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Environmental Criteria to Aid Developers in Site Evaluation for Small Scale Residential Developments in Cache County, Utah

Roger P. Fickes
Utah State University

ENVIRONMENTAL CRITERIA TO AID DEVELOPERS IN SITE EVALUATION FOR SMALL SCALE RESIDENTIAL DEVELOPMENTS IN CACHE COUNTY, UTAH

by

Roger P. Fickes

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Roger P. Fickes

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF PHOTOGRAPHS

ABSTRACT

Environmental Criteria to Aid Developers in Site Evaluation

for Small Scale Residential Developments

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by

Roger P. Fickes, Master of Landscape Architecture

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Major Professor: Professor Gerald L. Smith
Department: Landscape Architecture - Environmental Planning

The purpose of this paper is the preparation of environmental criteria to be used to aid future developers, county planning board, and county commissioners in the evaluation of sites for proposed small scale residential developments, and whether that development will have an irreparable environmental impact. The criteria are intended to fill the gap between standards for housing developments and finished design and that of environmental impact of small scale housing developments in Cache County, Utah.

(98 pages)

CHAPTER I

INTRODUCTION

As urban sprawl and metropolitan decay overtake today's society, it becomes imperative to know and understand the mechanisms and procedures for planning communities so as to insure an ordered and logical growth in America. Population predictions estimate the current population will double in thirty-four years (Ehrilich & Ehrilich, 1970, p. 10). To accommodate these people as well as insure a high quality of life, will take a great deal of long-range planning, i.e. city and regional planning, new community planning, etc. "To adapt human settlements to dynamic change may soon outstrip even disease and starvation as the gravest risk, short of war, facing the human species" (Eckardt, Wolf von, October 26, 1963, p. 16). To ignore the problem of population and its settlement patterns is a serious mistake. We must insure our future by a better understanding of planning and the problems and the impacts that will arise from that planning.

"It has been estimated that the United States needs 2.6 million new housing units a year and nearly 20 million new units by 1980" (Huntoon, Maxwell, Jr., 1971, p. 8). This observation says nothing of the creation of new housing units to meet the repair of dilapidated housing. In order to house these people effectively and contribute as little damage as possible to the environment, we must form guidelines for the residential developer.

Today it is not the environmentalist, ecologist, city or regional planner who says where new communities are to spring up. It is the housing developer with a wary eye for easily accessible land with a potential high dollar return and little conscious evaluation of the impact a housing development would have on the land, who makes the planning decisions. One of the most desirable ways to solve current housing problems and curb urban sprawl is the use of the planned unit development concept. P.U.D. is a relatively new method or concept in community planning, approximately 1965 (Huntoon, Maxwell, Jr., 1971, p. 13). The following is a definition of planned unit development.

> A P.U.D. includes a minimum of about 100 acres. There can be exceptions, but that is about the smallest area that can hold the 700 to 1,000 living units required to make up a real community and still meet other P.U.D. requirements.
>
> A P.U.D. has at least 25% of its area in open land, and wherever possible this land is left in its natural state.
>
> A P.U.D. is cluster planned. This frees land for open areas, lets buildings be sited so that the remaining land can be minimally disturbed and makes utilities and services cheaper to install for the builder and cheaper to install for the builder and cheaper to maintain for the town.
>
> A P.U.D. includes all types of housing--single family detached, townhouses, garden apartments. Thus it does not contribute to urban sprawl, and it gives the town a balanced community. (Rahenkamp, Sachs & Wells)

Small scale developers have the least capital to expend on planning or decision making, and usually contribute the most to urban sprawl and

environmental damage by using only small parcels of land at any given time in a sort of "leap frog" approach to urban sprawl. Therefore, this paper will orient itself toward the small to intermediate size developer (usually under 100 acres). I think a current misconception concerning Planned Unit Developments and smaller scale developments should be dealt with. Many times developers in an effort to appear innovative in their planning methods and techniques apply the term Planned Unit Development to their project. Often the application of this term is either purely a misunderstanding of the basic concept or a means of enticing prospective buyers to a new development under the guise of a term that has become very popular and greatly misunderstood by the general public. As can be seen by the preceding definition a Planned Unit Development is a development at least 100 acres in size with 25% of that land in open space; it includes cluster planning, and all types of housing--single family detached, apartments, townhouses. Therefore, development that does not meet these limitations is not a Planned Unit Development.

> The challenge is not to declare a moratorium on all new projects because of possible deleterious ecological or environmental impact, but to guide these projects into desirable patterns into new communities which not only will be economically self-sufficient, but also a contributor to the long range quality of life in a region. (Gow, Victoria, September 1970, pp. 1-2)

There are many areas or categories of study that could be undertaken in an impact study of a small scale residential development--such as

sociological, economical, population, environmental or ecological, housing, etc. It is the scope of this study to focus on one of the many impact areas of small scale residential developments--that being the natural environment. The Planned Unit Development concept has been in existence for almost 10 years, but new and innovative planning methods are not enthusiastically received. No matter how long this trend continues the residential developer will need help in decision-making. We not only need state and federal land use laws and environmental stipulations, but it is the purpose of this study to also establish decipherable environmental criteria that the housing developer may use in order that he may make valid decisions when planning new developments.

There are areas or conditions within the natural environment that serve as indicators of whether any particular development will have a severe or moderate impact upon that environment. From these general indicator conditions (hydrologic, climatic, wildlife, to be established as research progresses), I will establish criteria to guide developers in the planning of development.

These criteria will be relevant to a case study area (Cache County study area will be defined later in this chapter). For example, one of the environmental criteria might be the watertable. This condition has very significant effects upon placement of housing units and should be analyzed before any development takes place.

Following the establishing of criteria for the case study area, conclusions were drawn. These conclusions appear in the form of:

1. Weaknesses established by a comparison of what developers are actually using now, and what the ideal situation should be.
2. Pictorial examples of developments that violate the environment through an obvious lack of guidelines, and also examples of developments sensitive to the environment.
3. Recommended problem areas uncovered within this study that need further consideration.
4. Are developers willing to help solve the many housing problems we have today and still respect the environment?

Case Study

The case study area is Cache County. It is an ideal study area in that it provides an example of the early stages of urban sprawl, that may be checked if adequate guidelines are established to help developers. There are currently no environmental guidelines which sufficiently direct developers in making environmental decisions, thus the application of the thesis could be immediate.

In summary it is the objective of this thesis to establish environmental guidelines to aid developers in site evaluation for small scale residential developments in Cache County, Utah. These guidelines will be

in the form of criteria pertaining to the specific environmental conditions existing in Cache County, and additional information concerning agencies and professionals who may be contacted for specific environmental studies and requirements.

CHAPTER II

DOCUMENTATION OF ENVIRONMENTAL INDICATORS

Volumes of research and educational material have been published on general aspects of the environment that should be studied when selecting housing sites, either for one house or many housing units. This chpater will attempt to examine this information which has been published all over the country and extract the basic characteristics or aspects of the natural environment that are common denominators, no matter where one is located.

In this chapter I will examine selected sources of information; not because they are the only ones but simply because they are the ones that have been most recognized and noted. These sources will cover different levels of expertise, starting with the federal government which has recently issued the National Environmental Policy Act. Another large organization whose work merits study is the Urban Land Institute. I will also examine a large environment-oriented group's contribution (California Tomorrow), and a new planning commission's recommendations of the indicator factors that must be studied before any development can take place (Tahoe Regional Planning Agency). The Cooperative Extension Service at Cornell University has also delineated certain environmental aspects that govern housing site selection and the implications that arise from these environmental aspects. And last, I have included the work done by a leading planning firm which uses

the hydrologic cycles as the sole indicator for the land's capability for handling future development (Rahenkamp, Sachs, Wells, Assoc.). These sources have been merely quoted and briefly discussed to establish the general environmental indicator factors that should govern future housing design decisions throughout the country.

The National Environmental Policy Act

Title I

Declaration of National Environmental Policy

> Sec. 101. (a) The Congress, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, high-density urbanization, industrial expansion, resource exploitation, and new and expanding technological advances and recognizing further the critical importance of restoring and maintaining environmental quality to the overall welfare and development of man, declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.
>
> (b) In order to carry out the policy set forth in this Act, it is the continuing responsibility of the Federal Government to use all practicable means. Consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may--
>
> (1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.

> (2) assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings.
>
> (3) attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences.
>
> (4) preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice.
>
> (5) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and
>
> (6) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.
>
> (c) The Congress recognizes that each person should enjoy a healthful environment and that each person has a responsibility to contribute to the preservation and enhancement of the environment.

The Environmental Policy Act gives a very broad range of aspects to be studied when speaking of environmental effect. While these guidelines cover almost every contingency, they do not supply concrete guidance which a developer can grasp and make valid, logical decisions.

The Urban Land Institute identifies the critical environmental issues that developers will be faced with. Problems pertaining to these issues must be solved by the developer in order that he insures environmentally sensitive projects.

The issues as outlined by U.L.I. are water, air, aesthetics, and noise.

The problems of environmental improvement are complex, and solutions are extremely difficult. U.L.I. emphasizes the role of the developer as having a very significant effect upon the face of our landscape. He also carries a great responsibility, that of structuring human living environments for many years to come. He must be aided every way possible so that his decision-making process is compatible with the finite environment. The following are the critical concerns as outlined by U.L.I.

Water

Water is a limiting factor for future urban development. Consequently, development should be encouraged close to adequate supplies and discouraged in areas of inadequate and uncertain supply.

Waste Water

An important aspect of new development is guarantee of a pure water supply. Purity of water sources can be protected through various engineering practices, use restrictions, and protective covenants.

Under no circumstances should lakes, ponds, rivers, streams, and other water courses be used for dumping of liquid waste unless all bacteria and chemical pollutants in the liquid waste have been removed beforehand.

Insofar as possible, chemicals and bacterial pollutants should be removed on site rather than transporting them by water. Research and development efforts now underway to develop means of concentrating, detoxifying, and disposing of solid, liquid, and gaseous wastes on site should be encouraged and accelerated. On-site treatment would not only lessen the danger of pollution, but would also save the costs of complex traditional sewage collection and disposal systems.

Toxic chemicals used in fertilizers and agricultural processes should be prohibited if they cannot be disposed of on-site. Large animal populations should not be

located where their wastes may pollute surface and underground water supplies.

Storm Water

As much run-off as possible should be carried through surface channels rather than large underground pipes. Proper design of surface drainage offers a supplemental system to existing underground facilities to handle overloads generated by intense rainfall.

With proper design of surface channels, including street gutters, sizing of underground storm drainage pipe can be reduced. An integrated surface of land and underground system not only reduces the cost of land development, but protects against storms of extreme intensity for which it is economically unfeasible to provide sufficient underground pipe capacity.

It is generally true that it is economically inadvisable to combine storm water and sanitary sewage into a single drainage system. Furthermore care should be given to designing the storm drainage system to prevent the invasion of sanitary sewage by substantial amounts of storm water. The addition of storm water to a sanitary system overloads sewage treatment plants resulting in decreased efficiency. Conversely, care should be exercised to assure that sanitary sewage or any other form of pollution does not invade the storm water system. Provision for maximum surface drainage and separation of underground storm and sanitary systems is strongly recommended.

Recreational Waters

Recreational water bodies, whether natural or man-made, are in increasing demand. Man-made water bodies, properly conceived and maintained provide not only amenities that increase land value, but also benefits to the natural environment.

Air

Because air is ubiquitous and the harmful effects of its pollution are mobile, control of air pollution requires governmental regulation over large geographic areas. The individual land use planner and developer has only

limited "defensive" control over atmospheric pollution from outside his development or from public automobile, rail, air, and water transportation. However, he can take positive steps to mitigate air pollution resulting from activities that are carried on within his development, particularly from stationary sources. Three basic methods for pollution management are available to him: 1) pollution abatement technology. 2) regulatory control. 3) locational planning.

At the governmental level, locational control must be exercised over large industrial and power-generating sources of pollution. It should be noted however, that, whether at the local or regional level, locational planning serves only to mitigate the effects of air pollution on the surrounding area. It does not prevent atmospheric contamination if one considers the long-range effects on the earth's atmosphere as a whole. Inter-governmental effort will be required to solve this more far reaching problem.

Aesthetics

Land planning is especially critical in high density development. Care must be exercised not only with such safety and convenience concerns as separation of pedestrian and vehicular movements, but also in aesthetic considerations. It is fundamental to improvement of the aesthetic environment that strict architectural control of all buildings be maintained by the developer or his successor.

Noise

Among the major sources of noise are 1) auto and truck traffic. 2) aircraft. 3) industry. 4) public and private recreation areas and institutional uses. The developer should consider the three major ways open to him to control sound: 1) location of activities. 2) architectural and engineering design. 3) restrictive covenants governing noise-producing activities.

The developer's first consideration should be the location of his project with reference to its surroundings. He must consider not only the potentially detrimental effects

> of noise external to his development, but also the impact of noise generated by the activities in his development on the surrounding area and within the development itself.
>
> The chief pollution problems which the developer should be aware of during construction are: contamination of air and water, land despoilment, and noise. Good "housekeeping" practices can do much to curb potential temporary and permanent harm to the environment. (Environment and the Land Developer, Urban Land Institute, 1971, pp. 1-21)

California Tomorrow is an organization deeply concerned with the quality environment we are making for ourselves and our children. This organization relies mainly on examples of environmental destruction to drive home their point. They cite intrusions of "recreational" subdivisions as changing wildlife patterns, altering stream courses, interference with normal drainage patterns, and devastation of natural ground cover permanently altering the environment. The answer foreseen by California Tomorrow is legislation at the state and local level to curtail the "promoter" and the "speculator" and give local governments guidelines to work with. The following is an excerpt from one of their publications that outlines the kinds of mistakes developers are making, and the consequences these mistakes have on the environment.

The Damage to the Land

> Huge acreages are going into speculative subdivisions more every year. Boise Cascade claims 29 projects as of March 10, 1970--18 of them in California--totalling 71,000 acres, and they are now attempting to get permissions to cut up thousands of acres more.

In addition to the adverse effects these subdivisions may have on buyers, communities and adjoining land owners, the greatest harm done is to the land itself.

In the past it was thought that requiring expensive "improvements" would slow down unneeded development. It is now clear that there is a seller's market at almost any price in times of inflation, prosperity and dissatisfaction with city living. The more the consumer is "protected" (by the requirements for sewers, water systems, longlasting streets, etc.) the more the land is harmed, because it is prohibitively expensive to return it to a natural state again. The removal of the scars is more difficult than making them.

Patterns of subdivision design change; for instance, the 25-foot frontage lot in the country is no longer acceptable, although it was 50 years ago. And in the next 50 years we may go far beyond our present concepts of satisfactory lot design and land use. Most speculative subdivisions are far behind even current innovations in design because of two things; they frankly aim to sell every square inch of land they are permitted to, and the buyers they attract are not usually those who are looking for sophistication. This is the reason we see the repetition of a San Fernando Valley suburb at the 5,000-foot elevation, where it is grossly inappropriate.

But the creation of these lots by the thousands will commit the land to the tired old design styles no matter what future experimentation and experience teach us.

When we really need the land for proper lot development or other, better uses, the best of it will be gone. And meanwhile, our open space decreases every year. The intrusion of the "recreational" subdivision changes patterns of wildlife, alters the course of streams. Even though there is little building or use, the cut and fill construction, interference with normal drainage patterns and devastation of natural ground cover permanently alter the environment. They affect hunting, fishing, hiking and all the pleasures people take in the land. They preclude future cultivation, grazing, timbering. The land as a resource is gone. (Cry California, 1970, pp. 10-11)

The Cooperative Extension Service at Cornell University has released several educational bulletins which dictate certain environmental guidelines and briefly discuss the environmental indices that must be considered, for single home site selection. It is intuitively obvious that if these general indicators are important at one home site, they would be magnified many times at a larger scale, meaning a P.U.D. or similar development with more that one dwelling unit. The cooperative Extension Services Environmental guides are: topography, soils, and bedrock, surface drainage, existing vegetation, sewage disposal, water supply.

Topography

Level, clear areas with a pleasant view are often the most in demand and are usually the easiest on which to build. Slopes are conducive to imaginative site planning. Grade changes permit opportunity for building-to-building relationships, auto storage and outdoor recreation areas. Gentle slopes are preferable to rugged terrain for most residential building.

Soils and bedrock

The depth of soil to bedrock is important for excavation, drainage and landscaping.

Sewage disposal

Where public systems are not available, county, town and village health regulations, often will dictate what type of sewage disposal system is required.

Surface drainage

Natural water drainage systems should be identified and protected.

Existing vegetation

The value of natural vegetation as a part of site quality, and development cannot be over-estimated. Where healthy and attractive vegetation exists on an undeveloped lot, it should be preserved.

Water supply

If water is to be supplied by a community water system, check to find out if the supply is adequate, especially during summer months. (Home Site Selection, 1970, pp. 2-4)

The counties around Lake Tahoe have formed a planning commission to establish guidelines for future development. The guidelines are quite stringent and refer to specific aspects of the environment that must be noted and analyzed. These guidelines are covered under two headings: General Environmental, and Specific Requirements for Subsurface Investigations Standards. The general categories that the specific aspects fall under are: topography and slopes, aesthetics, vegetation, soils, wildlife habitat, geology, hydrology.

General Environmental Standards

Subdivisions shall be planned, designed, constructed and maintained to preserve the natural environment and scenic beauty of the Lake Tahoe Region.

Specific consideration shall be given to preservation of natural topography such as drainage swales, rock outcropping, slopes, and areas of special natural beauty or scientific interest, particularly where of scenic or environmental importance and value, to preservation of existing vegetation; to retention of major land forms, and to preservation of important vistas.

Subdivisions shall be planned, designed, constructed and maintained to require the minimum feasible amounts of land coverage, and the minimum feasible disturbance of soil and site by grading, excavation and other land alterations.

Subdivisions shall be planned, designed, constructed and maintained to avoid substantial probabilities of:

(a) accelerated erosion;

(b) pollution, contamination, or siltation of lakes, rivers and streams;

(c) damage to vegetation;

(d) injury to wildlife and fish habitats

Buildings, structures and other improvements shall not be located within any 100 year flood plain as determined by the permit-issuing authority, water course, drainage or channel within the high water level of Lake Tahoe or within the area subject to Lake Tahoe wave action. (Subdivision Ordinance, March 22, 1972, pp. 7-8)

Specific Requirements of Subsurface Investigations

In particular, subsurface investigations shall be conducted where stability will be lessened by proposed grading or filling or where any of the following conditions are discovered or proposed:

At fault zones where past land movement is evident.

At contact zones between two or more geological formations.

At zones of trapped water or highwater table.

At bodies of intrusive materials.

At historic landslides of where the topography is indicative of prehistoric landslides.

At adversely sloped bedding planes, short-range folding, overturned folds, and other geologic formations of similar importance.

Where side hill fills are to be placed on existing slopes steeper than 16%.

> Wherever groundwater from either the grading project or adjoining properties is likely to substantially reduce the subsurface stability.
>
> Where any of the particular problem areas listed above or other weaknesses are found, the subsurface investigation shall be of sufficient intensity to describe the problem thoroughly. The person or firm making the report shall submit a written report of their findings and recommendations. (Grading Ordinance February 10, 1972, pp. 6-7)

Rahenkamp, Sachs & Wells, noted land planners and landscape architects have taken quite a different approach to guiding land development. They have hypothesized that the hydrologic cycle is the specific indicator of the quality of the natural systems. If disruption of the hydrologic cycle is controlled the natural systems will be able to maintain quality. This means the only environmental indicator Rahenkamp, Sachs & Wells use is the hydrologic cycle. Following is a short explanation of their method.

> The technical assumption implicit in this work is that if disruption of the hydrological cycle is controlled within tolerable limits, the natural systems will be able to maintain a reasonable level of quality indefinitely. This restriction, however, must recognize private property rights which are constantly being redefined by the courts. We have tentatively accepted recent decisions of the Pennsylvania Supreme Court which had indicated that one dwelling unit/acre is the most restrictive zoning classification which the courts will recognize as non-confiscatory. (Appeal of Kitmar Builders, Inc., 439 Pa., 1970, p. 466)

> The procedure which we have developed and applied, produces a numerical output table which can be mapped for use and delineated for display. Each grid cell receives a % designation which is the maximum impervious cover which can be placed in that location.

The water budget in a drainage area refers to the disposition of the annual precipitation.

1. Interception. Moisture retained on the surfaces of ledges, rocks, etc. and evaporated directly.
2. Direct Runoff. Water running directly into streams without soaking into the ground.
3. Infiltration. Precipitation which is not lost to interception and direct runoff infiltrates into the ground at a rate which is a function of the type of ground cover and solid characteristics.
4. Evapotranspiration. A portion of infiltration is transpired by plants from roots to leaves and hence evaporated.
5. Base Runoff. Infiltrated water moves through soil and bedrock and enters the surface drainage system as base runoff from springs. A portion of it is extracted from wells for human use, but most of this is returned to surface drainage. Base runoff fluctuates seasonally.
6. Hydrologic Response. HR is direct runoff in inches divided by annual precipitation in inches. High values indicate storm drainage problems.
7. Peak Discharge. A measure of water flowing past a control point. This is a measure of the effect of runoff, while the direct runoff equation analysis cause of runoff.

Runoff Computation

1. Direct Runoff. To compute runoff for any given storm we have chosen the method devised by the Soil Conservation Service (SCS), which is explained in detail in Chapter II of the SCS Field Manual and the SCS National Engineering Handbook: Section 4, Hydrology; Part I - Watershed. (Rahenkamp, Sachs & Wells, 1970, p. 82)

As can be seen by cursory examination of this chapter there are certain critical indicator aspects of the natural environment that can be noted as common throughout the country when speaking of future development.

These common aspects apply to the natural environment no matter where the development takes place. Granted certain of the indicators will be more critical depending on the geographic location one is studying, but still all must apply. The indicators were arrived at by a sampling of Federal, State and private research done pertaining to housing and its impact upon the quality of the environment. The indicators that are common throughout the sampling are: hydrology (groundwater, surface water, drainage, waste water), geology, air (climate), aesthetics, vegetation, soils, topography, wildlife.

CHAPTER III

ESTABLISHMENT OF CRITERIA

As has been stated in the previous chapter, there are certain environmental indicators that are common throughout the natural environment no matter what location one is in. By comparing Cache County environmental conditions and the general indicators from chapter two (pp. 19-20) which are hydrology, geology, climate, aesthetics, vegetation, soils, topography, and wildlife, environmental criteria may logically be established to guide developers in site evaluation for small scale residential developments in Cache County.

Undesirable new developments may result from many possible sources, poor design, poor location, poor market analysis, insufficient funds, to name just a few. It is usually the job of the local officials, county or city commissioners, or local planning commission, to determine if the proposal for the location of new residential developments are good or bad. There are usually three location factors or considerations that county officials must analyze.

1. Is the development properly located as to community development objectives.
2. Is the community willing to extend needed services.
3. Is the land physically suited to subdividing and development. (Guiding land subdividing, October, 1964, p. 1)

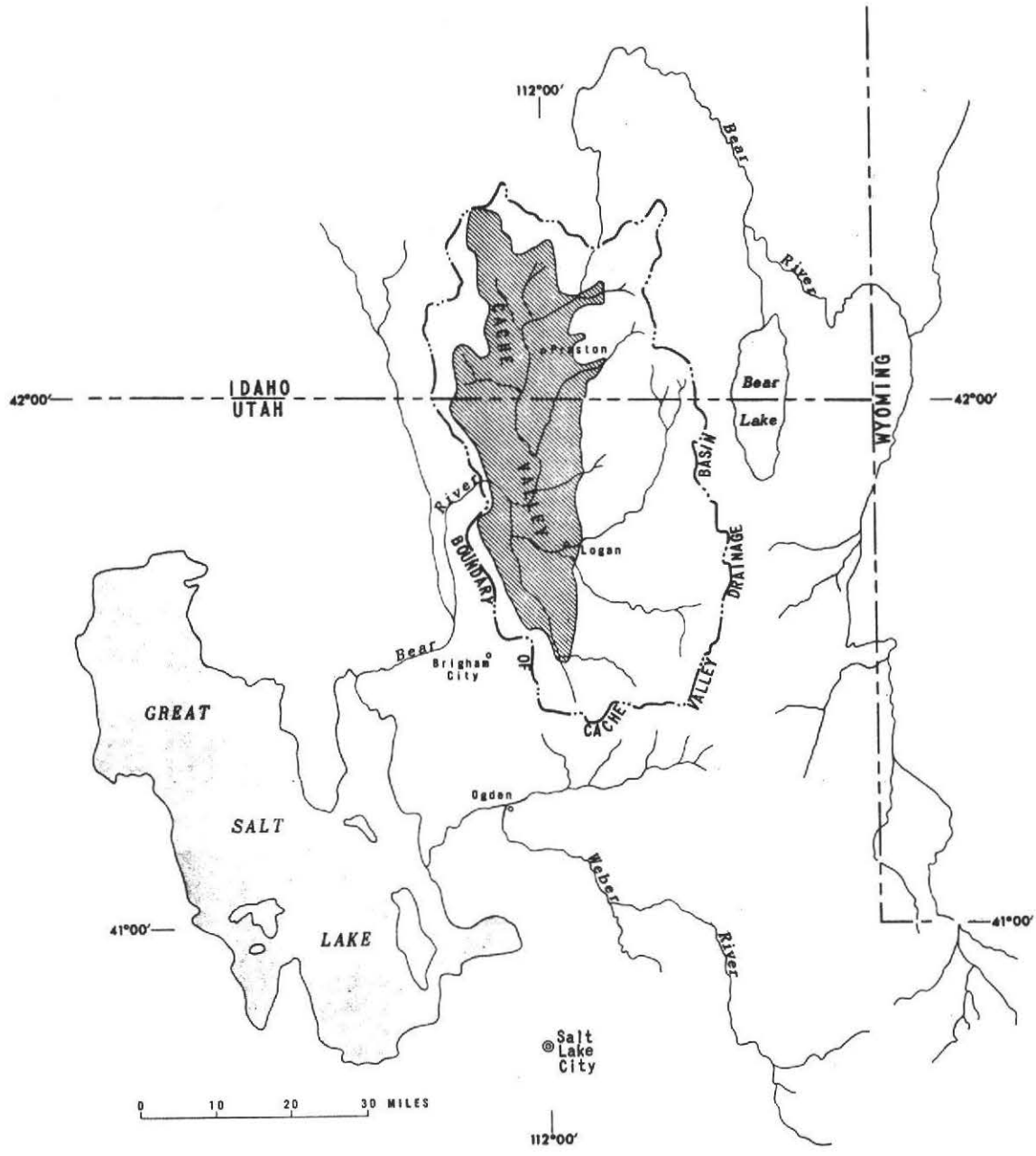


Figure 1. Location map of Cache County, Utah.

It is the purpose of this chapter to focus on the last of the preceding considerations to see just what makes a parcel of land suitable or unsuitable for residential development.

New developments not required to conform to certain environmental standards usually have an adverse effect upon the natural environment. An environmental effect is always felt when land use is changed by man. Environmental effects or impacts can be grouped into three categories.

1. On site impact . . . grubbing, grading, and related improvements.
2. Off site impact . . . roads, drainage ditches, sewers and leach fields, utility installations, visual quality.
3. General impact on the region . . . a major change to one parcel of land has to have, even though small, an effect on adjacent lands. This effect or impact can be anything from changing migratory patterns of feed and roost. To serious impact on down river domestic and irrigation water affected with nutrients and effluents from the new development. (Munger, Maynard, Jr., 1971, p. 10)

There are areas or conditions within the natural environment that serve as indices of whether any particular development will have a severe or moderate impact upon that environment. These environmental indicators fall into two general categories--on site and off site. The following are the most important environmental indices established in Chapter II.

1. Soils
2. Hydrology (ground water, drainage, flood plain)
3. Geology (subsoils)

4. Slope (topography)
5. Aesthetics
6. Climate
7. Plant Associations
8. Wildlife

They are a guide to the environmental requirements affecting housing design for a specific case study area. These criteria may or may not be intended to establish hard rules, depending upon the disposition of the local governing body (County Commissioners). Rules and standards are available in various zoning and subdivision ordinances within the county. However, these criteria are intended to fill one of the gaps between standards and finished design; that of environmental impact of small scale housing developments within Cache County. They indicate specific needs which will allow the designer or prospective developer to determine which are most critical for a specific case.

The items included in the criteria resulted from reviewing the many sources indicated in the bibliography and comparing the environmental indices, which are common throughout the country, with the existing conditions within the case study area.

Certain items of the criteria must be filled in or clarified by the prospective developer for each project, such as economic influences, social impact, etc. The criteria are listed under the specific environmental indicators arrived at in Chapter II.

The following format will be observed throughout this chapter.

1. General information about indicators, i.e. soils, hydrology, historical geology, etc.
2. Elaboration of criteria in more detail.
3. Explanation of how to use criteria and possible professionals and agencies to contact.

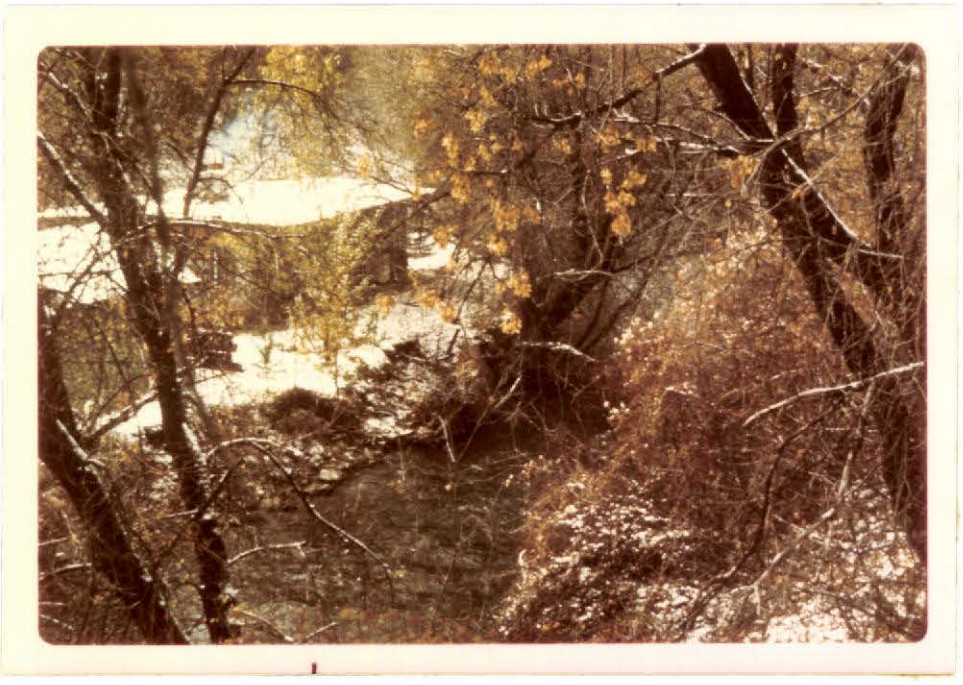
Soils and Surficial Geology

In general there are two basic considerations when determining if soils are suitable for building purposes. First, does the soil have a suitable bearing capacity, that is, can the soil support the weight of numerous structures from a city or municipal line? Second, will the soil be suitable for the construction of individual septic tank systems?

Soil permeability will aid in knowing if septic tanks can be operated successfully. And lot sizes must be large enough to accommodate drain fields from the septic tanks. Usually soils consisting of coarse sands and gravel have highest permeability rates, therefore are best for septic tank and drain field operation.

1. More sand than silt or clay is usually acceptable.
2. Equal amounts of sand, silt and clay are usually unacceptable.
3. High clay and organic content is unacceptable. (Cache Soil Survey, 1966, p. 43)

The three categories previously mentioned are general standards that may be followed; however, some soils of high permeability are not acceptable as building sites because they are low lying areas along streams and would thus allow effluents to do directly into the stream, or not enough depth to bedrock and would not allow sufficient percolation to neutralize the effluents before they reach the ground water (elaborated on p. 33).



Photograph 1. Pollution--Blacksmith Fork River

Stagnant water may be another dangerous drainage problem, either due to impervious soils or extremely high watertable. These areas must be drained properly at considerable expense to the builder, or better yet, no new development would be the wiser choice.

Another fact that should be mentioned at this time is the capabilities and limitations of certain types of soils to support plant life. If soils are too acid or alkaline; too wet or dry; to high in organic content or too low, they may pose serious problems as to what kinds of plants would survive. It would be very disheartening to a homeowner to find out after a lot is purchased that only sedge grass and gophers grow on his land.

As can be seen on the accompanying soils map (Figure 2), Cache County soils are very diverse. There are three main associations on the valley floor, the Logan-Salt Lake association, Trenton association, Greeson, Nibley, Collette association, all deep, moderately fine and fine textured, and somewhat poorly drained. The bench and foothill areas of Cache County consist of five basic associations, Mendon-Avon association; Wheelon-Collinston association; Ricks-Timpanogos-Parleys-McMurdie association (Lake Bonneville Deposits); Nebeker-Hendricks association; Richmond-Sterling-Deweyville association. Each of these soils is well drained, and from moderately fine and fine textured soils of the intermediate and high lake terraces, to gravelly and stony coarse textured soils of the uplands. The remaining soil types of Cache County are well and somewhat excessively drained soils of the Yeates Hollow-Ant Flat-Goring association, Sheep Creek-Hoskin-Curtis Creek association, Agassiz-rock outcrops association, Dateman-Agassiz-Baker Pass associations, Lucky Star-Cluff-Bickmore association, all ranging from moderately fine and fine textured soils to

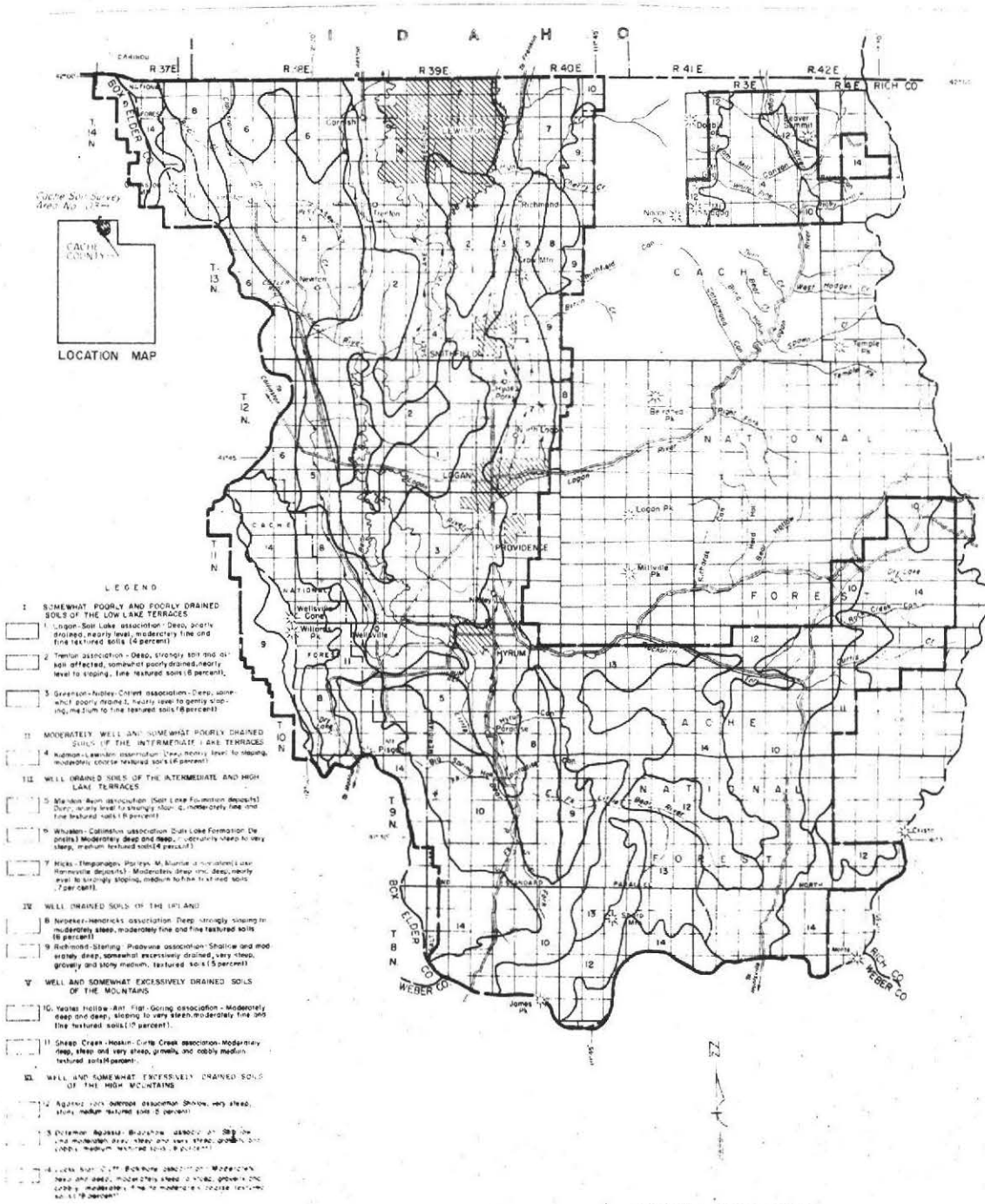


Figure 2.

GENERAL SOILS MAP
CACHE SOIL SURVEY AREA No. 103
CACHE COUNTY, UTAH

JUNE 1966

gravelly, cobbly, stony textured soils. From closer study of the soils map (Figure 2) one can ascertain the general relationships of the different soils types and the restrictions they dictate.

Criteria

1. Soils should be of suitable bearing capacity to support the numbers of building units proposed.
2. Soils should not be susceptible to creep, slide or flow.

These two criteria fall within the limits of soil mechanics. There are two problems when dealing with the soil and its physical suitability for bearing structures. One type of soil action involves "deformations." Deformation occurs when the supported structure is too great for the soil's bearing capacity. This usually entails settlements which can be witnessed by cracks in foundation walls, uneven settling of foundation, roadways, parking lots, etc. The soil yields or deforms without actually reaching the point of failure, which leads us to the other type of soil action. This is the actual shear or sliding failure of the soil due to insufficient strength to sustain applied loads. (See Photograph 2.)

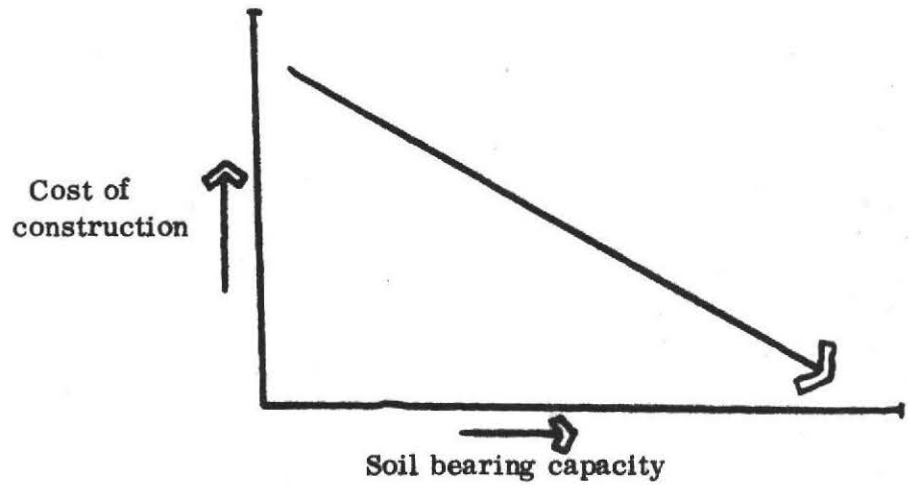
Actions of this type include stability of earth slopes, pressure of earth on retaining walls, ultimate bearing capacity of footings resting on soil, etc.

Photograph 2. Sliding failure of unstable soil

Soils of Cache County have a wide variety of textures and bearing capacities, from poorly drained fine textures of the valley floor to excessively drained gravelly and cobby textured soils of the foothills and high mountains. Soils of the low lying areas of Cache County are the finest textured soils, and also generally have the poorest soil bearing capacity. Water is the major hazard in these type soils, due to the holding capacity of the finer grains. Soils of the intermediate elevations with medium textures are most suitable for large bearing capacity. The mixture of fine grained and moderately coarse textures gives the best bearing capacity. However, certain conditions do exist within Cache County at the intermediate levels that restrict bearing capacity, that of a medium texture and the

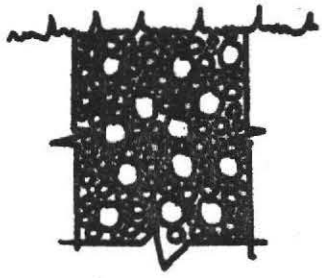
unsolidified character of benches and other alluvial deposits. Once water permeates the top layer and is absorbed by the fine grained clayed layer, the clay acts like a skid under extreme bearing loads and the soil is susceptible to slump or flow. Soils of higher elevations are the distinct opposite of lower elevations where grain size is cobby and coarse textured and excessively well drained, which also dictates low bearing capacity unless stabilized in some manner.

All soils are manageable from an engineering standpoint. If soils are unstable or of unsuitable bearing capacity they are still usable; however, there will have to be larger expenditures of money to solve these problems.

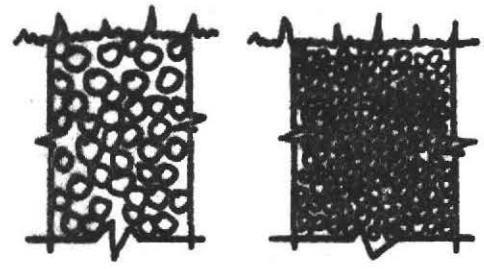


One can see by the simple graph as the soil bearing capacity goes up, the relative cost of construction goes down. (Less money will have to be expended on engineering techniques to stabilize the soils.)

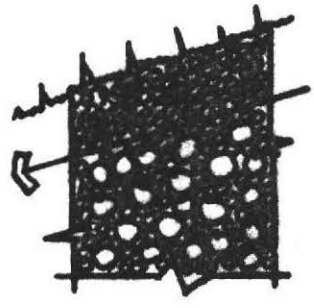
What makes a soil of suitable bearing capacity?



Soils of all different sizes of particles well mixed are best because there are little or no air spaces and cohesion is at a maximum.



Soils of generally unsuitable bearing capacity are those of all large textured grains (gravelly) or small textured grains (sandy) unless some stabilization method is used.



Clay type soil over more stable well-mixed types could be subject to movement or flow, if wet and large loads are placed on them.

Cache County has many interesting and unique soil problems that influence bearing capacity of the soil. These problems must be identified and solved before any development can proceed. All studies must be done on an individual site basis.

3. Soils must have adequate permeability rate if units are not joined to city or main sewer lines.

One method of sewage disposal is, of course, to be able to join a minaline. This way the homebuilder or developer does not need to worry about solving the problems of sewage distribution. If, however, no sewage main is available one must either rely on holding tanks or leach field systems, as is the case in Cache Valley. For more information about coverage of sewage (public) systems in Cache Valley refer to the year 1990 plan available at the Courthouse of Logan City.

Due to the extra cost of pumping out holding tanks at periodic intervals, septic tank and leach fields are easiest and least expensive to maintain and use. However, where sewage is disposed on site, these systems must be kept far enough away from the water supply so they don't become contaminated and unusable. This means adequate percolation tests must be done to determine the type and design of the spetic tank and leach field system. Well-drained soils often permit a smaller leach field; however, one must exercise caution in excessively drained soils so that contamination of ground water does not occur. Poorly drained clay type soils require more extensive and elaborate leach fields.

Percolation rates are completely dependent upon soil types. Soils are composed of layers or horizons that differ in color, texture, structure, porosity, ph, plant nutrients, organic matter, minerals and other features. Soils should be identified and studied at each site by engineering surveys.

On the valley floor in Cache County the water table is very high (Figure 5). Even if the percolation rate is adequate, the perched water table is so high that any discharge of effluents into the ground would almost certainly result in pollution. On the higher ground in Cache County the soil types are more suitable for an adequate percolation rate; however, at these elevations care should be taken to study and analyze the soil types such that no pollution of the streams and watersheds will occur.

How are soil criteria used? First of all the need for soils study must be recognized. If the need is recognized, soils studies must be undertaken. It should be determined if the soils are of suitable bearing capacity, and if they might be susceptible to creep, slide or flow. The developer can make preliminary observations himself. If he detects too much sand, clay, or gravelly soil (those with lowest bearing capacity, and very different characteristics when wet), he should contact a professional for further study, ie. Utah State Univ. Soils Dept., Soil Conservation Service, County Engineering Office. The developer may aid the professional by taking him soil samples from different depths all over the site so they may be analyzed as to structure texture, bearing capacity, porosity. The result of this study will tell the developer if he has suitable soil for building purposes. Any soils deemed unsuitable in its natural state for bearing loads will consequently have to be stabilized by some engineering method such as retaining walls, pilings, etc. (at considerable expense). The next question that must

be answered is that of percolation rate. These tests must be done by a competent professional usually available through the county health department, or County Engineering office. If percolation rates are insufficient, this means no leach fields are plausible; however, the developer has other alternatives: 1. Join a main line if available from the nearest public facility. 2. Use individual holding tanks, water tight. The cost of pumping these out at periodic intervals may prove a deterrent to prospective home builders due to cost.

If the preceding steps are undertaken and questions answered satisfactorily the developer can proceed to other analyses.

1. Are soils of suitable bearing capacity?
2. Are soils susceptible to creep, slide or flow?
3. What is percolation rate?

Hydrology (Groundwater, Drainage, Flood Plain)

There are five major rivers flowing into Cache County: Bear River, Cub River, Logan River, Blacksmith Fork River, and the East Fork Little Bear River (Figure 3). Figure 4 explains the relationship of the confined, unconfined and perched groundwater within Cache County. Most of the valley has a perched water table with the water between 0-10 feet below the land surface (Figure 5). Figure 6 shows the locations of selected wells and springs within Cache Valley and their use.

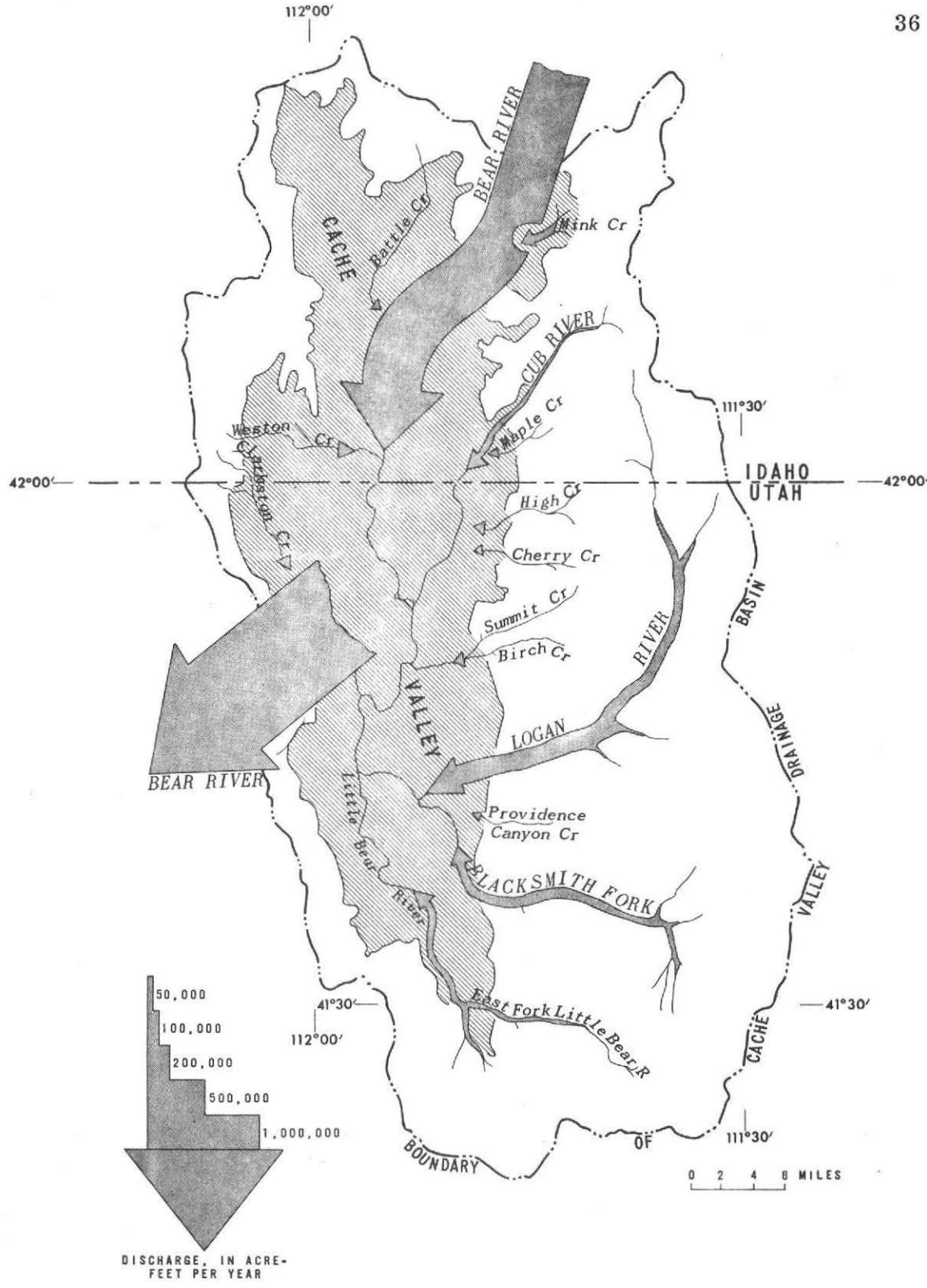


Figure 3. Major rivers of Cache County, Utah.

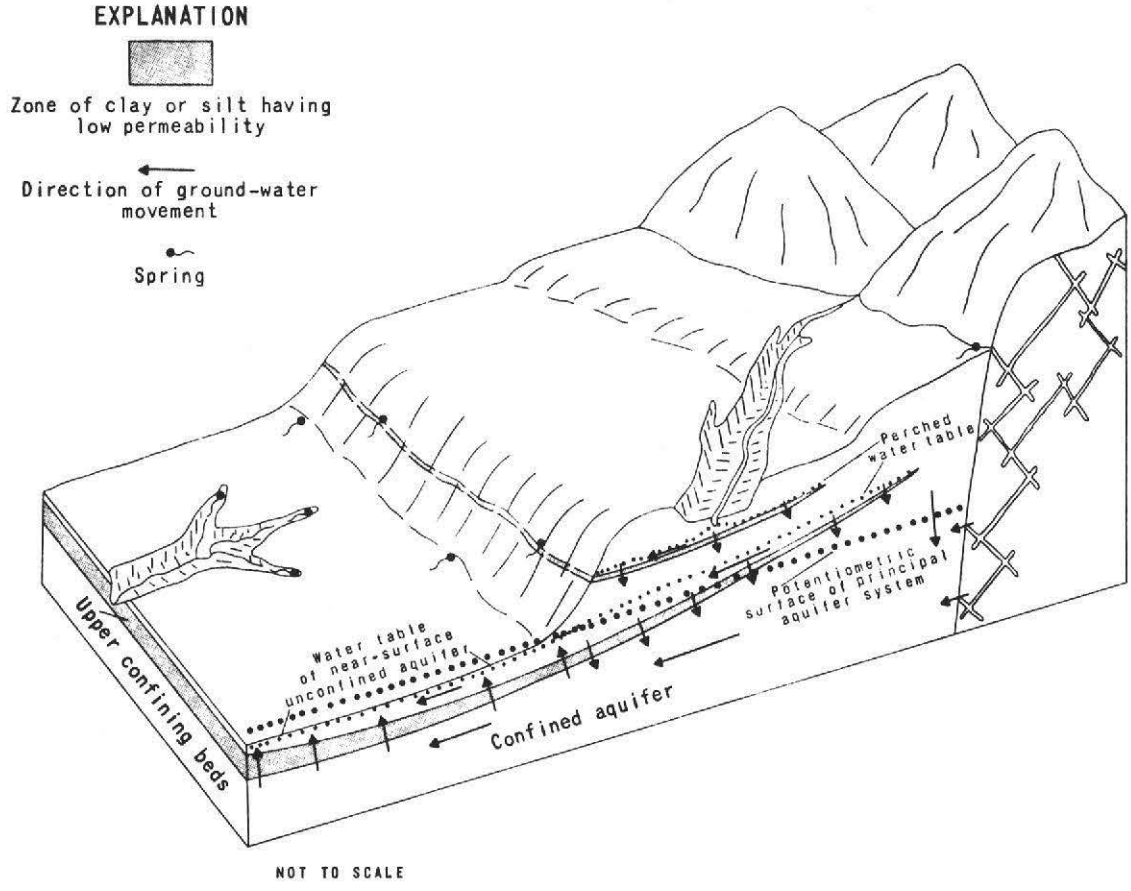


Figure 4. **Relation of confined, unconfined, and perched ground water in Cache Valley.**

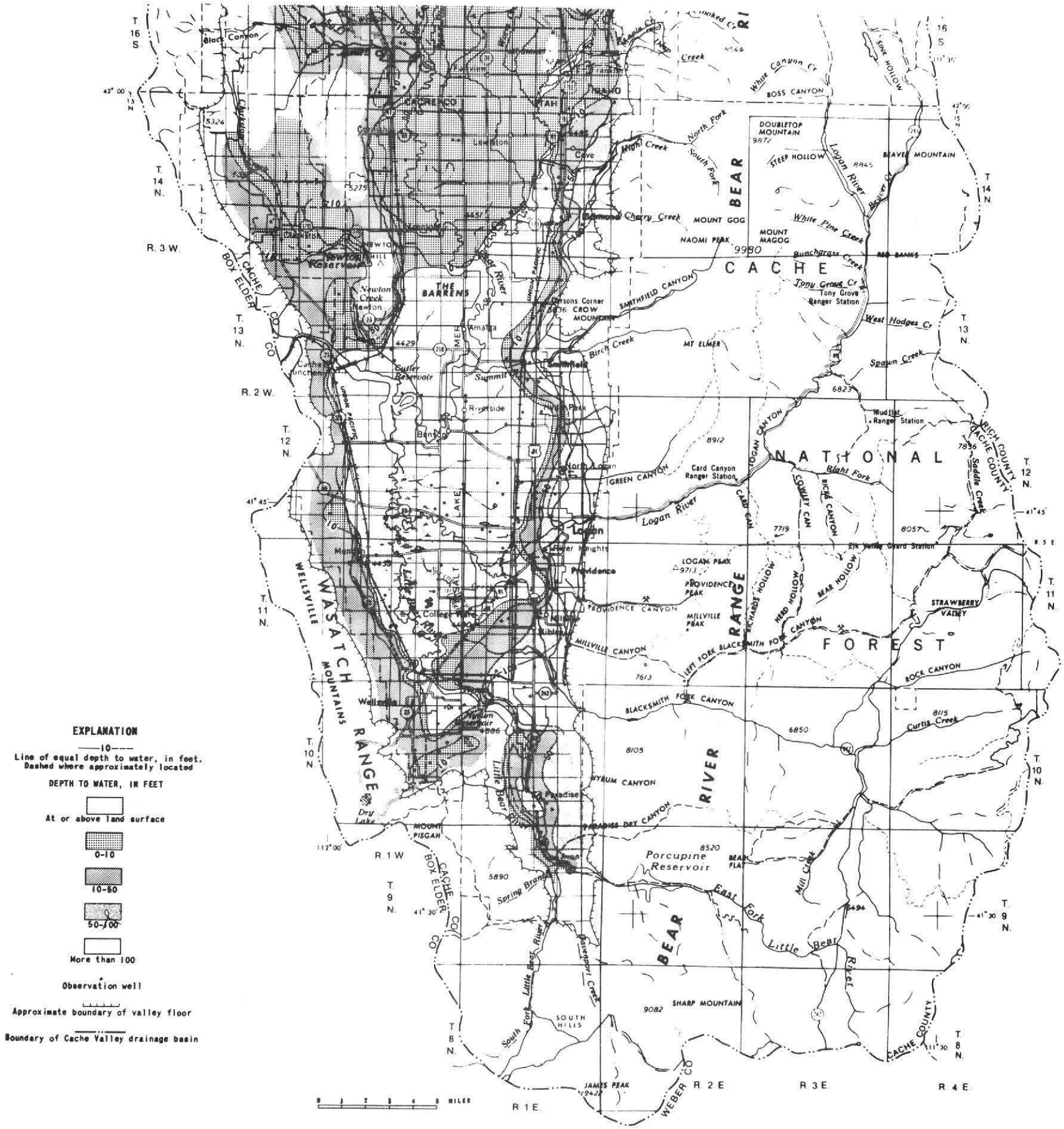


Figure 5. MAP SHOWING RELATION OF WATER LEVELS TO LAND SURFACE IN CACHE VALLEY, UTAH AND IDAHO

(Utah State Dept. Natural Resources, 1971, Ground Water Resources of Cache Valley, Utah and Idaho, Tech. Pub. No. 36, Plate 3.)

Legend

Flowing

Non-flowing

(Domestic, stock, commercial, fire-protection, recreation, or unused well)

Flowing

Non-flowing

(Irrigation well)

Flowing

Non-flowing

(Industrial well)

Public Supply Well

Water used for irrigation

Water unused

(Drainage well)

Test well or destroyed well

Spring

3

2

Number of wells or springs represented

Boundary of valley floor

Cache Valley drainage basin, Cache County

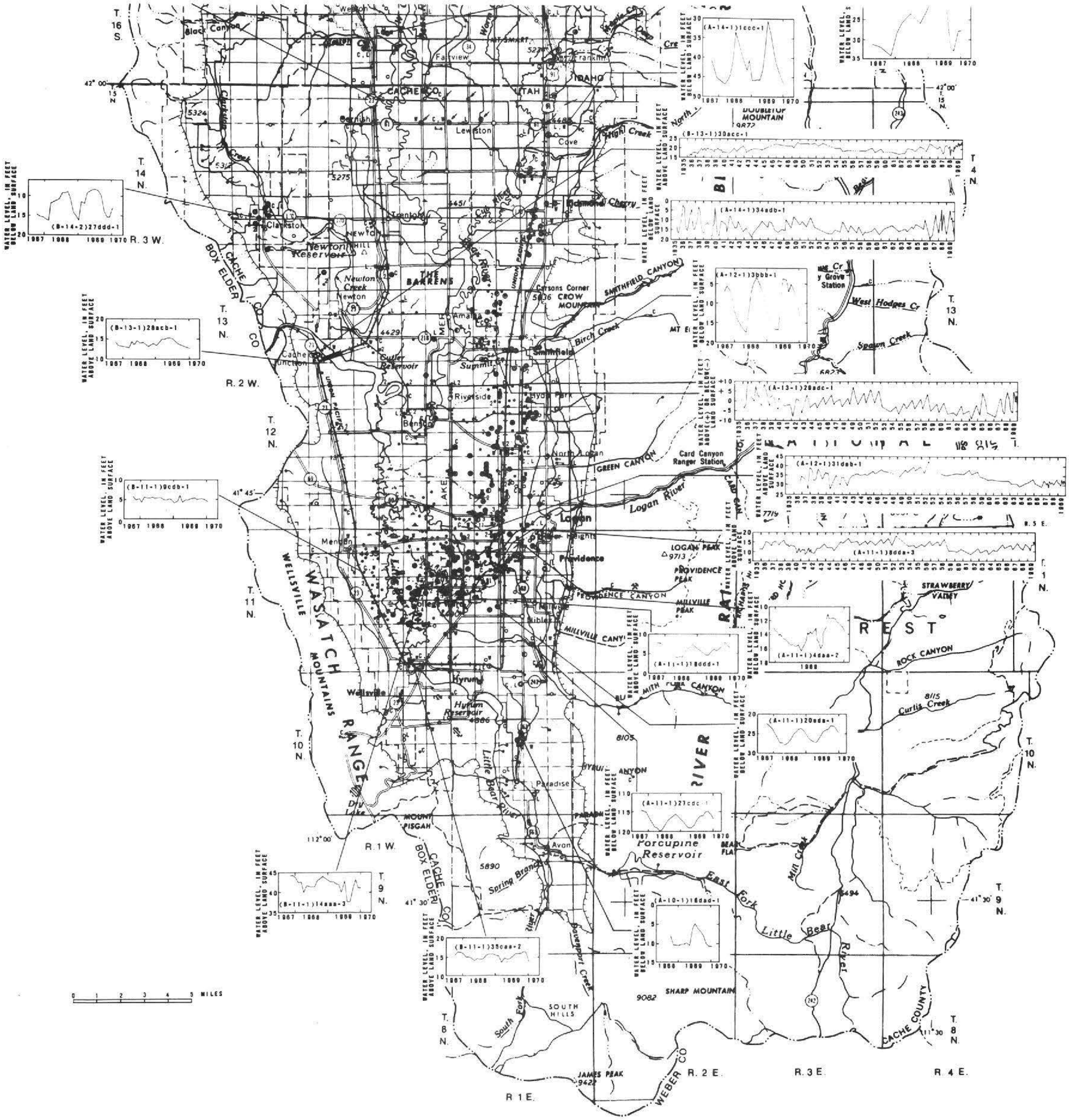


Figure 6.
MAP SHOWING LOCATIONS OF SELECTED WELLS AND SPRINGS AND HYDROGRAPHS OF SELECTED WELLS IN CACHE VALLEY, UTAH AND IDAHO

(Utah State Dept. Natural Resources, 1971, Ground Water Resources of Cache Valley, Utah and Idaho, Tech. Pub. No. 36, Plate 2.)

Needless to say an adequate water supply is necessary if not essential to a new residential development. If a "hook-up" to the public or municipal water supply is not possible, individual wells will have to provide an adequate supply of water and be free from pollutants. While an adequate supply of groundwater may be necessary, one must consider the level of that groundwater. The level of the watertable should be low enough, so as not to flood basements of proposed structures or clog individual sewer systems if not connected to a main line.

Flood plains are very hazardous and expensive places to construct a new residential development. If building is allowed on areas subject to flooding during periods of high water, buildings may be destroyed or damaged to a great extent, utilities rendered unusable, roads may become impassable, people displaced at great expense to themselves and the rest of the community, and many unforeseen health hazards.

Any new development results in an increase in surface runoff of storm waters. This is because where you previously had surface soils and vegetation to stop and retain storm water you now have impervious materials such as roof tops, streets, parking, etc. And, as has been before, plant association also dictates certain kinds of wildlife which inhabit an area.

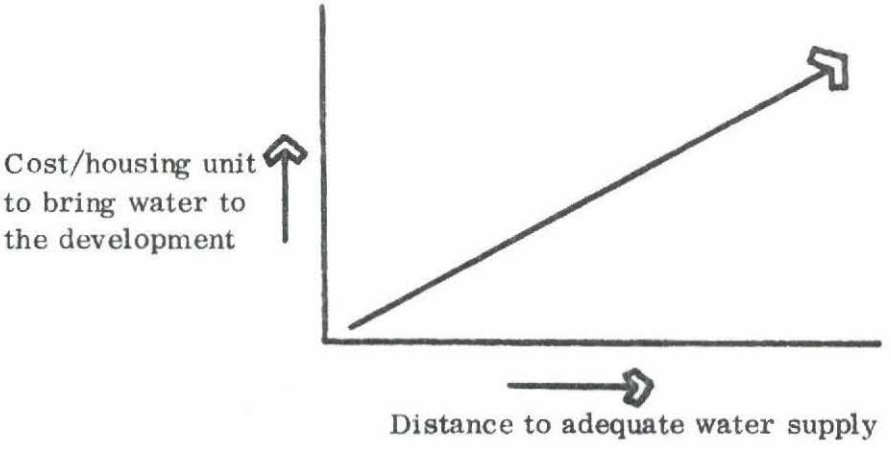
Photograph 3. Floodplain in Cache Valley

Criteria

1. Adequate water supply must be available.
2. Land must not be in a location where surface water is a problem.

There are two means of securing water in Cache County. One is by joining the main water lines that provide water for its various communities, and the other is to use well or spring water on each individual site. If one must rely on well water many problems must be considered. Will the well provide a satisfactory yield for the development? A satisfactory well yield for a family of six is approximately 10 gallons per minute, or 600 gallons per hour (Kreese, Eric, 1970, p. 4). It is usually economically unfeasible

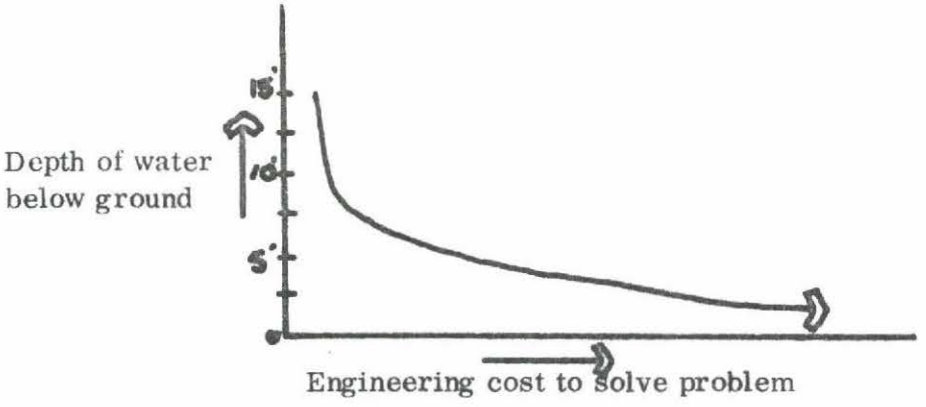
to move water great distances to support urban development in areas of limited water supply. Policy should require preparation of basic water supply facilities in adequate amounts and at an early enough time ahead of actual development is approved and construction underway.



This graph is a simple expression of the relationship of distance to an adequate water supply and the relative cost to bring it to the new community. As the distance to water supply increases the cost of pumping that water supply to the homes in the development increases.

Even if there is adequate ground water supply on site, probable sources of pollution or contamination should be determined in order that the water sources are not destroyed later by future development. If adequacy of ground water is a problem then the converse is true (i.e. Cache Valley floor, Figure 5). If too much water is on the site or the watertable is too high or perched, it may be very expensive to relieve the problem through pumping and drainage efforts, which would probably only transfer the

problem to another location, not to mention the high probability of destroying the indigenous flora and fauna of the high water area.



As the ground water table of perched water table gets closer to the ground surface the problems that arise are unsolvable without prohibitive expenditures of money and damage to the environment.

For instance in Cache County in order to build on the acres of high water table (at or just below the surface 0-10 ft.), the developer would have to stabilize the soil in some manner (discussed under soil bearing capacity), but before he could even tackle the soil problem he would have to pump a sufficient amount of water out to allow construction of foundations. Can you imagine the phenomenal expense of lowering the water table a couple of feet over 30 or 40 acres. Even if the developer could manage it, where would the water go? More than likely it would flood some other portion of land where it was being pumped. Another alternative might be to fill the wet land. This would be more feasible than trying to remove the water, but

still very expensive, due to transportation of large quantities of earth and then grading.

In Cache County high water areas are quite numerous and usually consist of fine textured soils unsuitable for foundations and construction.

3. Land must not be within or on a prominent flood plain.

High water and flood stages are fairly predictable in Cache County. Usually during the spring, highwater conditions exist throughout most of the county, making it necessary for inhabitants of low lying areas along streams to either move or get ready to move at a minute's notice. Therefore, it would be advisable to limit new developments to the 50-year flood plain at least, and larger developments to the 100-year flood plain, thus minimizing the chances of extensive damage by high water or flooding conditions. Although flooding is an aspect of the natural environment that is given little recognition when evaluating housing sites it is very important. If a residential housing development is to be constructed on a prominent floodplain, the prospective buyers should be warned of this possibility (especially if flood plain zoning does not exist).

For more in-depth information on urbanizing watershed and runoff potentials, refer to the publication by Israelsen and Riley, 1970.

Photograph 4. Floodplain in Cache Valley (Nibley)

4. Developable land should not be in prominent drainage areas.

If new residential developments are allowed to infringe on natural drainage areas, many severe problems will be encountered. Natural drainageways are nature's way of subduing excess of storm water. If these ways are denuded of vegetation for future development they no longer exhibit the same characteristics (refer to Israelson, Riley, 1970). Erosion is accelerated excessively, thus contaminating downstream water with suspended material, also allowing excess drainage and little percolation of water into the ground culminating in high water and flood damage on lower reaches of drainage way, including flooded basements and mud slides which

may endanger the entire development. Prominent drainageways are very critical to the entire hydrologic cycle of a watershed. If destroyed, that cycle may be irreparably damaged with not only on-site implications, but also far-reaching effects.

Each potential housing site should be studied individually as to its possible infringement upon and/or destruction of natural drainage patterns.

Photograph 5. Development on drainage way

How does the developer use these hydrology criteria? Step one is to determine if there is an adequate water supply available. If the development is going to use a public supply system, costs and distance to hook up should be ascertained. If wells are to be used, satisfactory yields should

be dictated (discussed earlier). Step two is to describe surface and ground water conditions and if they will be a problem. The developer may answer this question himself just by observation on the site, and test boring to determine if water level is too high (engineering aspects discussed earlier). Step three is to determine the possibilities of flooding or injury of natural drainage ways. If the proposed development is near a water course, probable flooding of major extent will occur about every twenty years. If land is level and adjacent to water course which has low banks it is possible minor flooding would affect the development. If the developer cannot read the signs of flood plains he should contact a professional, possibly the Utah Department of Natural Resources or Utah State Water Laboratory for further assistance in determination of possible flood hazards. It is very difficult to build a residential development in Cache County and not build on a natural drainage way. To analyze the drainage way and water-shed the developer should contact someone to aid him in his analysis, and outline the ramifications of development on a drainageway. Contact the Utah State University Range and Watershed Management Departments or Utah State University Water Lab, Utah State Department of Natural Resources.

Steps to be taken are:

1. Is adequate water supply available?
2. Describe surface and ground water conditions.
3. Is land on prominent flood plain?
4. Is land on prominent natural drainage way?

Historical Geology

Cache County's geologic history is a very vivid one. The valley itself is composed of downthrown fault blocks covered by deposits of the Cenozoic Age. Upthrown blocks surrounding the valley form the mountain ranges. The valley floor is predominantly lake-bottom deposits of silt, clay and sand from Lake Bonneville. The deposits of the valley edge (benches) are of the Lake Bonneville group also, but instead of lake-bottom deposits they are shore line deposits of gravel, sand, and silt. The mountain ranges themselves are composed of limestone, dolomite and include sandstone, quartzite, mudstone, siltstone and shale (Figure 7).

Generally speaking, poorly compated fills, shifting sands, peat, etc. are not the most suitable kinds of subsoils to withstand the weight of numerous buildings and building equipment. Many times subsoils of this nature result in uneven settlement of structures, resulting in cracked walls and split foundations which are very costly to repair. New developments should not be permitted in unstable soil and geologic conditions such as fault lines, volcanic protrusions, areas susceptible to soil sag and landslides, etc. However, at the other end of the spectrum, construction may become uneconomical if hardpan or bedrock is too close to the surface. This condition would raise drastically the cost of excavation for foundation, utilities, etc. Geologic and bedrock conditions also indicate major aquifer recharge areas

Legend

Qal - Flood plain alluvium
Qt - Terrace deposits
Qs - Silt and sand
Qf - Alluvial-fan deposits
Qsd - Spring deposits

- Lake Bonneville Group -

Qp - Predominantly lake-related deposits of gravel, sand, and silt deposited at and below the Provo level of Lake Bonneville.

Qps - Thin lake-related deposits overlying the Salt Lake Formation at and below the Provo level. Includes small exposures of the Salt Lake Formation.

Qb - Predominantly lake-related deposits of gravel, sand, and silt deposited between the Bonneville and Provo levels of Lake Bonneville.

Qbs - Thin lake-related deposits overlying the Salt Lake Formation between the Bonneville and Provo levels. Includes small exposures of the Salt Lake Formation.

Qpb - Predominantly lake-bottom deposits of silt, clay and sand.

Qca - Colluvium, alluvium, and undifferentiated deposits. Includes glacial deposits in the Bear River Range.

Qd - Diamictite.

Tsl-Td - Salt Lake Formation.

Tw - Wasatch Formation.

Per - Permian through Cambrian rocks. Predominantly limestone and dolomite, but include sandstone, quartzite, mudstone, siltstone, shale.

Eper- Cambrian and Precambrian rocks.

contact (dashed where inferred)

fault (dashed where inferred) (dotted where concealed)

Lake Bonneville at highest shoreline.

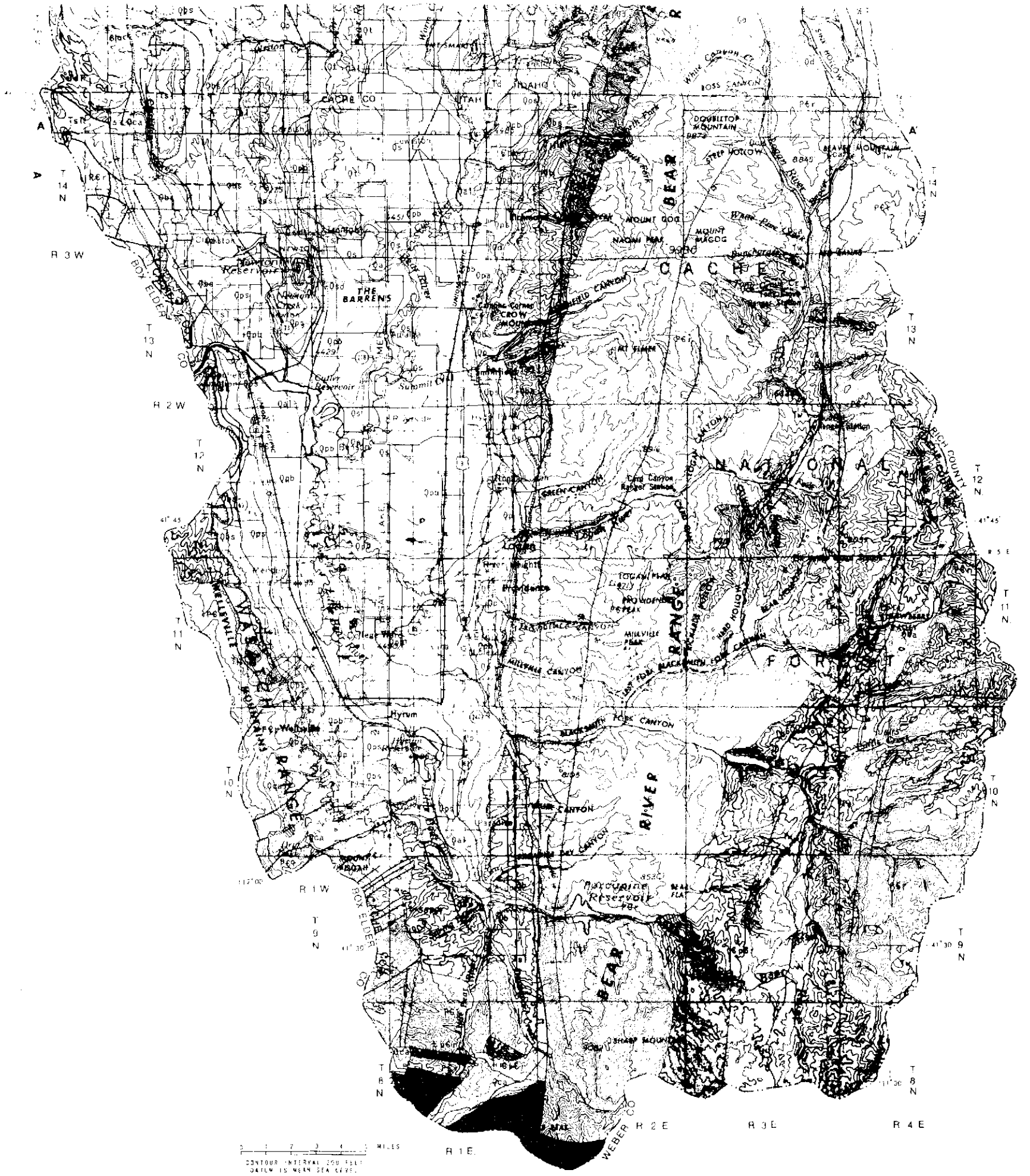


Figure 7. GEOLOGIC MAP AND SECTION OF CACHE VALLEY, UTAH AND IDAHO AND TOPOGRAPHIC MAP OF CACHE COUNTY UTAH

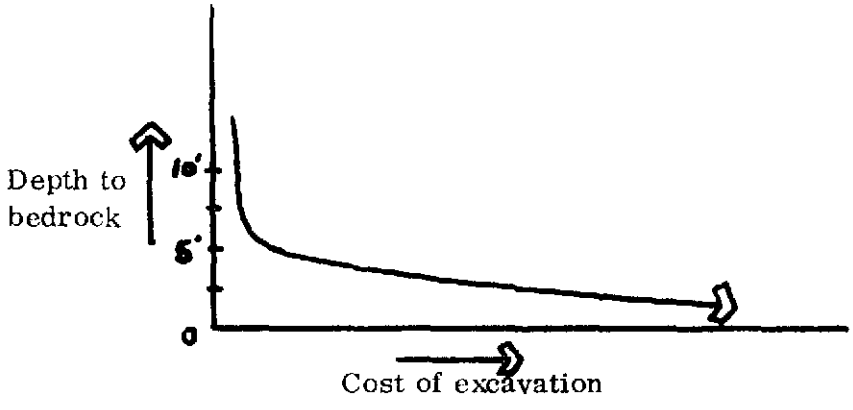
(Utah State Dept. Natural Resources, 1971, Ground Water Resources of Cache Valley, Utah and Idaho, Tech. Pub. No. 36, Plate 1.)

(Bjor klund, L. J., McGreevy, L. J., 1971, p. 18). If geologic history is not known, possible pollution of major water sources for an entire valley or watershed may occur.

Criteria

1. Bedrock must be at a sufficient depth to allow construction.

Where bedrock is near the surface, within 3-5 feet of the surface, there may be problems of excavation for footings, foundations and underground facilities (excavation costs for shallow soil over bedrock is 10 to 20 times greater) (N. Y. S. Coop. Extension, 1971, p. 3).



This graph delineates the relationship between cost of excavation and depth to bedrock. Excavation costs remain relatively constant when soil is all that is being encountered while digging foundations; however, costs rise drastically when bedrock is encountered.

The developer may also have to make extra surface drainage provisions. With bedrock close to the surface, establishing and maintaining vegetation is often very difficult. While rock outcroppings and bedrock often complicate initial site work, they may become assets in final site appearance.

2. Land must not be on important aquifer recharge areas.

In a mountain valley situation such as Cache County, aquifer recharge becomes a very critical factor when analyzing environmental implications of future residential development. Aquifer recharge areas exist in most of Cache County's back canyon areas, and supply all of Cache County's ground water. To build on a site of this nature would jeopardize water supplies to communities in Cache Valley. An excellent example of this concept is the Sardine Canyon in southwest Cache County. This canyon provides the water source for Wellsville City and surrounding areas. Any development would almost certainly endanger the water supply of the whole community.

Building directly adjacent to the recharge areas such as stream beds and channels will also contaminate. "Utah State Board of Health requires that development take place no closer than 100 feet of water courses" (Hill, Willard, 1973). The proposed development in Smithfield, Canyon is an excellent example of what not to do.

Photograph 6. Aquifer Recharge--Sardine Canyon

3. Land to be developed should not be on fault zones or zones of other geologic activity.

The types of bedrock and the stability of rock formations are important characteristics that should be analyzed. In Cache County there are indicators of strong geologic activity in the past. Several major fault zones exist within the county, one extending the entire length of the Bear River Range north to south, another extending north-south from Hyrum to Cornish, and yet another from Nibley north to Lewiston. Faults show areas of previous geologic activity and possible future activity. Any development occurring on or near these zones are building on potentially hazardous conditions if the fault becomes active only to move a couple of inches.

The public should be made aware of these existing geologic conditions. The previous geologic activity may not affect the proposed development but prospective busyers should know of the possible hazards inherent in zones of geologic activity.

What does the Historical Geology criteria mean to the developer? They show him what geologic characteristics and problems to look for. First of all the developer must ascertain depth of bedrock. There may be indications that can guide the developer, such as large rock outcroppings. This may mean bedrock is close to the surface. It should be determined how close to the surface the bedrock layer is. If the developer cannot ascertain this information himself, he should engage a qualified professional, possibly from Utah State University Geology Department or from U.S.G.S. If bedrock is close to the surface this doesn't mean development is off--but would a developer want to spend 10-20 times as much money in construction costs? The second step is to determine if the prospective land to be developed is an important aquifer recharge area. Aquifer recharge means this land is someone's source of water. If the land is not a recharge area, fine, but if it is, certain concessions must be made to retain this water supply. 1. The water must not be contaminated--normal sewage disposal will not work. The sewage disposal will have to be either connected with a public system to carry sewage away or an airtight holding tank that will not allow any effluent to escape into the ground to pollute the water supply coming from

this water shed. 2. Careful consideration must be given to plant associations and amount of impervious ground cover. For after all, if the drainage and runoff characteristics are changed so the aquifer recharge characteristics will change. When impervious cover or lack of vegetation allows the water to run off and not penetrate the recharge system there is no more recharge system. The developer may be able to overcome this last item by sensitive design, retaining all possible natural vegetation, low density of housing units, smallest amount of impervious ground cover, or retaining runoff on the site, i.e. ponds. The third step in analyzing geology is delineating zones of previous geologic activity. The developer will need a professional to give him this information, Utah State University Geology Department or U.S.G.S. If prospective land is found to be on a zone of geologic activity, the ramifications must be analyzed. Maybe the zone will be inactive for the next 1000 years, but on the other hand houses may be destroyed by a seismic shock the very next year.

The necessary steps are:

1. Determine depth of bedrock.
2. Is land important aquifer recharge area?
3. Delineate zones of previous geologic activity.

Topography

Land that is too steep necessarily increases cost of construction, i.e. level changes in homes, extensive foundation and support measures,

danger in construction, etc., not to mention extreme problems of soil erosion and the resultant pollution. When a development is started the vegetative cover is nearly always removed allowing great susceptibility of unprotected soil to extensive erosion even from the smallest amount of water. At the same time new housing developments on flat land may come up against problems in sewer installation and surface water drainage. The lack of sufficient slope or gradient may result in additional expense being incurred to provide pumping for both sewer and drainage. It is generally considered that gently rolling land is more desirable and economical for new residential developments than too steep or too flat landscapes.

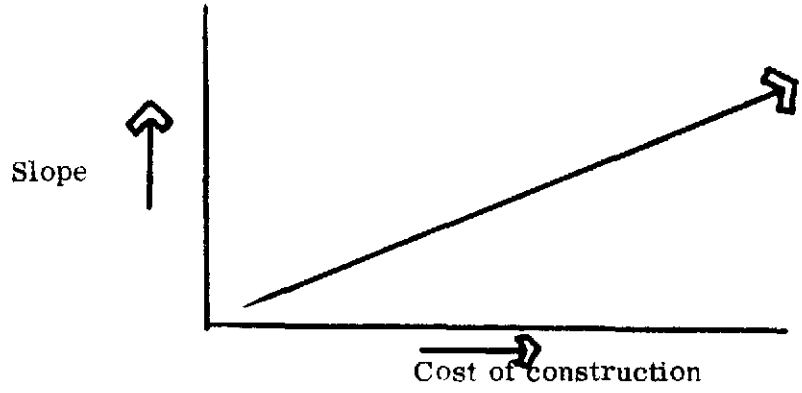
The topography in Cache County is very rugged and diverse, as can be seen by the accompanying topography map (Figure 7). Cache County relief ranges from very flat to verticle walls of the mountains. Cache County lies within two physiographic provinces: Cache Valley and the Wellsville Range are in the Great Basin section of the Basin and Range physiographic province; the Bear River Range is in the Middle Rocky Mountain physiographic province. The valley floor includes a low flat plain, gentle alluvial slopes, terraces and deltas left by Lake Bonneville, ranging from about 4,400-5,400 feet above sea level. The mountains surrounding the valley were caused by faulting and upheaval and then eroded away. Most of the mountain crests are between 7,000-9,000 feet above sea level.

Criteria

1. Residential development should not take place on very steep slopes.
2. Development should not occur on excessively flat land.

Slopes of 0-5% may have problems with water removal and sewage disposal. Slopes of approximately 5-15% can provide a more varied and pleasing housing development, but the installation of roads, pipelines, and other facilities may be more costly. Steep slopes of 15-25% have very severe problems connected with their use for residential housing. They often require very expensive and elaborate footings and extensive earthwork to achieve a usable building space. Twenty-five percent or greater slopes are virtually impossible to build on without great expenditures of capital to make the site usable. More extensive earth work is necessary, and it may be difficult to establish plant material on such a steep incline. Even if the earth is stabilized a few years of weather may rapidly erode the engineering solutions. As slopes become steeper, drainage also increasingly becomes a problem. Soils, if cleared of vegetation, erod rapidly and may have an increasing tendency to slide or flow.

What does the topography criteria mean to the developer? He must determine the relative steepness of his site. As was stated earlier, 5-15%. Slopes are usually the most suitable for housing development, due to the variety that can be achieved from these slopes. Information concerning



This illustration examines the relationship between cost of construction and increasing slope. As slope increases so does the cost of construction of multi-level buildings, roads, utilities, etc.

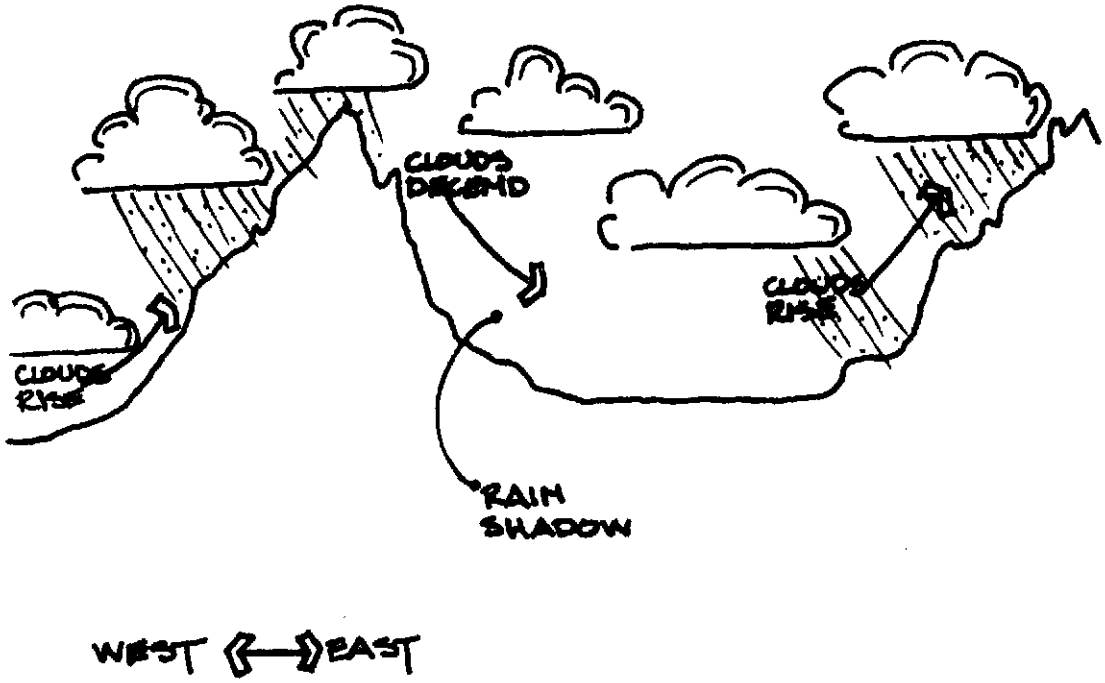
slopes can be obtained from the Utah State University Library or from U.S. Geologic Survey which produces topographic maps.

Climate

The main characteristics of Cache County climatic conditions are large daily temperature changes, cold damp winters, warm dry summers and between 10-20 inches of precipitation in the valley, 20-50 inches of precipitation in the mountains. Most of the precipitation results from humid air coming from the northwest during fall, winter, and spring. Runoff which results mostly from melting snow usually reaches its peak during May and June.

When considering climatic effects the most prominent factors are air pollution and climatic relationship to physiography. The most important

aspects of these two factors are building orientation--whether the structure faces north or south to catch the sun, or east or west to utilize the morning or evening sunlight, winds and wind direction, snow loads, and storm patterns. For after all, who would want to live down wind from a steel mill or a waste treatment plant where the prevailing wind dropped soot on clean laundry or ruined your appetite every time the wind changed direction. Many times in a large watershed where there is great physiographic relief there is a rain shadow which might influence the placement of a new residential development. This not only means there is less rainfall and less hazard of



As clouds rise, the moisture within them condenses and falls as rain. As clouds descend, they pick up moisture instead of dropping it.

erosion and excess storm drainage problems, but also less snow in winter conditions, less expense for removal and fewer related accidents. Areas of great physiographic relief also are influenced very quickly by temperature. If elevation changes quickly so does temperature. Air temperature decreases about one degree for every degree of latitude north of the equator, and air temperature also decrease approximately one degree for every five hundred feet of altitude (Kormondy, 1969, p. 138).

Criteria

1. Developments should be located with specific relation to prevailing winds, storm and mountain shadow patterns.
2. Developments should not be located in prominent cold air drainage areas.

These climatic criteria are more to protect the inhabitant or developer from the environment than the environment from the developer. Cache County offers several unique climatic features that must be dealt with before development takes place. Cold air drainage is a major factor. When building at or near the mouth of a canyon, the air cooling faster at the higher elevations comes pouring down out of the canyons many hours of the night and day. These winds may result in excessive snow drifting on residential streets in the winter months, or damage to cultivated plants such as hedges, specimen trees, etc. High and exposed areas on the benches of the eastern valley take the brunt of storm patterns, prevailing winds being from the southwest during the summer and the northwest during the winter. Parts of the county receive more precipitation than others, for instance the mountainous areas around the valley receive approximately twice as much rain as the valley itself. While the east side of the valley gets the

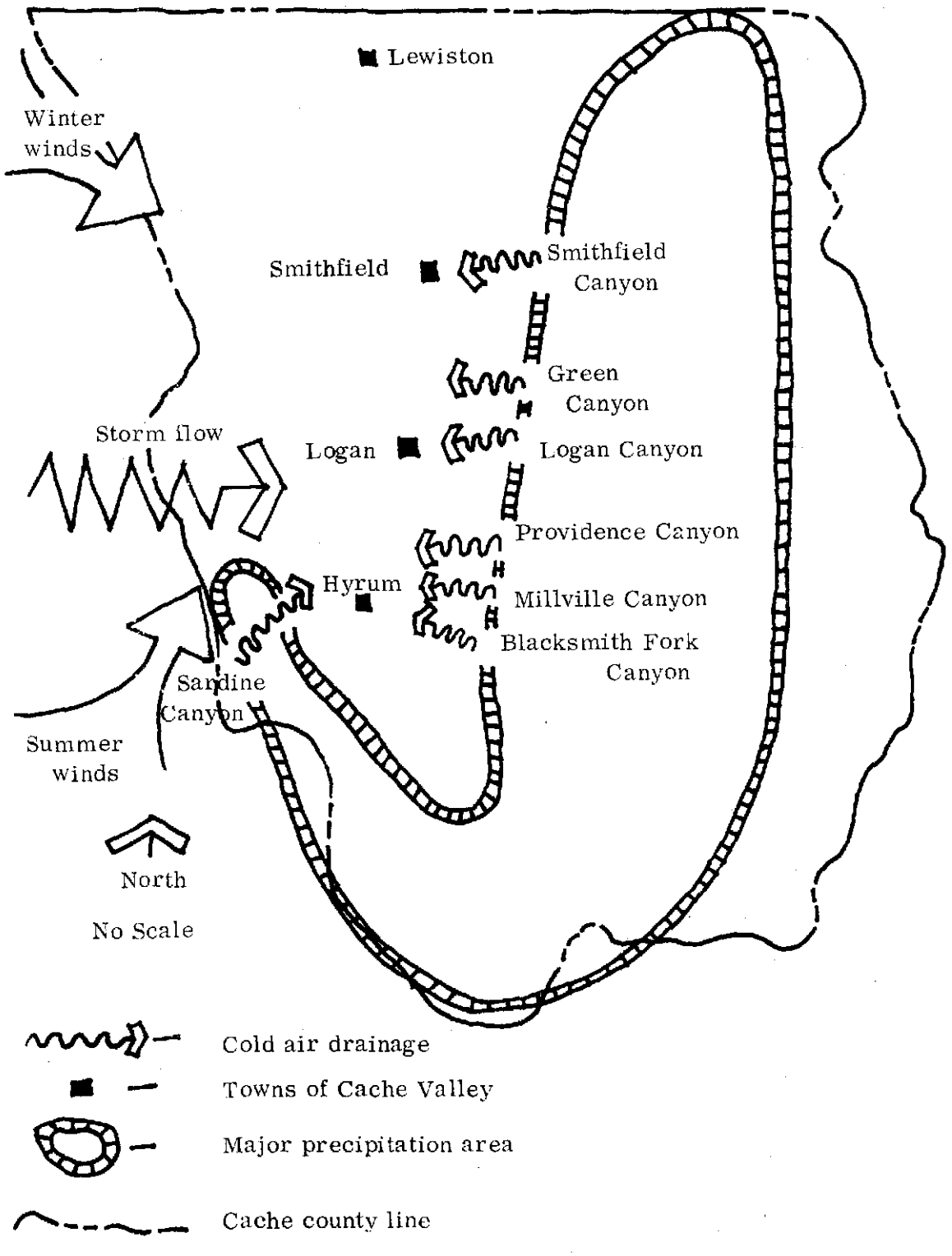


Figure 8. Climatic map of Cache County, Utah.

brunt of the storms, the west side is somewhat protected from the storms by the mountains (Richardson, Arlo, 1971).

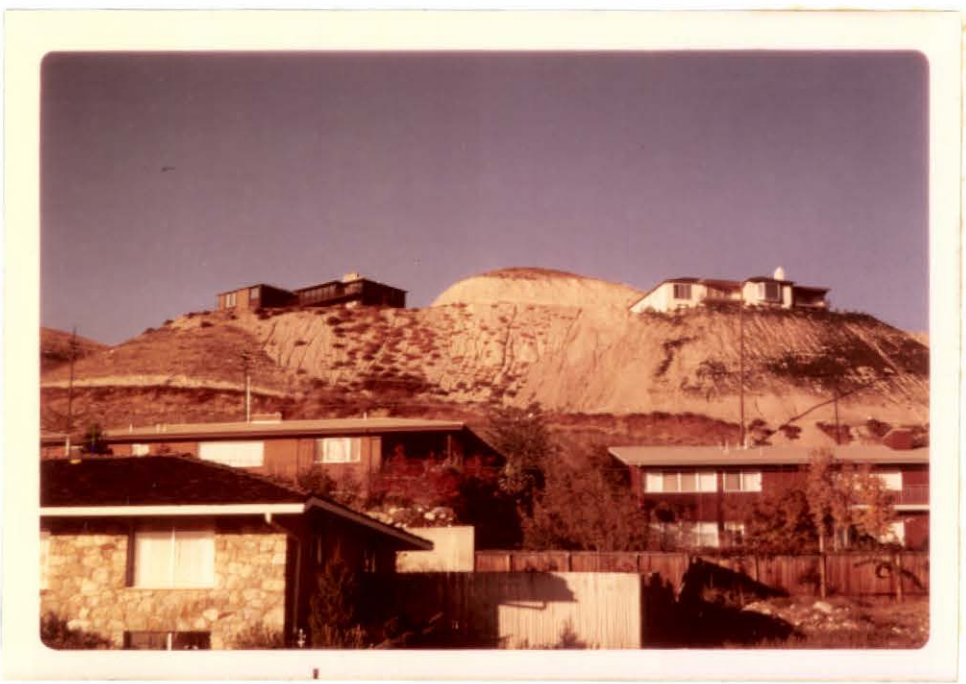
Within the valley there are other climatic phenomena that must be analyzed. Such things as fog pockets that are prevalent mainly in late winter, spring and summer. These areas can cause hazardous conditions when driving through residential developments.

How does the developer use these climatic criteria? The developer must know and analyze the different climatic aspects of Cache County, where the prevailing winds are from, which dictate storm patterns, where the prominent cold air drainage ways are. These can be translated to understandable repercussions. If potential buyers know this development is going to be on a south facing slope where the micro-climate is going to be 5^{o} - 10^{o} hotter in the summer, or at the mouth of a cold air drainage way, and the wind will be blowing constantly, or in a mountain shadow pattern where the sun's rays do not touch in late afternoon or exposed in such a way that they take the brunt of all storm, the buyers may opt for a housing choice with more sensitivity in climatic considerations. Climatic features are relatively easily found, by first hand observation, or by contacting U. S. Weather Bureau, or Utah State University Department of Soils and Biometerology. (Refer to Figure 8.)

Plant Associations

Plant associations change with topography and so do their tolerance. Certain types of plants are extremely sensitive to pollution and groundcover

changes (i.e. paving around trees), that usually accompany urbanization. Some areas offer rare species of plants and flowers indigenous to that area alone. Extensive root systems keep erosion to a minimum. When that root system is removed there is nothing to protect the landscape from being washed away causing flash flooding, pollution of down stream waters, etc.



Photograph 7. Erosion due to lack of vegetation

Plant associations are very difficult to describe in general terms and there are no overall studies of plant associations of Cache County. The best source of information is a listing of Vascular Plants of the Northern Wasatch by Holmgren and Anderson. Each perspective housing site must be analyzed,

by itself, to determine what the vegetation has to contribute to its probable suitability for future development.

Criteria

1. Development should not take place on lands of unique vegetation types.
2. Land to be developed should not be located on areas of marginal vegetation (i.e. vegetation that if removed would cause irreparable damage due to erosion, loss of soil capabilities, pollution, etc.).

The value of existing plant life as a part of a site should not be taken lightly. The plant life often offers indicators as to what may be successfully done with the site. Existing trees, shrubs, and grasses can serve as erosion control, climatic modifiers, and slope stabilizers. To remove this vegetation would not only destroy the beauty, but also cause greater damage by erosion, pollution of down stream waters, completely negate the wildlife habitat and could have a noticeable effect on the entire valley. The marshy areas of Cache County with unique indigenous plant growth and wetland wildlife provide ideal areas suitable for nature study if not developed. Cache County offers many plant variations and compatibilities such as the short-lived alder and cottonwood, and others like the aspen,fir, locust, and pine, all of which have natural place in the county and must be respected when speaking of development.

Many environmental problems can be solved through engineering techniques as was outlined earlier in this chapter. Many plant association

problems can be solved by sensitive design of the development itself. Competent design work and retention of most of the indigenous plant life can minimize most of the problems inherent in massive grubbing and grading.

How does the developer use the Plant Association criteria? First the developer must know what kinds of vegetation are on his site, and what their capabilities are as to soil stabilization, moisture retention, slope stabilization. This information might best be sought from a professional who has a knowledge of the indigenous plantlife and its characteristics. Professionals would be available in the Utah State University Botany Department, or the Utah State Herbarium, or the U.S. Forst Service. The general practice of most developments is to level all existing vegetation and grub of the topsoil then build and respread topsoil, replant and regrade. Is there any logic in this method? Definitely not. Let's look at what the developer has to do if he levels a site before building. First of all he has to level and stock pile all soil when he could be building and doing selective grading. He must also replant all vegetation--the consideration here is the expense involved in obtaining new vegetation and establishment time. Is it cheaper to buy all new vegetation or use existing flora? When answering this question one must consider how large the plant materials are that are to be purchased--the larger the more expensive. The developer must also be aware that a certain percentage of these plants will not survive, thus adding more to the cost. True, nearly full grown trees cost more and are more expensive

to transplant; however, let's look at maturity vs. housing use. Trees live between 75 and 150 years, and mature around 35 to provide their maximum benefits. If they are planted in a residential development when they are 5-10 years old it will be at least 20 to 25 years before the residents gain full appreciation. By the time the tree has matured the building is approximately half obsolete (assuming the average building life is 50 years, after which time physical depreciation and location decrease efficient use) (Baer, Wm., Gordon, April 1972, pp. 236-239). The developer must also ask himself the question--would a development be more desirable to a prospective buyer if it had fully developed plant life with shade, no possibility of newly established plant material dying, no mud in the basements after a heavy rain because there wasn't enough vegetative cover to stop erosion? The answer is, "Yes, it would be much more desirable." If the developer needs more help in ascertaining pertinent plant association data he can contact Utah State University Botany Department, or the Utah State Herbarium.

Aesthetics (Visual Quality)

There are many scenic amenities associated with valleys, canyons, mountain, plains, etc. such as fall foliage, geologic outcrops, snow on the high grounds, expansive panoramas, the sheer enjoyment of walking or hiking and learning to appreciate nature. On the one hand, it would be very delightful to live in a place of pristine beauty with panoramic views of the

surrounding countryside, but by doing so you destroy the very same value for others. One person or a few persons can derive a great amount of enjoyment, while development destroys the beauty that was once enjoyed by many, many more.

Criteria

1. Development should not be located so as to inhibit or infringe upon the use of unique natural features, whether viewing or actual physical use.

Aesthetic considerations are very important both from the standpoint of impinging upon the environment, and the visual quality of the development itself. Cache County has many aesthetic ammenities to offer the casual visitor or the resident. But urbanization is trying to subdue most of them. When a residential development destroys scenic beauty accessible to many people, it doubtless makes

Photograph 8. Visual quality of bench and mountains destroyed

the residents happy to be living there; but more important, it infringes upon the rights of many, many people to appreciate such a piece of scenic landscape.

However, development within scenic landscape is not totally without merit if the proposed development conforms to the environment around it and is integrated well with it. All too often one sees too many garish signs, billboards, and panoramic views framed by telephone poles, and transformer boxes; this need not be the case.

Visual quality of the natural environment is often an aspect that is taken for granted. It is also an environmental aspect that is often disregarded as a legitimate criterion to judge whether a development has a moderate or severe impact upon the environment. Many people say it is impossible to judge what is aesthetically pleasing or unpleasing. What is pleasing to some people is not to others. This is not completely true; landscapes can be judged. As discussed in a paper by Shafer-Mietz, it is possible to quantify and judge certain aspects of the landscape. In the paper a procedure was outlined to judge the visual preference of a landscape view. This was done by first asking fifty people around Salt Lake City, Utah, to judge seven landscape photographs and rank them 1 through 7 from most preferred to least preferred. After this was done these preferences were compared with the mathematical ranking. The mathematical ranking is achieved through dividing each landscape photograph into eight zones. 1. Sky and Clouds, 2. Immediate trees and shrubs, 3. Intermediate trees and shrubs, 4. Distant trees and shrubs, 5. Immediate other features, 6. Intermediate other features, 7. Distant other features, 8. Water. After the zones

were delineated, areas and/or perimeters were calculated by placing a 1/4 inch plastic grid over the photograph. These areas and/or perimeters were then plugged into the mathematical formula and the rankings of each photograph were ascertained. When comparing the observed ranking by people and the predicted ranking by the mathematical model, it was seen that observed and predicted were the same in four out of seven instances and the other three only varied by one (i.e. predicted 2, observed 3). The only shortcoming of this procedure is that it does not provide an economic value for aesthetic quality--this may never be possible (Mietz, J., Shafer, E.L., 1967, p. 12). However, it does provide a quantitative measure of how much one landscape is generally preferred over another. For further information, refer to Shafer-Mietz, 1967.

How are the aesthetic or visual quality criteria used by the developer? This is a very difficult question to answer. I suppose the only reliable method is to contact the public, by this I mean a sampling of public opinion to determine a certain site's importance as to recreation or visual quality. The easiest and cheapest way this might be carried out would be to run an ad in a local newspaper inviting comment and/or criticism of a proposed use of a specific site. The developer may draw his own conclusions from this method. An excellent example of visual quality playing an important role in planning decisions is the role it played in Sardine Canyon rezoning attempts in 1971. As a future developer is it wiser to know the feelings of

the public or proceed with development plans and learn that the public will not allow such development because it infringes upon their rights of visual and recreational enjoyment. Is it better to know this before planning or to find out at a public hearing, which is usually too late? For further information refer to Cache Defenders of the Environment (in Bibliography).

Wildlife

It is known that some animals have a great tolerance to man, like squirrels, while others are extremely wary and would not be found within a hundred miles of man. These are the concepts that must be analyzed when developing land. The wildlife of this country is much like the native American Bald Eagle, pushed from place to place, whether they wanted to go or not. However, being almost totally intolerable to man this great bird has almost become extinct.

What are the needs of wildlife as they exist in Cache County? Most of all they need space in which to live unmolested, where they won't be in clost contact with humans: they need food, water, winter and summer range. These needs must be understood to determine if a proposed residential development will destroy them and thus the wildlife population. Many species have become almost extinct as development advances unchecked and unplanned across the landscape. The wildlife of any specific area of development must be studied and understood so impact upon vulnerable

populations can be kept to a minimum. A good example of this vulnerability of certain species exists in Birch Creek just south of Smithfield Canyon. There is believed to be a small population of what may be the last remaining true native Cutthroat trout in the west (Burns, J., Lee T., 1972, p. 2). Any development within this area would surely destroy this population. For further information consult the accompanying map (Figure 9).

Criteria

1. Potentially developable land should not be located so as to destroy major wildlife habitat.

Cache County happens to be lucky enough to be on a major migratory waterfowl flyway, and the marsh and wetlands in Cache Valley supply an ideal place for water fowl to stop over, being advantageous to the hunter and nature lover alike. Elk and deer abound in the mountains of Cache County and must come down to lower elevations to forage in the winter months. As development moves on, these animals are pushed further and further back into the mountains. Many streams in Cache County have been sterilized due to careless development, not only by on-site impact, but also by downstream pollution which destroys fish and fish habitat. Wildlife destruction does not seem to be a major problem now, but as is witnessed by many Cache County residents, wildlife is moving increasingly far from urbanization, or being killed by it. This is why we must plan and use guidelines, right now, to help preserve them.

Mountains	Bench - 4,200-5,000 ft.	Fish
Elk	Deer - Winter Range	Bass
Deer	Pheasant	Crapie
Moose	Chukar Partridge	Trout
Ruff Grouse	Hungarian Partridge	Catfish
Sharptail Grouse	Cottontail	Suckers
Bobcat	Jacks	Carp
Beaver	Elk - Winter Range	Bull Heads
Mountain Lion	Sage Grouse	White Fish
Snowshoe	Coyote	Sun Fish
Sage Grouse	Bobcat	
Jacks	Owls	
Cottontails	Eagles	
Coyote	Hawks	
Owls		
Eagles - nest		
Hawks - nest		
Weasels		
Mink		

Valley

Ducks - Spring nesting	Deer - Winter Range
Geese - Stopovers on migration	Rabbits
Pheasant	Owls - Nest
Pelicans - Feed here in Spring	Eagles
Great Blue Heron - Nests in Spring	Hawks - Nest
Sandhill Crane - Nests in Spring	Weasels
Muskrat	

Note: In Birch Creek, just south of Smitfhield Canyon, there is believed to be a small population of what may be the last remaining true Native Cutthroat Trout in the west. This area is now being considered for a wilderness area.

Of course, any heavy development in any of the canyon mouths with creeks and rivers will have a devastating effect on the fish populations both there and further up the canyon.

Increase in Cats cause decrease in Bird populations (pheasants, chuckers, etc.)

Decrease in small mammals (mice, meadow voles) effects birds of prey (decrease).

(Burns, J., Lee, T., 1972)

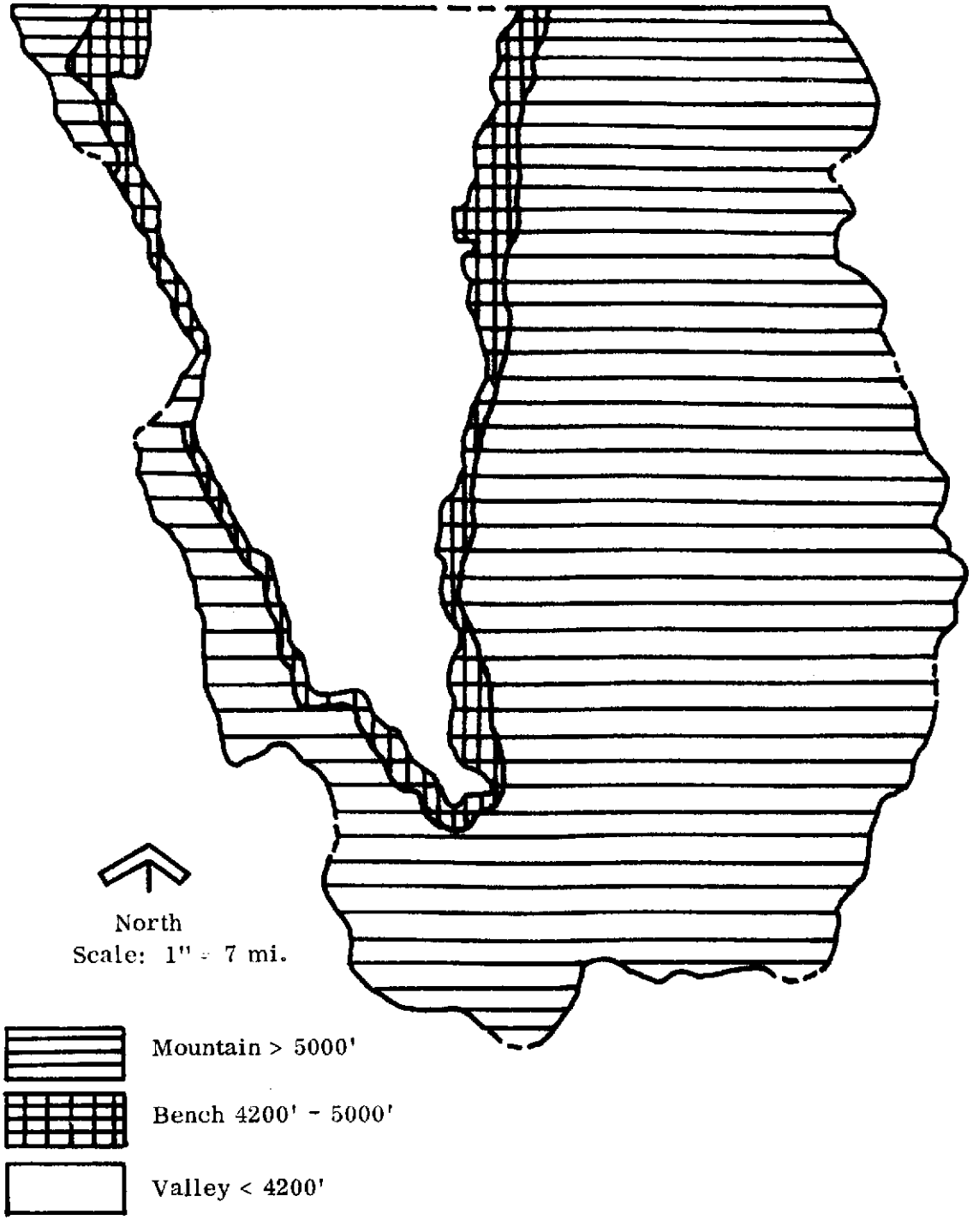


Figure 9. Cache County wildlife habitat.

2. Developments should be located in such a manner that wildlife does not infringe upon the environment of the residents.

Many times in late winter we hear of wildlife moving down from the mountains to browse on garden remnants, shrubs, etc. in residential areas. These wildlife were here first, and through improper management and sprawling urban development, we seem to be destroying much of our native wildlife's habitat. Soon there will be few winter grazing areas left which will precipitate the demise of those creatures that need this winter grazing land desperately. The poignant question is--does the wildlife infringe on the community or does the community infringe upon the wildlife?

What do these wildlife criteria mean to the potential developer? The first step is to determine if his site is on major wildlife habitat. This information is easily found by contacting the Utah State University, Range Department or Cache National Forest offices. Observations made by the developer himself may partially fill this requirement (i.e. evidence of deer browsing). The second step is to ascertain the possibilities of wildlife infringing on the environment of the residents. If evidence of game feeding on site is found, likely this feeding will continue after the development is there. Only when the wildlife feeds it will be choosing from such delicacies as garden remnants, costly specimen plants and shrubs, all to the dismay of the resident who must pay for their replacement.

As can be seen by the brief analysis of each indicator factor, many are interrelated and rely heavily upon each other. A severe impact in one of the indicator areas almost certainly will have an adverse effect on one or more of the other indices. For this reason these environmental indices must be studied and analyzed carefully to give guidance to potential residential land developers. From the historical analysis of Cache County we see many points of interest and unique environmental aspects. As was seen in Chapter II there seem to be certain environmental indicators that are used no matter what location one is in. The general indicators definitely hold true for Cache County. By comparing on the one hand the environmental indicators used in other parts of the country and the "givens' (the existing environmental conditions in Cache County), we find there are specific indicators that are critical to Cache County. These are soils, surficial geology, historical geology, topography, aesthetics, climate, plant association, and wildlife. From a closer analysis of these indicators and their inherent problems, one can readily see the emergence of critical environment criteria that will provide guidance in future residential development in Cache County, Utah.

Many of the criteria in this chapter notably overlap, and justifiably so. When one is speaking of high water table or surface water, many other environmental factors are indicated such as: plantlife associated with this condition, geologic substratum, indigenous wildlife associated with certain plant life, and associated soil conditions.

There is great diversity in the environment of Cache County, but that diversity has its own balance for a specific purpose--that of survival.

This brief analysis clearly indicates that many factors rely on one another and if you tamper with or influence one of them in any way all the other factors are changed accordingly. This is why complete and comprehensive studies and analysis must be done for each potential residential housing site using these criteria for guidelines.

CHAPTER IV

SUMMARY

In this chapter I will briefly summarize the preceding chapters in a paragraph or two and outline a list of professional services that the potential developer has at his disposal within Cache County. Included also is a flow chart that indicates the critical decision points for the developer, which, if followed, will insure the correct steps are taken (Figure 10).

Chapter I outlines the problem facing Cache County and the rest of the country concerning urbanization. It also establishes the difference between Planned Unit Developments and small-scale residential developments which are eating up the landscape in Cache County. Chapter II indicates the sources of environmental indicators that other parts of the country consider important when evaluating housing sites. This chapter (II) will acquaint the developer with the kinds of studies that are necessary to evaluate a prospective housing site and the general information that is inherent in these studies.

Chapter III delineates the environmental criteria that are most important when discussing the possibility of residential development in Cache County. Chapter III gives the developer enough knowledge to make valid decisions on their own as to evaluation of sites for small-scale residential developments. But the question still remains, with this information and

background in the hands of the small-scale developer of Cache County, how do these people use it? What questions do they ask? What further information do they need? When do they need further information? Who do they consult when this need is recognized?

Chapter III indicates also what the major problems are in Cache County and specific information concerning each of the problem areas, which are:

Soils
Hydrology
Geology
Topography
Aesthetics
Climate
Plant Associations
Wildlife

and allows the developer to accomplish some preliminary analysis of his prospective site to determine what kinds of environmental conditions exist on his site. The comparison of each of the established criteria with the developer's site will dictate which are most important, which will need more study to make more logical decisions and which are satisfied without further study. By this point in the paper the developer should be completely aware of the intricate interrelationships of the different environmental aspects. Figure 11 shows the separate criteria and which are most closely related.

Will this study give the developer enough information to work with? In some aspects of the environment it will; but what should he do if he

wants more information? After all, he isn't a professional at all these different aspects. The solution is to contact someone who has more knowledge of a particular subject than he does. The following is a list of professional services that can answer the questions a developer needs to have anwered.

Soils - Utah State University
Soils and Biometeorology Department
Library
Soil Conservation Service
U.S.G.S.
Health Department
County Engineering Office

Hydrology - Utah State University
Range Department
Water Laboratory
Library
Canal Companies
Utah State Department of Natural Resources
U.S. Geological Survey

Historical Geology - Utah State University
Geology Department
Library
U.S. Geological Survey

Topography - Utah State University
Library
U.S. Geological Survey

Climate - Utah State University
Library
Soils and Biometeorology Department
U.S. Weather Bureau

Aesthetics - Utah State University
Landscape Architecture and Environmental Planning Department
Library
Institute for Tourism and Outdoor Recreation
Utah Tourist Council
Wasatch Office of U.S. Forest Service

Plant Associations - Utah State University
Botany Department
Library
U.S. Forest Service
Utah State Herbarium

Wildlife - Utah State University
Wildlife Department
Library
U.S. Forest Service
Utah State Division of Fish and Game

What should a developer expect from these professionals? All facts should be separated from analysis, conjecture and interpretation, and should be backed up by references. How much is enough? The knowledge supplied by these criteria and their explanation gives the guidelines. Once the questions that are raised within the criteria are answered, the developer can make his final decision as to whether development is suitable. The point that must be remembered is that the developer isn't a professional at analyzing all the different aspects of the environment and oft times in his haste toward development, certain key points that are environmentally critical to his development are overlooked, and that is what a professional is for--objectivity.

From this point I think it is essential to understand exactly when these criteria should be used. Any information of this nature is absolutely worthless if the prospective developer first invests in property, decides to develop it, and then attempts to use these criteria for guidance. The only way the criteria are valid is when they are used before purchasing a parcel of property to evaluate its merits for housing purposes. If land is purchased first and then evaluated using these criteria, chances are the indicators will be ignored and development will take place anyhow, and the potential of higher development costs is excellent. This is why it is imperative that prospective developers evaluate the land they wish to develop before actually purchasing it.

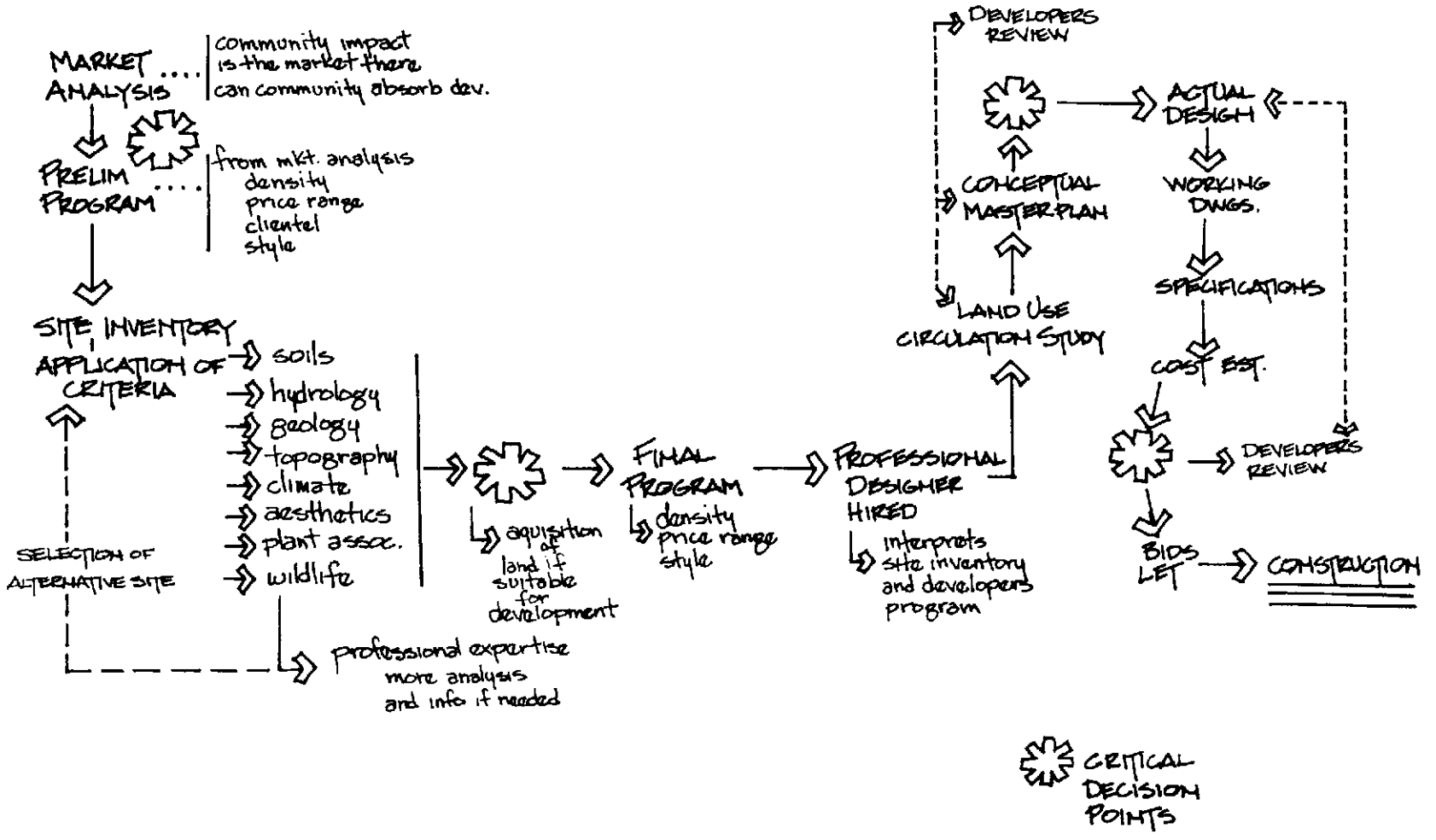


Figure 10 — FLOWCHART —
DEVELOPERS DECISION MAKING PROCESS

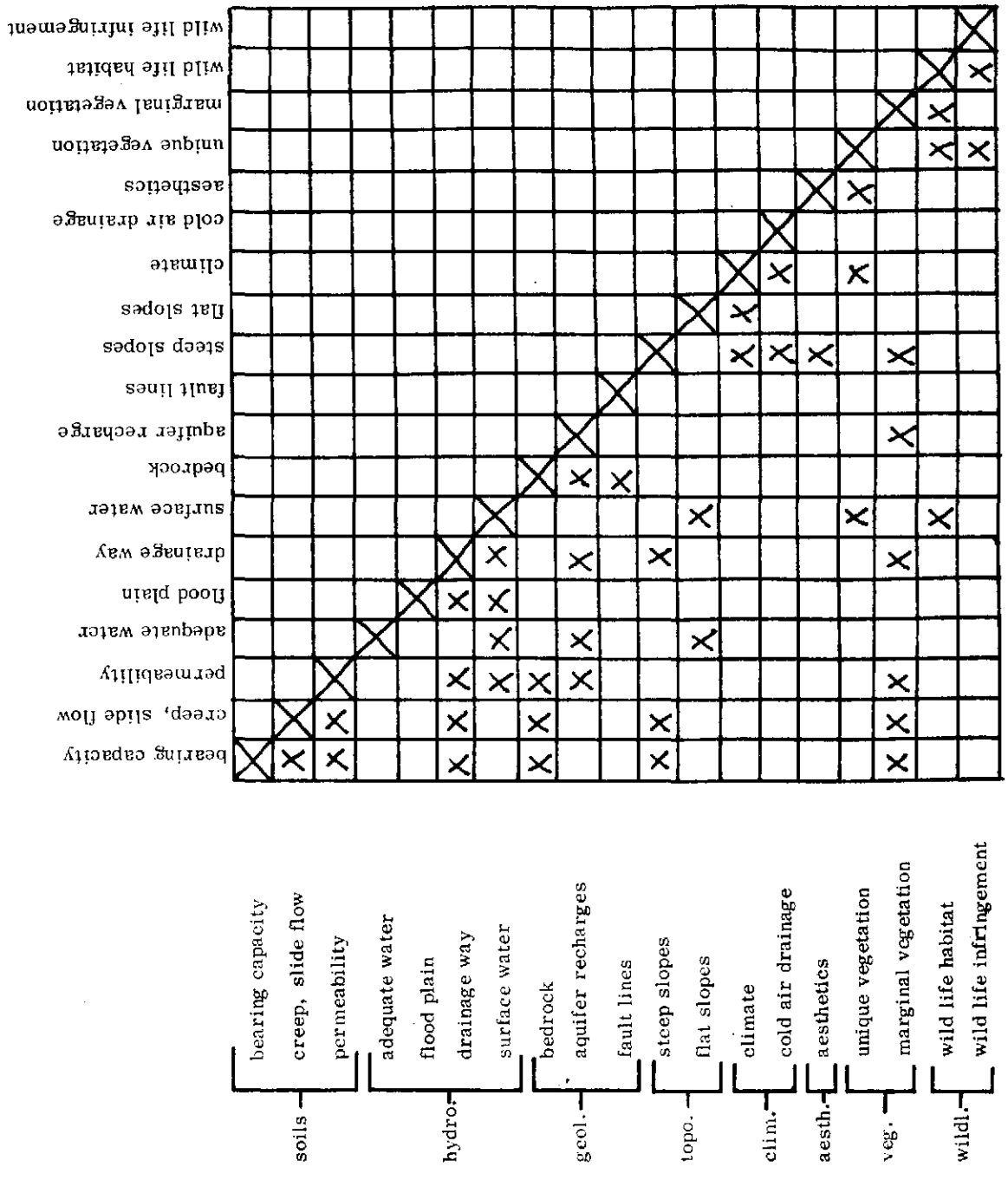


Figure 11. Criteria with closest interrelationship.

CHAPTER V

CONCLUSIONS

The purpose of this thesis has been the preparation of criteria to be used to aid future developers, planning commissions, county commissioners in evaluation of sites for proposed small scale residential developments, and whether that development will have an irreparable environmental impact. As explained in Chapter IV the elements of the criteria were derived from the best available sources at my disposal. These are by no means the only sources. A complete compilation of the different sources of information would be a worthwhile thesis topic. Technical journals, college and university studies which are not published, research, etc., which are not catalogued by ordinary methods, and thus are only found by chance are other potentially valuable sources of information.

The established criteria are valid for they summarize known information about environmental indicators and existing conditions within Cache County. The major inadequacy of this study is that the needs determined have not been determined on a purely abstract basis. Determination of the true needs to be satisfied when selecting sites for future residential development, not based on existing situations, would be the most accurate and purely scientific basis for site selection criteria.

The arrangement and classification of the criteria established in this thesis should be studied more fully to clarify priorities. The relative importance of the various criteria should be established to allow accurate and consistent decisionmaking.

Other areas of study more specifically are:

1. P. U. D. . . . what is a planned unit development as interpreted by designers and non-design oriented people? How do P. U. D.'s differ from typical subdivisions or cluster housing?
2. Economic determinism . . . pros and cons of economics vs. environmental impact. Are certain areas so economically lucrative that development will proceed no matter what the environmental indicators dictate?
3. Scale of Development and Its Effect upon Environment . . . is it possible to require that small parcels of land be combined so more innovative planning procedures can be used (legal aspects) rather than haphazard individual developments eating up the landscape piece by piece.
4. Who gives approval or disapproval of a residential development? . . . should the "go ahead" for further development be in the local governing body or the citizens of the planning commission?

5. Education . . . educational programs set up mainly for the laymen showing that future developments adhering to the environment are not only less costly to the inhabitants but increase the livability of the community itself and surrounding communities.

All these potential areas of research are emphasized by a study of this nature which necessarily deals with a small part of the whole problem--that of site evaluation for future residential developments within the case study area, and still be socially acceptable, prosperous and environmentally sensitive. The importance of continuing research cannot be emphasized too strongly, for as we can see happening all around us, developers are continuing to search for land with a high dollar return and no consideration for the environment. As the population increases this method will become more marked, so now is the time to establish guidelines and adhere to them in order to insure an environment that is livable for both us and our children. The developer of the places in which we live should be obligated to provide the best possible living experience, and the developer also deserves the best possible research to help him do this job successfully.

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VITA

Roger P. Fickes

Candidate for the Degree of

Master of Landscape Architecture

Thesis: Environmental Criteria to Aid Small Scale Developers in Site Evaluation for Cache County, Utah

Major Field: Landscape Architecture

Biographical Information:

Personal Data: Born at Everett, Pennsylvania, July 14, 1947, son of Glenn and Mildred L. Fickes; married Patricia Davis, March 10, 1973.

Education: Attended elementary school in Bedford, Pennsylvania; graduated from Bedford High School in 1965; received a Bachelor of Science Degree from Pennsylvania State University, with a major in Landscape Architecture in 1970; completed requirements for the Master of Landscape Architecture Degree at Utah State University in 1973.

Professional Experience: 1969, summer student landscape architectural assistant, Advanced Planning Section, Pennsylvania Bureau of State Parks; 1971, instructor of Introductory Landscape Architecture, Utah State University.