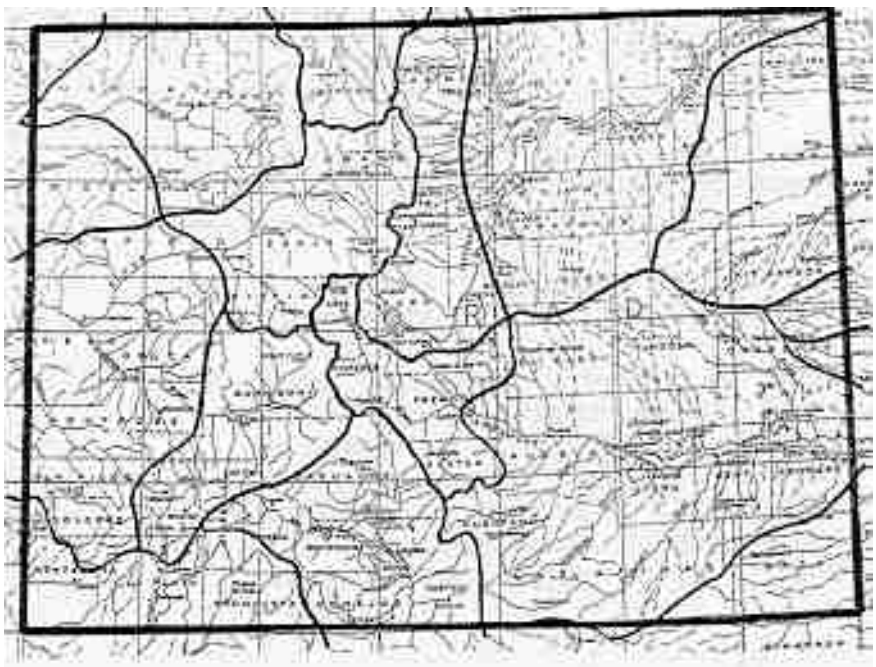
Rule S-6: Do first SRU Approximation boundaries, created by Subregional Watershed boundaries, extend for at least 100 miles before they intersect?

No: Erase first SRU Approximation boundary.

Yes: Leave first SRU Approximation boundary in place.

After completing the test of Rule S-6 on each First SRU Approximation boundary, the Second SRU Approximation Map is completed (Figure 8). Rules S- 7 through S-11 analyze this map against a population variable to arrive at the Preliminary Social Resource Unit Map.

Figure 8
Second SRU Approximation Map of Colorado



The first step in making final SRU delineations is to determine if an SRU boundary, delineated by Rules S-1 through S-6, passes through a county, separating it into two or more SRUs.

Rule S-7: Is the county split by an SRU boundary?

No: Determine population density (in people per square mile) for the county, Then go to Rule S-8.

Yes: Assign each portion of the county to the SRU within which it occurs.

Determine within which SRU the majority of the county's population resides.

Determine the area of that portion of the county, and calculate population density per square mile for that portion of the County. Then go to Rule S-8.

Rule S-8: Has population density for last county determined?

No: Go to Rule S-7.

Yes: Go to Rule S-9.

Rule S-9.: Do two or more counties in an SRU have population densities in excess of 150 people per square mile?

No: Go to Rule S-10.

Yes: Are counties with densities in excess of 150 people/square mile adjacent to each other?

No: These are "Isolated Population Concentrations". Go to Rule S-10.

Yes: Find population center of each county. Delineate an SRU boundary at a distance of 20-25 miles (30 minutes highway travel time) from the population center until an SRU boundary previously delineated is encountered, Then go to Rule S-11.

Rule S-10: Do 1-hour highway travel times from the population center of the "Isolated Population Centers" touch or overlap with each other or with other counties with population densities of 150 people per square mile?

No: Go to Rule S-11.

Yes:Delineate an SRU boundary at a distance of 20-2S miles (30 minutes highway travel time) from the population center until an SRU boundary previously delineated is encountered. Then go to Rule S-11.

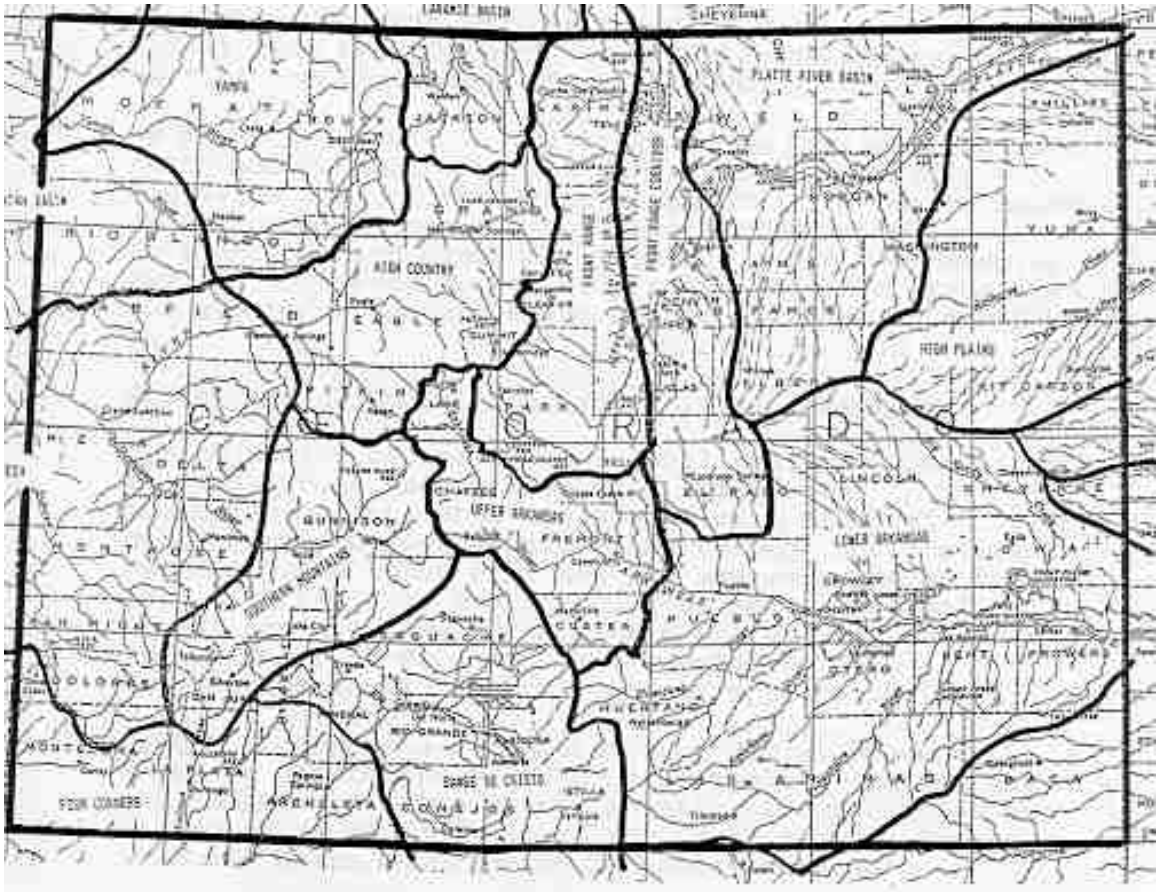
Rule S-11: Has last SRU delineated by Rules S-1 through S-6 been checked by Rule S-9 and/or Rule S-10?

No: Go to Rule S-9 or Rule S-10, which ever was last used.

Yes: Preliminary SRU's have been delineated.

The Preliminary SRU Map of Colorado, resulting from the application of Rules S-7 through S-11, is shown in Figure 9. Applying rules S-7 through S-11 resulted in delineation of one additional SRU. A number of counties were split by SRU boundaries delineated by Rules S-1 through S-6, but only four, Boulder, Larimer, Jefferson and El Paso Counties, had population densities of 150 people per square mile or more. Three of these counties (Boulder, Larimer and Jefferson) are adjacent to one another. They are also adjacent to Adams, Arapaho and Denver counties which also have population densities of 150 or more. Thus, these six counties, based on rules S-7 through S-11, form a portion of an additional SRU called the Front Range Corridor.

Figure 9
Preliminary SRU Man
of Colorado



El Paso County, with Colorado Springs as its population center, also has a population density greater than 150 people per square mile. However, Colorado Springs is isolated from the Front Range Corridor by Douglas County which does not have a population density meeting the criteria of Rule S-8.

Had Douglas County's population density exceeded 150 people per square mile, it would have been included in the Front Range Corridor SRU. Were this the case, El PasoCounty would also have been included as it would have been adjacent to a county with a population density in excess of 150 people per square mile. The SRU boundary between Douglas and El Paso counties would have been delineated because characteristics of densely populated areas are stronger influences in shaping the cultural patterns of an area than the physical characteristics where densely populated areas occur.

However, since Douglas County's population density is less than 150 people per square mile, Colorado Springs becomes an "Isolated Population Center". It is, therefore, tested against Rule S-10. One-hour travel time from Colorado Springs overlaps with the one-hour travel time from Denver. Thus, Colorado Springs is part of the Front Range Corridor SRU.

As shown in Figure 9, the Front Range Corridor SRU is a north-south running band at the foot of the Rocky Mountains east of the Front Range SRU. It begins south of Colorado Springs and runs north to an area between Fort Collins and Cheyenne, Wyoming. Note that Greeley (which is in Weld County with a population of less than 150 people per square mile) is not included in the SRU.

3. Comparison of Social Resource Unit Delineations

The objective of the Phase I Small Business Innovative Research Grant was to develop a model using quantitative data that would replicate cultural boundaries previously determined through qualitative methods. The Upper Arkansas SRU was selected as the test site for this project but, as mentioned earlier, it was found necessary to extend the area of analysis to the State of Colorado when developing SRU delineation variables and rules of application.

Figure 10 presents a comparison of Social Resource Units as determined by FUND using qualitative methods and those delineated bythe quantitative variables and eleven rules of application set forth above. Social Resource Units occurring in Colorado are shown.

The "FUND" map of Colorado is reproduced from the map *"Social Resource Units of the Western United States",* prepared by FUND in 1982 (15). The map based on quantitative variables and rules of application set forth in this report is a reproduction of Figure 9 with one exception. The SRU boundaries for the Upper Arkansas SRU were transferred from the large scale (l:2,500,000) mapto a small scale (l:500,000) map. This transfer process is done as the first step in Human Resource Unit delineation (see Section B., below). This "grounds" the boundary line based on local topography and presents a more “final” preliminary SRU boundary.

Close similarities between the two maps are evident. Both maps have delineations of the Sangre De Cristo, Four Corners, Mesa, Uintah Basin, Yampa, Laramie Basin, High Country, Front Range, Platte River, High Plains, Lower Arkansas and Upper Arkansas

SRUs. However, closer examination of Figure 10 reveals inconsistencies in some boundaries between the two maps and that the Preliminary SRU Mapcreated by the quantitative variables and rules of application shows two additional SRU's; the Front Range Corridor and the Southern Mountains SRU.

The Upper Arkansas SRU was selected as the Test Site for this project. Therefore, a comparison of it between the two maps is presented first. Then a more general discussion comparing other SRUs in the State is presented.

Comparison of Upper Arkansas SRU Boundaries:

The Upper Arkansas SRU, as depicted on the FUND map, includes the South Park area. On the Preliminary SRU Map,this area is not included in the SRU. Rather, it is included in the Front Range SRU. The South Park area is in the South Platte watershed rather than the Arkansas River Watershed. The rule using the Regional Watershed variable (application of Rule S-1) caused the South Park area to be placed in a different SRU. Field investigations in conjunction with FUND's Upper South Platte Water Conservancy District project (20) confirm that the South Park area is not in the Upper Arkansas SRU.

The FUND map shows the eastern boundary of the Upper Arkansas SRU extending out onto the Great Plains beyond Pueblo, Colorado and past the town of La Junta. The Preliminary map places the eastern boundary west of Pueblo. The SRU boundary shown on the Preliminary map is based on the application of Rule S2 because it identifies a Major Division. The FUND map indicates that Puebloand La Junta are oriented toward and part of the Upper Arkansas SRU while the Preliminary map indicates that they belong to the Lower Arkansas SRU. Field study in conjunction with this research project indicated that Pueblo belonged to the Lower Arkansas SRU as defined by the new quantitative model.

Comparison of Colorado SRU Boundaries:

The preliminary map shows two additional SRU's than are shown on the FUND map. These are the Front Range Corridor and Southern Mountain SRU's. As with the east boundary of the Upper Arkansas SRU, both of these additional SRU's result from application of Rule S-2, the Major Division variable. This variable divides FUND's Front Range SRU into the Front Range and the Front Range Corridor on the Preliminary SRU map. It also splits the mountainous portion of FUND's Mesa SRU into the Mesa SRU and Southern Mountains SRU on the Preliminary SRU Map.

Use of Major Division boundaries reconfigures the shape of the High Country SRU and the Yampa SRU, but the “comfort” level on the reconfiguration, as was the case with the shifting of the South Park area out of the Upper Arkansas SRU, is high.

Use of Regional Watershed boundaries as Social Resource Units on the Great Plains results in expanded Platte River Basin and Lower Arkansas SRUs with the High Plains

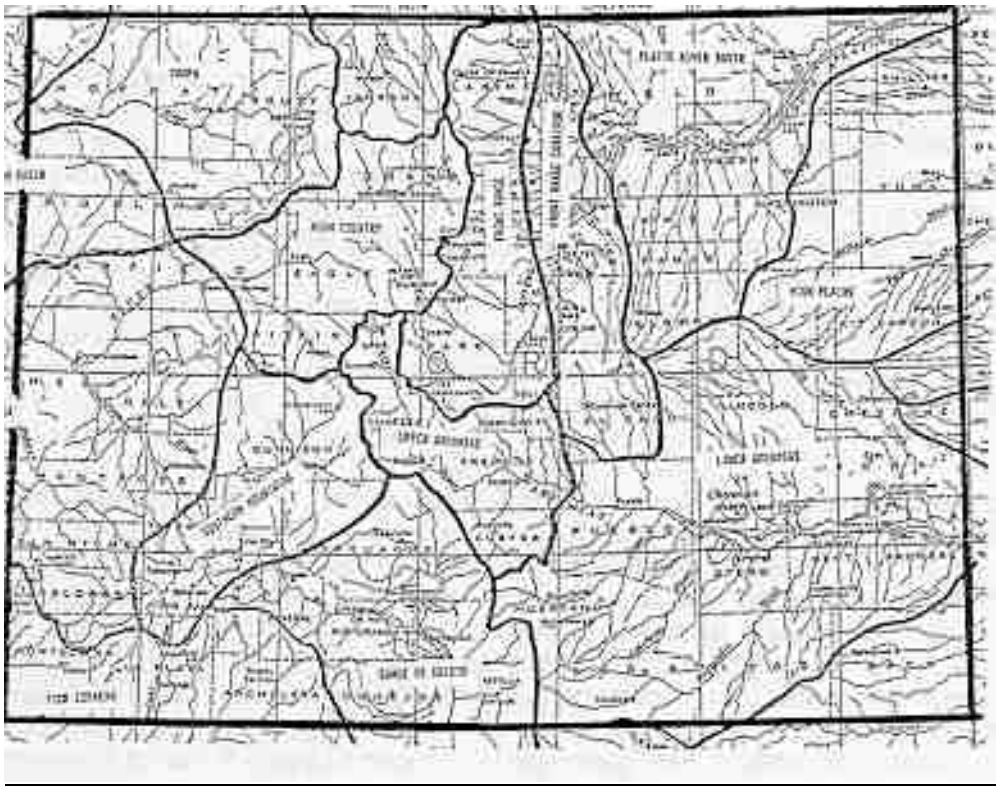
SRU being restricted to a much smaller area. The basis for the original FUND lines needs to be better defined so that a thorough comparative analysis can be made.

Other variations in boundaries are minor. Social Resource Unit boundary differences do not appear irreconcilable, but do reinforce the need for further field study focusing to confirm the validity of Major Divisions (and therefore Provinces) as delineation variables and the proper weight to afford Regional Watershed boundaries on large areas of gentle relief as is typified by the Great Plains.

Figure 10
SRU Comparison Maps

SRU's Based on the Qualitative FUND System.

SRU's Based on the New Quantitative Method.



B. Human Resource Unit Delineation

The Human Resource Unit is a much more specific unit and one with which residents are more knowledgeable and to which they can relate more directly. This awareness and understanding of "place" is stronger at the Human Resource Unit level where one sees and experiences the boundaries of his or her cultural area daily.

Grounding the Social Resource Unit:

Prior to beginning the process of delineating Human Resource Units, the Social Resource Unit boundaries delineated on large scale maps are transferred to a 1:500,000 map (approximately 8 miles to the inch) in the area of study. This establishes a context within which to delineate the Human Resource Units and provides "cutoff points" for some of the HRU delineation variables.

Transferring SRU boundaries which follow Regional and Subregional watersheds is simple and straight-forward. Contour lines on the 1:500,000 scale map used for HRU delineation clearly show these divides. Transferring SRU boundaries which follow Major Divisions and Provinces is a little less precise. Fenneman's delineations are at a map scale of over 110 miles to the inch. Even a thin line at this scale becomes quite thick when reproduced at a scale of only 8 miles to the inch. Fenneman addresses this situation in his Preface:

> "The student of a small area may well find the treatment here given inadequate to his district. In describing or discussing large units ... it is of the essence of the problem to ignore details which may be vastly important locally. Especially in the vicinity of physiographic boundary lines is it necessary to take into account the difference between describing a large area and a small one. ... it is expected that the critical student of a small area bounded or traversed by any of the lines here used will delineate such boundaries witha degree of detail suited to the scale on which he works." (10)

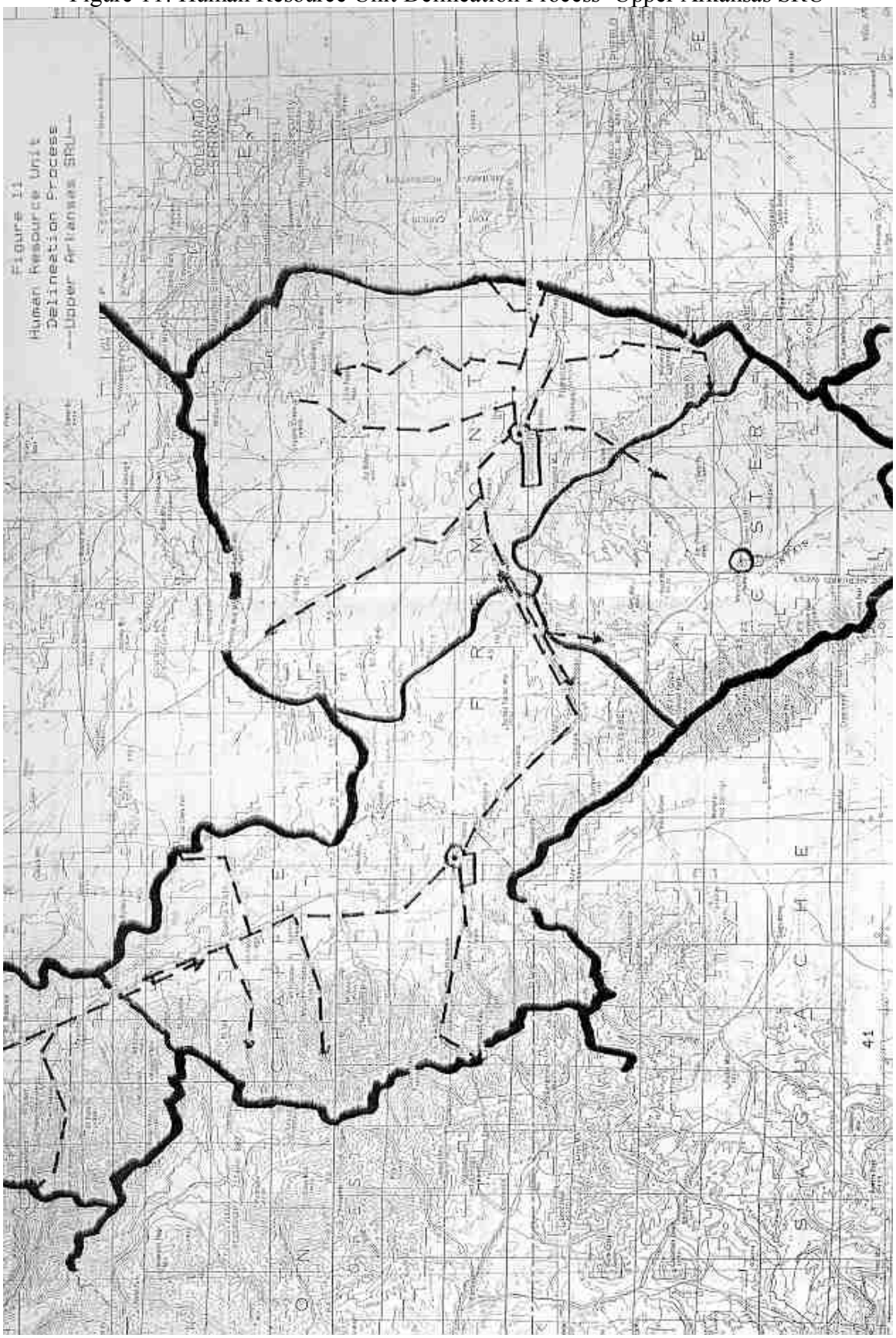
The objective of using physical land forms as a delineation variable is to identify boundaries which are commonly held by those groups of people who reside within them. A map line's precise location on the ground is of less importance than the perceived location of change in the resident's mind. Again, barriers, physical or psychological, in the proximity of the line are of significance in locating the human boundary on the ground. These barriers may be rivers or escarpments or ridgelines. They may be roads or most any kind of physical or mental divider. In the area of study, ridgelines kept surfacing as significant points of demarcation.

For instance, Fenneman's Major Division between plainsand mountains running north and south through Colorado form SRU boundaries all along the way. This line is mapped by Fenneman at the base of the mountains where they contact the plains. However, when one is on the plains looking to the mountains, the first mountain slope seems to "belong" more to the plains than to the distant mountains. Conversely , when standing on the ridgetop of this first slope and looking down toward the plains, there is more of a feeling of "having arrived" at the plains and of "having left" the mountains.

Thus a rule for transferring SRU boundaries which follow Major Division or Province boundaries from large-scale maps to smaller scale (1:5000,000) is born. Where SRU boundaries follow Major Division or Province boundaries, place the line on the first ridgeline or escarpment in proximity to the line.

These criteria resulted in delineation of the Upper Arkansas SRUboundary as shown in Figure 11. The Figure was developed on a map of a scale of 1:5000,000, and then reduced for ease of display in this report. Note that the boundary following Regional and Subregional watersheds is the same as was delineated on the Preliminary SRU Map of Colorado (Figure 7), but that the north-south boundary of the SRU, the boundary defined by the Division between mountains and plains, has been relocated. The most noticeable change being in the Canon City area where the boundary is relocated from west of Canon City to the east.

Figure 11: Human Resource Unit Delineation Process--Upper Arkansas SRU



Establishing the SRU boundary on the smaller scale map sets the stage for delineation of Human Resource Units.

1. Human Resource Unit Delineation Variables

Human Resource Units are delineated for the Upper Arkansas SRU, the test site selected for the SBIR Phase I grant. They have are also delineated for the Lower Arkansas SRU to test delineation criteria in areas of shallow topographic relief. A map scale of 1:500,000 with contours was used. This relatively small map scale provides a sufficient level of local detail. Maps showing contours are necessary in order to see changes and degree of change in the local relief.

Four variables were used to delineate H RU boundaries. These were:

Population hubs;
Highway travel time;
Local topographic features ; and
School districts.

Population Hubs:

Population hubs of 2,500 or more indicate a community concentration of retail and other services sufficient to generate repeated social and economic interaction. Human Resource Units have one, and if closely adjacent may have more than one, of these population hubs (called Urban Hubs) within their boundaries. Where more than one Urban Hub occurs within one HRU, the largest is usually the "Capitol" because the larger population base generates move economic and social activities and options. The most recent Census Bureau data was used as the source of this information (21).

In Figure 11, The towns of Leadville (3,822 population), Salida (4,908) and Canon City (13,037) are the only communities within the Upper Arkansas SRU that meet the Urban Hub criteria.

Exceptions to this criteria occur when travel times, discussed below, do not extend completely into rural areas. When this situation occurs, additional hubs of under 2,500 population (Rural Hubs) are selected to provide the focus for an additional rural HRU.

Highway Travel Time:

Travel cost or travel time consistently shows as a significant factor in the frequency with which people visit or use an area (12) (13). Studies also show that the vast majority of travel or visits occur within one hours travel (14). Travel time lines of one hour from the above three Urban Hubs were used to identify the extent of the hub's area of influence.

Where travel time between Urban Hubs approach one hour, there will be a Human Resource Unit boundary about mid-way between them since both are large enough to draw from an area of influence. For instance, if one can get what they want in a town 20 miles away, they normally will not drive 30 miles in the other direction to get the same thing.

Where an SRU boundary is encountered within the one-hour travel zone, the hub's area of influence stops. Where one-hour travel zones approach but do not touch the SRU boundary, the line is extended to the SRU boundary.

Travel times for various road classes and terrain were determined as follows:

Table 3
TRAVEL TIMES in MILES PER HOUR
by
Road Class and Terrain Conditions

	Terrain Condition		
Road Class	Shallow	Moderate	Strong
Four Lane Paved	50	45	40
Two Lane Paved	45	40	30
Surface Treated	30	20	10

The extent of the lines drawn in this fashion from a given Urban Hub identify the first rough delineation of the Human Resource Unit. Areas not strongly linked to a hub become immediately apparent as they are areas untapped by the one-hour travel zone lines. These areas are rural areas with no population center of 2,500 or more, and which are separated from adjacent populations by travel times in excess of one hour's one-way travel.

For these rural areas, a new hub is selected (the largest community in the area). Travel time lines are not drawn from these hubs. Rural Hubs do not have sufficient economic drawing power to warrant the same kind of "sphere of influence" delineation.

One-hour travel zones are shown on Figure 11 from each of the above three Urban Hubs. Note the rural area where the one-hour travel zone from any of the three population hubs of 2,500 people or more did not reach. Note that the community of Westcliff was selected as the Rural Hub around which to form an additional Human Resource Unit.

Note also that the one-hour travel zone from each of the three Urban Hubs overlap each other. This situation, and the situation relative to Rural Hubs sets the stage for the third variable used to delineate Human Resource Unit boundaries. This variable is Local Topographic Features.

Local Topographic Features:

Local topographic features; ridgelines, escarpments, rivers etc., are the third variable used in the delineation process once travel zones from Urban Hubs have been established and any Rural Hubs identified. Two situations related to travel zones are likely to occur. One is where one-hour travel zones between Urban Hubs overlap, and the other is where areas within the SRU boundary are left untapped.

In areas where one-hour travel lines overlap between Urban Hubs, a local topographic feature within the overlap area serves as the logical dividing line or boundary between the two hubs. Between Salida and Leadville, as shown in Figure 11, this overlap occurs in a broad valley. However, just north of the overlap area toward Leadville, a major ridge extends toward the road from both the east and the west. it is on this ridge that the boundary between the Leadville and Salida HRUs is drawn.

Overlap in one-hour travel time also occurs between Salida and Canon City. From about the midpoint of this overlap area near the community of Texas Creek, the HRU boundary is drawn northward along the crest of a ridge to Waugh Mountain and then across the broad divide to the northern SRU boundary. On the south, the boundary is drawn along the canyon rim and then along the ridgeline to Cottonwood Peak on the Sangre De Cristo Mountains - the southern SRU boundary.

The Westcliff area is untapped by any of the one-hour travel times, although the travel line from Canon City, as shown on Figure 11, does reach into the Wet Mountain Valley south of Texas Creek and, from the east, reaches to the crest of the Wet Mountain range. Thus the boundary between the Canon City and Westcliff HRUs is drawn along the crest of the Wet Mountains and then along the escarpment of the Arkansas River Canyon to intersect with the other HRU boundary at Texas Creek. The Four Human Resource Units delineated by the above procedure are shown in Figure 11.

School Districts:

The Upper Arkansas SRU was located in a mountainous area, an area of strong local topographic relief. In the Upper Arkansas situation, local topographic relief seemed to be a reliable variable upon which to base Human Resource Unit boundaries. However, local topographic relief is very gentle or shallow in the Lower Arkansas SRU, and could not be relied upon as a primary delineation variable by itself.

Human Resource Units were also delineated in the Lower Arkansas SRU because the test site for the project, the original Upper Arkansas SRU extended out onto the Great Plains beyond Pueblo and La Junta. An obligation was felt to extend the analysis over the entire originally selected test site. Also, it seemed wise to search for additional delineation variables away from areas of strong local topographic relief.

In areas of shallow or gentle relief, local topographic features did not seem to be a solid variable upon which HRU boundaries could be drawn. In the Lower Arkansas SRU, the topography was so gentle, no clear pattern emerged which showed where some of the boundaries should go.

Local school district boundaries were selected as an important variable, particularly in areas such as those encountered in the Lower Arkansas SRU, because they reflect not only logical travel routes and travel times, but also because they reflect the way local residents have organized important educational and other social activities. In delineating Human Resource Units in areas of gentle local relief, school district boundaries were used to separate the areas of influence of two adjacent population hubs.

If two or more population centers of 2,500 people or more were within 10 to 15 miles of each other, the town with the largest population was designated as the Urban Hub and the other population centers of more than 2,500 were considered as part of the designated Hub's area of influence.

If the one-hour travel lines from two Urban Hubs approached and overlapped each other, the school district boundary in the vicinity of overlap, rather than a local topographic feature, was used to determine the respective areas of influence.

School district boundaries can be followed quite easily on 1:500,000 USGS Base Maps. These maps show that local road systems and school district boundaries generally separate into logical areas based on access and travel time to the school. If some feature of local relief was visible in close proximity of the school district boundary line, the HRU boundary was drawn along the topographic feature. Where topographic features were not readily apparent, the actual school district boundary, straightening some of the legal subdivision corners, but keeping road systems separate, were used.

2. Rules of Application

Based on the above discussion, Rules of Application for the variables have been identified. Rule numbers are prefixed by the letter "H" to indicate that they are rules for delineating Human Geographic Units.

Rule H-1: Are there towns of 2,500 or more people located in the area?

No: Go to Rule H-4.

Yes: Go to Rule H-2.

Rule H-2: Are town of 2,500 or more people within 10 to 15 miles of each other?

No: Identify town as an Urban Hub.

Based on road class and terrain, determine one-hour travel zones from each Urban Hub. Then go to Rule H-3.

Yes: The town with the largest population is the Urban Hub.

Based on road class and terrain, determine one-hour travel zones from each Urban Hub. Then go to Rule H-3.

Rule H-3: Do one-hour travel lines from adjacent Urban Hubs overlap or come within a few miles of each other?

No: Go to Rule H-4.

Yes: Go to Rule H-S.

Rule H-4: Are there population centers of less than 2,500 within this untapped, rural area?

No: Extend travel times from the nearest Urban Hubs until they meet. Then go to Rule H-5.

Yes: Identify the population center with the highest population as a Rural Hub. Then go to Rule H-S.

Rule H-5: Are there prominent topographic features within or near the overlap area?

No: Go to Rule H-S.

Yes: Delineate HRU boundary along topographic feature until another HRU or an SRU boundary is encountered. Then go to Rule H-6.

Rule H-6: Are school district boundaries within or near the overlap area?

No: You are "somewhere else". Identify this "no-mans-land" as an HRU.

Yes: Delineate HRU boundary along topographic feature in close proximity to the school district boundary or, if none is present, use the school district boundary as the HRU boundary.

Application of the above Rules in the Lower Arkansas SRU resulted in the delineation of nine Human Resource Units. These are shown in Figure 12.

3. Comparison of HRU Maps

Human Resource Units delineated in the Upper Arkansas and Lower Arkansas Social Resource Units are shown on the first map in Figure 12. The second map in the Figure shows Human Resource Units as pre viously delineated using the qualitative FUND process (16). A comparison of Upper Arkansas HRUs is made first. This is followed by a comparison of HRUs delineated in the Lower Arkansas SRU.

Comparison of Upper Arkansas HRU Boundaries

By applying the variables and rules of application described above, four Human Resource Units were delineated in the Upper Arkansas SRU. These were the:

Leadville HRU
Salida HRU
Canon City HRU
Westcliff HRU

The boundaries of these HRUs are the same as those shown on the FUN D map, except for the eastern boundary of the Social Resource Unit as was discussed previously. What the FUND map shows as the "Lower Arkansas HRU" is shown as two HRUs; the Canon City HRU in the Upper Arkansas SRU, and the Pueblo HRU in the Lower Arkansas SRU.

Comparison of Lower Arkansas HRU Boundaries

The most obvious difference between the Upper and Lower Arkansas SRUs is the size of the Human Resource Units. They are bigger in the Lower Arkansas SRU than in the Upper Arkansas and reflect the longer distances that can be traveled in one hour's travel time.

In comparing the two maps, the wide variation between SRU boundaries delineated by the criteria and rules of application and those previously delineated by the qualitative FUND process are apparent. Using the process established here, all of the Arkansas River Watershed east of the mountains is included in the Lower Arkansas SRU. With the FUND process, portions of this area is included in the Front Range SRU, the High Plains SRU, and the Lower Arkansas SRU.

The variables and rules of application result in delineation of nine Human Resource Units in the Lower Arkansas SRU. These are:

Walsenburg HRU
Trinidad HRU
Pueblo HRU

Rocky Ford-La Junta HRU
Kimm HRU
Lamar HRU
Kit Carson HRU Limon HRU
Pikes Peak HRU

The Walsenberg and the Trinidad HRUs are essentially the same on both maps, as is the Pikes Peak HRU.

The Kimm HRU is a small rural HRU along the southern boundary of the Lower Arkansas SRU. It was created, based an the rules of application, because travel time lines from Trinidad, Colorado and from the Rocky Ford-La Junta areas did not reach far enough to include it in either of those two HRUs. The inclination was to include the area into the Springfield, Colorado area, but this area, based on the rules of application, did not fall within the Lower Arkansas SRU. However, Springfield, Colorado, which is 50 miles east of Kimm, is not a population center of 2,500 people or more. It is probably a part of the Boise City, Oklahoma HRU. Kimm is too far away from Boise City to be included in that HRU also.

Kit Carson HRU was delineated because it also is beyond the one-hour travel zone of the surrounding Urban Hubs. The FUND map shows the Kit Carson HRU area as part of the Cheyenne Wells HRU, and that is really where it is thought it should belong. However, Cheyenne Wells is just outside the SRU boundary as delineated using the variables and rules of application, so the area was kept separate so as not to compromise the variables and rules at this stage of process development.

The FUND map shows an Eads HRU north of Lamar. Application of the variables and rules includes the area designated as the Eads HRU into the Lamar HRU. The FUND map shows a large Human Resource Unit, the Ordway HRU covering the area east of Colorado Springs and north of Rocky Ford-La Junta. Using the variables and rules of application, this area is "whittled down" and called the Limon HRU. The southern portion of the FUND area which includes Ordway is included within the Rocky Ford-La Junta HRU based on travel time criteria. The Pikes Peak and the Pueblo HRU boundaries extend eastward (again based on travel times) to include portions of the western part of FUND's Ordway HRU. What is left is called the Limon HRU, a rural HRU as there are no towns within it having a population of 2,500 people or more.

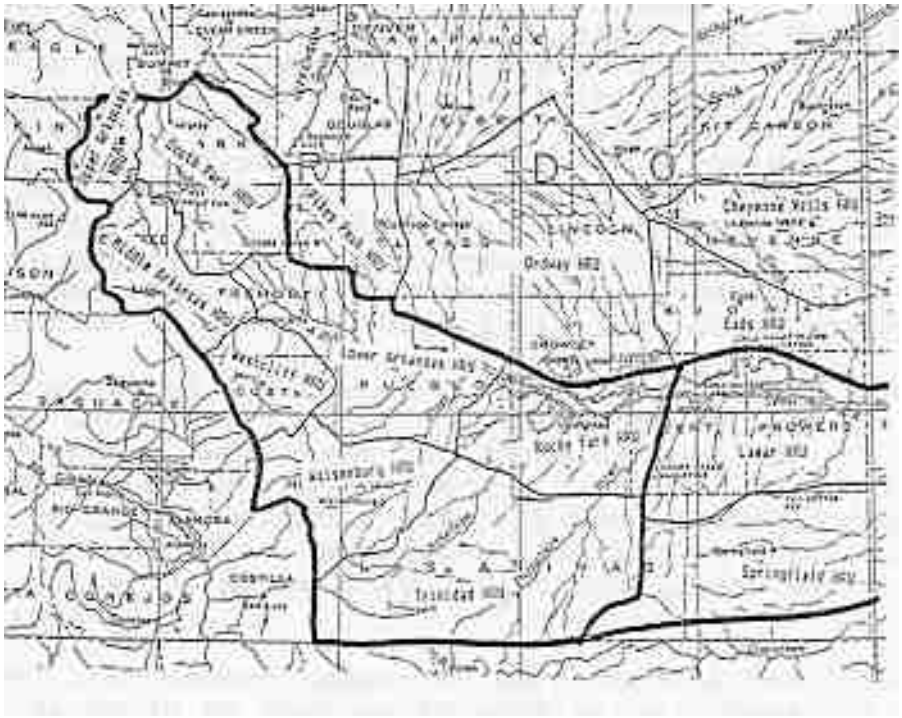
The Walsenburg and Trinidad HRU's are essentially the same as are depicted on the FUND map. It is difficult to decide which set of boundaries, those delineated by the various variables and the rules of implication or those previously delineated by the qualitative FUND process, are more correct. Rationale for the FUND boundaries is not available, so a good analysis as to why the boundaries are located where they are is not possible.

In the Upper Arkansas SRU, the process of first identifying Urban Hubs, then defining one-hour travel zones, and then delineating HRU boundaries on significant local topographic features works well. However, in areas of shallow or gentle relief such as the Lower Arkansas SRU, school district boundaries must be employed as the third step in the process and then, if local topographic features are not apparent near the school district boundary, it should be used as the basis for the HRU boundary.

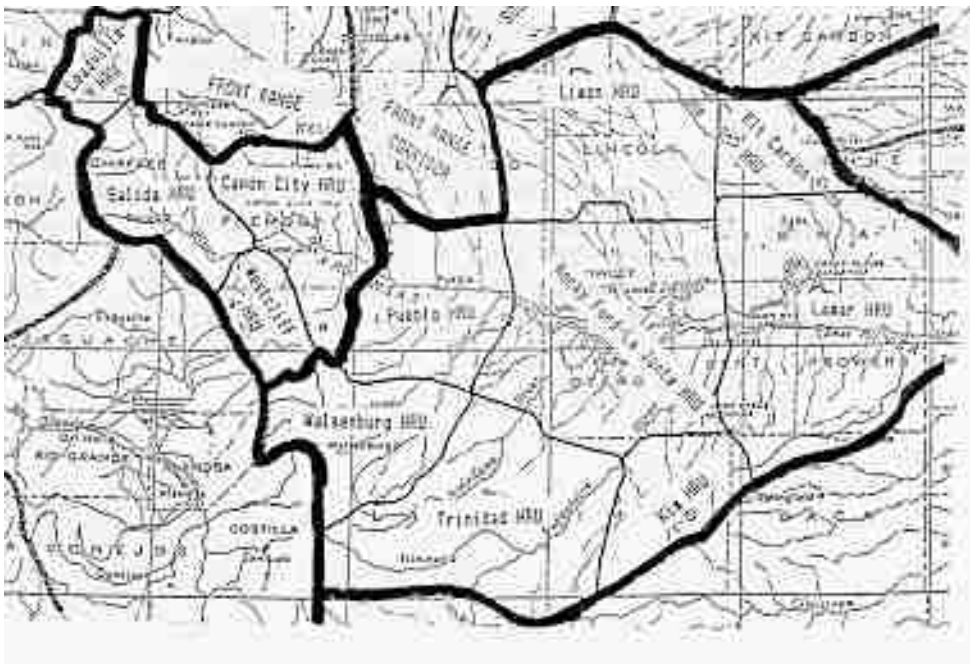
Major questions concerning SRU and HRU delineation surfaced when Human Resource Units were delineated in the Lower Arkansas SRU where local topographic relief is gentle. Are Regional and Subregional Watershed boundaries reliable SRU delineation criteria by themselves in areas of shallow topographic relief? Are these criteria adequate for the broader SRU delineations but need adjustment with school district boundary considerations to more accurately define them in areas of shallow relief? Field examination is needed to determine the accuracy of the HRU delineations where they are in error, and what criteria should be used to strengthen the process.

Figure 12: Comparison of Human Resource Units

HRU's Based on the Qualitative FUND System.



HRU's Based on the New Quantitative Model.



C. Neighborhood Resource Unit Delineation

Neighborhood characteristics include race, income, housing type, age, subdivision development, etc., but were not defined on the basis of any of the above nor any predictable combination of them. Neighborhood Resource Units could be described in terms of these characteristics, but not defined by them. For example, whereas an outside observer could preceive an area of similar style and housing type as being homogeneous (the Blocks area in Pueblo), a resident perceives more subtle boundary distinctions (the area in whih a resident is comfortable and "at home" is only a portion of the Blocks area). Neighborhood Resource Unit boundaries are defined on a very personal basis by those living within them. Neighborhood boundaries are defined by a combination and corroboration of many of these individual observations.

Neighborhoods, as delineated by field observation and interview (Appendix E) do not match those defined by the Pueblo Planning Department nor those defined for statistical purposes by the Census Bureau. The usefulness of City or County planning data, or Census Bureau data is limited because it is aggregated accordng to externally imposed criteria rather than on internally derived definitions.

Although, with enough research, Neighborhood Resource Unit boundaries could be derived by statistical means, it is our opinion that the process would be as arduous and costly as - or more so - the current system of employing field observation and personal interviews. Statistically delineated boundaries would still need to be field-tested. During the field-testing process, not only boundaries, but insights into locally held preoccupations and issues would emerge - the information most vital to both private and public project development.

Our conclusion is that neighborhoods, and therefore the Neighborhood Resource Unit, is such a personalized and individually important Unit that we did not want to reduce it's delineation to a set of statistical correlates. Efforts to find a set of quantitative variables to delineate boundaries of Neighborhood Resource Units was stopped.

Appendix A:
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